OFFICE OF CHIEF ACADEMIC OFFICER
Summary of State Board of Education Agenda Items
Consent Agenda
December 17, 2020

OFFICE OF CAREER AND TECHNICAL EDUCATION

H. Approval to begin the Administrative Procedures Act process: To revise selected Mississippi Secondary Curriculum Frameworks in Career and Technical Education

Executive Summary

The Mississippi Secondary Curriculum Frameworks have a four-year curricula revision cycle. The revision cycle includes input from local district personnel and business/industry partners. Approved secondary curricula will be disseminated for implementation in the 2021-2022 school year.

The following secondary curriculum frameworks are recommended for approval:

1. Forestry (Miss. Admin. Code 7-120)
2. Horticulture (Miss. Admin. Code 7-156)
3. Food Products (Meats) (Miss. Admin. Code 7-119)
4. Heating, Ventilation, and Air Conditioning (HVAC) (Miss. Admin. Code 7-157)
5. Industrial Maintenance (Miss. Admin. Code 7-158)
6. Television Broadcasting and Production (Miss. Admin. Code 7-79)
7. Keystone (Miss. Admin. Code 7-141)

All curricula frameworks are designed to provide local programs with an instructional foundation that can be used to develop localized instructional management plans and course syllabi. Additionally, the frameworks include the following elements for each revised secondary curriculum:

- Program
- Description
- Classification of Instructional Program (CIP) Code and CIP Name
- Course Outline and Codes
  - Curriculum
  - Student Competencies
  - Suggested Student Objectives

The Office of Career and Technical Education has provided executive summaries of the curriculum framework revisions.

Recommendation: Approval

Back-up material attached

Summary of Secondary Curricula Changes for Career & Technical Education

2021 Forestry

- Document in new curriculum format.
- Competencies and objectives reflect current standards and industry recommendations.
- Minor adjustments made throughout units.
- Unit 2 - List of 28 group leadership skills added.
- Notes added to the end of Unit 3 to acknowledge safety and the need for ongoing reference throughout the year.
- Unit 4 - added competency 4: Discuss the carbon cycle in pine plantations.
- Unit 5 - List added of 15 common names/binomial names of trees.
- Unit 6 - Renamed Unit to: Forest Traversing and Mapping.
- Added Unmanned Aerial Systems (UAS) information to many units.

2021 Horticulture

- Document in new curriculum format.
- Competencies and objectives reflect current standards and industry recommendations.
- Minor adjustments made throughout units.
- Shifted competencies around Unit 1 and added competency for a Supervised Agricultural Experience (SAE).
- Details and notes added to Unit 2.
- Change name of Unit 3 to “Basic Plant Structure and Function”.
- Added Unit 4 - “Plant Media”.
- Unit 5 is old Unit 4.
- Unit 6 is old Unit 5.
- Unit 7 is old Unit 6.
- Unit 8 is old Unit 7.
- Unit 9 is old Unit 8.
- Unit 10 is old Unit 9.
- Unit 11 is old Unit 10 and added competency 3 about business operations.
- Unit 12 is old Unit 11.
- Unit 13 is old Unit 12.
- Unit 14 is old Unit 13.
- Unit 15 is old Unit 14.
- Unit 16 is old Unit 15.

2021 Food Products (Meats)

- Document in new curriculum format.
- Competencies and objectives reflect current standards and industry recommendations.
- Minor adjustments made throughout units.
- More notes about safety and competencies include more safety concepts.

- Chronic Wasting disease added to list of hazards to include current issues in the state.

2021 HVAC

- Document placed in new curriculum format.
- Adjusted competencies and objectives to reflect current standards and industry recommendations.
- Added Work - Based Learning to Unit 1.
- Created new Units 2, 3, and 4.
- Moved Unit 2 to 5.
- Moved Unit 3 to 6.
- Split Unit 4 to 7 and 8.
- Moved Unit 5 to 9.
- Moved Unit 6 to 10.
- Unit 11 changed to “Introduction to HVAC” and other material split to Units 12 and 13.
- Moved Unit 7 to 12 and 13.
- Moved Unit 8 to 14.
- Removed old Unit 9 “Basic Refrigeration Gauges”.
- Moved Unit 10 to 15.
- Moved Unit 11 to 16.
- Moved Unit 12 to 17.
- Moved Unit 13 to 18 and moved old competency 2 to new Unit 19.
- Unit 19 added.
- Moved Unit 14 to 20, deleted competency 2, 3.a., and 3.b.
- Moved Unit 15 to 21, added competency 2 and removed old competency 3.
- Moved Unit 16 to 22, added competency 1.

2021 Industrial Maintenance

- Document placed in new curriculum format.
- Units renumbered to reflect additions and changes.
- Adjusted competencies and objectives to reflect current standards and industry recommendations.
- Created new Units 2, 3, and 4.
- Moved Unit 2 to 5.
- Moved Unit 3 to 6.
- Split Unit 4 to 7 and 8.
- Moved Unit 5 to 9.
- Moved Unit 6 to 10.
- Added Work-Based Learning to Unit 1.
- Created new Units 11, 12, and 13 from old Unit 7 material.
- Moved material from old Units 8 and 9 to Unit 14.
- Moved Unit 10 to 15.
- Moved Unit 11 to 16 and added competency 4.

- Moved Unit 12 to 17.
- Split Unit 13 into new Units 18, 19, 20, and 21.
- Split Unit 14 into new Units 22, 23, 24, and 25.
- Split Unit 16 into new Units 26, 27, and 28.
- Deleted content in old Unit 17.
- Changed content in Unit 29 to SMAW – Groove Welds with Backing.

2021 Television Broadcasting and Production

- Document placed in new curriculum format.
- Units renumbered to reflect additions and changes.
- Adjusted competencies and objectives to reflect current standards and industry recommendations.
- Split old Unit 1 into new Unit 1 and Unit 2.
- Added competency 2 to new Unit 4.
- Added competency 2 to new Unit 5.
- Material from old Unit 9 moved to new Units 6 and 7.
- Moved Unit 5 to 9.
- Moved Unit 7 to 10.
- Moved Unit 4 to 11.
- Moved Unit 10 to 12.
- Moved Unit 11 to 13, added competencies 4, 5, and 7.
- Moved Unit 13 to 14 and changed name to “Social Media and Nontraditional Media”.
- Removed old competency 2 from Unit 15.
- Moved Unit 19 to 16.
- Moved Unit 15 to 17.
- Unit 18 is new and material came from old Unit 15.
- Moved Unit 16 to 19.
- Moved Unit 17 to 20.
- Moved Unit 18 to 21.

2021 Keystone

- Document placed in newest curriculum format.
- Adjusted competencies and objectives to facilitate College and Career Ready standards and 21st Century Learning.
- Moved Unit 19, competency 1, objectives d - f to Unit 19, competency 2.
- Moved Unit 19, competency 2, objectives a - c to Unit 19, competency 3.
- Moved Unit 19, competency 3, objectives a - d to Unit 19, competency 4.
- Added Unit 19, competency 5.
- Renamed Unit 20.
- Removed Unit 20, competency 1 - 7, added new competencies and objectives.
- Removed Unit 21.
- Added a link to the Teacher Resource Document after each unit.
- Student Competency Profile changed to reflect unit moves/updates.

- Moved Unit references (Appendix A) to Teacher Resource Document.
- Edited appendices to reflect new standards and industry alignment.

2021 Forestry

Program CIP: CIP: 03.0511 – Forestry Technology/Technician

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Research and Curriculum Unit
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The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Acknowledgments

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Dr. Carey M. Wright, state superintendent of education
Dr. Jason S. Dean, chair
Ms. Rosemary G. Aultman
Mr. Glen East
Dr. Karen J. Elam
Mr. Omar G. Jamil, student representative
Ms. Amy Zhang, student representative

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Standards

Standards and alignment crosswalks are referenced in the appendices. Mississippi's CTE forestry curriculum is aligned to the following standards:

National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards
The National AFNR Career Cluster Content Standards were developed by the National Council on Agricultural Education to serve as a guide for what students should know or be able to do through a study of agriculture in grades 9-12 and two-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the agricultural industry, secondary and postsecondary instructors, and university specialists. The standards consist of a pathway content standard for each of the eight career pathways. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. A complete copy of the standards can be accessed at thecouncil.ffa.org/afnr/. The National AFNR Career Cluster Content Standards are copyrighted to the National Council for Agricultural Education and are used by permission.

International Society for Technology in Education Standards (ISTE)
Reprinted with permission from *ISTE Standards for Students* (2016). All rights reserved. Permission does not constitute an endorsement by ISTE.
iste.org

College- and Career-Ready Standards
College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College and Career Ready Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mde.k12.ms.us/mccrs

Framework for 21st Century Learning
In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. 21 *Framework Definitions* (2019).
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Strengthening Career and Technical Education for the 21st Century Act, 2019 (Perkins V); and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
: Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource
: Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call the RCU at 662.325.2510.

Executive Summary

Pathway Description
Forestry is a pathway in the agriculture, food, and natural resources career cluster. This program is designed for students who wish to enter occupations related to the field of forestry. The first-year topics include exploring the world of forestry, leadership/FFA activities, forest safety, tree growth and stand development, dendrology, forest surveying and mapping, legal land descriptions, tree and log measurements, and introduction to timber cruising. The second-year instruction focuses on identifying forests and forest products, employability skills/FFA activities, forest management practices, advanced timber cruising, timber marketing, timber harvesting, reforestation, forest fire management, and forest insects and diseases. Graduates may become employed at the entry level or pursue careers in forestry, agriculture, agribusiness, or natural resources education in postsecondary or higher education.

College, Career, and Certifications
Competencies and suggested performance indicators in the forestry course have been correlated to the National AFNR Career Cluster Content Standards, which have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Grade Level and Class Size Recommendations
It is recommended that students enter this program as a ninth grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and student maturity. A maximum of 15 students is recommended for both classroom- and lab-based courses.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at

mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning
If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

This curriculum consists of four 1-credit courses, which should be completed in the following sequence:

1. **Forestry Introduction—Course Code: 991502**
2. **Forestry Surveying and Measurements—Course Code: 991503**
3. **Forestry Cruising—Course Code: 991504**
4. **Forestry Marketing—Course Code: 991505**

Course Description: Forestry Introduction
Forestry Introduction provides the building blocks for knowledge and understanding in forestry. Students will cover topics such as the National FFA Organization, leadership skills, safety, and dendrology. Additionally, students will cover forest surveying and mapping techniques necessary for the next course offering.

Course Description: Forestry Surveying and Measurements
Forestry Surveying and Measurements offers insight into the world of legal documents used in forestry. Students will be well versed in the use of legal land descriptions as well as how to perform tree and log calculations. Students will also be introduced to timber cruising activities.

Course Description: Forestry Cruising
Forestry Cruising examines timber cruise practices more deeply. Students will also be exposed to employability skills and career opportunities in forestry. Additional topics include forest types, products, and management techniques.

Course Description: Forestry Marketing
Forestry Marketing delivers information about timber harvesting, sales, and reforestation techniques. Additionally, students will be exposed to fire management and safety as well as common insect and disease problems encountered in forestry.

Forestry Introduction—Course Code: 991502

Unit	Unit Name	Hours
1	Exploring the World of Forestry	7.5
2	Leadership Development	10
3	Forest Safety	20
4	Tree Growth and Stand Development	7.5
5	Dendrology	30
6	Forest Traversing and Mapping	37.5
Total		112.5

Forestry Surveying and Measurements—Course Code: 991503

Unit	Unit Title	Hours
7	Legal Land Descriptions	30
8	Tree and Log Measurements	37.5
9	Introduction to Timber Cruising	45
Total		112.5

Forestry Cruising—Course Code: 991504

Unit	Unit Name	Hours
10	Identifying Forests and Forest Products	7.5
11	Employability Skills and Leadership Development	7.5
12	Forest Management Practices	45
13	Advanced Timber Cruising	52.5
Total		112.5

Forestry Marketing—Course Code: 991505

Unit	Unit Name	Hours
14	Timber Marketing	15
15	Timber Harvesting	20
16	Reforestation	25
17	Forest Fire Management	25
18	Forest Insects and Diseases	22.5
Total		107.5

Option 2—Two 2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses, which should be completed in the following sequence:

1. **Forestry I—Course Code: 991500**
2. **Forestry II—Course Code: 991501**

Course Description: Forestry I
Forestry I is designed to introduce students to the forestry industry and careers in Mississippi. The course provides instruction on careers and leadership, forest safety, tree growth and development, dendrology, surveying and mapping, and tree and log measurements. Emphasis is placed on the scientific and technical principles of modern forest management.

Course Description: Forestry II
Forestry II is a continuation of Forestry I with additional emphasis on forest management, timber cruising, marketing and harvesting methods, reforestation, fire management, and forest pests. Emphasis is placed on scientific and technical principles.

Forestry I—Course Code: 991500

Unit	Unit Name	Hours
1	Exploring the World of Forestry	7.5
2	Leadership Development	10
3	Forest Safety	20
4	Tree Growth and Stand Development	7.5
5	Dendrology	30
6	Forest Traversing and Mapping	37.5
7	Legal Land Descriptions	30
8	Tree and Log Measurements	37.5
9	Introduction to Timber Cruising	45
Total		225

Forestry II—Course Code: 991501

Unit	Unit Name	Hours
10	Identifying Forests and Forest Products	7.5
11	Employability Skills and Leadership Development	7.5
12	Forest Management Practices	45
13	Advanced Timber Cruising	52.5
14	Timber Marketing	15
15	Timber Harvesting	20
16	Reforestation	25
17	Forest Fire Management	25
18	Forest Insects and Diseases	22.5
Total		220

Career Pathway Outlook

Overview

The agricultural and natural resources cluster covers a broad field of occupations related to the production and use of plants and animals for food, fiber, aesthetic, and environmental purposes. Forestry covers establishments primarily engaged in the operation of timber tracts, tree farms, or forest nurseries; in the gathering of forest products; or in performing forestry services. Forestry and conservation workers measure and improve the quality of forests. Forest and conservation workers typically work for state and local governments or on privately owned forest lands or nurseries. Governments also employ forest and conservation workers on a contractual basis. According to the MSU College of Forest Resources, forestry is Mississippi's second largest commodity, behind poultry and eggs. Forestry in combination with forest products is even larger and employs a workforce of 69,000 individuals in Mississippi across four sectors: logging, solid wood products, pulp and paper, and wood furniture.

Needs of the Future Workforce

Data for this synopsis were compiled from employment projections prepared by the U.S. Census Bureau, the U.S. Bureau of Labor Statistics (2019), and the Mississippi Department of Employment Security (2019).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2016	Projected Jobs, 2026	Change (Number)	Change (Percent)	Average Hourly Earnings (2019)
Conservation Scientists	700	730	30	4.3	$26.38
First-Line Supervisors of Farming, Fishing, and Forestry Workers	940	990	50	5.3	N/A
Foresters	190	200	10	5.3	$28.80
Forest and Conservation Technicians	220	230	10	4.6	$22.79
Forestry and Conservation Science Teachers, Postsecondary	40	50	10	25.0	N/A
Logging Equipment Operators	1,680	1,740	60	3.6	$18.48

Source: Mississippi Department of Employment Security; mdes.ms.gov (2020).

Perkins V Requirements and Academic Infusion

The forestry curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in fields related to agriculture and natural resources. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for forestry careers. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, the curriculum focuses on ongoing and meaningful professional development for teachers as well as

relationships with industry.

Transition to Postsecondary Education
The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices
Innovative Instructional Technologies
Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The forestry educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction
Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances, for example—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

CTE Student Organizations
There are student organizations relevant to this curriculum. Teachers are encouraged to charter one of these organizations if one is not already available to students. The suggested organization for this course is the National FFA Organization. Contact information for this and other related organizations is listed under the Professional Organizations section of this document.

Cooperative Learning
Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the forestry curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. This curriculum provides opportunities for students to work together and help each other complete complex tasks, including field experiences that will allow and encourage collaboration with professionals currently in the forestry field.

Work-Based Learning
Work-based learning is an extension of understanding competencies taught in the forestry classroom. This curriculum is designed in a way that necessitates active involvement by the students in the community around them and the global environment. These real-world connections and applications link to all types of students to knowledge, skills, and professional dispositions. Work-based learning should encompass ongoing and increasingly more complex involvement with local companies and forestry professionals. Thus, supervised collaboration and immersion into the forestry industry around the students are keys to students' success, knowledge, and skills development.

Professional Organizations

American Association for Agricultural Education (AAAE)
aaaeonline.org

Association for Career and Technical Education (ACTE)
acteonline.org

Mississippi ACTE
mississippiacte.com

Mississippi FFA/ Mississippi Association of Vocational Agriculture Teachers (MAVAT)
mississippiffa.org

National FFA Organization
ffa.org

National Association of Agricultural Educators (NAAE)
naae.org

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80% of the time in the course. The remaining percentage of class time will include instruction in nontested material, review for end-of-course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Teacher Resources
Teacher resources for this curriculum may be found in multiple places. Many program areas have teacher resource documents that accompany the curriculum and can be downloaded from the same site as the curriculum. The teacher resource document (TRD) contains references, lesson ideas, websites, teaching and assessment strategies, scenarios, skills to master, and other resources divided by unit. This document could be updated periodically by RCU staff. Please check the entire document, including the entries for each unit, regularly for new information. If you have something you would like to add or have a question about the document, call or email the RCU's instructional design specialist for your program. The teacher resource document can be downloaded at rcu.msstate.edu/curriculum/curriculumdownload.aspx. All teachers should request to be added to the Canvas Resource Guide for their course. This is where all resources will be housed in the future, if they are not already. To be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Many of the units include an enrichment section at the end. If the forestry program is currently using the Mississippi Career Planning and Assessment System (MS-CPAS) as a measure of accountability, the enrichment section of material will not be tested. If this is the case, it is suggested to use the enrichment material when needed or desired by the teacher and if time allows in the class. This material will greatly enhance the learning experiences for students. If, however, the forestry program is using a national certification or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be tested. It is the responsibility of the teacher to ensure all competencies for the selected assessment are covered throughout the year.

Unit 1: Exploring the World of Forestry

Competencies and Suggested Objectives
1. Explain the importance of forestry. DOK1 a. Describe the elements of a forest community, including trees, plants, shrubs, soil, water, and animal life. b. Describe the importance of trees and forests, including products, employment, climate, air quality, erosion, and recreation. c. Describe the amount of forested land worldwide and in the United States, including acres of forestland and acres of commercial land within the local county or regional area. d. Describe the history of forestry, including the importance of forestry to the South and to Mississippi. e. Describe the importance of forests in the South, including growing season, timber inventory, and economic impact. f. Describe resources considered in multiple-use forest management, including timber, soil, wildlife, recreation, and water.
2. Explain careers in the field of forestry. DOK1 a. Identify the careers available in the field of forestry. b. Describe educational requirements, job opportunities, duties, and responsibilities for professional, technical, and forestry workers.

Enrichment
<u>The Forest Community</u> Divide students into groups and assign one component of the forest community to each group to research, summarize, and prepare a fact sheet and present it to the class. Presentations will be scored based on the presentation rubric in the TRD. <u>Forestry Career Paths</u> Assign each student a career within forestry to investigate and compare educational requirements, job opportunities, and duties and responsibilities. Students will develop a slideshow presentation to the class about their findings. Presentations will be scored based on the presentation rubric.

Unit 2: Leadership Development

Competencies and Suggested Objectives

1. Explain the benefits of FFA participation. DOK 1
   a. Identify FFA organizational activities that promote and recognize achievements in forestry, including career development events, personal development seminars, leadership conferences, national and international exchange programs, education experience with industry, and personal and community development programs.
   b. Identify the benefits of FFA participation to an individual and to the forestry industry, including personal growth and development, exposure to the forestry industry environment, and multicultural experiences.
   c. Identify opportunities for members in FFA, including personal development, personal recognition, career exploration, and self-expression.

2. Demonstrate group leadership skills and personal traits. DOK 2

- Communication
- Considerate
- Cooperation
- Dependability
- Effective listening
- Empathy
- Enthusiasm
- Getting along with others
- Good manners
- Honesty
- Humility
- Interpersonal skills
- Loyalty
- Open-minded
- Positive self-concept
- Problem-solving
- Punctuality
- Rational thinking
- Resilience
- Respect for others
- Responsibility
- Responsible use of social media
- Safety conscious
- Self-motivated/determined
- Setting priorities
- Teamwork
- Trustworthy
- Work ethic

Enrichment

Select a local, county, or state FFA officer or alumni to discuss with students the benefits of the FFA. Students will be required to write a report discussing the various benefits following the speaker's presentation. Reports will be scored based on the written report rubric in the TRD.

Unit 3: Forest Safety

Competencies and Suggested Objectives
1. Explain forest safety practices. DOK 1 a. Describe first aid and first aid equipment used in forestry work. b. Describe job site safety practices, including hazard awareness, safety equipment, safety regulations, prevention of accidents, and appropriate use of personal technology. c. Explain the impact of federal and state safety regulations (such as the Occupational Safety and Health Administration [OSHA]) on forestry operations.
2. Describe forest environmental hazards, including heat, cold, plants, insects, wildlife, and topographical hazards. DOK 2 a. Identify characteristics of forest insects and wildlife. b. Explain signs and symptoms of exposure to insects and wildlife.
3. Demonstrate forest safety practices. DOK 2 a. Apply safety practices to environmental, wildlife, and topographical hazards. b. Apply job site safety practices. c. Discuss types and frequency of forest accidents.
Enrichment
Safety is as Safety does You have been hired to be the safety officer for a large forestry division. As safety officer, you are responsible for monitoring harvesting site safety practices. Using the safety checklist, monitor job site safety practices used in forestry. Make notes about good and bad practices as well as solutions for any problems identified. Safety officers (students) will be scored based on the safety checklist in the TRD. Safety Regulations Students will develop a poster that shows the various local, county, state, and federal regulations that impact forestry and forest harvesting in Mississippi. Students will be grouped into teams and scored based on the poster rubric in the TRD.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 4: Tree Growth and Stand Development

Competencies and Suggested Objectives
1. Explain tree physiology. DOK2 a. Describe the main parts of a tree, including trunk, crown, and roots along with their functions. b. Describe tree respiration and photosynthesis, including respiration, transfer of water, minerals, nutrients, and production of food. c. Describe environmental and biological factors that affect tree growth, including temperature, moisture, light, air, soil, tolerance, and hardiness. d. Describe the methods of tree reproduction, including sprouts, seeds, and suckers. e. Identify characteristics of tree growth, including height and diameter growth.
2. Explain forest stand development. DOK2 a. Identify stands according to classifications, including age, size, and composition. b. Identify trees according to crown classes, including dominant, codominant, intermediate, and suppressed.
3. Discuss advances in biotechnology for forestry applications, including grafting, tissue culture, varietals, and genetic improvement. DOK2
4. Discuss the carbon cycle in pine plantations. DOK1
Enrichment
Tour Guide to the Trees You are an urban forester for a local school district. You have been asked to teach a forestry seminar to local high school students. Take the class around and identify the factors that affect tree growth, methods of tree reproduction, and characteristics of tree growth forest stand classifications and crown classes using trees on your campus. You will guide the classroom discussion about the tree growth characteristics. Biotechnology Activity You have been asked to give a lecture to a group of educators (the class) about biotechnology. Research an application of biotechnology in forestry and summarize your findings for presentation to the educators (students). Use the presentation rubric in the TRD.

Unit 5: Dendrology

Competencies and Suggested Objectives
1. Explain the tree classification system. DOK 2 a. Identify nomenclature and taxonomy terms. b. Identify common names and/or binomial names of trees, including: • Loblolly pine—*Pinus taeda* • Longleaf pine—*Pinus palustris* • Shortleaf pine—*Pinus echinate* • Slash pine—*Pinus elliotti* • Bald cypress—*Taxodium distichum* • Eastern red cedar—*Juniperus virginiana* • White oak—*Quercus alba* • Southern red oak—*Quercus falcata* • Swamp chestnut oak—*Quercus michauxii* • Water oak—*Quercus nigra* • Cherrybark oak—*Quercus pagoda* • Southern live oak—*Quercus virginiana* • Mockernut hickory—*Carya tomeutosa* • Yellow poplar—*Liriodendron tulipifera* • Red maple—*Acer rubrum cv.*
2. Identify trees by their characteristics. DOK 2 a. Describe identifying characteristics and uses of trees, including fruit, leaves, twigs, bark, and tree form. b. Collect leaves, fruit, and/or bark samples of species found locally.
Enrichment
Leaf Collection Students are to collect, preserve, and display leaves and bark of a minimum of 40 local species. All specimens are to be identified by common and scientific name.

Unit 6: Forest Traversing and Mapping

Competencies and Suggested Objectives
1. Explain concepts of forest traversing. DOK 2 a. Define terms, including bearings, acre, azimuths, chaining, boundary lines, angles, surveying, traversing, latitude, and longitude. b. Describe the importance of surveying to forestry, including timber sales, land measurement, boundary marking, and mapping. c. Identify characteristics of a forest survey, including use of compass, measuring distances, and mapping. d. Identify surveying tools, including compass, chain (metal tape), plumb bob, and range pole. e. Label parts of a compass, including magnetic needle, pivot point, housing, graduated degrees, and sighting mirror. f. Identify and calculate compass measurements and symbols, including azimuths, bearings, and degrees.
2. Perform forestry surveying and mapping techniques. DOK 3 a. Determine the number of paces per chain using common pacing techniques. b. Perform compass, pacing, and chaining skills, including completing a traverse of a selected area. c. Describe and utilize new technologies for forest surveying and mapping to include Unmanned Aircraft Systems (UAS), Global Positioning Systems (GPS) and/or Geographic Information Systems (GIS), and remote sensing.
3. Calculate acreage of forest tracts. DOK 3 a. Determine acreage from new technologies, such as UAS, remote sensing, GPS/GIS, and/or Google Maps. b. Determine acres from traditional methods such as a traverse or grid system.
Enrichment
Forest Surveying Your company was hired to survey a forest for a landowner. Demonstrate the proper techniques for pacing, chaining, and traversing within your group. Also, demonstrate the various tools used in surveying. If available, demonstrate the use of GPS in surveying.

Unit 7: Legal Land Descriptions

Competencies and Suggested Objectives
1. Describe the United States Public Land Survey System. DOK 2 a. Explain and identify the principal meridians, baselines, and initial points used in Mississippi, including location of these lines on a map. b. Define legal land description terms, including bearing, blaze, hack, contour, elevation, legend, plot, sea level, topographic map, and corner markers. c. Explain reasons and importance for land location in forestry, including retrace, location, and layout of boundaries.
2. Identify information found on maps. DOK 2 a. Interpret information from and demonstrate use of ownership maps. b. Interpret information from and demonstrate use of topographic maps. c. Interpret information from and demonstrate use of GPS/GIS and/or internet map applications.
3. Apply principles of legal land description. DOK 2 a. Write, read, and locate parcels of land using legal land descriptions. b. Observe the records of timber and land deeds located in the chancery clerk's office.
Enrichment
Map It Out As a cartographer (mapmaker), you are required to label the principal meridians, baselines, and initial points on a map of Mississippi. Demonstrate your knowledge of map reading, interpretation, and labeling by completing the assignment for your employer. Courthouse Search As a forester for your local timber company, you need to locate the legal description for a property you are attempting to purchase through a bidding process. Visit your local courthouse and obtain the legal land description for the property in question from the chancery clerk's office. After you have located the document, explain, discuss, and demonstrate how to write, read, and locate parcels of land using legal land descriptions.

Unit 8: Tree and Log Measurements

Competencies and Suggested Objectives

1. Explain tree measurement techniques. DOK 2
   a. Define terms, including board feet, basal area, cord, diameter at breast height (DBH), diameter, diameter inside bark (DIB), diameter outside bark (DOB), form class, 1000 board feet (MBF), merchantable height, sawlog, and sawtimber.
   b. Identify tools used in taking tree measurements and associate them with their uses, including D-tape, tree stick, bark gauge, tree calipers, wedge prism, clinometer, and increment borer.
   c. Classify DBH measurements into the correct diameter classes, including 1 and 2 in. classes.
   d. Demonstrate the correct location of DBH measurements, including trees on level ground, slopes, leaning, forking, and deformed.
   e. Identify merchantable height, including heights for sawtimber, (10-in. top for hardwood and 8-in. basic top for pine), pulpwood, and specialty products (i.e., pellets, poles, pilings, veneer, etc.).
   f. Distinguish among the major log rules, including Doyle, Scribner, and International log rules.
   g. Draw tally symbols, including dot-tally method.
2. Perform volume measurements of standing timber and sawlogs. DOK 3
   a. Determine the volume of standing timber (board foot/cord volume), volume computation from DBH and height measurements and basal area.
   b. Calculate the board foot of logs, including measuring length and DIB at small end of log to obtain volume and weight scaling of logs for volume.
   c. Calculate the volume of standing timber using traditional methods and available technology.

Enrichment

As owner of a forestry consulting firm, you were hired by a landowner to determine the volume of standing timber on their property using traditional methods and/or available technology. In addition to this information, you must measure and tally 10 pulpwood and 10 sawlog trees. From these 20 trees, determine the correct location of DBH measurements and include examples with the following scenarios: level ground, slopes, leaning, forking, and deformed. After these measurements have been taken, calculate the net volume of logs, including measuring length and DIB at small end of log to obtain volume and weight scaling of logs for volume. Return your findings in the form of a typed written proposal to be given to the landowner (instructor).

Unit 9: Introduction to Timber Cruising

Competencies and Suggested Objectives
1. Describe procedures for cruising timber. DOK 2 a. Discuss terms associated with cruising, including basal area, board foot, bole, circumference, cord, cull, DBH, dendrometer, diameter, DIB, DOB, form class, hypsometer, MBF, merchantable height, sawlog, sawtimber, taper, and whorl. b. Describe reasons for conducting a cruise, including management and procurement. c. Describe factors that determine cruise intensity, including acreage, species, timber density, value, and purpose of cruise.
2. Perform a timber cruise. DOK 3 a. Describe cruising techniques. b. Perform a cruise and volume calculation using traditional methods and/or available technology.
Enrichment
Cruising Activity As a forester for a local company, your assignment is to perform a 100% cruise on a plot of forest. Your performance will be evaluated using the timber cruise rubric in the TRD.

Unit 10: Identifying Forests and Forest Products

Competencies and Suggested Objectives
1. Apply procedures to identify forest types. DOK 2 a. Define terms associated with forest types. b. Distinguish between softwoods and hardwoods, including all characteristics of hardwoods and softwoods. c. Identify forest regions of the United States on a map, including Pacific Coast, Rocky Mountains, Northern, Central Hardwood, Southern, and Tropical. d. Identify the principal species associated with the forest regions of Mississippi, including oak-pine, oak-gum-cypress, oak-hickory, loblolly pine plantation, loblolly-shortleaf, and longleaf-slash.
2. Apply procedures to identify the physical properties of wood. DOK 2 a. Identify the physical properties of wood according to wood uses, including specific gravity, grain, strength, stiffness, bending, hardness, toughness, ability to be stained, and chemical properties. b. Describe Mississippi wood products according to their importance to the state and local economies, including sawlogs, pulpwood products, poles and posts, veneer, furniture products, biofuels, biomass fuels, miscellaneous, and byproducts. c. Describe the role of recycling in the forest products industry, including impact on forest management and harvesting practices.
Enrichment
Divide students into groups and assign one component of the forest region to each group. The groups should research, summarize, and prepare a fact sheet to be presented to the class. Presentations will be scored based on the presentation rubric found in the TRD.

Unit 11: Employability Skills and Leadership Development

Competencies and Suggested Objectives
1. Develop employability skills. DOK 1 a. Review group leadership skills and personal traits from Unit 2 (see associated list) and discuss how this affects employability. b. Prepare a resume containing essential information, including personal information, education, and employment experience using correct grammar, spelling, and punctuation. c. Complete job application forms using correct grammar, spelling, and punctuation. d. Explain procedures for job interviews using correct job etiquette. e. Demonstrate the role of an applicant in a job interview using correct interview procedures. f. Explore job opportunities in forestry.
2. Identify FFA leadership activities associated with forestry. DOK 1 a. Identify FFA organizational activities that promote and recognize achievements in forestry, including personal development activities, seminars, leadership conferences, national and international exchange programs, education experience with industry, and personal and community development programs. b. Identify the benefits of FFA participation to an individual and to the forestry industry, including personal growth and development, exposure to the forestry industry environment, and multicultural experiences. c. Identify opportunities for members in the FFA organization, including personal development, personal recognition, travel, association with persons from other parts of the United States and abroad, career exploration, and self-expression.

Unit 12: Forest Management Practices

Competencies and Suggested Objectives
1. Explain forest management practices. DOK 2 a. Define terms associated with forest management practices, including best management practices (BMPs) and streamside management zones (SMZs), age classifications, forest management, improvement cutting, selection cutting, timber stand improvement, stand types, and wildlife management. b. Identify the role of forest management, including forest crops, management of stands, measurement of stands, goals and objectives of the landowner, and voluntary best management practices. c. Describe forest management practices, including silviculture, reproduction, harvest cuttings, fertilization, and herbicide application. d. Discuss the Sustainable Forestry Initiative (SFI), including BMPs and SMZs, and potential certifications in these areas. e. Examine the impact of federal and state regulations on issues such as water quality and threatened and endangered species in forest operations.
2. Apply forest management practices. DOK 3 a. Describe the purposes of intermediate cutting in forest management, including maximizing growth, control spacing, and removal of undesirable trees. b. Determine the type of intermediate cut, including precommercial, pulpwood, release, sanitation, and salvage. c. Classify timber stand improvement (TSI) needs, including thinning overstocked stands, prescribed burning, fertilization, herbicide release, and sanitation and salvage cuts.
Enrichment
Conduct a field trip to evaluate forest management practices, including BMPs and SMZs. Have students record their observations in their journal/notebook. While there, divide students into groups and assign a tract to each group to formulate a forest management plan and present the plan to the class. Use the presentation rubric found in the TRD.

Unit 13: Advanced Timber Cruising

Competencies and Suggested Objectives
1. Describe the different types of sampling techniques used in measuring standing timber, including line plot, strip, and prism cruising. DOK 2
2. Plan and conduct a timber cruise. DOK 3 a. Prepare cruise layouts, including drawing of a diagram describing a 10% sample systematic grid. b. Conduct timber cruises and determine tract volume and values, including 10%, 20%, and 100% samples. c. Discuss and perform point sampling.
Enrichment
Cruise Types A local landowner wants to know which cruise method is best for calculating his profits. Conduct a field exercise to participate in timber cruising. You and your crew (each group) will conduct a cruise of a given tract of timber. You will calculate the board footage on the tract and compare their findings to the groups. Each group will be given one of the following cruise types: fixed radius plot, point sampling, strip cruise, or 100%. Use timber cruise rubric in TRD.

Unit 14: Timber Marketing

Competencies and Suggested Objectives
1. Explain timber marketing procedures. DOK 2 a. Define terms associated with timber marketing, including harvesting compliance, management prescriptions, grantee, and grantor. b. Describe marketing practices for selling at the highest return, including marking, cruising, determining the value of timber, and selling the timber for the highest price. c. Identify potential markets, financial opportunities, and effects of supply and demand of the following: pulp paper mills, post mills, sawmills, specialty markets, export markets, and firewood sales. d. Describe how to determine the highest value of a timber stand, including preparing a prospectus and a timber sale contract.
2. Describe conditions of sale and harvesting of timber. DOK 2 a. Describe legal documents used in the sale and harvesting of timber, including the prospectus, timber sale contract, timber deed, and harvesting contract. b. Describe desirable postharvest land conditions which may be specified in a harvesting contract. c. Describe logistics of transporting timber to markets, including proximity to the mill and its effect upon the price received by the producer.
Enrichment
Let's Make A Deal You are a forester for a large paper company. You have been tasked with cruising a large tract of land. In this process, you must prepare the legal documents used in the sale and harvesting of this tract (i.e., prospectus, timber sale contract, timber deed, and harvesting contract). Within this set of documents, the landowner has requested a postharvest land condition line be placed in the harvest contract which will describe the conditions of the property at close of harvest. Also, your company requires you to provide information about logistics and transportation and their effects on timber prices. These reports will be presented to the head forester (instructor) and will be evaluated by the report rubric from the TRD.

Unit 15: Timber Harvesting

Competencies and Suggested Objectives
1. Explain timber harvesting procedures. DOK 2 a. Define terms associated with timber harvesting, including harvesting layout, BMPs and SMZs, felling, topping, bunching, skidding, merchandising, loading areas and hauling. b. Describe the methods of harvesting timber, including selection, seed tree, shelterwood, clear-cut, and row thinning. c. Identify the products of harvesting, including pulpwood, sawlogs, and specialty wood products.
2. Develop a timber harvesting plan. DOK 3 a. Identify types of harvesting equipment, including chainsaws, cutoff saws, delimber, flail delimber, fellerbunchers, prehaulers, skidders, whole tree chippers, loaders, and hauling vehicles. b. Observe timber harvesting operations, including total harvest, intermediate harvesting, and forest management practices. c. Describe desirable postharvesting land conditions, including condition of nonmerchantable timber, dead trees, treetops, soil cover, and damage caused by logging equipment. d. Develop a simple harvesting plan for a given tract of timber.

Enrichment
<u>Methods of Harvesting Research</u> As an upstart logging company, you are in search of the best harvesting methods. Research and prepare a report on methods of harvesting timber, including selection, seed tree, shelterwood, clear-cut, and mechanical. The written report rubric in the TRD can be used to evaluate the report describing the methods of harvesting timber <u>Harvesting Plan</u> Based on the methods you researched above, select a harvesting method and develop a harvesting plan for a tract of land for which you are bidding. The plan will be presented to the landowner (instructor) for evaluation using the presentation and/or report rubric in the TRD.

Unit 16: Reforestation

Competencies and Suggested Objectives
1. Explain reforestation practices. DOK 2 a. Define reforestation terms, including planting tools and site preparation. b. Identify the sources of tree seedlings. c. Describe the methods of handling seedlings, including planting as soon as possible and keeping in cold storage. d. Describe the methods of planting, including direct seeding, hand planting, and machine planting. e. Describe the different types of site preparation, including roll chop, shearing, burning, chemical, piling, and bedding. f. Describe the types of reforestation, including artificial and natural means. g. Describe the economics of reforestation. h. Identify federal and state reforestation programs available locally.
2. Perform reforestation practices. DOK 2 a. Plant seedlings, including using all available methods. b. Perform a compliance check, including carrying out a standard Mississippi Forestry Commission compliance check. c. Calculate number of seedlings per acre and associated costs needed for reforestation.

Enrichment
<u>Reforestation</u> Divide the class into groups and have them use the internet or a textbook to research all available federal and state reforestation cost-share programs available to landowners. Have students summarize their findings into fact sheets and distribute to the class. <u>Seedling Activity</u> You are a crew foreman on a reforestation job. Demonstrate to your crew (fellow class members) seedling planting techniques. After the project is completed, demonstrate procedures for conducting a compliance check to evaluate the planting efforts.

Unit 17: Forest Fire Management

Competencies and Suggested Objectives
1. Explain forest fire management practices. DOK 2 a. Define the terms associated with forest fires, including types of fires, fire behavior, fuels, controls, and weather conditions. b. Identify the elements of the fire triangle, including heat, fuel, and oxygen. c. Identify the classes of fires, including ground, surface, and crown. d. Identify the methods of attack, including direct and indirect. e. Identify firefighting tools according to their uses, including rakes, swatters, cutting tools, backpack sprayer, drip torch, fire plows, and new technology (i.e., UAS).
2. Apply forest fire management techniques. DOK 3 a. Develop a prescribed burning plan that details fire lanes, weather conditions, wind speed and direction, timber type, fuel conditions, manpower, and procedures for obtaining permission to burn. b. Explain the significance of a certified burn manager on the site of all prescribed burns. c. Develop a forest fire prevention plan that details fire lanes, section roads, prescribed burning, and emergency notification procedures.
Enrichment
As a county forester, you have been asked to develop a prescribed burning plan for your service area. Create a report discussing the common elements of a prescribed burn plan to present to the county supervisors (instructor and class). In your presentation, be prepared to demonstrate the use of firefighting tools and procedures. Use written report rubric in TRD.

Unit 18: Forest Insects and Diseases

Competencies and Suggested Objectives

1. Identify and discuss forest insects and diseases. DOK 2
   a. Define the terms associated with forest insects and diseases, including wood damage, leaf eaters, wood eaters, epidemic, predator, habitat, diseases, and signs of damage.
   b. Identify the following common insects that affect the forestry industry:
      - Southern pine beetle
      - Ips engraver beetle
      - Black turpentine beetle
      - Nantucket pine tip moth
      - Fall web worm
      - Forest tent caterpillar
      - Pales weevil
      - Locust leafminer
      - Bag worm
      - Gypsy moth

   c. Identify the following common diseases that affect the forestry industry:
      - Brown spot needle blight
      - Cedar apple gall rust
      - Needle cast
      - Heart rot
      - Oak leaf wilt
      - Verticillium wilt
      - Annosus root rot
      - Fusiform rust
      - Black knot fungus
      - Mistletoe

   d. Identify insect and disease damage and match the damage observed to the origin.
   e. Identify symptoms of insect or disease damage for the following: leaf eaters, wood eaters, sap eaters, phloem eaters, cone borers, root feeders, and terminal feeders.
2. Discuss control methods of forest insects and diseases. DOK 2
   a. Describe the various methods used to control insects and diseases, including direct control and indirect control.
   b. Identify the reasons for identifying insect and disease damage, including prevention of epidemics and loss of timber volume.
   c. Describe aerial forest detection procedures, including UAS technology, for insect and disease problems.

Enrichment

Collect photos of various timber insects, diseases, and associated damage. Include scientific names, common names, development stages, and control methods for each.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Exploring the World of Forestry		
	1.	Explain the importance of forestry.
	2.	Explain careers in the field of forestry.
Unit 2: Leadership Development		
	1.	Explain the benefits of FFA participation.
	2.	Demonstrate group leadership skills and personal traits.
Unit 3: Forest Safety		
	1.	Explain forest safety practices.
	2.	Describe forest environmental hazards.
	3.	Demonstrate forest safety practices.
Unit 4: Tree Growth and Stand Development		
	1.	Explain tree physiology.
	2.	Explain forest stand development.
	3.	Discuss advances in biotechnology for forestry applications.
	4.	Discuss the carbon cycle in pine plantations.
Unit 5: Dendrology		
	1.	Explain the tree classification system.
	2.	Identify trees by their characteristics.
Unit 6: Forest Traversing and Mapping		
	1.	Explain concepts of forest traversing.
	2.	Perform forestry surveying and mapping techniques.
	3.	Calculate acreage of forest tracts.
Unit 7: Legal Land Descriptions		
	1.	Describe the United States Public Land Survey System.

	2.	Identify information found on maps.
	3.	Apply principles of legal land description.
Unit 8: Tree and Log Measurements		
	1.	Explain tree measurement techniques.
	2.	Perform volume measurements of standing timber and sawlogs.
Unit 9: Introduction to Timber Cruising		
	1.	Describe procedures for cruising timber.
	2.	Perform a timber cruise.
Unit 10: Identifying Forests and Forest Products		
	1.	Apply procedures to identify forest types.
	2.	Apply procedures to identify the physical properties of wood.
Unit 11: Employability Skills and Leadership Development		
	1.	Develop employability skills.
	2.	Identify FFA leadership activities associated with forestry.
Unit 12: Forest Management Practices		
	1.	Explain forest management practices.
	2.	Apply forest management practices.
Unit 13: Advanced Timber Cruising		
	1.	Describe the different types of sampling techniques used in measuring standing timber.
	2.	Plan and conduct a timber cruise.
Unit 14: Timber Marketing		
	1.	Explain timber marketing procedures.
	2.	Describe conditions of sale and harvesting of timber.
Unit 15: Timber Harvesting		
	1.	Explain timber harvesting procedures.
	2.	Develop a timber harvesting plan.
Unit 16: Reforestation		
	1.	Explain reforestation practices.
	2.	Perform reforestation practices.
Unit 17: Forest Fire Management		
	1.	Explain forest fire management practices.
	2.	Apply forest fire management techniques.

Unit 18: Forest Insects and Diseases		
	1.	Identify and discuss forest insects and diseases.
	2.	Discuss control methods of forest insects and diseases.

Appendix A: Industry Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDS AND PERFORMANCE ELEMENTS

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
AFNR										
AGRIBUSINESS SYSTEMS									X	X
ANIMAL SYSTEMS		X								
BIOTECHNOLOGY					X		X	X		X
ENVIRONMENTAL SERVICE SYSTEMS		X		X	X		X	X	X	X
NATURAL RESOURCE SYSTEMS		X		X	X	X	X	X	X	X
PLANT SYSTEMS					X	X				
POWER, STRUCTURAL, AND TECHNICAL SYSTEMS								X	X	X

	Units	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
AFNR										
AGRIBUSINESS SYSTEMS				X		X				
ANIMAL SYSTEMS										
BIOTECHNOLOGY										X
ENVIRONMENTAL SERVICE SYSTEMS		X		X	X	X	X	X	X	X
NATURAL RESOURCE SYSTEMS		X		X	X	X	X	X	X	X
PLANT SYSTEMS								X		X
POWER, STRUCTURAL, AND TECHNICAL SYSTEMS							X	X		

Agriculture, Food, and Natural Resources (AFNR) Pathway Content Standards and Performance Elements

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AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Apply management planning principles in AFNR businesses.

ABS.01.01. Apply micro- and macroeconomic principles to plan and manage inputs and outputs in an AFNR business.

ABS.01.02. Read, interpret, evaluate, and write statements of purpose to guide business goals, objectives, and resource allocation.

ABS.01.03. Devise and apply management skills to organize and run an AFNR business in an efficient, legal, and ethical manner.

ABS.01.04. Evaluate, develop, and implement procedures used to recruit, train, and retain productive human resources for AFNR businesses.

ABS.02. Use record keeping to accomplish AFNR business objectives, manage budgets and comply with laws and regulations.

ABS.02.01. Apply fundamental accounting principles, systems, tools and applicable laws and regulations to record, track and audit AFNR business transactions (e.g., accounts, debits, credits, assets, liabilities, equity, etc.).

ABS.02.02. Assemble, interpret, and analyze financial information and reports to monitor AFNR business performance and support decision-making (e.g., income statements, balance sheets, cash-flow analysis, inventory reports, break-even analysis, return on investment, taxes, etc.).

ABS.03. Manage cash budgets, credit budgets and credit for an AFNR business using generally accepted accounting principles.

ABS.03.01. Develop, assess, and manage cash budgets to achieve AFNR business goals.

ABS.03.02 Analyze credit needs and manage credit budgets to achieve AFNR business goals.

ABS.04. Develop a business plan for an AFNR business.

ABS.04.01. Analyze characteristics and planning requirements associated with developing business plans for different types of AFNR businesses.

ABS.04.02. Develop production and operational plans for an AFNR business.

ABS.04.03. Identify and apply strategies to manage or mitigate risk.

ABS.05. Use sales and marketing principles to accomplish AFNR business objectives.

ABS.05.01. Analyze the role of markets, trade, competition, and price in relation to an AFNR business sales and marketing plans.
ABS.05.02. Assess and apply sales principles and skills to accomplish AFNR business objectives.
ABS.05.03. Assess marketing principles and develop marketing plans to accomplish AFNR business objectives.

ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals

AS.01. Analyze historic and current trends impacting the animal systems industry.
AS.01.01. Evaluate the development and implications of animal origin, domestication and distribution on production practices and the environment.
AS.01.02. Assess and select animal production methods for use in animal systems based upon their effectiveness and impacts.
AS.01.03. Analyze and apply laws and sustainable practices to animal agriculture from a global perspective.

AS.02. Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare.
AS.02.01. Demonstrate management techniques that ensure animal welfare.
AS.02.02. Analyze procedures to ensure that animal products are safe for consumption (e.g., use in food system, etc.).

AS.03. Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction, and/or economic production.
AS.03.01. Analyze the nutritional needs of animals.
AS.03.02 Analyze feed rations and assess if they meet the nutritional needs of animals.
AS.03.03 Utilize industry tools to make animal nutrition decisions.

AS.04. Apply principles of animal reproduction to achieve desired outcomes for performance, development, and/or economic production.
AS.04.01. Evaluate animals for breeding readiness and soundness.
AS.04.02. Apply scientific principles to select and care for breeding animals.
AS.04.03 Apply scientific principles to breed animals.

AS.05. Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health.
AS.05.01. Design animal housing, equipment, and handling facilities for the major s systems of animal production.
AS.05.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.06. Classify, evaluate, and select animals based on anatomical and physiological characteristics.
AS.06.01. Classify animals according to taxonomic classification systems and use (e.g. agricultural, companion, etc.).

AS.06.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.06.03. Select and train animals for specific purposes and maximum performance based on anatomy and physiology.

AS.07. Apply principles of effective animal health care.

AS.07.01. Design programs to prevent animal diseases, parasites and other disorders and ensure animal welfare.

AS.07.02. Analyze biosecurity measures utilized to protect the welfare of animals on a local, state, national, and global level.

AS.08. Analyze environmental factors associated with animal production.

AS.08.01. Design and implement methods to reduce the effects of animal production on the environment.

AS.08.02. Evaluate the effects of environmental conditions on animals and create plans to ensure favorable environments for animals.

BIOTECHNOLOGY

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.

BS.01. NCAE Standard: Assess factors that have influenced the evolution of biotechnology in agriculture (e.g., historical events, societal trends, ethical and legal implications, etc.).

BS.01.01. Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).

BS.01.02. Evaluate the scope and implications of regulatory agencies on applications of biotechnology in agriculture and protection of public interests (e.g., health, safety, environmental issues, etc.).

BS.01.03. Analyze the relationship and implications of bioethics, laws, and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).

BS.02. NCAE Standard: Demonstrate proficiency by safely applying appropriate laboratory skills to complete tasks in a biotechnology research and development environment (e.g., standard operating procedures, record keeping, aseptic technique, equipment maintenance, etc.).

BS.02.01. Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations, and results.

BS.02.02. Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.

BS.02.03. Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.

BS.02.04. Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

BS.02.05. Examine and perform scientific procedures using microbes, DNA, RNA, and proteins in a laboratory.

BS.03. NCAE Standard: Demonstrate the application of biotechnology to solve problems in Agriculture, Food and Natural Resources (AFNR) systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).

BS.03.01. Apply biotechnology principles, techniques, and processes to create transgenic species through genetic engineering.

BS.03.02. Apply biotechnology principles, techniques, and processes to enhance the production of food through the use of microorganisms and enzymes.

BS.03.03. Apply biotechnology principles, techniques, and processes to protect the environment and maximize use of natural resources (e.g., biomass, bioprospecting, industrial biotechnology, etc.).

BS.03.04. Apply biotechnology principles, techniques, and processes to enhance plant and animal care and production (e.g., selective breeding, pharmaceuticals and biodiversity, etc.).

BS.03.05. Apply biotechnology principles, techniques, and processes to produce biofuels (e.g., fermentation, transesterification, methanogenesis, etc.).

BS.03.06. Apply biotechnology principles, techniques, and processes to improve waste management (e.g., genetically modified organisms, bioremediation, etc.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures and instruments to manage environmental service systems.

ESS.01.01. Analyze and interpret laboratory and field samples in environmental service systems.

ESS.02. Evaluate the impact of public policies and regulations on environmental service system operations.

ESS.02.01. Interpret and evaluate the impact of laws, agencies, policies, and practices affecting environmental service systems.

ESS.03. Develop proposed solutions to environmental issues, problems, and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry, and ecology.

ESS.03.01. Apply meteorology principles to environmental service systems.

ESS.03.02. Apply soil science and hydrology principles to environmental service systems.

ESS.03.03. Apply chemistry principles to environmental service systems.

ESS.03.04. Apply microbiology principles to environmental service systems.

ESS.03.05. Apply ecology principles to environmental service systems.

ESS.04. Demonstrate the operation of environmental service systems (e.g., pollution control, water treatment, wastewater treatment, solid waste management, and energy conservation).

ESS.04.01. Use pollution control measures to maintain a safe facility environment.

ESS.04.02. Manage safe disposal of all categories of solid waste in environmental service systems.

ESS.04.03. Apply techniques to ensure a safe supply of drinking water and adequate treatment of wastewater according to applicable rules and regulations.

ESS.04.04. Compare and contrast the impact of conventional and alternative energy sources on the environment and operation of environmental service systems.

ESS.05. Use tools, equipment, machinery, and technology common to tasks in environmental service systems.

ESS.05.01. Use technological and mathematical tools to map land, facilities, and infrastructure for environmental service systems.

ESS.05.02. Perform assessments of environmental conditions using equipment, machinery, and technology.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.

NRS.01.01. Apply methods of classification to examine natural resource availability and ecosystem functions in a particular region.

NRS.01.02. Classify different types of natural resources to enable protection, conservation, enhancement, and management in a particular geographical region.

NRS.01.03 Apply ecological concepts and principles to atmospheric natural resource systems.

NRS.01.04 Apply ecological concepts and principles to aquatic natural resource systems.

NRS.01.05 Apply ecological concepts and principles to terrestrial natural resource systems.

NRS.01.06 Apply ecological concepts and principles to living organisms in natural resource systems.

NRS.02.01 Analyze the interrelationships between natural resources and humans.

NRS.02.01. Examine and interpret the purpose, enforcement, impact and effectiveness of laws and agencies related to natural resource management, protection, enhancement, and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).

NRS.02.02. Assess the impact of human activities on the availability of natural resources.

NRS.02.03. Analyze how modern perceptions of natural resource management, protection, enhancement, and improvement change and develop over time.
NRS.02.04. Examine and explain how economics affects the use of natural resources.
NRS.02.05. Communicate information to the public regarding topics related to the management, protection, enhancement, and improvement of natural resources.

NRS.03. Develop plans to ensure sustainable production and processing of natural resources.

NRS.03.01. Sustainability produce, harvest, process and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).
NRS.03.02. Demonstrate cartographic skills, tools, and technologies to aid in developing, implementing, and evaluating natural resource management plans.

NRS.04. Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.

NRS.04.01. Demonstrate natural resource protection, maintenance, enhancement, and improvement techniques.
NRS.04.02. Diagnose plant and wildlife diseases and follow protocol to prevent their spread.
NRS.04.03. Prevent or manage introduction of ecologically harmful species in a particular region.
NRS.04.04 Manage fires in natural resource systems.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Develop and implement a crop management plan for a given production goal that accounts for environmental factors.

PS.01.01. Determine the influence of environmental factors on plant growth.
PS.01.02. Prepare and manage growing media for use in plant systems.
PS.01.03. Develop and implement a fertilization plan for specific plants or crops.

PS.02. Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

PS.02.01. Classify plants according to taxonomic systems.
PS.02.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.
PS.02.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.03. Propagate, culture, and harvest plants and plant products based on current industry standards.

PS.03.01 Demonstrate plant propagation techniques in plant system activities.

PS.03.02. Develop and implement a management plan for plant production.
PS.03.03. Develop and implement a plan for integrated pest management for plant production.
PS.03.04. Apply principles and practices of sustainable agriculture to plant production.
PS.03.05 Harvest, handle, and store crops according to current industry standards.

PS.04. Apply principles of design in plant systems to enhance an environment (e.g. floral, forest landscape, and farm).
PS.04.01. Evaluating, identifying, and preparing plants to enhance an environment.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.
PST.01.01. Apply physical science laws and engineering principles to assess and select energy sources for AFNR power, structural and technical systems.
PST.01.02. Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems in AFNR situations.
PST.01.03. Apply physical science principles to metal fabrication using a variety of welding and cutting processes (e.g., SMAW, GMAW, GTAW, fuel-oxygen and plasma arc torch, etc.).

PST.02. Operate and maintain AFNR mechanical equipment and power systems.
PST.02.01. Perform preventative maintenance and scheduled service to maintain equipment, machinery and power units used in AFNR settings.
PST.02.02. Operate machinery and equipment while observing all safety precautions in AFNR settings.

PST.03. Service and repair AFNR mechanical equipment and power systems.
PST.03.01. Troubleshoot, service and repair components of internal combustion engines using manufacturers' guidelines.
PST.03.02. Service electrical systems and components of mechanical equipment and power systems using a variety of troubleshooting and/or diagnostic methods.
PST.03.03. Utilize manufacturers' guidelines to diagnose and troubleshoot malfunctions in machinery, equipment, and power source systems (e.g., hydraulic, pneumatic, transmission, steering, suspension, etc.).

PST.04. Plan, build and maintain AFNR structures.
PST.04.01. Create sketches and plans for AFNR structures.
PST.04.02. Determine structural requirements, specifications and estimate costs for AFNR structures.

PST.04.03. Follow architectural and mechanical plans to construct and/or repair AFNR structures (e.g., material selection, site preparation and/or layout, plumbing, concrete/masonry, etc.).

PST.04.04. Apply electrical wiring principles in AFNR structures.

PST.05. Use control, monitoring, geospatial and other technologies in AFNR power structural and technical systems.

PST.05.01. Apply computer and other technologies (e.g., robotics, CNC, UAS, etc.) to solve problems and increase the efficiency of AFNR systems.

PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot electronic control systems in AFNR settings.

PST.05.03. Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.

2014 Forestry

Mississippi Department of Education

Program CIP: 03.0511 – Forestry Technology/Technician

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~~The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.~~

Table of Contents

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Dr. Lynn House, Interim State Superintendent of Education
Dr. O. Wayne Gann, Chair
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Mr. William Harold Jones
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Lee James, Program Coordinator, Office of Career and Technical Education and Workforce Development, Mississippi Department of Education, Jackson, MS

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Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the Forestry *Curriculum Framework and Supporting Materials* are based on the following:

National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards

The National AFNR Career Cluster Content Standards were developed by the National Council on Agricultural Education to serve as a guide for what students should know or be able to do through a study of agriculture in grades 9–12 and 2-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the agricultural industry, secondary and postsecondary instructors, and university specialists. The standards consist of a pathway content standard for each of the eight career pathways. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. A complete copy of the standards can be accessed at https://aged.learn.com. The National AFNR Career Cluster Content Standards are copyrighted to the National Council for Agricultural Education and are used by permission.

Common Core State Standards Initiative

The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. 2010©. National Governors Association Center for Best Practices and Council of Chief State School Officers. All rights reserved. States and territories of the United States as well as the District of Columbia that have adopted the Common Core State Standards in whole are exempt from this provision, and no attribution to the National Governors Association Center for Best Practices and Council of Chief State School Officers is required. Reprinted from http://www.corestandards.org/.

National Educational Technology Standards for Students

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~~21st Century Skills and Information and Communication Technologies Literacy Standards~~

~~In defining 21st century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and information and communication technology (ICT) literacy.~~

Preface

Secondary career and technical education programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at

The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

My PLC: An online registration for all professional development sessions

To register for any session, teachers will need an account in the registration system, MyPLC, https://myplc.rcu.msstate.edu. To create an account, click on the link and navigate to the "Request a Guest ID" link. The ID should be the teacher's first initial and last name and the last four (4) digits of the social security number. Teachers should complete the entire form, which will then be sent to a secure server. Upon activation of the teacher's account, he or she will receive an e-mail with login instructions. The teacher may then browse for the available sessions and register for the desired courses.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

Forestry is an instructional program designed to prepare students to enter occupations related to the field of forestry. The first year topics include Exploring the World of Forestry, Leadership/FFA Activities, Forest Safety, Tree Growth and Stand Development, Dendrology, Forest Surveying and Mapping, Legal Land Descriptions, Tree and Log Measurements, and Introduction to Timber Cruising. The second year instruction focuses on Identifying Forests and Forest Products, Employability Skills/FFA Activities, Forest Management Practices, Advanced Timber Cruising, Timber Marketing, Timber Harvesting, Reforestation, Forest Fire Management, and Forest Insects and Diseases. Graduates may become employed at the entry level or pursue careers in Forestry, Agriculture, Agribusiness, or Natural Resources Education in postsecondary or higher education.

Industry Certification

Competencies and suggested performance indicators in the Forestry course have been correlated to the National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content. Standards that have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Assessment

The latest assessment blueprint for the curriculum can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

If there are questions regarding assessment of this program, please contact the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be able to experience success in the Forestry program, the following student prerequisites are suggested:

4. C or higher in English (the previous year)
5. C or higher in Math (last course taken or the instructor can specify the math)
6. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

3. TABE Reading Score (eighth grade or higher)
4. Instructor Approval

or

2. Instructor Approval

Applied Academic Credit

Content of the Forestry course has been aligned to the *2010 Mississippi Science Curriculum Framework*. Students who successfully complete the first and second year Forestry curriculum will receive two elective science credits that will count toward high school science graduation requirements.

Teacher Licensure

The latest teacher licensure information can be found at

http://www.mde.k12.ms.us/educator-licensure

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for a professional learning specialist.

Course Outlines

Option 1—Four One-Carnegie-Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

5. **Forestry Introduction—Course Code: 991502**
6. **Forestry Surveying and Measurements—Course Code: 991503**
7. **Forestry Cruising—Course Code: 991504**
8. **Forestry Marketing—Course Code: 991505**

Course Description: Forestry Introduction

The forestry introduction course provides the building blocks for knowledge and understanding in forestry. Students will cover topics such as the FFA, leadership skills, safety, and dendrology. Additionally, students will cover forest surveying and mapping techniques necessary for the next course offering.

Course Description: Forestry Surveying and Measurements

The forestry surveying and measurements course offers insight into the world of legal documents used in forestry. Student will be well versed in the use of legal land description as well as how to perform tree and log calculations. Students will also be introduced to timber cruising activities.

Course Description: Forestry Cruising

The forestry cruising course will examine more deeply timber cruise practices. Students will also be exposed to employability skills and career opportunities in forestry. Additional topics include forest types, forest products, and forest management techniques.

Course Description: Forestry Marketing

The forestry marketing course delivers information about timber harvesting, sales, and reforestation techniques. Additionally students will be exposed to fire management and safety as well as common insect and disease problems encountered in forestry.

Forestry Introduction—Course Code: 991502

Unit	Unit Name	Hours
1	Exploring the World of Forestry	7.5
2	Leadership/FFA Activities	7.5
3	Forest Safety	15
4	Tree Growth and Stand Development	7.5
5	Dendrology	30
6	Forest Surveying and Mapping	37.5
Total		105

Forestry Surveying and Measurements—Course Code: 991503

Unit	Unit Name	Hours
7	Legal Land Descriptions	30
8	Tree and Log Measurements	37.5
9	Introduction to Timber Cruising	45
Total		112.5

Forestry Cruising—Course Code: 991504

Unit	Unit Name	Hours
10	Identifying Forests and Forest Products	7.5
11	Employability Skills/FFA Activities	7.5
12	Forest Management Practices	45
13	Advanced Timber Cruising	52.5
Total		112.5

Forestry Marketing—Course Code: 991505

Unit	Unit Name	Hours
14	Timber Marketing	15
15	Timber Harvesting	15
16	Reforestation	22.5
17	Forest Fire Management	22.5
18	Forest Insects and Diseases	22.5
Total		97.5

Option 2—Two Two-Carnegie Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. **Forestry I—Course Code: 991500**
2. **Forestry II—Course Code: 991501**

Course Description: Forestry I

Forestry I is designed to introduce the student to the forest industry and forestry careers in Mississippi. The course provides instruction on forest careers and leadership, forest safety, tree growth and development, dendrology, surveying and mapping, and tree and log measurements. Emphasis is placed on the scientific and technical principles of modern forest management.

Course Description: Forestry II

Forestry II is a continuation of Forestry I with additional emphasis on forest management, timber cruising, marketing and harvesting methods, reforestation, fire management, and forest pests. Emphasis is placed on scientific and technical principles.

Forestry I – Course Code: 991500

Unit	Unit Name	Hours
1	Exploring the World of Forestry	7.5
2	Leadership/FFA Activities	7.5
3	Forest Safety	15
4	Tree Growth and Stand Development	7.5
5	Dendrology	30
6	Forest Surveying and Mapping	37.5
7	Legal Land Descriptions	30
8	Tree and Log Measurements	37.5
9	Introduction to Timber Cruising	45
Total		217.5

Forestry II—Course Code: 991501

Unit	Unit Name	Hours
10	Identifying Forests and Forest Products	7.5
11	Employability Skills/FFA Activities	7.5
12	Forest Management Practices	45
13	Advanced Timber Cruising	52.5
14	Timber Marketing	15
15	Timber Harvesting	15
16	Reforestation	22.5
17	Forest Fire Management	22.5
18	Forest Insects and Diseases	22.5
Total		210

Research Synopsis

Introduction

The Agricultural and Natural Resources Cluster covers a broad field of occupations related to the production and use of plants and animals for food, fiber, aesthetic, and environmental purposes. According to the U.S. Department of Labor, the growing interest in worldwide standardization of agricultural equipment should result in increased employment of agricultural related jobs. Job opportunities should also result from the increasing demand for agricultural products, the continued efforts for more efficient agricultural production, and the increasing emphasis on the conservation of resources. According to the Division of Agriculture, Forestry, and Veterinary Medicine at Mississippi State University, Mississippi's value of production estimates for 2010 amounted to $6.875 billion. Additionally, the Mississippi Department of Agriculture and Commerce estimates that 29% of the state's workforce is employed in jobs relating directly or indirectly to agriculture. The total economic impact is $12.7 billion each year. Agriculture makes an impact in all 82 counties in the state of Mississippi, our nation, and around the world.

The Forestry Career Pathway will target careers at the professional and technical levels in agriculture. Students enrolled in these courses should be better prepared to pursue degrees at the community college and 4-year college level.

Needs of the Future Workforce

As shown in Table 1, the most growth for Forestry jobs in Mississippi is expected for Conservation Scientists (11.9%) and Foresters (9.8%). These growth rates are higher than the national projected growth rate, as the U.S. Bureau of Labor Statistics reports that by the year 2020 the combined occupations are only expected to grow at a rate of 5%. Citing fiscal crises in the private sector, the U.S. Bureau of Labor Statistics states that opportunities for employment will be better in state and local governments.

Table 1: Current and Projected Occupation Report for Forestry Jobs in Mississippi

Description	Jobs, 2008	Projected Jobs, 2018	Change (Number)	Change (Percent)	Average Hourly Earning
Conservation Scientists	840	940	100	11.9	$25.62
First-Line Supervisors of Farming, Fishing, and Forestry Workers	940	970	30	3.2	$21.19
Foresters	410	450	40	9.8	$19.30
Forest and Conservation Workers	340	340	0	0.0	$17.47

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed February 14, 2013).

Perkins IV Requirements

The Forestry curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. It also offers students a program of study including secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the Forestry curriculum is integrated with academic

common core standards. Lastly, the Forestry curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the Forestry curriculum are the Common Core Standards for Mathematics and Science, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the Common Core Standards are designed to prepare students for success in community colleges, Institutions of Higher Learning and careers.

Academic Infusion

The Forestry curriculum is aligned to the Mississippi Academic Science Standards. Content of the Forestry courses have been aligned to the Mississippi Science Curriculum Framework. Students who complete Forestry will receive two electives and two equivalent science credits or four elective credits that will count toward high school science graduation requirements.

The Forestry curriculum is tied to the 2010 Mississippi Science Curriculum Framework Common Core Science and Mathematics standards. The curriculum provides multiple opportunities to enhance and reinforce these academic skills. Since students will be required to communicate effectively in the classroom as well as in the workforce, there is a considerable amount of writing in this curriculum. The academic content in the Forestry curriculum provides several opportunities for focus in science and

mathematics as it directly related to Forestry content. Overall the Forestry content requires students to preform calculations and use strategic and critical thinking skills to solve real world problems.

Academic Credit

If academic credit is awarded, please review the Research and Curriculum Unit link at https://www.rcu.msstate.edu/MDE/PathwaystoSuccess.aspx.

Click *"Curriculum Enhancement List"*. Check this site often as it is updated frequently.

Transition to Postsecondary Education

The latest articulation information for Secondary to Postsecondary can be found at the Mississippi Community College Board (MCCB) website http://www.mccb.edu/

Best Practices

Experiential Learning (SAE)

The Experiential Learning (SAE) has long been and continues to be the backbone of every agriculture program. The experiential learning projects can be used in a variety of situations to reinforce and compliment classroom theory and content. The experiential learning project consists of entrepreneurship, placement, research/experimentation and career exploration.

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. Each classroom should incorporate one teacher desktop or laptop as well as student computers in a networked environment. It is suggested that each classroom be equipped with an interactive white board and projector, intensifying the interaction

between students and teachers during class. To make use of the latest online communication tools such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning management system, for example, the Forestry LMS Content Management System, that introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a unique learner emerges. By encouraging various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

There are student organizations for students that would be relevant to this curriculum. Teachers are encouraged to charter one of these organizations if one is not already available to students. The suggested organization for this course is FFA. Contact information for this and other related organizations is listed under "Professional Organizations" in this document.

Conclusions

The Forestry curriculum will be filled with opportunities to develop workforce skills. Widely used teaching strategies such as cooperative learning, problem-based learning, and demonstration are suggested. These will help to prepare students for the hands-on instruction they will likely receive upon

~~entering the workforce. The curriculum document will be updated regularly to reflect the needs of the forestry workforce.~~

Professional Organizations

American Association for Agricultural Education. May be found at http://aaaeonline.org/

Mississippi ACTE. May be found at http://www.mississippiacte.com/

Mississippi FFA/ Mississippi Association of Vocational Agriculture Teachers (MAVAT). May be found at www.mississippiffa.org

National FFA Organization

P.O. Box 68960, 6060 FFA Drive

Indianapolis, IN 46268

317-802-6060

http://www.ffa.org

National Association of Agricultural Educators

300 Garrigus Building- University of Kentucky

Lexington, KY 40546

800 - 509 - 0204

http://www.naae.org/

Using This Document

Suggested Time on Task

This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives

A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are identified.

References

A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Exploring the World of Forestry

Competencies and Suggested Objectives
1. Explain the importance of forestry. DOK1, AE, AN a. Describe the elements of a forest community, including trees, plants, shrubs, soil, water, and animal life. b. Describe the importance of trees and forests, including products, employment, climate, air quality, erosion, and recreation. c. Describe the amount of forested land worldwide and in the United States, including acres of forestland and acres of commercial land within the local county or regional area. d. Describe the history of forestry, including the importance of forestry to the South and to Mississippi. e. Describe the importance of forests in the South, including growing season, timber inventory, and economic impact. f. Describe resources considered in multiple-use forest management, including timber, soil, wildlife, recreation, and water.
2. Explain careers in the field of forestry. DOK1, CS a. Identify the careers available in the field of forestry. b. Describe educational requirements, job opportunities, duties, and responsibilities for professional, technical, and forestry workers.

Scenarios

The Forest Community

Unit 1

Divide students into groups and assign one component of the forest community to each group to research, summarize, and prepare a fact sheet and present it to the class. Presentations will be scored based on the presentation rubric.

Attachments for Scenario

See the presentation rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Forestry Career Paths

Unit 1

Assign each student a career within forestry to investigate and compare educational requirements, job opportunities, and duties and responsibilities. Students will develop a slideshow presentation to the class about their findings. Presentations will be scored based on the presentation rubric.

Attachments for Scenario

See the career rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 2: Leadership/FFA Activities

Competencies and Suggested Objectives
1. Explain the benefits of FFA participation. DOK 1, CS a. Identify FFA organizational activities that promote and recognize achievements in forestry, including career development events, personal development seminars, leadership conferences, national and international exchange programs, education experience with industry, and personal and community development programs. b. Identify the benefits of FFA participation to an individual and to the forestry industry, including personal growth and development, exposure to the forestry industry environment, and multicultural experiences. c. Identify opportunities for members in the FFA organization, including personal development, personal recognition, career exploration, and self-expression.
2. Demonstrate group leadership skills. DOK 2, CS

Scenario

Why join the FFA?

Unit 2

Select a local, county, or state FFA officer or alumni to discuss with students the benefits of the FFA. Students will be required to write a report discussing the various benefits following the speaker's presentation. Reports will be scored based on the written report rubric.

Attachments for Scenario

See the written report rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 3: Forest Safety

Competencies and Suggested Objectives
1. Explain forest safety practices. DOK 1, AE, AN, CS a. Describe first aid and first aid equipment used in forestry work. b. Describe job site safety practices, including the hazards, carelessness, safety equipment, safety regulations, and prevention of accidents. c. Explain the impact of federal and state safety regulations (such as OSHA) on forestry operations.
2. Describe forest environmental hazards, including heat, cold, plants, insects, wildlife, and topographical hazards. DOK 2, AE, AN, CS a. Identify characteristics of forest insects and wildlife. b. Explain signs and symptoms of exposure to insects and wildlife.
3. Demonstrate forest safety practices. DOK 2, AE, AN, CS a. Apply safety practices to environmental, wildlife, and topographical hazards. b. Apply job site safety practices. c. Discuss types and frequency of forest accidents.

Scenario

Safety is as Safety does

Unit 3

You have been hired to be the Safety Officer for a large forestry division. As safety officer, you are responsible for monitoring harvesting site safety practices. Using the safety checklist, monitor job site safety practices used in forestry. Make notes about good and bad practices as well as solutions for any problems identified. Safety officers (students) will be scored based on the Safety Checklist.

Attachments for Scenario

See the checklist in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Safety Regulations

Unit 3

Students will develop a poster that discusses the various local, county, state and federal regulations that impact forestry and forest harvesting in Mississippi. Students will be grouped into teams and scored based on the Poster rubric.

Attachments for Scenario

See the poster rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 4: Tree Growth and Stand Development

Competencies and Suggested Objectives
1. Explain tree physiology. DOK 2, AE, AN, AP a. Describe the main parts of a tree, including trunk, crown, and roots along with their functions. b. Describe tree respiration and photosynthesis, including respiration, transfer of water, minerals, nutrients, and production of food. c. Describe environmental and biological factors that affect tree growth, including temperature, moisture, light, air, soil, tolerance, and hardiness. d. Describe the methods of tree reproduction, including sprouts, seeds, and suckers. e. Identify characteristics of tree growth, including height and diameter growth.
2. Explain forest stand development. DOK 2, AE, AN, AP a. Identify stands according to classifications, including age, size, and composition. b. Identify trees according to crown classes.
3. Discuss advances in biotechnology for forestry applications. DOK 2, AE, AN, AP, AO

Scenario

Tour Guide to the Trees

Unit 4

You are a tree expert for a local school district. You have been asked to teach a forestry seminar to local high school students. Take the "class" around and identify the factors that affect tree growth, methods of tree reproduction, and characteristics of tree growth forest stand classifications and crown classes using trees on your "campus." As a group you will guide the classroom discussion about the tree growth characteristics.

Attachments for Scenario

None

WIB? (What is Biotechnology)

Unit 4

You have been asked to give a lecture to a group of educators about biotechnology. Research an application of biotechnology in forestry and summarize your findings for presentation to the educators (class). You will be evaluated using the presentation rubric.

Attachments for Scenario

See the presentation rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 5: Dendrology

Competencies and Suggested Objectives
1. Explain the tree classification system. DOK 2, AE, AN, AP a. Identify nomenclature and taxonomy terms. b. Identify common names and/or binomial names of trees.
2. Identify trees by characteristics. DOK 2, AE, AN, AP a. Describe identifying characteristics of trees, including fruit, leaves, twigs, bark, and tree form. b. Collect leaves, fruit, and/or bark samples of species found locally.

Scenario

Leaf Collection

Unit 5

~~Students will collect, preserve, and display leaves and bark of a minimum of 40 local species. All specimens are to be identified by common and scientific name.~~

~~**Attachments for Scenario**~~

~~None~~

Unit 6: Forest Surveying and Mapping

Competencies and Suggested Objectives
1. Explain concepts of forest surveying. DOK 2, AE, AN a. Define terms, including bearings, acre, azimuths, chaining, boundary lines, angles, surveying, traversing, latitude, and longitude. b. Describe the importance of surveying to forestry, including timber sales, land measurement, boundary marking, and mapping. c. Identify characteristics of a forest survey, including use of compass, measuring distances, and mapping. d. Identify surveying tools, including compass, chain, plumb bob, and range pole. e. Label parts of a compass, including magnetic needle, pivot point, housing graduated degrees, and sighting mirror. f. Identify and calculate compass measurements and symbols, including azimuths, bearings, and degrees.
2. Perform forestry surveying and mapping techniques. DOK 3, AE, AN a. Determine the number of paces per chain using common pacing techniques. b. Perform compass, pacing, and chaining skills, including completing a traverse of a selected area. c. Utilize new technologies for forest surveying and mapping to include GPS and/or GIS and remote sensing.
3. Calculate acreage of forest tracts. DOK 3, AE, AN a. Determine acreage from new technologies such as remote sensing, GPS/GIS, and/or Google Maps©. b. Determine acres from traditional methods such as a traverse or grid system.

Scenario

~~Forest Surveying~~

~~Unit 6~~

~~Your company has been hired to survey a forest for a landowner. Demonstrate the proper techniques for pacing, chaining, and traversing within your group. Also demonstrate the various tools used in surveying. If available, demonstrate the use of GPS in surveying.~~

~~Attachments for Scenario~~

~~None~~

Unit 7: Legal Land Descriptions

Competencies and Suggested Objectives
1. Describe the United States Public Land Survey System. DOK 2, AE, AN a. Explain and identify the principal meridians, baselines, and initial points used in Mississippi, including location of these lines on a map. b. Define legal land description terms, including bearing, blaze, contour, elevation, legend, plot, sea level, topographic map, and corner markers. c. Explain reasons and importance for land location in forestry, including retrace, location, and layout of boundaries.
2. Identify information found on maps. DOK 2, AE, AN a. Interpret information from and demonstrate use of ownership maps. b. Interpret information from and demonstrate use of topographic maps. c. Interpret information from and demonstrate use of GPS/GIS and/or internet map applications.
3. Apply principles of legal land description. DOK 2, AE, AN a. Write, read, and locate parcels of land using legal land descriptions. b. Observe the records of timber and land deeds.

Scenario

Map It Out

Unit 7

As a cartographer (mapmaker) you are required to label the principal meridians, baselines, and initial points on a map of Mississippi. Demonstrate your knowledge of map reading, interpretation, and labeling by completing the assignment for your employer.

Attachments for Scenario

None

Courthouse Search

Unit 7

As a forester for your local timber company, you need to locate the legal description for a property you are bidding on. Visit your local courthouse and obtain the legal land description for the property in question. After you have located the document, explain, discuss, and demonstrate how to write, read, and locate parcels of land using legal land descriptions to the class.

Attachments for Scenario

None

Unit 8: Tree and Log Measurements

Competencies and Suggested Objectives
1. Explain tree measurement techniques. DOK 2, AE, AN a. Define terms, including board feet, basal area, cord, diameter at breast height (DBH), diameter, diameter inside bark (DIB), diameter outside bark (DOB), form class, one thousand board feet (MBF), merchantable height, sawlog, and, sawtimber. b. Identify tools used in taking tree measurements and associate them with uses, including D-tape, tree stick, tree calipers, wedge prism, clinometer, and increment borer. c. Classify DBH measurements into the correct diameter classes, including one- and two-inch classes. d. Demonstrate the correct location of DBH measurements, including trees on level ground, slopes, leaning, forking, and deformed. e. Identify merchantable height, including heights for sawtimber, pulpwood, and specialty products. f. Distinguish among the major log rules, including Doyle, Scribner, and International log rules. g. Draw tally symbols, including dot-tally method.

2. Perform volume measurement of standing timber and sawlogs. DOK 3, AE, AN

   a. Determine the volume of standing timber, including volume computation from DBH and height measurements and basal area.

   b. Calculate the net volume of logs, including measuring length and DIB at small end of log to obtain volume and weight scaling of logs for volume.

   c. Calculate the volume of standing timber using traditional methods and computer software.

Scenario

How Much Wood Could a Woodchuck Chuck?

Unit 8

As owner of a forestry consulting firm, you have been hired by a landowner to determine the volume of standing timber on their property. Using traditional methods and/or computer software determine the volume of standing timber on the property. In addition to this information, measure and tally 10 pulpwood and 10 sawlog trees. On these 20 trees, determine the correct location of DBH measurements, including trees on level ground, slopes, leaning, forking, and deformed. After these measurements have been taken, calculate the net volume of logs, including measuring length and DIB at small end of log to obtain volume and weight scaling of logs for volume. Return your findings in the form of a type written proposal to be given to the landowner (instructor).

Attachments for Scenario

See the written report rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 9: Introduction to Timber Cruising

Competencies and Suggested Objectives
1. Describe procedures for cruising timber. DOK 2, AE, AN, AP a. Discuss terms associated with cruising, including basal area, board foot, bole, circumference, cord, cull, cunit, diameter at breast height (DBH), dendrometer, diameter, DIB, DOB, form class, hypsometer, MBF, merchantable height, sawlog, sawtimber, taper, and whorl. b. Describe reasons for conducting a cruise, including management and procurement. c. Describe factors that determine cruise intensity, including acreage, species, timber density, value, and purpose of cruise.
2. Perform timber cruising. DOK 3, AE, AN, AP a. Describe cruising techniques. b. Perform a cruise and volume calculation using traditional methods and/or computer software.

Scenario

Cruisin'

Unit 9

As a forester for a local company, your assignment is to perform a 100% cruise on a plot of forest. Your performance will be evaluated using the timber cruise rubric.

Attachments for Scenario

See the conducting a timber cruise rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 10: Identifying Forests and Forest Products

Competencies and Suggested Objectives
1. Apply procedures to identify forest types. DOK 2, AE, AN, AP a. Define terms associated with forest types. b. Distinguish between softwoods and hardwoods, including all characteristics of hardwoods and softwoods. c. Identify forest regions of the United States on a map, including Pacific Coast, Rocky Mountains, Northern, Central Hardwood, Southern, and Tropical. d. Identify the principal species associated with the forest regions of Mississippi, including oak-pine, oak-gum-cypress, oak-hickory, loblolly-shortleaf, and longleaf-slash.
2. Apply procedures to identify the physical properties of wood. DOK 2, AE, AN, AP a. Identify the physical properties of wood according to wood uses, including specific gravity, grain, strength, stiffness, bending, hardness, toughness, ability to be stained, and chemical properties. b. Describe Mississippi wood products according to their importance to the state and local economy, including sawlogs, pulpwood products, poles and posts, veneer, furniture products, biofuels, miscellaneous, and by-products. c. Describe the role of recycling in the forest products industry, including impact on forest management and harvesting practices.

Scenario

Forest Region Research

Unit 10

Divide students into groups and assign one component of the forest region to each group to research, summarize, and prepare a fact sheet to be presented to the class. Presentations will be scored based on the presentation rubric.

~~Attachments for Scenario~~

~~See the presentation rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx~~

Unit 11: Employability Skills/FFA Activities

Competencies and Suggested Objectives
1. Develop employability skills. DOK 1, CS a. Discuss employability traits. b. Prepare a resume containing essential information including personal information, education, and employment experience using correct grammar, spelling, and punctuation. c. Complete job application forms including correct grammar, spelling, and punctuation. d. Explain procedures for job interviews using correct job etiquette. e. Demonstrate the role of an applicant in a job interview using correct interview procedures. f. Explore job opportunities in forestry.
2. Identify FFA leadership activities associated with forestry. DOK 1, CS a. Identify FFA organizational activities that promote and recognize achievements in forestry, including personal development activities, seminars, leadership conferences, national and international exchange programs, education experience with industry, and personal and community development programs. b. Identify the benefits of FFA participation to an individual and to the forestry industry, including personal growth and development, exposure to the forestry industry environment, and multicultural experiences. c. Identify opportunities for members in the FFA organization, including personal development, personal recognition, travel, association with persons from other parts of the United States and abroad, career exploration, and self-expression.

Scenario

Get a job!

Unit 11

You are in search of a full-time job. After searching through the want ads, you find a job you want to pursue. Prepare a personal résumé and fill out a job application for this job. Your résumé and application will be evaluated using the résumé and application rubric.

Attachments for Scenario

See the resume assessment rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 12: Forest Management Practices

Competencies and Suggested Objectives
1. Explain forest management practices. DOK 2, AE, AN, AP a. Define terms associated with forest management practices, including BMPs and SMZs, age classifications, forest management, improvement cutting, selection cutting, timber stand improvement, stand types, and wildlife management. b. Identify the role of forest management, including forest crops, management of stands, measurement of stands, goals and objectives of the landowner, and voluntary best management practices. c. Describe forest management practices, including silviculture, reproduction, harvest cuttings, fertilization, and herbicide application. d. Discuss BMPs and SMZs. e. Examine the impact of federal and state regulations on issues such as water quality and endangered species in forest operations.
2. Apply forest management practices. DOK 3, AE, AN, AP a. Describe the purposes of intermediate cutting in forest management, including maximizing growth, control spacing, and removal of undesirable trees. b. Determine the type of intermediate cut, including pre-commercial, pulpwood, release, and salvage. c. Classify timber stand improvement needs, including thin overstocked stands, prescribed burning, fertilization, herbicide use, and salvage cuts.

Scenario

Best Practices

Unit 12

Conduct a field trip to evaluate forest management practices including BMPs and SMZs. Have students record their observations in their journal/notebook. While there, divide students into groups and assign

a tract to each group to formulate a forest management plan and present the plan to the class. Presentations will be scored based on the presentation rubric.

Attachments for Scenario

See the presentation rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 13: Advanced Timber Cruising

Competencies and Suggested Objectives
1. Describe the different types of sampling techniques used in measuring standing timber including line plot, strip, and prism cruising. DOK 2, AE, AN, AP
2. Plan and conduct a timber cruise. DOK 3, AE, AN, AP a. Prepare cruise layouts, including drawing of a diagram describing a 10% sample systematic grid. b. Conduct timber cruises and determine tract volume and values, including 10%, 20%, and 100% samples. c. Discuss and perform point sampling.

Scenario

Cruise Types

Unit 13

A local landowner wants to know which cruise method is best for calculating his profits. Conduct a field exercise to participate in timber cruising. You and your crew (each group) will conduct a cruise of a given tract of timber. You will calculate the board footage on the tract and compare their findings to the groups. Each group will be given one of the following cruise types: fixed radius plot, point sampling, strip cruise, or 100%.

Attachments for Scenario

See the conducting a timber cruise rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 14: Timber Marketing

Competencies and Suggested Objectives
1. Explain timber marketing procedures. DOK 2, AB,AE, AN a. Define terms associated with timber marketing, including compliance, management prescriptions, grantee, and grantor. b. Describe marketing practices for selling at the highest return, including marking, estimating timber, determining the value of timber, and selling the timber for the highest price. c. Identify potential markets, including pulp-paper mills, post mill, sawmill, specialty markets, export markets, firewood sales, and distance to these markets. d. Describe how to determine the highest value of a timber stand, including preparing a prospectus and a timber sale contract.
2. Describe conditions of sale and harvesting of timber. DOK 2, AB,AE, AN a. Describe legal documents used in the sale and harvesting of timber, including the prospectus, timber sale contract, timber deed, and harvesting contract. b. Describe desirable post-harvest land conditions which may be specified in a harvesting contract. c. Describe logistics of transporting timber to markets, including the effect upon the price received by the producer.

Scenario

Let's Make A Deal

Unit 14

You are a forester for a large paper company. You have been tasked with cruising a large tract of land. In this process, you must prepare the legal documents used in the sale and harvesting of this tract (i.e. prospectus, timber sale contract, timber deed, and harvesting contract). Within this set of documents, the land owner has request a post-harvest land condition line be placed in the harvest contract which will describe the conditions of the property at close of harvest. Also, your company requires you provide

information about logistics, transportation, and their effects on timber prices. These reports will be presented to the Head Forester (instructor) and will be evaluated by the report rubric.

Attachments for Scenario

See the written report rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 15: Timber Harvesting

Competencies and Suggested Objectives
1. Explain timber harvesting procedures. DOK 2, AE, AN, AP a. Define terms associated with timber harvesting, including harvesting layout, BMPs and SMZs, felling, topping, bunching, skidding, merchandising, loading, and hauling. b. Describe the methods of harvesting timber, including selection, seed-tree, shelterwood, clear-cut, and row thining. c. Identify the products of harvesting, including pulpwood, sawlogs, and specialty wood products.
2. Develop a timber harvesting plan. DOK 3, AE, AN, AP a. Identify types of harvesting equipment, including saws, fellerbunchers, pre-haulers, skidders, whole tree chippers, loaders, and hauling vehicles. b. Observe timber harvesting operations, including forest management practices of pulpwood and sawlogs. c. Describe desirable post-harvesting land conditions, including condition of non-merchantable timber, dead trees, treetops, soil cover, and damage caused by logging equipment. d. Develop a simple harvesting plan for a given tract of timber.

Scenario

Tell Me All About It

Unit 15

As an upstart logging company, you are in search of the best harvesting methods. Research and prepare a report on methods of harvesting timber, including selection, seed-tree, shelterwood, clear-cut, and mechanical. The written report rubric will be used to evaluate the report describing the methods of harvesting timber.

Attachments for Scenario

See the written report rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Tell Me All About It

Unit 15

Based on the methods you researched above, select a harvesting method and develop a harvesting plan for a tract of land you are bidding on. The plan will be presented to the landowner (instructor) for evaluation using the presentation and/or report rubric.

Attachments for Scenario

See the written report rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 16: Reforestation

Competencies and Suggested Objectives
1. Explain reforestation practices. DOK 2, AE, AN, AP a. Define reforestation terms, including planting tools, methods of seeding, and site preparation. b. Identify the sources of tree seedlings. c. Describe the methods of handling seedlings, including plant as soon as possible, heel in, and keep in cold storage. d. Describe the methods of planting, including direct seeding, hand planting, and machine planting. e. Describe the different types of site preparation, including roll chop, shearing, burning, chemical, piling, and bedding. f. Describe the types of reforestation, including artificial and natural means. g. Describe the economics of reforestation. h. Identify federal and state reforestation programs available locally.
2. Perform reforestation practices. DOK 2, AE, AN, AP a. Plant seedlings, including using all available methods. b. Perform a compliance check, including carrying out a standard Mississippi Forestry Commission compliance check. c. Calculate number of seedlings per acre and associated costs needed for reforestation.

Scenario

Reforestation

Unit 16

Divide the class into groups and have them use the Internet or textbook to research reforestation practices. Have students summarize their findings into fact sheets and distribute to the class.

Attachments for Scenario

None

How Are Those Seedlings?

Unit 16

You are a crew foreman on a reforestation job. Demonstrate to your crew (fellow class members) seedling planting techniques. After the project is completed, demonstrate procedures for conducting a compliance check to evaluate the planting efforts.

Attachments for Scenario

None

Unit 17: Forest Fire Management

Competencies and Suggested Objectives
1. Explain forest fire management practices. DOK 2, AE, AN a. Define the terms associated with forest fires, including types of fires, behavior, fuels, controls, and weather conditions. b. Identify the elements of the fire triangle, including heat, fuel, and oxygen. c. Identify the classes of fires, including ground, surface, and crown. d. Identify the methods of attack, including direct and indirect. e. Identify firefighting tools according to their uses, including rakes, swatters, cutting tools, back pack sprayer, drip torch, and fire plows.
2. Apply forest fire management techniques. DOK 3, AE, AN a. Develop a prescribed burning plan, including fire lanes, weather conditions, wind speed and direction, timber type, fuel conditions, manpower, and procedures for obtaining permission to burn.

b. Develop a forest fire prevention plan, including fire lanes, section roads, prescribed burning, and emergency notification procedures.

Scenario

Fire, Fire, Fire

Unit 17

As a county forester, you have been asked to develop a prescribed burning plan for your service area. Create a report discussing the common elements of a prescribed burn plan to present to the county supervisors (instructor and class). In your presentation, be prepared to demonstrate the use of firefighting tools and procedures.

Attachments for Scenario

See the written report rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 18: Forest Insects and Diseases

Competencies and Suggested Objectives

1. Identify and discuss forest insects and diseases. DOK 2, AE, AN, AP

   a. Define the terms associated with forest insects and diseases, including wood damage, leaf eaters, wood eaters, epidemic, predator, habitat, diseases, and signs of damage.

   b. Identify the common insects and diseases that affect the forestry industry.

   INSECTS

   i. Southern Pine Beetle
   ii. Ips Engraver Beetle
   iii. Black Turpentine Beetle
   iv. Nan Tucket Pine Tip Moth
   v. Fall Web Worm
   vi. Forest Tent Caterpillar
   vii. Pales Weevil
   viii. Locust Leafminer
   ix. Bag Worm
   x. Gypsy Moth

   DISEASE

   xi. Brown Spot Needle Blight
   xii. Cedar Apple Gall Rust
   xiii. Needle Cast
   xiv. Heart Rot
   xv. Oak Leaf Wilt
   xvi. Verticillium Wilt
   xvii. Annosus Root Rot
   xviii. Fusiform Rust
   xix. Black Knot Fungus
   xx. Mistletoe

   c. Identify insect and disease damage, including comparing the damage observed to the insect that caused the damage.

   d. Identify the insect or disease with the symptoms of damage, including leaf eaters, wood eaters, sap eaters, phloem eaters, core borers, root feeders, and terminal feeders.

2. Discuss control methods of forest insects and diseases. DOK 2, AE, AN, AP

   a. Describe the various methods used to control insects and diseases, including direct control and indirect control.

~~b. Identify the reasons for identifying insect and disease damage, including prevention of epidemics and loss of timber volume.~~

~~c. Describe aerial forest detection procedures, including those for insect and disease problems.~~

Scenario

Insects, Diseases, and Trees, Oh my!

Unit 18

Students will collect photos of various timber insects, diseases, and associated damage. This collection should include scientific names, common names, development stages, and control methods for each.

Attachments for Scenario

None

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Forestry I **Unit 1: Exploring the World of Forestry**		
	1.	Explain the importance of forestry.
	2.	Explain careers in the field of forestry.
Unit 2: Leadership/FFA Activities		
	1.	Explain the benefits of FFA participation.
	2.	Demonstrate group leadership skills.
Unit 3: Forest Safety		
	1.	Explain forest safety practices.
	2.	Describe forest environmental hazards, including heat, cold, plants, insects, wildlife, and topographical hazards.
	3.	Demonstrate forest safety practices.
Unit 4: Tree Growth and Stand Development		
	1.	Explain tree physiology.
	2.	Explain forest stand development.
	3.	Discuss advances in biotechnology for forestry applications.
Unit 5: Dendrology		
	1.	Explain the tree classification system.

	2.	Identify trees by characteristics.
Unit 6: Forest Surveying and Mapping		
	1.	Explain concepts of forest surveying.
	2.	Perform forestry surveying and mapping techniques.
	3.	Calculate acreage of forest tracts.
Unit 7: Legal Land Descriptions		
	1.	Describe the United States Public Land Survey System.
	2.	Identify information found on maps.
	3.	Apply principles of legal land description.
Unit 8: Tree and Log Measurements		
	1.	Explain tree measurement techniques.
	2.	Perform volume measurement of standing timber and sawlogs.
Unit 9: Introduction to Timber Cruising		
	1.	Describe procedures for cruising timber.
	2.	Perform timber cruising.
Forestry II **Unit 10: Identifying Forests and Forest Products**		
	1.	Apply procedures to identify forest types.
	2.	Apply procedures to identify the physical properties of wood.
Unit 11: Employability Skills/FFA Activities		
	1.	Develop employability skills.
	2.	Identify FFA leadership activities associated with forestry.
Unit 12: Forest Management Practices		
	1.	Explain forest management practices.
	2.	Apply forest management practices.
Unit 13: Advanced Timber Cruising		

	1.	Describe the different types of sampling techniques used in measuring standing timber including line plot, strip, and prism cruising.
	2.	Plan and conduct a timber cruise.
Unit 14: Timber Marketing		
	1.	Explain timber marketing procedures.
	2.	Describe conditions of sale and harvesting of timber.
Unit 15: Timber Harvesting		
	1.	Explain timber harvesting procedures.
	2.	Develop a timber harvesting plan.
Unit 16: Reforestation		
	1.	Explain reforestation practices.
	2.	Perform reforestation practices.
Unit 17: Forest Fire Management		
	1.	Explain forest fire management practices.
	2.	Apply forest fire management techniques.
Unit 18: Forest Insects and Diseases		
	1.	Identify and discuss forest insects and diseases.
	2.	Discuss control methods of forest insects and diseases.

Appendix A: Unit References

All of the Forestry references listed under General Books and Trade Publications are used for multiple units. Unit-specific references are listed under the appropriate unit number.

General Books and Trade Publications

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The list below shows the different sources used in each unit.

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Appendix B: Industry Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY

CONTENT STANDARDS AND PERFORMANCE ELEMENTS

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
AFNR										
AB - AGRIBUSINESS SYSTEMS										
AS - ANIMAL SYSTEMS										
AO - BIOTECHNOLOGY					X					
AE - ENVIRONMENTAL SERVICE SYSTEMS		X		X	X	X	X	X	X	X
AF - FOOD PRODUCTS AND PROCESSING SYSTEMS										
AN - NATURAL RESOURCE SYSTEMS		X		X	X	X	X	X	X	X
AP - PLANT SYSTEMS				X	X	X				X
AT - POWER, STRUCTURAL, AND TECHNICAL SYSTEMS										
CS - LIFEKNOWLEDGE* AND CLUSTER SKILLS		X	X	X						
	Units	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18

AFNR										
AB - AGRIBUSINESS SYSTEMS						X				
AS - ANIMAL SYSTEMS										
AO - BIOTECHNOLOGY										
AE - ENVIRONMENTAL SERVICE SYSTEMS		X		X	X	X	X	X	X	X
AF - FOOD PRODUCTS AND PROCESSING SYSTEMS										
AN - NATURAL RESOURCE SYSTEMS		X		X	X	X	X	X	X	X
AP - PLANT SYSTEMS		X		X	X		X	X		X
AT - POWER, STRUCTURAL, AND TECHNICAL SYSTEMS										
CS - LIFEKNOWLEDGE[2] AND CLUSTER SKILLS			X							

AB - AGRIBUSINESS SYSTEMS

AE - ENVIRONMENTAL SERVICE SYSTEMS

AF - FOOD PRODUCTS AND PROCESSING SYSTEMS

AN - NATURAL RESOURCE SYSTEMS

AO - BIOTECHNOLOGY

AP - PLANT SYSTEMS

AS – ANIMAL SYSTEMS

AT – POWER, STRUCTURAL, AND TECHNICAL SYSTEMS

CS – LIFEKNOWLEDGE® AND CLUSTER SKILLS

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AB – AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.

ABS.01.01. Apply principles of capitalism in the business environment.

ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.

ABS.02.01. Compose and analyze a business plan for an enterprise.

ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.

ABS.02.03. Apply appropriate management skills to organize a business.

ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.

ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.

ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.

ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.

ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.

ABS.06.01. Conduct appropriate market and marketing research.

ABS.06.02. Develop a marketing plan.

ABS.06.03. Develop strategies for marketing plan implementation.

ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.

ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.

ABS.07.02. Develop a production and operational plan.

ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.

ABS.07.04. Manage risk and uncertainty.

AS - ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals.

AS.01. Examine the components, historical development, global implications, and future trends of the animal systems industry.

AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution.

AS.02. Classify, evaluate, select, and manage animals based on anatomical and physiological characteristics.

AS.02.01. Classify animals according to hierarchical taxonomy and agricultural use.

AS.02.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.02.03. Select animals for specific purposes and maximum performance based on anatomy and physiology.

AS.03. Provide for the proper health care of animals.

AS.03.01. Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.

AS.03.02. Provide for the biosecurity of agricultural animals and production facilities.

AS.04. Apply principles of animal nutrition to ensure the proper growth, development, reproduction, and economic production of animals.

AS.04.01. Formulate feed rations to provide for the nutritional needs of animals.

AS.04.02. Prescribe and administer animal feed additives and growth promotants in animal production.

AS.05. Evaluate and select animals based on scientific principles of animal production.

AS.05.01. Evaluate the male and female reproductive systems in selecting animals.

AS.05.02. Evaluate animals for breeding readiness and soundness.

AS.05.03. Apply scientific principles in the selection and breeding of animals.

AS.06. Prepare and implement animal handling procedures for the safety of animals and producers and consumers of animal products.

AS.06.01. Demonstrate safe animal handling and management techniques.

AS.06.02. Implement procedures to ensure that animal products are safe.

AS.07. Select animal facilities and equipment that provide for the safe and efficient production, housing, and handling of animals.

AS.07.01. Design animal housing, equipment, and handling facilities for the major systems of animal production.

AS.07.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.08. Analyze environmental factors associated with animal production.

AS.08.01. Reduce the effects of animal production on the environment.

AS.08.02. Evaluate the effects of environmental conditions on animals.

~~AO - BIOTECHNOLOGY~~

~~Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.~~

~~**BS.01. Recognize the historical, social, cultural, and potential applications of biotechnology.**~~

~~BS.01.01. Distinguish major innovators, historical developments, and potential applications of biotechnology in agriculture.~~

~~BS.01.02. Determine regulatory issues, and identify agencies associated with biotechnology.~~

~~BS.01.03. Analyze the ethical, legal, social, and cultural issues relating to biotechnology.~~

~~**BS.02 Demonstrate laboratory skills as applied to biotechnology.**~~

~~BS.02.01. Maintain and interpret biotechnology laboratory records.~~

~~BS.02.02. Operate biotechnology laboratory equipment according to standard procedures.~~

~~BS.02.03. Demonstrate proper laboratory procedures using biological materials.~~

~~BS.02.04. Safely manage biological materials, chemicals, and wastes used in the laboratory.~~

~~BS.02.05. Perform microbiology, molecular biology, enzymology, and immunology procedures.~~

~~**BS.03. Demonstrate the application of biotechnology to Agriculture, Food, and Natural Resources (AFNR).**~~

~~BS.03.01. Evaluate the application of genetic engineering to improve products of AFNR systems.~~

~~BS.03.02. Perform biotechnology processes used in AFNR systems.~~

~~BS.03.03. Use biotechnology to monitor and evaluate procedures performed in AFNR systems.~~

~~AE - ENVIRONMENTAL SERVICE SYSTEMS~~

~~Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.~~

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

ESS.03.01. Apply meteorology principles to environmental service systems.

ESS.03.02. Apply soil science principles to environmental service systems.

ESS.03.03. Apply hydrology principles to environmental service systems.

ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.

ESS.03.05. Apply chemistry principles to environmental service systems.

ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

ESS.04.01. Use pollution control measures to maintain a safe facility environment.

ESS.04.02. Manage safe disposal of all categories of solid waste.

ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.

ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.

ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

AF – FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

AN - NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.

NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.

NRS.02.03. Measure and survey natural resource status to obtain planning data.

NRS.02.04. Demonstrate natural resource enhancement techniques.

NRS.02.05. Interpret laws related to natural resource management and protection.

NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.

NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.

NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

AP – PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.

PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.

PS.02.02. Prepare growing media for use in plant systems.

PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.

PS.03.02. Develop and implement a plant management plan for crop production.

PS.03.03. Develop and implement a plan for integrated pest management.

PS.03.04. Apply principles and practices of sustainable agriculture to plant production.

PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

AT – POWER, STRUCTURAL, AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.

PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.

PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.

PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.

PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.

PST.03.03. Service and repair hydraulic and pneumatic systems.

PST.03.04. Troubleshoot and service electrical systems.

PST.03.05. Service vehicle heating and air-conditioning systems.

PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build, and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.

PST.04.02. Apply structural plans, specifications, and building codes.

PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.

PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.

PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.

PST.05.03. Use geospatial technologies in agricultural applications.

CS - LifeKnowledge® and Cluster Skills

Pathway Content Standard: The student will demonstrate competence in the application of leadership, personal growth and career success skills necessary for a chosen profession while effectively contributing to society.

CS.01. Acquire the skills necessary to positively influence others.

CS.01.01. Exhibit the skills and competencies needed to achieve a desired result..

CS.01.02. Build a constituency through listening, coaching, understanding and appreciating others.

CS.01.03. Establish a clear image of what the future should look like.

CS.01.04. Conduct professional and personal activities based on virtues.

CS.01.05 Desire purposeful understanding related to professional and personal activities.

CS.01.06 Pursue learning and growth opportunities related to professional and personal aspirations.

CS.02. Develop a skill set to enhance the positive evolution of the whole person.

CS.02.01. Address personal health by understanding, respecting and managing your body's needs.

CS.02.02. Interact with others in a manner that respects the differences of a diverse and changing society.

CS.02.03 Develop awareness and apply skills necessary for achieving career success.

CS.02.04 Demonstrate the effective application of reasoning, thinking, and coping skills.

CS.02.05 Demonstrate healthy responses to one's feelings.

CS.03. Demonstrate those qualities, attributes and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society.

CS.03.01. Demonstrate oral, written and verbal skills.

CS.03.02. Analyze situations and execute an appropriate course of action.

CS.03.03. Describe traits that enable one to be capable and willing to accept change.

CS.04. Examine roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment.

CS.04.01. Examine performance and goals to appreciate organizations and industries within AFNR.

CS.05. Apply technology principles in the use of agricultural technical systems.

CS.05.01. Manage organizational structures and processes to better serve customers.

CS.05.02. Examine the components of the AFNR systems and address their maintenance requirements.

CS.05.03. Research geographical data related to AFNR systems.

CS.06. Examine the importance of health, safety, and environmental management systems in organizations and their importance to performance and regulatory compliance.

CS.06.01. Observe required regulations to maintain/improve safety, health and environmental management systems.

CS.06.02. Develop a plan to maintain and improve health, safety and environmental compliance and performance.

CS.06.03 Provide health, safety, and environmental operating guidelines.

CS.06.04 Examine health risks associated with a particular skill to better develop personnel safety guidelines.

CS.07. Safety, Health, and Environmental: Demonstrate appropriate health and safety procedures for AFNR occupations.

CS.07.01. Apply safety/health practices to AFNR worksites.

CS.07.02. Demonstrate recognized first aid knowledge and procedures to show how they are used by AFNR industries.

CS.07.03 Follow appropriate procedures in case of an emergency.

CS.07.04 Assess workplace safety.

CS.08. Use tools, equipment, machinery and technology appropriate to work within areas related to AFNR.

CS.08.01. Evaluate and select the appropriate tool to perform a given task.

CS.08.02. Use appropriate protective equipment and handle AFNR tools and equipment to demonstrate safe and proper use of the tools and equipment.

CS.08.03 Maintain tools for efficient use.

CS.09. Compare and contrast issues affecting the AFNR industry.

CS.09.01. Apply economic principles to AFNR systems (e.g., supply, demand and profit).

CS.09.02. Apply skills with computer software to accomplish a variety of business activities.

CS.09.03 Use technology to demonstrate the ability to network and interface with technology.

CS.10. Envision emerging technology and globalization to project its influence on widespread markets.

CS.10.01. Examine new technologies to project their impact in the global market of AFNR.

CS.10.02. Relate technology advancements to the need for Continuing Education/Career Development.

CS.11. Utilize scientific inquiry as an investigative method.

CS.11.01. Recognize the questions and theory needed to guide scientific investigations.

CS.11.02. Design and conduct a scientific

Appendix C: 21st Century Skills[1]

21st Century Crosswalk for Forestry										
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
21st Century Standards										
CS1										
CS2										
CS3			X							
CS4										
CS5		X		X	X	X	X	X	X	X
CS6			X	X		X	X	X	X	X
CS7			X	X		X	X	X	X	X
CS8		X	X	X		X	X	X	X	X
CS9		X	X		X	X	X	X	X	X
CS10		X	X		X	X	X	X	X	X
CS11		X	X		X	X	X	X	X	X
CS12			X	X	X	X	X	X	X	X
CS13			X	X	X	X	X	X	X	X
CS14			X	X	X	X	X	X	X	X
CS15			X	X	X	X	X	X	X	X
CS16			X	X	X	X	X	X	X	X
		Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
CS1			X			X				
CS2		X				X				
CS3										
CS4			X							
CS5			X	X	X	X	X	X	X	X
CS6		X	X	X	X	X	X	X	X	X

[1] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

CS7		X	X	X	X	X	X	X	X	X
CS8		X	X	X	X	X	X	X	X	X
CS9		X	X	X	X	X	X	X	X	X
CS10		X	X	X	X	X	X	X	X	X
CS11		X	X	X	X	X	X	X	X	X
CS12		X	X	X	X	X	X	X	X	X
CS13		X	X	X	X	X	X	X	X	X
CS14		X	X	X	X	X	X	X	X	X
CS15		X	X	X	X	X	X	X	X	X
CS16		X		X	X	X	X	X	X	X

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2 Learning and Innovation Skills

CS6 Creativity and Innovation
1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving
1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration
1. Communicate Clearly
2. Collaborate with Others

CSS3 Information, Media and Technology Skills

CS9 Information Literacy
1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy
1. Analyze Media
2. Create Media Products

CS11 ICT Literacy
1. Apply Technology Effectively

CSS4 Life and Career Skills

CS12 Flexibility and Adaptability
1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction
1. Manage Goals and Time

2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix D: Common Core Standards

Common Core Crosswalk for English/Language Arts (11-12)											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
Common Core Standards											
RL.11.1.		X			X	X	X	X	X	X	X
RL.11.2.		X			X	X	X	X	X	X	X
RL.11.3.		X			X	X	X	X	X	X	X
RL.11.4.		X			X	X	X	X	X	X	X
RL.11.5.		X			X	X	X	X	X	X	X
RL.11.6.		X			X	X	X	X	X	X	X
RL.11.7.											
RL.11.8.											
RL.11.9.											
RL.11.10.											
RI.11.1.											
RI.11.2.											
RI.11.3.											
RI.11.4.											
RI.11.5.											
RI.11.6.											
RI.11.7.											
RI.11.8.											
RI.11.9.											
RI.11.10.											
W.11.1.											
W.11.2.											
W.11.3.											
W.11.4.		X			X	X	X	X	X	X	X
W.11.5.		X			X	X	X	X	X	X	X
W.11.6.		X			X	X	X	X	X	X	X

W.11.7.		X			X	X	X	X	X	X	X
W.11.8.		X			X	X	X	X	X	X	X
W.11.9.		X			X	X	X	X	X	X	X
W.11.10.											
SL.11.1.		X			X	X	X	X	X	X	X
SL.11.2.		X			X	X	X	X	X	X	X
SL.11.3.		X			X	X	X	X	X	X	X
SL.11.4.		X			X	X	X	X	X	X	X
SL.11.5.		X			X	X	X	X	X	X	X
SL.11.6.		X			X	X	X	X	X	X	X
L.11.1.		X			X	X	X	X	X	X	X
L.11.2.		X			X	X	X	X	X	X	X
L.11.3.		X			X	X	X	X	X	X	X
L.11.4.		X			X	X	X	X	X	X	X
L.11.5.		X			X	X	X	X	X	X	X
L.11.6.		X			X	X	X	X	X	X	X
RH.11.1.											
RH.11.2.											
RH.11.3.											
RH.11.4.											
RH.11.5.											
RH.11.6.											
RH.11.7.											
RH.11.8.											
RH.11.9.											
RH.11.10.											
RST.11.1.		X			X	X	X	X	X	X	X
RST.11.2.		X			X	X	X	X	X	X	X
RST.11.3.		X			X	X	X	X	X	X	X
RST.11.4.		X			X	X	X	X	X	X	X
RST.11.5.		X			X	X	X	X	X	X	X
RST.11.6.		X			X	X	X	X	X	X	X

RST.11.7.		X			X	X	X	X	X	X	X
RST.11.8.		X			X	X	X	X	X	X	X
RST.11.9.		X			X	X	X	X	X	X	X
RST.11.10.		X			X	X	X	X	X	X	X
WHST.11.1.		X			X	X	X	X	X	X	X
WHST.11.2.		X			X	X	X	X	X	X	X
WHST.11.3.		X			X	X	X	X	X	X	X
WHST.11.4.		X			X	X	X	X	X	X	X
WHST.11.5.		X			X	X	X	X	X	X	X
WHST.11.6.		X			X	X	X	X	X	X	X
WHST.11.7.		X			X	X	X	X	X	X	X
WHST.11.8.		X			X	X	X	X	X	X	X
WHST.11.9.		X			X	X	X	X	X	X	X
WHST.11.10.		X			X	X	X	X	X	X	X

Common Core Crosswalk for English/Language Arts (11-12)

	Units	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18		
Common Core Standards											
RL.11.1.		X			X	X	X	X	X		
RL.11.2.		X			X	X	X	X	X		
RL.11.3.		X			X	X	X	X	X		
RL.11.4.		X			X	X	X	X	X		
RL.11.5.		X			X	X	X	X	X		
RL.11.6.		X			X	X	X	X	X		
RL.11.7.											
RL.11.8.											
RL.11.9.											
RL.11.10.											
RI.11.1.											
RI.11.2.											
RI.11.3.											
RI.11.4.											

~~RI.11.5.~~											
~~RI.11.6.~~											
~~RI.11.7.~~											
~~RI.11.8.~~											
~~RI.11.9.~~											
~~RI.11.10.~~											
~~W.11.1.~~											
~~W.11.2.~~											
~~W.11.3.~~											
~~W.11.4.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~W.11.5.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~W.11.6.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~W.11.7.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~W.11.8.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~W.11.9.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~W.11.10.~~											
~~SL.11.1.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~SL.11.2.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~SL.11.3.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~SL.11.4.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~SL.11.5.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~SL.11.6.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~L.11.1.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~L.11.2.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~L.11.3.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~L.11.4.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~L.11.5.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~L.11.6.~~		~~X~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~RH.11.1.~~											
~~RH.11.2.~~											
~~RH.11.3.~~											
~~RH.11.4.~~											

RH.11.5.											
RH.11.6.											
RH.11.7.											
RH.11.8.											
RH.11.9.											
RH.11.10.											
RST.11.1.		X			X	X	X	X	X		
RST.11.2.		X			X	X	X	X	X		
RST.11.3.		X			X	X	X	X	X		
RST.11.4.		X			X	X	X	X	X		
RST.11.5.		X			X	X	X	X	X		
RST.11.6.		X			X	X	X	X	X		
RST.11.7.		X			X	X	X	X	X		
RST.11.8.		X			X	X	X	X	X		
RST.11.9.		X			X	X	X	X	X		
RST.11.10.		X			X	X	X	X	X		
WHST.11.1.		X			X	X	X	X	X		
WHST.11.2.		X			X	X	X	X	X		
WHST.11.3.		X			X	X	X	X	X		
WHST.11.4.		X			X	X	X	X	X		
WHST.11.5.		X			X	X	X	X	X		
WHST.11.6.		X			X	X	X	X	X		
WHST.11.7.		X			X	X	X	X	X		
WHST.11.8.		X			X	X	X	X	X		
WHST.11.9.		X			X	X	X	X	X		
WHST.11.10.		X			X	X	X	X	X		

Reading Standards for Literature (11-12)

College and Career Readiness Anchor Standards for *Reading Literature*

Key Ideas and Details

RL.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RL.11.2. Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

RL.11.3. Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4. Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)

RL.11.5. Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.

RL.11.6. Analyze a case in which grasping point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7. Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)

RL.11.8. (Not applicable to literature)

RL.11.9. Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10. By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Informational Text (11-12)

College and Career Readiness Anchor Standards for *Informational Text*

Key Ideas and Details

RI.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RI.11.2. Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

RI.11.3. Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure

RI.11.4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RI.11.5. Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.

RI.11.6. Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness, or beauty of the text.

Integration of Knowledge and Ideas

RI.11.7. Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

RI.11.8. Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).

RI.11.9. Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including The Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity

RI.11.10. By the end of grade 11, read and comprehend literary nonfiction in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11–CCR text complexity band independently and proficiently.

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

W.11.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from and supports the argument presented.

W.11.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

W.11.3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

a. Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.

b. Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters

c. Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).

d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

W.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12 on page 54.)

W.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

W.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

W.11.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

a. Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").

b. Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

College and Career Readiness Anchor Standards for *Speaking and Listening*

Comprehension and Collaboration

SL.11.1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SL.11.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11.3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4. Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

SL.11.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11.6. Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 on page 54 for specific expectations.)

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

L.11.1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

a. Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

b. Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

L.11.2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

a. Observe hyphenation conventions.

b. Spell correctly.

~~Knowledge of Language~~

~~L.11.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.~~

~~a. Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.~~

~~Vocabulary Acquisition and Use~~

~~L.11.4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.~~

~~a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.~~

~~b. Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).~~

~~c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.~~

~~d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).~~

~~L.11.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.~~

~~a. Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.~~
~~b. Analyze nuances in the meaning of words with similar denotations.~~

~~L.11.6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.~~

Reading Standards for Literacy in History/Social Studies (11-12)

Key Ideas and Details

RH.11.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

RH.11.2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas

RH.11.3. Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain

Craft and Structure

RH.11.4. Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RH.11.5. Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

RH.11.6. Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.

Integration of Knowledge and Ideas

RH.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

RH.11.8. Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

RH.11.9. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Range of Reading and Level of Text Complexity

RH.11.10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Literacy in Science and Technical Subjects (11-12)

Key Ideas and Details

RST.11.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

RST.11.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

RST.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

RST.11.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–*CCR* text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (11-12)

Text Types and Purposes

WHST.11.1. Write arguments focused on discipline-specific content.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST.11.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11.3. (Not applicable as a separate requirement)

Production and Distribution of Writing

WHST.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

WHST.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

~~WHST.11.9. Draw evidence from informational texts to support analysis, reflection, and research.~~

~~Range of Writing~~

~~WHST.11.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.~~

Common Core Crosswalk for Mathematics (11-12)											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
Common Core Standards											
N-RN.1.											
N-RN.2.											
N-RN.3.											
N-Q.1.							X			X	
N-Q.2.											
N-Q.3.											
N-CN.1.											
N-CN.2.											
N-CN.3.											
N-CN.4.											
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N-CN.9.											
N-VM.1.											
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N-VM.3.											
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N-VM.9.											
N-VM.10.											
N-VM.11.											
N-VM.12.											
A-SSE.1.											

~~A-SSE.2.~~											
~~A-SSE.3.~~											
~~A-SSE.4.~~											
~~A-APR.1.~~											
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~~A-CED.1.~~											
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~~A-CED.3.~~											
~~A-CED.4.~~											
~~A-REI.1.~~							~~X~~		~~X~~	~~X~~	
~~A-REI.2.~~							~~X~~		~~X~~	~~X~~	
~~A-REI.3.~~							~~X~~		~~X~~	~~X~~	
~~A-REI.4.~~							~~X~~		~~X~~	~~X~~	
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~~F-TF.8.~~							~~X~~		~~X~~	~~X~~	
~~F-TF.9.~~											
~~G-CO.1.~~							~~X~~		~~X~~	~~X~~	
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~~Common Core Crosswalk for Mathematics (11-12)~~

	~~Units~~	~~Unit 11~~	~~Unit 12~~	~~Unit 13~~	~~Unit 14~~	~~Unit 15~~	~~Unit 16~~	~~Unit 17~~	~~Unit 18~~		
~~Common Core Standards~~											
~~N-RN.1.~~											
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~~N-RN.3.~~											
~~N-Q.1.~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~				
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~~Mathematics (High School)~~

~~Number and Quantity~~

~~The Real Number System~~

~~N-RN.1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.~~

~~N-RN.2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.~~

~~N-RN.3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.~~

~~Quantities~~

~~N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.~~

~~N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.~~

~~N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.~~

~~The Complex Number System~~

~~N-CN.1. Know there is a complex number i such that i2= −1, and every complex number has the form a + bi with a and b real.~~

~~N-CN.2. Use the relation i2= −1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.~~

~~N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.~~

~~N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.~~

~~N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, (−1 + √3 i)3= 8 because (−1 + √3 i) has modulus 2 and argument 120°.~~

~~N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.~~

~~N-CN.7. Solve quadratic equations with real coefficients that have complex solutions.~~

~~N-CN.8. (+) Extend polynomial identities to the complex numbers. For example, rewrite x2+ 4 as (x + 2i)(x − 2i).~~

~~N-CN.9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.~~

~~Vector and Matrix Quantities~~

~~N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).~~

~~N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.~~

~~N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.~~

~~N-VM.4. (+) Add and subtract vectors~~

~~N-VM.4.a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.~~

~~N-VM.4.b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.~~

~~N-VM.4.c. Understand vector subtraction v − w as v + (−w), where −w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.~~

~~N-VM.5. (+) Multiply a vector by a scalar.~~

~~N-VM.5.a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy).~~

~~N-VM.5.b. Compute the magnitude of a scalar multiple cv using $\|cv\| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).~~

~~N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.~~

~~N-VM.7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.~~

~~N-VM.8. (+) Add, subtract, and multiply matrices of appropriate dimensions.~~

~~N-VM.9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties~~

~~N-VM.10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.~~

~~N-VM.11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.~~

N-VM.12. (+) Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra

Seeing Structure in Expressions

A-SSE.1. Interpret expressions that represent a quantity in terms of its context.

A-SSE.1.a. Interpret parts of an expression, such as terms, factors, and coefficients.

A-SSE.1.b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

A-SSE.2. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-SSE.3.a. Factor a quadratic expression to reveal the zeros of the function it defines.

A-SSE.3.b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

A-SSE.3.c. Use the properties of exponents to transform expressions for exponential functions.

A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.

~~Arithmetic with Polynomials and Rational Expressions~~

~~A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials~~

~~A-APR.2. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).~~

~~A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.~~

~~A-APR.4. Prove polynomial identities and use them to describe numerical relationships.~~

~~A-APR.5. (+) Know and apply the Binomial Theorem for the expansion of (x+ y)n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.~~

~~A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x)in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.~~

~~A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.~~

~~Creating Equations~~

~~A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.~~

A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

A-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V =IR to highlight resistance R.

Reasoning with Equations and Inequalities

A-REI.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

A-REI.4. Solve quadratic equations in one variable.

A-REI.4.a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x − p)2= q that has the same solutions. Derive the quadratic formula from this form.

A-REI.4.b. Solve quadratic equations by inspection (e.g., for x2= 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

A-REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = −3x and the circle x2+y2= 3.

A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.

A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

A-REI.12.Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Interpreting Functions

F-IF.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

~~F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.~~

~~F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.~~

~~F-IF.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a~~

~~factory, then the positive integers would be an appropriate domain for the function.~~

~~F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.~~

~~F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.~~

~~F-IF.7.a. Graph linear and quadratic functions and show intercepts, maxima, and minima.~~

~~F-IF.7.b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.~~

~~F-IF.7.c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.~~

~~F-IF.7.d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.~~

F-IF.7.e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

F-IF.8.a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.8.b. Use the properties of exponents to interpret expressions for exponential functions.

F-IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Building Functions

F-BF.1. Write a function that describes a relationship between two quantities.

F-BF.1.a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.1.b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.1.c. (+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a

function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

F-BF.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4. Find inverse functions.

F-BF.4.a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse.

F-BF.4.b. (+) Verify by composition that one function is the inverse of another.

F-BF.4.c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.

F-BF.4.d. (+) Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Linear, Quadratic, and Exponential Models

F-LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

F-LE.1.a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.

F-LE.1.b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

F-LE.1.c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another

F-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

F-LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

F-LE.4. For exponential models, express as a logarithm the solution to ab ct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

F-LE.5. Interpret the parameters in a linear or exponential function in terms of a context.

Trigonometric Functions

F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π−x, π+x, and 2π−x in terms of their values for x, where x is any real number.

F-TF.4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.

F-TF.8. Prove the Pythagorean identity sin2 (θ) + cos 2 (θ) = 1 and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle.

F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Congruence

G-CO.1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

~~G-CO.4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.~~

~~G-CO.5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.~~

~~G-CO.6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.~~

~~G-CO.7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.~~

~~G-CO.8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.~~

~~G-CO.9. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.~~

~~G-CO.10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.~~

~~G-CO.11. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.~~

G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Similarity, Right Triangles, and Trigonometry

G-SRT.1. Verify experimentally the properties of dilations given by a center and a scale factor:

G-SRT.1.a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

G-SRT.1.b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2. Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

G-SRT.4. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

G-SRT.6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7. Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

G-SRT.9. (+) Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Circles

G-C.1. Prove that all circles are similar.

G-C.2. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

G-C.4. (+) Construct a tangent line from a point outside a given circle to the circle.

G-C.5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Expressing Geometric Properties with Equations

G-GPE.1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

G-GPE.2. Derive the equation of a parabola given a focus and directrix.

G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

G-GPE.4. Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

G-GPE.6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

Geometric Measurement and Dimension

G-GMD.1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

G-GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

G-GMD.4. Identify the shapes of two-dimensional cross-sections of three dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Modeling with Geometry

G-MG.1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

G-MG.2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Statistics and Probability

Interpreting Categorical and Quantitative Data

~~S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots).~~

~~S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.~~

~~S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).~~

~~S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate.~~

~~Use calculators, spreadsheets, and tables to estimate areas under the normal curve.~~

~~S-ID.5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.~~

~~S-ID.6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.~~

~~S-ID.6.a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.~~

~~S-ID.6.b. Informally assess the fit of a function by plotting and analyzing residuals.~~

~~S-ID.6.c. Fit a linear function for a scatter plot that suggests a linear association.~~

~~S-ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.~~

S-ID.8. Compute (using technology) and interpret the correlation coefficient of a linear fit.

S-ID.9. Distinguish between correlation and causation.

Making Inferences and Justifying Conclusions

S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

S-IC.3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

S-IC.4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

S-IC.5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

S-IC.6. Evaluate reports based on data.

Conditional Probability and the Rules of Probability

S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").

S-CP.2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

S-CP.3. Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

S-CP.4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

S-CP.6. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.

S-CP.7. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.

S-CP.8. (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.

S-CP.9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Using Probability to Make Decisions

S-MD.1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.

S-MD.3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.

~~S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?~~

~~S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.~~

~~S-MD.5.a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.~~

~~S-MD.5.b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.~~

~~S-MD.6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).~~

~~S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).~~

Appendix E: National Educational Technology Standards for Students (NETS-S)

NETS Crosswalk for Agriculture and Natural Resources											
	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
NETS Standards											
T1					X	X	X	X	X	X	X
T2		X	X	X	X	X	X	X	X	X	X
T3		X	X	X	X	X	X	X	X	X	X
T4				X	X	X	X	X	X	X	X
T5		X	X		X	X	X	X	X	X	X
T6		X	X		X	X	X	X	X	X	X
		Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18		
T1			X	X	X	X	X	X	X		
T2		X	X	X	X	X	X	X	X		
T3		X	X	X	X	X	X	X	X		
T4			X	X	X	X	X	X	X		
T5		X	X	X	X	X	X	X	X		
T6		X	X	X	X	X	X	X	X		

T1 – Creativity and Innovation

T2 – Communication and Collaboration

T3 – Research and Information Fluency

T4 – Critical Thinking, Problem Solving, and Decision Making

T5 – Digital Citizenship

T6 – Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.

b. Create original works as a means of personal or group expression.

c. Use models and simulations to explore complex systems and issues.

d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.

b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.

c. Develop cultural understanding and global awareness by engaging with learners of other cultures.

d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.

b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.

d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.

b. Plan and manage activities to develop a solution or complete a project.

c. Collect and analyze data to identify solutions and/or make informed decisions.

d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.

b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.

c. Demonstrate personal responsibility for lifelong learning.

d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.

b. Select and use applications effectively and productively.

c. Troubleshoot systems and applications.

d. Transfer current knowledge to learning of new technologies.

~~Appendix F: Academic Standards~~

~~MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES~~

MS Science Standards for Forestry											
	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
MS Science Standards											
AQ 1											
AQ 2											
AQ 3											
AQ 4											
BIOI 1					X						
BIOI 2					X						
BIOI 3		X			X						X
BIOI 4		X			X						
BIOI 5											
BIOI 6		X			X						X
BIOII 1											
BIOII 2					X						
BIOII 3											
BIOII 4					X						
BIOII 5					X						
BO 1					X	X					
BO 2					X	X					X
BO 3					X	X					
BO 4					X	X					X
BO 5					X						
CHI 1											
CHI 2											
CHI 3											

CHI 4											
CHI 5											
ORGC 1											
ORGC 2											
ORGC 3											
E1											
E2											
E3											
E4		X		X							
E5		X			X						
ES 1											
ES 2		X		X	X						
ES 3				X	X						X
G 1											
G 2											
G 3											
GE1											
GE2											
PS 1											
PS 2											
PS 3											
PS 4											
PS 5											
PHYI 1											
PHYI 2											
PHYI 3											
PHYI 4											
PHYI 5											
PHYI 6											
SP 1							X				
SP 2							X				
ZO 1											

~~ZO 2~~											
~~ZO 3~~											
~~ZO 4~~											
		~~Unit 11~~	~~Unit 12~~	~~Unit 13~~	~~Unit 14~~	~~Unit 15~~	~~Unit 16~~	~~Unit 17~~	~~Unit 18~~		
~~AQ 1~~											
~~AQ 2~~											
~~AQ 3~~											
~~AQ 4~~											
~~BIOI 1~~											
~~BIOI 2~~			~~X~~								
~~BIOI 3~~			~~X~~								
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~~CHI 1~~											
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~~E5~~											
~~ES 1~~							~~X~~		~~X~~		
~~ES 2~~			~~X~~				~~X~~		~~X~~		
~~ES 3~~			~~X~~				~~X~~		~~X~~		
~~G 1~~											
~~G 2~~											
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~~PS 1~~											
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~~PHYI 6~~											
~~SP 1~~											
~~SP 2~~											
~~ZO 1~~									~~X~~		
~~ZO 2~~									~~X~~		
~~ZO 3~~									~~X~~		
~~ZO 4~~									~~X~~		

Marine and Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.

AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.

AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, and so forth
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)

c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

d. Construct and analyze graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

a. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)

b. Explain the causes and characteristics of tides. (DOK 1)

c. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

d. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)

e. Investigate the causes and effects of erosion, and discuss conclusions. (DOK 2)
f. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater
g. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
   - Barrier island, coral reef, tidal pool, and ocean
   - River, stream, lake, pond, and swamp
   - Bay, sound, estuary, and marsh

3. Apply an understanding of the diverse organisms found in aquatic environments.

a. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
   - Adaptations of representative organisms for their aquatic environments
   - Relationship of organisms in food chains/webs within aquatic environments
b. Research, calculate, and interpret population data. (DOK 2)
c. Research and compare reproductive processes in aquatic organisms. (DOK 2)
d. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
e. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
f. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. Draw conclusions about the relationships between human activity and aquatic organisms.

a. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
   - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
   - Effectiveness of a variety of methods of environmental management and stewardship
   - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
b. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
c. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
   - Careers related to aquatic science
   - Modern technology within aquatic science (e.g., mariculture and aquaculture)
   - Contributions of aquatic technology to industry and government

Biology I

BIOI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

BIOI 2 Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

BIOI 3 Investigate and evaluate the interaction between living organisms and their environment.

BIOI 4 Analyze and explain the structures and function of the levels of biological organization.

BIOI 5 Demonstrate an understanding of the molecular basis of heredity.

BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, and so forth
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)

c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)

d. Construct and analyze graphs (e.g., plotting points, labeling *x*- and *y*-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

a. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
   - Subatomic particles and arrangement in atoms
   - Importance of ions in biological processes

b. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)

c. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)

d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
   - Basic chemical composition of each group

- Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
- Basic functions (e.g., energy, storage, cellular, and heredity) of each group

e. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
- Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)

f. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
- ATP function

g. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
- Light-dependent reactions and light-independent reactions in photosynthesis, including requirements and products of each
- Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

a. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, and tropical rainforest). (DOK 2)
- Plant and animal species
- Climate (temperature and rainfall)
- Adaptations of organisms

b. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, and leaves)
- Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
- Roles of beneficial bacteria
- Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

c. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, and consumption of resources). (DOK 2)

4. Analyze and explain the structures and function of the levels of biological organization.

a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], and cytosol)
- Components of mobility (e.g., cilia, flagella, and pseudopodia)

b. Differentiate between types of cellular reproduction. (DOK 1)

- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
- Binary fission (e.g., budding, vegetative propagation, etc.)
- Significance of meiosis in sexual reproduction
- Significance of crossing over

c. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, and types of tissues.) (DOK 1)

d. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials and plant reproduction). (DOK 1)

5. Demonstrate an understanding of the molecular basis of heredity.

a. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
   - Structures of DNA and RNA
   - Processes of replication, transcription, and translation
   - Messenger RNA codon charts

b. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

c. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, and gel electrophoresis). (DOK 2)

d. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
   - Significance of nondisjunction, deletion, substitutions, translocation, and frame shift mutation in animals
   - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, and color blindness

6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

a. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
   - Characteristics of the six kingdoms
   - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
   - Body plans (symmetry)
   - Methods of sexual reproduction (e.g., conjugation, fertilization, and pollination)
   - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, and spore formation)

b. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, and Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

c. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)

d. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, and geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.

BIOII 3 Investigate and discuss the molecular basis of heredity.

BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.

BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
b. Clarify research questions, and design laboratory investigations. (DOK 3)
c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling *x*- and *y*-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Describe and contrast the structures, functions, and chemical processes of the cell.

a. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
b. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
c. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
   - The impact of enzymatic reactions on biochemical processes
   - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
d. Differentiate between photosynthesis and cellular respiration. (DOK 2)

- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
- Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, and electron transport chain)
- Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
- Oxidation and reduction reactions

3. Investigate and discuss the molecular basis of heredity.

a. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
b. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
c. Relate gene expression (e.g., replication, transcription, and translation) to protein structure and function. (DOK 2)
   - Translation of a messenger RNA strand into a protein
   - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
   - Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
   - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
d. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
   - Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, and recombinant DNA) in agriculture, medicine, and forensics
e. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, and stem cell research). (DOK 3)

4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.

a. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
   - Main periods of the geologic timetable of earth's history
   - Roles of catastrophic and gradualistic processes in shaping planet Earth
b. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
c. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)

d. Formulate a scientific explanation based on fossil records of ancient life forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
e. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
f. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
g. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
h. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution and molecular biology). (DOK 3)
i. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

a. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction) and the cladistic approach. (DOK 2)
b. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)
   - Bacteria, fungi, and protists
   - Characteristics of invertebrates (e.g., habitat, reproduction, body plan, and locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, and Echinodermata)
   - Characteristics of vertebrates (e.g., habitat, reproduction, body plan, and locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia)
   - Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, and nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

BO 2 Distinguish among the characteristics of botanical organization, structure, and function.

BO 3 Demonstrate an understanding of plant reproduction.

BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.

BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**

    a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
        - Safety rules and symbols
        - Proper use and care of the compound light microscope, slides, chemicals, and so forth
        - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
    b. Formulate questions that can be answered through research and experimental design. (DOK 3)
    c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
    d. Construct and analyze graphs (e.g., plotting points, labeling x- and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
    e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
    f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
    g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. **Distinguish among the characteristics of botanical organization, structure, and function.**

    a. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, and flowers). (DOK 1)
    b. Differentiate the characteristics found in various plant divisions. (DOK 2)
        - Differences and similarities of nonvascular plants
        - Characteristics of seed-bearing and non-seed-bearing vascular plants relative to taxonomy
        - Major vegetative structures and their modifications in angiosperms and gymnosperms
    c. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
    d. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
        - Classification scheme used in botany
        - Classification of native Mississippi plants
    e. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
        - Relationships among photosynthesis, cellular respiration, and translocation
        - Importance of soil type and soil profiles to plant survival
        - Mechanism of water movement in plants
        - Effects of environmental conditions for plant survival
        - Tropic responses of a plant organ to a given stimulus

3. **Demonstrate an understanding of plant reproduction.**

    a. Compare and contrast reproductive structures (e.g., cones and flowers). (DOK 2)

b. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
c. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
   - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
   - Functions of flower parts, seeds, and cones
   - Spore production in bryophytes and ferns
d. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
e. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
f. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

a. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
b. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)
c. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
d. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

a. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
b. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
c. Discuss the effects of genetic engineering of plants on society. (DOK 2)
d. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
   - Plant extracts, their function, and origin
   - Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

CHI 3 Develop an understanding of the periodic table.

CHI 4 Analyze the relationship between microscopic and macroscopic models of matter.

CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**

   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions, and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling *x*- and *y*-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. **Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.**

   a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
      - Physical properties (e.g., melting points, densities, and boiling points) of a variety of substances
      - Substances and mixtures
      - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
   b. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
   c. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
      - Properties and interactions of the three fundamental particles of the atom
      - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
   d. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
      - Three major types of radioactive decay (e.g., alpha, beta, and gamma) and the properties of the emissions (e.g., composition, mass, charge, and penetrating power)
      - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
   e. Compare the properties of compounds according to their type of bonding. (DOK 1)
      - Covalent, ionic, and metallic bonding

- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

f. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

g. Develop a three-dimensional model of molecular structure. (DOK 2)
- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, and atomic/covalent/ionic radius)

c. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

4. Analyze the relationship between microscopic and macroscopic models of matter.

a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region

- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, and atomic/covalent/ionic radius)

c. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

5. Compare factors associated with acid/base and oxidation/reduction reactions.

a. Analyze and explain acid/base reactions. (DOK 2)
- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
- Formation of acidic and basic solutions
- Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
- The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
- How a buffer works and examples of buffer solutions

b. Classify species in aqueous solutions according to the Arrhenius and Bronsted–Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

c. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.

ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols

- Proper use and care of the compound light microscope, slides, chemicals, and so forth
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

a. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

b. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
c. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

d. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
e. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
f. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

a. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

b. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
   - Common uses of polymers and organic compounds in medicine, drugs, and personal care products
   - Compounds that have the property to dye materials
   - Petrochemical production
   - Biologically active compounds in terms of functional group substrate interaction

c. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

E2 Develop an understanding of the history and evolution of the universe and earth.

E3 Discuss factors that are used to explain the geological history of earth.

E4 Demonstrate an understanding of earth systems relating to weather and climate.

E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, and so forth
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.

b. Formulate questions that can be answered through research and experimental design. (DOK 3)

c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

d. Construct and analyze graphs (e.g., plotting points, labeling x- and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

a. Summarize the origin and evolution of the universe. (DOK 2)

- Big bang theory
- Microwave background radiation
- The Hubble constant
- Evidence of the existence of dark matter and dark energy in the universe and the history of the universe

b. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)

c. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in "ordinary" stars and supernovae lead to the formation of all other elements. (DOK 2)

d. Summarize the early evolution of the earth, including the formation of earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
- How Earth acquired its initial oceans and atmosphere

3. Discuss factors that are used to explain the geological history of earth.

a. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
- Modern and ancient geological features to each kind of plate tectonic boundary
- Production of particular groups of igneous and metamorphic rocks and mineral resources
- Sedimentary basins created and destroyed through time

b. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, and phosphates). (DOK 2)

c. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)

d. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, and tsunamis) to their effects on specific plate tectonic locations. (DOK 2)

e. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)

f. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
- Types of unconformity (e.g., disconformity, angular unconformity, and nonconformity)
- Geological timetable

g. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)

h. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. Demonstrate an understanding of earth systems relating to weather and climate.

a. Explain the interaction of earth systems that affect weather and climate. (DOK 1)

- Latitudinal variations in solar heating
- The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).

b. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, and global warming). (DOK 2)

c. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

d. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)

e. Research and explain how external forces affect earth's topography. (DOK 2)
- How surface water and groundwater act as the major agents of physical and chemical weathering
- How soil results from weathering and biological processes
- Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

a. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
- Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
- Geochemical and ecological processes (e.g., rock, hydrologic, carbon, and nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion; damming and channeling of rivers)

b. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)

c. Identify the cause-and-effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
- Photosynthesis and the atmosphere
- Multicellular animals and marine environments
- Land plants and terrestrial environments

d. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.

ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, and so forth
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)

c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

d. Construct and analyze graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

a. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)

b. Explain the flow of matter and energy in ecosystems. (DOK 2)
   - Interactions between biotic and abiotic factors
   - Indigenous plants and animals and their roles in various ecosystems
   - Biogeochemical cycles within the environment

c. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)

d. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
   - How a species adapts to its niche
   - Process of primary and secondary succession and its effects on a population
   - How changes in the environment might affect organisms

e. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, and predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)

f. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)

g. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations, and diversity. (DOK 1)

3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

a. Summarize the effects of human activities on resources in the local environments. (DOK 2)
   - Sources, uses, quality, and conservation of water
   - Renewable and nonrenewable resources
   - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

b. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

c. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

G 2 Analyze the structure and function of the cell and cellular organelles.

G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)

b. Clarify research questions, and design laboratory investigations. (DOK 3)

c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

d. Organize data to construct graphs (e.g., plotting points, labeling x- and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)

e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

a. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
b. Describe how organic components are integral to biochemical processes. (DOK 2)
c. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
   - Cell cycle and mitosis
   - Meiosis, spermatogenesis, and oogenesis
d. Explain the significance of the discovery of nucleic acids. (DOK 1)
e. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation, and DNA repair. (DOK 2)
f. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
g. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

a. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
b. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
   - Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
   - Inheritance of autosomal and sex-linked traits
   - Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
   - Chromosomal theory of inheritance
c. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
   - Genetic variability
   - Hardy–Weinberg formula
   - Migration and genetic drift
   - Natural selection in humans
d. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
   - Steps in genetic engineering experiments
   - Use of restriction enzymes
   - Role of vectors in genetic research
   - Use of transformation techniques
e. Research and present a justifiable explanation for the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
f. Develop and present a scientifically based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
g. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1Apply inquiry-based and problem-solving processes and skills to scientific investigations.

GE2Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**

    a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
        - Safety rules and symbols
        - Proper use and care of the compound light microscope, slides, chemicals, and so forth
        - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
    b. Formulate questions that can be answered through research and experimental design. (DOK 3)
    c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
    d. Construct and analyze graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
    e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
    f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
    g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. **Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.**

    a. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
    b. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
    c. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
        - Physical weathering (e.g., atmospheric, glacial, etc.)
        - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
    d. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
        - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
        - Processes that create earthquakes and volcanoes
        - Asthenosphere
    e. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
    f. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, and nitrogen) interact through time to cycle matter and energy and how

human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)

g. Interpret how the earth's geological time scale relates to geological history, landforms, and life forms. (DOK 2)
h. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.) (DOK 1)
i. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
j. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
k. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

PS 2 Describe and explain how forces affect motion.

PS 3 Demonstrate an understanding of general properties and characteristics of waves.

PS 4 Develop an understanding of the atom.

PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
   - Safety symbols and safety rules in all laboratory activities
   - Proper use and care of the compound light microscope
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
b. Identify questions that can be answered through scientific investigations. (DOK 3)
c. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
   - Predicting, gathering data, and drawing conclusions
   - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
   - Critically analyzing current investigations/problems using periodicals and scientific scenarios
d. Interpret and generate graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

a. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
   - Inertia and distance–time graphs to determine average speed
   - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
   - Effects of the gravitational force on objects on earth and effects on planetary and lunar motion
   - Simple harmonic motion (oscillation)

b. Explain the connection between force, work, and energy. (DOK 2)
   - Force exerted over a distance (results in work done)
   - Force–distance graph (to determine work)
   - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

c. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)

d. Draw and assess conclusions about charges and electric current. (DOK 2)
   - Static/current electricity and direct current/alternating current
   - Elements in an electric circuit that are in series or parallel
   - Conductors and insulators
   - Relationship between current flowing through a resistor and voltage flowing across a resistor

e. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)

3. Demonstrate an understanding of general properties and characteristics of waves.

a. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, and steel beam). (DOK 1)

b. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, and Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)

c. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
   - The emission of light by electrons when moving from higher to lower levels
   - Energy (photons as quanta of light)
   - Additive and subtractive properties of colors
   - Relationship of visible light to the color spectrum

d. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. Develop an understanding of the atom.

a. Cite evidence to summarize the atomic theory. (DOK 1)

- Models for atoms
- Hund's rule and Aufbau process to specify the electron configuration of elements
- Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
- Atomic orbitals (s, p, d, f) and their basic shapes

b. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)

c. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
- Contributions of scientists (e.g., John Dalton, J. J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
- Technology (e.g., X-rays, cathode-ray tubes, and spectroscopes)
- Experiments (e.g., gold-foil, cathode-ray, etc.)

d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
- Periodic trends using the periodic table (e.g., valence, reactivity, and atomic radius)
- Average atomic mass from isotopic abundance
- Solids, liquids, and gases
- Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, and atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. Investigate and apply principles of physical and chemical changes in matter.

a. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)

b. Balance chemical equations. (DOK 2)

c. Classify types of chemical reactions (e. g., composition, decomposition, single displacement, double displacement, combustion, and acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

PHYI 2 Develop an understanding of concepts related to forces and motion.

PHYI 3 Develop an understanding of concepts related to work and energy.

PHYI 4 Discuss the characteristics and properties of light and sound.

PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.

PHYI 6 Analyze and explain concepts of nuclear physics.

1. **Investigate and apply principles of physical and chemical changes in matter.**

    a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
    b. Clarify research questions, and design laboratory investigations. (DOK 3)
    c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
    d. Organize data to construct graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
    e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
    f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
    g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. **Develop an understanding of concepts related to forces and motion.**

    a. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
        - Vector and scalar quantities
        - Vector problems (solved mathematically and graphically)
        - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
        - Relations among mass, inertia, and weight
    b. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, and the special case of freefall). (DOK 2)
    c. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
    d. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
        - Situations where g is constant (falling bodies)
        - Concept of centripetal acceleration undergoing uniform circular motion
        - Kepler's third law
        - Oscillatory motion and the mechanics of waves

3. **Develop an understanding of concepts related to work and energy.**

    a. Explain and apply the conservation of energy and momentum. (DOK 2)
        - Concept of work and applications
        - Concept of kinetic energy, using the elementary work–energy theorem
        - Concept of conservation of energy with simple examples
        - Concepts of energy, work, and power (qualitatively and quantitatively)
        - Principles of impulse in inelastic and elastic collisions

b. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
c. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
d. Investigate and summarize the principles of thermodynamics. (DOK 2)
    - How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
    - Temperature and thermal energy as related to molecular motion and states of matter
    - Problems involving specific heat and heat capacity
    - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
e. Develop the kinetic theory of ideal gases, and explain the concept of Carnot efficiency. (DOK 2)

4. Discuss the characteristics and properties of light and sound.

a. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
    - Simple harmonic motion
    - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
    - Energy of a wave in terms of amplitude and frequency.
    - Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
b. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
c. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
d. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
e. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. Apply an understanding of magnetism, electric fields, and electricity.

a. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
    - Characteristics of static charge and how a static charge is generated
    - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
    - Magnetic poles, magnetic flux and field, Ampère's law, and Faraday's law
    - Coulomb's law
b. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
c. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. Analyze and explain concepts of nuclear physics.

a. Analyze and explain the principles of nuclear physics. (DOK 1)
    - The mass number and atomic number of the nucleus of an isotope of a given chemical element

- The conservation of mass and the conservation of charge
- Nuclear decay

b. Defend the wave–particle duality model of light, using observational evidence. (DOK 3)
- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
b. Clarify research questions, and design laboratory investigations. (DOK 3)
c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

a. Describe the characteristics of the electromagnetic spectrum.
b. Using images and graphs, interpret the absorption/reflection spectrum.
c. Distinguish between passive and active sensor systems.
d. Analyze the effects of changes in spatial, temporal, and spectral resolution.
e. Analyze the effects on images due to changes in scale.
f. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

ZO 2 Develop an understanding of levels of organization and animal classification.

ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.

ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, and so forth
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)

c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

d. Construct and analyze graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of levels of organization and animal classification.

a. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
   - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
   - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)

b. Identify and describe characteristics of the major phyla. (DOK 1)
   - Symmetry and body plan
   - Germ layers and embryonic development
   - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
   - Locomotion and coordination

c. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)

d. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
   - Phylogenic sequencing of the major phyla
   - Invertebrate characteristics (e.g., habitat, reproduction, body plan, and locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
   - Vertebrate characteristics (e.g., habitat, reproduction, body plan, and locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.

a. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
b. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
    - Division of labor within a group of animals
    - Communication within animals groups
    - Degree of parental care given in animal groups
c. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
d. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
    - Terrestrial and aquatic ecosystems
    - Herbivores, carnivores, omnivores, decomposers, and other feeding relationships
    - Symbiotic relationships such as mutualism, commensalisms, and parasitism
e. Contrast food chains and food webs. (DOK 2)

4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.

a. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
    - Relationship between natural selection and evolution
    - Mutations, crossing over, non-disjunction
    - Nonrandom mating, migration, and so forth
    - Effects of genetic drift on evolution
b. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

2021 Horticulture

Program CIP: 01.0601 – Applied Horticulture/Horticultural Operations, General

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The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Standards

Standards and alignment crosswalks are referenced in the appendix. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE horticulture curriculum is aligned to the following standards:

National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards
The National AFNR Career Cluster Content Standards were developed by the National Council on Agricultural Education to serve as a guide for what students should know or be able to do through a study of agriculture in grades 9-12 and two-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the agricultural industry, secondary and postsecondary instructors, and university specialists. The standards consist of a pathway content standard for each of the eight career pathways. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. A complete copy of the standards can be accessed at thecouncil.ffa.org/afnr. The National AFNR Career Cluster Content Standards are copyrighted to the National Council for Agricultural Education and are used by permission.

International Society for Technology in Education Standards (ISTE)
Reprinted with permission from *ISTE Standards for Students* (2016). All rights reserved. Permission does not constitute an endorsement by ISTE.
iste.org

College- and Career-Ready Standards
College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College and Career Ready Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/OAE/college-and-career-readiness-standards

Framework for 21st Century Learning
In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. 21 *Framework Definitions* (2019).
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
: Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource
: Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call the RCU at 662.325.2510.

Executive Summary

Pathway Description
Horticulture is a pathway in the agriculture, food, and natural resources career cluster. This program is designed for students who wish to pursue entry-level employment or continuing education in a wide variety of fields in the horticulture industry. Topics covered in the two-year program include plant structure and growth; plant propagation; pest management; floristry; greenhouse crops and management; olericulture; plantscaping; landscape design, installation, and management; and turfgrass management.

College, Career, and Certifications
No national industry-recognized certifications are known to exist at this time in the field of horticulture. Competencies and suggested performance indicators in the horticulture courses have been correlated, however, to the *AFNR Career Cluster Content Standards* that have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Grade Level and Class Size Recommendations
It is recommended that students enter this program as a ninth grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and student maturity. A maximum of 15 students is recommended for both classroom- and lab-based courses.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

a. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning
If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

This curriculum consists of four 1-credit courses that should be completed in the following sequence:

1. **Introduction to Horticulture—Course Code: 991402**
2. **Horticulture Plant Processes—Course Code: 991403**
3. **Horticulture Nursery—Course Code: 991404**
4. **Horticulture Landscape and Turfgrass—Course Code: 991405**

Course Description: Introduction to Horticulture
This course teaches students about horticulture orientation and leadership development. Students are introduced to basic plant and soil sciences (plant structure and growth). This course also focuses on horticulture structures.

Course Description: Horticulture Plant Processes
This course focuses on plant propagation, principles of pest management, greenhouse crops, and olericulture production.

Course Description: Horticulture Nursery
This course is a comprehensive course that reviews leadership, careers, and safety. It also introduces students to nursery and landscape plant identification, horticulture marketing, and business procedures, as well as container and field crop production.

Course Description: Horticulture Landscape and Turfgrass
This course covers the concepts of landscape design, installation, construction, and maintenance. Students will learn skills and knowledge associated with turfgrass installation and maintenance, pomology production, and basic principles of floristry.

Introduction to Horticulture—Course Code: 991402

Unit	Unit Name	Hours
1	Horticulture Orientation and Leadership Development	15
2	Horticulture Safety	15
3	Basic Plant Structure and Function	35
4	Plant Media	30
5	Horticulture Structures	15
Total		110

Horticulture Plant Processes—Course Code: 991403

Unit	Unit Name	Hours
6	Plant Propagation	35
7	Principles of Pest Management	30
8	Greenhouse Crops and Olericulture Production	40
Total		105

Horticulture Nursery—Course Code: 991404

Unit	Unit Name	Hours
9	Leadership, Careers, and Safety	15
10	Nursery and Landscape Plant Identification	25
11	Horticulture Marketing and Business Procedures	30
12	Container and Field Crop Production	30
Total		100

Horticulture Landscape and Turfgrass—Course Code: 991405

Unit	Unit Name	Hours
13	Landscape Design, Installation, Construction, and Maintenance	55
14	Turfgrass Installation and Maintenance	25
15	Principles of Floristry	25
16	Pomology Production	10
Total		115

Option 2—Two 2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses that should be completed in the following sequence:

1. **Horticulture I—Course Code: 991400**
2. **Horticulture II—Course Code: 991401**

Course Description: Horticulture I
This course introduces students to basic plant and soil sciences (plant structure and growth). It focuses on horticulture structures, plant propagation, and principles of pest management. It also covers greenhouse crops and olericulture production.

Course Description: Horticulture II
This course reviews leadership, careers, and safety in the horticulture field. It introduces students to plant identification, horticulture marketing and business procedures, and container and field crop production. It includes concepts of landscape design, installation, construction, and maintenance. Students are introduced to turfgrass installation and maintenance, pomology, and basic principles of floristry.

Horticulture I—Course Code: 991400

Unit	Unit Name	Hours
1	Horticulture Orientation and Leadership Development	15
2	Horticulture Safety	15
3	Basic Plant Structure and Function	35
4	Plant Media	30
5	Horticulture Structures	15
6	Plant Propagation	35
7	Principles of Pest Management	30
8	Greenhouse Crops and Olericulture Production	40
Total		215

Horticulture II—Course Code: 991401

Unit	Unit Name	Hours
9	Leadership, Careers, and Safety	15
10	Nursery and Landscape Plant Identification	25
11	Horticulture Marketing and Business Procedures	30
12	Container and Field Crop Production	30
13	Landscape Design, Installation, Construction, and Maintenance	55
14	Turfgrass Installation and Maintenance	25
15	Principles of Floristry	25
16	Pomology Production	10
Total		215

Career Pathway Outlook

Overview

Horticulture is a science that focuses on the commercial production of specialty crops that help sustain and enrich our lives by providing nutritious food, enhancing the beauty of our homes and communities, and reducing our carbon footprint. These specialty crops include fruits, vegetables, ornamental plants, and turfgrass. A shortlist of places horticulturists may work includes labs, floral shops, arboretums, garden centers, and golf courses. Careers fields in horticulture include landscape design, golf and sports turf management, teaching, and research. Many with a background in horticulture start their own businesses.

Most careers in horticulture require at least an associate degree, although careers with the highest earning potential—scientists and postsecondary teachers, for example—usually require advanced degrees.

Needs of the Future Workforce

Careers in horticulture are projected to grow as research into agricultural production methods and techniques continues. Data for this synopsis were compiled from employment projections prepared by the U.S. Census Bureau, the U.S. Bureau of Labor Statistics (2020), and the Mississippi Department of Employment Security (2020).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2016	Projected Jobs, 2026	Change (Number)	Change (Percent)	Average Hourly Earnings (2019)
Food Scientists and Technologists	40	50	10	25	$28.05
Agricultural and Food Science Technicians	260	270	10	3.9	$18.18
Agricultural Sciences Teachers, Postsecondary	150	160	10	6.7	NA
Soil and Plant Scientists	110	110	0	0	$43.61
Farm and Home Management Advisors	290	300	10	3.5	$23.73
Landscaping and Groundskeeping Workers	6,000	6,620	620	10.3	$12.46
First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	980	1,090	110	11.2	$18.22

Source: Mississippi Department of Employment Security; mdes.ms.gov (2019).

Perkins V Requirements and Academic Infusion
The horticulture curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in horticulture fields. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for careers in horticulture. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, it focuses on ongoing and meaningful professional development for teachers, as well as relationships with industry.

Transition to Postsecondary Education
The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The horticulture educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances, for example—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several in Mississippi that will foster the types of learning expected from the horticulture curriculum. The National FFA Organization is the student organization for horticulture. FFA provides students with growth opportunities and competitive events and also opens the doors to the world of agriculture and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the horticulture curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The horticulture curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the curriculum that will allow and encourage collaboration with professionals currently in the horticulture field.

Work-Based Learning

Work-based learning is an extension of understanding competencies taught in the horticulture classroom. This curriculum is designed in a way that necessitates active involvement by the students in the community around them and the global environment. These real-world connections and applications link to all types of students to knowledge, skills, and professional dispositions. Work-based learning should encompass ongoing and increasingly more complex involvement with local companies and horticulture professionals. Thus, supervised collaboration and immersion into the horticulture industry around the students are keys to students' success, knowledge, and skills development.

Professional Organizations

American Association for Agricultural Education (AAAE)
aaaeonline.org

Association for Career and Technical Education (ACTE)
acteonline.org

Mississippi ACTE
mississippiacte.com

Mississippi FFA/ Mississippi Association of Vocational Agriculture Teachers (MAVAT)
mississippiffa.org

National FFA Organization
ffa.org

National Association of Agricultural Educators (NAAE)
naae.org

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80% of the time in the course. The remaining percentage of class time will include instruction in nontested material, review for end-of-course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Teacher Resources
Teacher resources for this curriculum may be found in multiple places. Many program areas have teacher resource documents that accompany the curriculum and can be downloaded from the same site as the curriculum. The teacher resource document contains references, lesson ideas, websites, teaching and assessment strategies, scenarios, skills to master, and other resources divided by unit. This document could be updated periodically by RCU staff. Please check the entire document, including the entries for each unit, regularly for new information. If you have something you would like to add or have a question about the document, call or email the RCU's instructional design specialist for your program. The teacher resource document can be downloaded at rcu.msstate.edu/curriculum/curriculumdownload.aspx. All teachers should request to be added to the Canvas Resource Guide for their course. This is where all resources will be housed in the future, if they are not already. To be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Many of the units include an enrichment section at the end. If the horticulture program is currently using the Mississippi Career Planning and Assessment System (MS-CPAS) as a measure of accountability, the enrichment section of material will not be tested. If this is the case, it is suggested to use the enrichment material when needed or desired by the teacher and if time allows in the class. This material will greatly enhance the learning experiences for students. If, however, the horticulture program is using a national certification or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be tested. It is the responsibility of the teacher to ensure all competencies for the selected assessment are covered throughout the year.

Unit 1: Horticulture Orientation and Leadership Development

Competencies and Suggested Objectives

1. Identify school and program policies and procedures related to the horticulture program.[DOK1]
   a. Describe local program and career technical center policies and procedures including dress code, attendance, academic requirements, discipline, the school technology acceptable use policy, and horticulture regulations.
   b. Define and describe universally accepted ethics and values as applied to horticulture careers.
   c. Practice ethics and values in the horticulture classroom and lab.

2. Develop life and career skills for success in the 21st century. [DOK3]
   a. Identify, describe, and apply essential life and career skills/traits.
      - Communication
      - Considerate
      - Cooperation
      - Dependability
      - Effective listening
      - Empathy
      - Enthusiasm
      - Gets along with others
      - Good manners
      - Honesty
      - Humility
      - Interpersonal skills
      - Loyalty
      - Open-minded
      - Positive self-concept
      - Problem-solver
      - Rational thinking
      - Respect for others
      - Responsibility
      - Self-motivated/determined
      - Sets priorities
      - Teamwork
      - Trustworthy
      - Work ethic
   b. Explain the role of effective leadership.
   c. Apply the concepts of team building and team member participation.
   d. Self-evaluate students' personal leadership traits and develop a plan for improvement.
   e. Demonstrate basic parliamentary procedures (e.g., conduct a meeting, state a main motion, vote on a motion, understand the use of a gavel, distinguish between types of motions [main, subsidiary, incidental, privileged, etc.]).

3. Explore the role of the FFA in promoting leadership, personal development, and human relations skills. [DOK1]
   a. Explore the history and nature of the organization in promoting and developing leadership, personal development, and human relations skills.
   b. Identify career-related values and ethics promoted through the organization.
   c. Identify membership benefits.
   d. Select activities that promote personal development and leadership skills.

4. Complete a supervised agricultural experience (SAE) project.

Unit 2: Horticulture Safety

Competencies and Suggested Objectives
1. Demonstrate fundamental safety practices related to horticulture enterprises. DOK1 a. Identify hazards that may be found in horticulture operations, laboratories, and activities (e.g., poisons and other chemicals, sun exposure, ladders and scaffolds, electrical shock [GFI receptacles], fire, poisonous insects and snakes, equipment and tool hazards, spills, slipping, etc.). b. Identify and demonstrate the use of personal protection devices, including eye protection, hearing protection, foot protection, respiratory protection, clothing and body protection, fire extinguishers (Class A, B, and C), eyewash and shower stations, first-aid kits, and other general safety equipment.
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Unit 3: Basic Plant Structure and Function

Competencies and Suggested Objectives

1. Explore plant structure and their functions. DOK 2
   a. Draw a diagram of a flowering plant, and label and describe the major parts (roots, stems, leaves, and flowers) and functions as related to plant growth (cell division, cell elongation, and cell differentiation).
   b. Describe the process of respiration, photosynthesis, and transpiration.
   c. Describe the relationship of environmental and cultural factors to plant growth (water, light, temperature, soil, USDA climatic zones).

2. Apply systems of plant classification. DOK1
   a. Examine the taxonomy of plants including history, scientific classification, cultivars, and common nomenclature.
   b. Classify plants according to life cycle, including annual, perennial, deciduous, evergreen, etc.
   c. Interpret the scientific classification of the following shrubs:
      - Littleleaf boxwood / *Buxus microphylla cv.*
      - Common camellia / *Camellia japonica*
      - Common gardenia / *Gardenia jasminoides 'Fortuniana'*
      - Oakleaf hydrangea / *Hydrangea quercifolia*
      - Chinese holly / *Ilex cornuta cv.*
      - Japanese holly / *Ilex crenata cv.*
      - Chinese juniper / *Juniperus chinensis cv.*
      - Creeping juniper / *Juniperus horizontalis cv.*
      - Fountain grass / *Pennisetum ruppelia*
      - Lily-of-the-Valley Bush / *Pieris japonica*
      - Exbury hybrid azalea / *Rhododendron hybrid*
      - Yew / *Taxus spp. and cv.*
      - Chinese wisteria / *Wisteria sinensis cv.*
   d. Interpret the scientific class classification of the following trees:
      - Red maple / *Acer rubrum*
      - Japanese maple / *Acer palmatum cv.*
      - River birch / *Betula nigra*
      - Redbud / *Cercis canadensis*
      - Flowering dogwood / *Cornus florida cv.*
      - Ginkgo, Maidenhair tree / *Ginkgo biloba*
      - Crape myrtle / *Lagerstroemia indica cv.*
      - Sweet gum / *Liquidambar styraciflua*
      - Tulip poplar / *Liriodendron tulipifera*
      - Southern magnolia / *Magnolia grandiflora*
      - Colorado (blue) spruce / *Picea pungens cv.*
      - Japanese black pine / *Pinus thunbergiana*

- Kwanzan Japanese flowering cherry / *Prunus serrulata 'Kwanzan'*
- White oak / *Quercus alba*
- Pin oak / *Quercus palustris*
- Red oak / *Quercus rubra*
- Bald cypress / *Taxodium distichum*

Unit 4: Plant Media

1. Describe and apply principles of plant growth media. DOK2 a. Identify and compare the components of natural soil (sand, silt, and clay) and soilless mix. List and explain the characteristics each one imparts to the root medium. b. Prepare a growing media to specifications or identify the components and proportions in a commercially prepared root medium.
2. Describe the characteristics of an ideal growing medium, including nutrients, water- and air-holding capacity, water drainage, and potential of hydrogen (pH). DOK 1
3. Describe the use of soilless amendments, including vermiculite, perlite, bark, organic matter, and peat moss. DOK 1
4. Identify macronutrients and micronutrients and their effects on plant growth. DOK 2 a. Describe the effect of excesses and deficiencies of the macronutrients (nitrogen [N], phosphorus [P], potassium [K]). b. Predict the effect various pH levels will have on plant nutrition and growth. c. Analyze a growing media sample for nutrient deficiencies by using the scientific method. d. Calculate fertilizer application rates to meet nutritional requirements for a specific crop. e. Select fertilizer application methods for different plant enterprises to include broadcasting, injection systems, incorporating into media, and side dressing.

Unit 5: Horticulture Structures

Competencies and Suggested Objectives
1. Describe the characteristics and features of different types of greenhouses. DOK2 a. Identify and compare the greenhouse structures, coverings, and auxiliary (shade house, hot beds, and cold frame) types: quonset, ridge and furrow, even span, and shade houses. b. Describe environmental controls, including humidistat, thermostat, cooling, watering, and heating. c. Describe the importance of light in plant growth. d. Discuss water, fertigation, and chemigation management in growing plants. e. Identify and describe factors to consider in establishing a floor plan for a greenhouse, including sanitation, benching, flooring, potting facilities, chemical and dry storage, and traffic patterns.

Unit 6: Plant Propagation

Competencies and Suggested Objectives
1. Distinguish between sexual and asexual reproduction. DOK2 a. Describe sexual reproduction in plants. b. Describe the conditions needed for good seed germination. c. Plan and conduct a seed germination test. d. Interpret information found on a seed tag. e. Describe, discuss, or demonstrate how to propagate plants from scarified or stratified seeds. f. Identify and describe asexual reproduction techniques using grafting, budding, cuttings (root, stem and leaf), layering, separation and division, and tissue culture methods. g. Identify common tools, such as hand shears, and chemicals, including hormones, used in asexual reproduction and demonstrate their safe use and care.

Unit 7: Principles of Pest Management

Competencies and Suggested Objectives

1. Assess the effects of pests on plant production. DOK2
   a. Identify the following types of insects and describe how insect affects production, control, and integrated pest management (IPM) practices:
      - Aphid
      - Bagworm
      - Borer
      - Leaf hopper
      - Leaf miner
      - Scale
      - Spider mite
      - Snail/slug
      - Whitefly
      - White grub
   b. Identify the following types of diseases and describe how each disease affects production, control, and IPM practices:
      - Anthracnose
      - Apple scab
      - Black spot
      - Botrytis
      - Canker
      - Cedar-apple rust
      - Crown gall
      - Fire blight
      - Powdery mildew
      - Root rot
   c. Identify the following types of weeds and describe how each weed affects production, control, and IPM practices:
      - Annual bluegrass
      - Broadleaf plantain
      - Buckhorn plantain
      - Chickweed
      - Crabgrass
      - Dandelion
      - Henbit
      - Nutsedge
      - Oxalis
      - Purslane
      - White clover
   d. Identify the following types of physiological problems and describe how each problem affects production, control, and IPM practices:
      - Frost-freeze injury
      - Iron deficiency
      - Leaf scorch (drought/winter burn)
      - Nitrogen deficiency
      - Pot-bound roots
      - String trimmer injury
      - 2, 4-D injury
   e. Design an IPM plan for a designated horticulture crop.
2. Identify, describe, and apply pesticide safety procedures. DOK1
   a. Interpret safety and first aid precautions and formulations on pesticide labels (insecticide, herbicides, rodenticide, fungicide, miticide, molluscicide, and nematicides).
   b. Identify the following beneficial insects and discuss how they benefit plants:
      - Assassin bug
      - Beneficial nematode
      - Big-eyed bug
      - Braconid wasp
      - Mealybug destroyer
      - Praying mantis
      - Predatory stink bugs
      - Soldier beetle

- Green Lacewing
- Lady beetles
- Spider
- Paper wasp

c. Discuss the relationship between biological, chemical, cultural, and mechanical control methods.
d. Discuss and apply general precautions for working with pesticides in relation to the requirements for pesticide applicator's certification/licensure.

Unit 8: Greenhouse Crops and Olericulture Production

Competencies and Suggested Objectives

1. Describe and apply principles of greenhouse crop production. DOK2
   a. Identify and produce various common species of bedding plants, including:
      - Coleus
      - Chrysanthemums
      - Dianthus
      - Geraniums
      - Impatiens
      - Marigold
      - Pansy
      - Petunia
      - Salvia
      - Snapdragon
      - Verbena
      - Vinca
      - Wax begonia
      - Zinnia

   b. Identify and produce various common species of foliage/interior plants, including:
      - African Violet
      - Angelica
      - Cacti
      - Caladiums
      - Dracaena
      - Dumbcane
      - English ivy
      - Ferns (Boston, Kimberly, Macho, Sprengeri)
      - Nephthytis
      - Orchids
      - Peace lily
      - Philodendron
      - Poinsettias
      - Schefflera
      - Snake plant
      - Spider plant

   c. Identify cultural considerations for fertilizer, water, growing medium, pest control, temperature, natural and chemical growth control and stimulation, and light control for common crops.

2. Describe and apply principles of olericulture production. DOK2
   a. Describe characteristics (i.e. cultural requirements, direct seeding versus transplanting, plant growth style, and growing season) of common vegetables grown for commercial production, and distinguish between warm season and cool season crops. Including:
      - Beans
      - Broccoli
      - Brussel sprouts
      - Cabbage
      - Carrots
      - Cauliflower
      - Chives
      - Corn
      - Cucumber
      - Eggplant
      - Garlic
      - Kale
      - Lettuce
      - Okra
      - Onions
      - Peanuts
      - Peas
      - Peppers
      - Potatoes
      - Pumpkin
      - Spinach
      - Squash
      - Tomatoes

b. Identify and demonstrate the use of common tools and equipment used in gardening, including tillers, spreaders, sprayers, watering devices, rakes, hoes, and shovels.
c. Identify and describe factors to consider in preparing a seedbed, including soil class and texture, use of soil amendments, and characteristics of a properly prepared seedbed.
d. Develop a plan for an intensive culture garden including crop and variety selection, location and spacing of different crops, scheduling of crops, crop rotation, and harvesting and marketing of crops.
e. Discuss new and emerging technologies, trends, and issues concerning the production and marketing of vegetables in Mississippi. Identify and discuss the roles of agencies and organizations that regulate the production and marketing of vegetables.

Unit 9: Leadership, Careers, and Safety

Competencies and Suggested Objectives
1. Review program policies, procedures, and safety rules.[DOK2]
2. Practice leadership skills. [DOK2] a. Identify and discuss fundamental parliamentary procedures for participating in a public meeting and for public speaking. b. Select FFA activities that promote personal development and leadership skills.
3. Complete school-to-careers activities related to horticulture. [DOK1] a. Identify employment and career opportunities in the horticulture industry. b. Investigate educational opportunities related to horticulture at the postsecondary level. c. Describe national standards and certification/licensing procedures, trade organizations, associations, and unions as related to horticulture.
4. Complete an SAE. [DOK 3]

Unit 10: Nursery and Landscape Plant Identification

Competencies and Suggested Objectives
1. Review plant materials covered in Unit 3 (see associated list). DOK1
2. Identify and describe the use of major plants associated with nursery and landscape operations. DOK1 a. Identify and describe the following plants: • Adam's Needle (Yucca) / *Yucca filamentosa* • Bayberry / *Myrica pensylvanica* • Bearded iris / *Iris x germanica florentina* cv. • Border forsythia / *Forsythia* × *intermedia* cv. • Bumalda spirea / *Spiraea x bumalda* • Cherry laurel / *Prunus laurocerasus* cv. • Chinese (saucer) magnolia / *Magnolia x soulangiana* cv. • Common blanketflower / *Gaillardia aristata* cv. • Eastern white pine / *Pinus strobus* • Firethorn / *Pyracantha coccinea* cv. • Flowering crabapple / *Malus* spp. and cv. • Glossy abelia / *Abelia x grandiflora* cv. • Heavenly bamboo / *Nandina domestica* • Hybrid tea rose / *Rosa* spp. • Japanese (flowering) quince / *Chaenomeles speciosa* cv. • Lilyturf / *Liriope* spp. cv. • London planetree / *Platanus* × *acerifolia* • Mentor barberry / *Berberis* × *mentorensis* • Oregon grape / *Mahonia aquifolia* cv. • Plaintain lily / *Hosta x hybrida* cv. • Sour (black) gum / *Nyssa sylvatica* • Southern yew / *Podocarpus macrophyllus* • Thornless honeylocust / *Gleditsia triacanthos inermis* cv. • Washington hawthorn / *Crataegus phaenopyrum* • White ash / *Fraxinus americana* cv. • Wintercreeper / *Euonymus fortunei* cv.

Unit 11: Horticulture Marketing and Business Procedures

Competencies and Suggested Objectives

1. Describe and apply marketing and business practices associated with horticulture operations. DOK2
   a. Maintain an inventory of plants and supplies for the horticulture program (ongoing throughout the year).
   b. Develop an annual calendar of activities/enterprises for a horticulture business, including ordering materials/supplies for an enterprise.
   c. Describe factors to consider in pricing products of an enterprise and complete a sales transaction that includes providing customer service.
   d. Describe factors to consider in marketing and advertising products.

2. Review basic employee responsibilities and how to communicate effectively in on-the-job situations. DOK3
   a. Describe the following life skills:
      - Communication
      - Considerate
      - Cooperation
      - Dependability
      - Effective listening
      - Empathy
      - Enthusiasm
      - Gets along with others
      - Good manners
      - Honesty
      - Humility
      - Interpersonal skills
      - Loyalty
      - Open-mindedness
      - Positive self-concept
      - Problem-solving
      - Rational thinking
      - Respect for others
      - Responsibility
      - Self-motivated/determined
      - Sets priorities
      - Teamwork
      - Trustworthy
      - Work ethic

3. Discuss and explore business operations. DOK2
   a. Marketing's four Ps (price, product, place, promotion)
   b. Forms of business organizations (sole proprietorship, corporations, partnerships, limited liability companies)
   c. Sources of capital (wholesale versus retail)

Unit 12: Container and Field Crop Production

Competencies and Suggested Objectives

1. Describe and apply principles of container and field crop production. DOK2
   a. Describe advantages and disadvantages of container crop production versus field crop production.
   b. Identify and demonstrate the safe use of tools and equipment for container and field crop production. Include the following:
      - Ball cart (B&B truck)
      - Broadcast (cyclone) spreader
      - Burlap
      - Drip emitter, irrigation
      - Duster
      - Dust mask
      - Fertilizer tablet
      - Grafting tool
      - Granular fertilizer
      - Ground/pelleted limestone
      - Hearing protection
      - Hose-end repair fitting
      - Hose-end sprayer
      - Hose-end washer
      - Hose repair coupling
      - Impact sprinkler
      - Measuring wheel
      - Mist nozzle (mist bed)
      - Nursery container
      - Planting/earth/soil auger
      - Propagation mat
      - PVC (polyvinylchloride) pipe
      - Resin-coated fertilizer
      - Safety goggles
      - Soil sampling tube
      - Solenoid valve
      - Spray suit
      - Tape measure
      - Tree caliper
      - Tree wrap
      - Water breaker
   c. Describe automation and plug production in the nursery industry.
   d. Describe and contrast the different types of nursery irrigation systems.

Unit 13: Landscape Design, Installation, Construction, and Maintenance

Competencies and Suggested Objectives

1. Describe and apply principles of landscape design. DOK2
   a. Describe careers in the landscape design field.
   b. Identify and demonstrate the use of tools and equipment for landscape design, including computer-assisted landscape design hardware and software.
   c. Identify and demonstrate the methods of lettering and symbols used in landscape design plans.
   d. Describe principles of design and design processes associated with landscaping, including simplicity, balance, and proportion.
   e. Prepare a simple landscape plan to scale for a given site, including plant selection and location.

2. Describe and apply basic principles of landscape installation and construction. DOK2
   a. Prepare site analysis/needs assessment for a given site.
   b. Identify and demonstrate the safe use of equipment, materials, and hand tools for landscape maintenance, including:
      - Bark mulch
      - Bow saw
      - Compressed air sprayer
      - Chain saw
      - Edger (power or hand)
      - Edging
      - Erosion netting
      - Garden (spading) fork
      - Garden (bow) rake
      - Garden hoe
      - Gas mask
      - Gravity (drop) spreader
      - Hearing protection
      - Hedge shears
      - Hook-and-blade pruners
      - Landscape fabric
      - Leaf rake
      - Loppers
      - Mattock
      - Pickaxe
      - Pole pruner
      - Polyethylene pipe
      - Pop-up irrigation head
      - Post-hole digger
      - Power blower
      - Power hedge trimmer
      - Pruning saw
      - Reel mower
      - Respirator
      - Rotary mower
      - Rototiller
      - Round point shovel
      - Scoop shovel
      - Shade fabric
      - Sharpening stone
      - Siphon proportioner
      - Soaker hose
      - Spade
      - Square point (flat) shovel
      - String trimmer
      - Trowel
      - T-square
   c. Discuss the essential elements of a landscape installation contract including the warranty and an estimate.
   d. Develop a contract and pricing estimate for the landscape plan.

e. Describe and discuss procedures for preparing a planting site, installing plants, and providing posttransplant care according to a landscape plan. f. Describe licensing requirements for landscape installation. g. Discuss installation and maintenance of a landscape irrigation system.
3. Describe and apply principles of landscape maintenance. DOK2 a. Identify and discuss the proper procedures for pruning trees and shrubs. b. Demonstrate the proper procedure for taking a soil sample. c. Determine and discuss a cost estimate for fertilizer, pest control, and maintenance of trees, shrubs, and beds.

Unit 14: Turfgrass Installation and Maintenance

Competencies and Suggested Objectives

1. Describe and apply principles of turfgrass installation. DOK2
   a. Describe factors to consider in selecting a turfgrass for a specific area. Identify varieties of turfgrass and describe their characteristics. Include the following:
      - Bentgrass
      - Bermuda grass
      - Carpet grass
      - Centipede grass
      - Kentucky bluegrass
      - St. Augustine grass
      - Tall fescue
      - Zoysia

   b. Describe installation practices for different turfgrasses, including site preparation and initial care.

2. Describe and apply principles of turfgrass maintenance. DOK2
   a. Identify and demonstrate the safe use and maintenance of equipment and tools used for turfgrass maintenance, including mower types, dethatchers, aerators, and other equipment.
   b. Use mowers, sprayers, or spreaders for a specific grass.
   c. Identify and describe common turfgrass insects, including:
      - Army worms
      - Chinch bug
      - Japanese beetle
      - Sod webworm
      - White grubs
      - Mole cricket

   d. Identify and describe common turfgrass diseases, including:
      - Brown patch
      - Damping off
      - Dollar spot
      - Fairy ring
      - Grey leaf spot
      - Melting out
      - Pythium blight
      - Rust
      - Slime mold
      - Spring dead spot

   e. Identify and describe common turfgrass weeds, including:
      - Annual Bluegrass
      - Bahia grass
      - Broadleaf Plantain
      - Buckhorn Plantain
      - Common bermuda grass
      - Common chickweed
      - Common purslane
      - Curly dock
      - Cutleaf geranium
      - Dallisgrass
      - Dandelion
      - Goose grass
      - Henbit
      - Large crabgrass
      - Lawn burweed
      - Mouse-ear chickweed
      - Purple nutsedge
      - Smooth crabgrass
      - Smutgrass
      - Virginia buttonweed
      - White clover
      - Wild garlic
      - Wild onion
      - Wood sorrel
      - Yellow foxtail
      - Yellow nutsedge

d. Identify and describe common irrigation methods for turfgrass. e. Perform cultural practices, including aeration and dethatching. f. Develop a plan/cost estimate for a turfgrass management program.

Unit 15: Principles of Floristry

Competencies and Suggested Objectives
1. Describe and apply principles of floristry. DOK2 a. Demonstrate the procedures for receiving and storing (including the rotation of inventory) of floral materials. b. Apply basic elements of design with examples that include line, filler, form, and mass. c. Apply basic principles of design to include balance, transition, rhythm, focal point, proportion, and scale to achieve unity. d. Receive and process orders for floral products, including seasonal and event applications. e. Identify and demonstrate the safe and proper use of tools and supplies used in floristry, including shears, tape, foam, floral wire, and knives. Include plant materials (potted, flower, and foliage materials) used in floristry in these demonstrations.

Unit 16: Pomology Production

Competencies and Suggested Objectives

1. Describe and apply principles of fruit and berry production. DOK2
   a. Identify, discuss, and prepare a planting plan, cultural plan and marketing plan of common fruits and berries produced in Mississippi to include the following:
      - Apples
      - Blackberries
      - Blueberries
      - Cantaloupes
      - Figs
      - Melons
      - Muscadines
      - Oranges
      - Peaches
      - Pears
      - Persimmons
      - Plums
      - Pumpkins
      - Raspberries
      - Strawberries
      - Watermelons
   b. Identify, discuss, and describe the local marketing of fruits and vegetables as it relates to state, national, and international organizations that impact fruit and berry production.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Horticulture Orientation and Leadership Development		
	1.	Identify school and program policies and procedures related to the horticulture program.
	2.	Develop life and career skills for success in the 21st century.
	3.	Explore the role of the FFA in promoting leadership, personal development, and human relations skills.
	4.	Complete a supervised agricultural experience (SAE) project.
Unit 2: Horticulture Safety		
	1.	Demonstrate basic and fundamental safety practices related to horticulture enterprises.
Unit 3: Basic Plant Structure and Function		
	1.	Explore plant structure and their functions.
	2.	Apply systems of plant classification.
Unit 4: Plant Media		
	1.	Describe and apply principles of plant growth media.
	2.	Describe the characteristics of an ideal growing medium, including nutrients, water- and air-holding capacity, water drainage, and potential of hydrogen (pH).
	3.	Describe the use of soilless amendments, including vermiculite, perlite, bark, organic matter, and peat moss.
	4.	Identify macronutrients and micronutrients and their effects on plant growth.
Unit 5: Horticulture Structures		
	1.	Describe the characteristics and features of different types of greenhouses.
Unit 6: Plant Propagation		
	1.	Distinguish between sexual and asexual reproduction.
Unit 7: Principles of Pest Management		
	1.	Assess the effects of pests on plant production.
	2.	Identify, describe, and apply pesticide safety procedures.

Unit 8: Greenhouse Crops and Olericulture Production		
	1.	Describe and apply principles of greenhouse crop production.
	2.	Describe and apply principles of olericulture production.
Unit 9: Leadership, Careers, and Safety (Ongoing Review and Reinforcement)		
	1.	Review program policies, procedures, and safety rules.
	2.	Practice leadership skills.
	3.	Complete school-to-careers activities related to horticulture.
	4.	Complete an SAE.
Unit 10: Nursery and Landscape Plant Identification		
	1.	Review plant materials covered in Unit 3 (see associated list).
	2.	Identify and describe the use of major plants associated with nursery and landscape operations.
Unit 11: Horticulture Marketing and Business Procedures		
	1.	Describe and apply marketing and business practices associated with horticulture operations.
	2.	Review basic employee responsibilities and how to communicate effectively in on-the-job situations.
	3.	Discuss and explore business operations.
Unit 12: Container and Field Crop Production		
	1.	Describe and apply principles of container and field crop production.
Unit 13: Landscape Design, Installation, Construction, and Maintenance		
	1.	Describe and apply principles of landscape design.
	2.	Describe and apply basic principles of landscape installation and construction.
	3.	Describe and apply principles of landscape maintenance.
Unit 14: Turfgrass Installation and Maintenance		
	1.	Describe and apply principles of turfgrass installation.
	2.	Describe and apply principles of turfgrass maintenance.
Unit 15: Principles of Floristry		
	1.	Describe and apply principles of floristry.
Unit 16: Pomology Production		
	1.	Describe and apply principles of fruit and berry production.

Appendix A: Industry Standards

AFNR National Standards

Crosswalk for Horticulture																	
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**
ABS.01									X			X		X	X	X	X
ABS.02												X		X	X	X	X
ABS.03												X		X	X	X	X
ABS.04												X		X	X	X	X
ABS.05									X			X		X	X	X	X
ESS.01																	
ESS.02								X	X								X
ESS.03								X	X								
ESS.04			X						X								
ESS.05			X						X					X			X
FPP.01									X								X
FPP.02									X								X
FPP.03									X								X
FPP.04									X								X
NRS.01					X	X			X						X		X
NRS.02									X						X		
NRS.03									X						X		X
NRS.04								X	X						X		X
PS.01				X	X	X	X		X		X		X		X		
PS.02				X	X	X	X		X		X		X		X	X	
PS.03					X	X	X	X	X				X		X	X	
PS.04						X	X		X				X	X	X	X	
PST.01									X							X	
PST.02			X						X					X	X		
PST.03			X						X					X	X		
PST.04						X			X				X	X	X		
PST.05									X					X	X		

Agriculture, Food, and Natural Resources (AFNR) Pathway Content Standards and Performance Elements

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AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Apply management planning principles in AFNR businesses.

ABS.01.01. Apply micro- and macroeconomic principles to plan and manage inputs and outputs in an AFNR business.

ABS.01.02. Read, interpret, evaluate, and write statements of purpose to guide business goals, objectives, and resource allocation.

ABS.01.03. Devise and apply management skills to organize and run an AFNR business in an efficient, legal, and ethical manner.

ABS.01.04. Evaluate, develop, and implement procedures used to recruit, train, and retain productive human resources for AFNR businesses.

ABS.02. Use record keeping to accomplish AFNR business objectives, manage budgets, and comply with laws and regulations.

ABS.02.01. Apply fundamental accounting principles, systems, tools, and applicable laws and regulations to record, track, and audit AFNR business transactions (e.g., accounts, debits, credits, assets, liabilities, equity, etc.).

ABS.02.02. Assemble, interpret, and analyze financial information and reports to monitor AFNR business performance and support decision-making (e.g., income statements, balance sheets, cash-flow analysis, inventory reports, break-even analysis, return on investment, taxes, etc.).

ABS.03. Manage cash budgets, credit budgets, and credit for an AFNR business using generally accepted accounting principles.

ABS.03.01. Develop, assess, and manage cash budgets to achieve AFNR business goals.

ABS.03.02. Analyze credit needs and manage credit budgets to achieve AFNR business goals.

ABS.04. Develop a business plan for an AFNR business.

ABS.04.01. Analyze characteristics and planning requirements associated with developing business plans for different types of AFNR businesses.

ABS.04.02. Develop production and operational plans for an AFNR business.

ABS.04.03. Identify and apply strategies to manage or mitigate risk.

ABS.05. Use sales and marketing principles to accomplish AFNR business objectives.

ABS.05.01. Analyze the role of markets, trade, competition, and price in relation to an AFNR business sales and marketing plans.

ABS.05.02. Assess and apply sales principles and skills to accomplish AFNR business objectives.

ABS.05.03. Assess marketing principles and develop marketing plans to accomplish AFNR business objectives.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures and instruments to manage environmental service systems.

ESS.01.01. Analyze and interpret laboratory and field samples in environmental service systems.

ESS.02. Evaluate the impact of public policies and regulations on environmental service system operations.

ESS.02.01. Interpret and evaluate the impact of laws, agencies, policies, and practices affecting environmental service systems.

ESS.03. Develop proposed solutions to environmental issues, problems, and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry, and ecology.

ESS.03.01. Apply meteorology principles to environmental service systems.
ESS.03.02. Apply soil science and hydrology principles to environmental service systems.
ESS.03.03. Apply chemistry principles to environmental service systems.
ESS.03.04. Apply microbiology principles to environmental service systems.
ESS.03.05. Apply ecology principles to environmental service systems.

ESS.04. Demonstrate the operation of environmental service systems (e.g., pollution control, water treatment, wastewater treatment, solid waste management, and energy conservation).

ESS.04.01. Use pollution control measures to maintain a safe facility environment.
ESS.04.02. Manage safe disposal of all categories of solid waste in environmental service systems.
ESS.04.03. Apply techniques to ensure a safe supply of drinking water and adequate treatment of wastewater according to applicable rules and regulations.
ESS.04.04. Compare and contrast the impact of conventional and alternative energy sources on the environment and operation of environmental service systems.

ESS.05. Use tools, equipment, machinery, and technology common to tasks in environmental service systems.

ESS.05.01. Use technological and mathematical tools to map land, facilities, and infrastructure for environmental service systems.
ESS.05.02. Perform assessments of environmental conditions using equipment, machinery, and technology.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.

FPP.01.01. Analyze and manage operational and safety procedures in food products and processing facilities.

FPP.01.02. Apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

FPP.01.03. Apply food safety procedures when storing food products to ensure food quality.

FPP.02. Apply principles of nutrition, biology, microbiology, chemistry and human behavior to the development of food products.

FPP.02.01. Apply principles of nutrition and biology to develop food products that provide a safe, wholesome, and nutritious food supply for local and global food systems.

FPP.02.02. Apply principles of microbiology and chemistry to develop food products to provide a safe, wholesome, and nutritious food supply for local and global food systems.

FPP.02.03. Apply principles of human behavior to develop food products to provide a safe, wholesome, and nutritious food supply for local and global food systems.

FPP.03. Select and process food products for storage, distribution, and consumption.

FPP.03.01. Implement selection, evaluation, and inspection techniques to ensure safe and quality food products.

FPP.03.02. Design and apply techniques of food processing, preservation, packaging, and presentation for distribution and consumption of food products.

FPP.03.03. Create food distribution plans and procedures to ensure safe delivery of food products.

FPP.04. Explain the scope of the food industry and the historical and current developments of food product and processing.

FPP.04.01. Examine the scope of the food industry by evaluating local and global policies, trends, and customs for food production.

FPP.04.02. Evaluate the significance and implications of changes and trends in the food products and processing industry in the local and global food systems.

FPP.04.03. Identify and explain the purpose of industry organizations, groups, and regulatory agencies that influence the local and global food systems.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Plan and conduct natural resource management activities that apply logical, reasoned, and scientifically based solutions to natural resource issues and goals.

- NRS.01.01. Apply methods of classification to examine natural resource availability and ecosystem functions in a particular region.
- NRS.01.02. Classify different types of natural resources to enable protection, conservation, enhancement, and management in a particular geographical region.
- NRS.01.03. Apply ecological concepts and principles to atmospheric natural resource systems.
- NRS.01.04. Apply ecological concepts and principles to aquatic natural resource systems.
- NRS.01.05. Apply ecological concepts and principles to terrestrial natural resource systems.
- NRS.01.06. Apply ecological concepts and principles to living organisms in natural resource systems.

NRS.02.01. Analyze the interrelationships between natural resources and humans.

- NRS.02.01. Examine and interpret the purpose, enforcement, impact, and effectiveness of laws and agencies related to natural resource management, protection, enhancement, and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).
- NRS.02.02. Assess the impact of human activities on the availability of natural resources.
- NRS.02.03. Analyze how modern perceptions of natural resource management, protection, enhancement, and improvement change and develop over time.
- NRS.02.04. Examine and explain how economics affects the use of natural resources.
- NRS.02.05. Communicate information to the public regarding topics related to the management, protection, enhancement, and improvement of natural resources.

NRS.03. Develop plans to ensure sustainable production and processing of natural resources.

- NRS.03.01. Sustainability produce, harvest, process, and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).
- NRS.03.02. Demonstrate cartographic skills, tools, and technologies to aid in developing, implementing, and evaluating natural resource management plans.

NRS.04. Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.

NRS.04.01. Demonstrate natural resource protection, maintenance, enhancement, and improvement techniques.
NRS.04.02. Diagnose plant and wildlife diseases and follow protocol to prevent their spread.
NRS.04.03. Prevent or manage introduction of ecologically harmful species in a particular region.
NRS.04.04. Manage fires in natural resource systems.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Develop and implement a crop management plan for a given production goal that accounts for environmental factors.

PS.01.01. Determine the influence of environmental factors on plant growth.
PS.01.02. Prepare and manage growing media for use in plant systems.
PS.01.03. Develop and implement a fertilization plan for specific plants or crops.

PS.02. Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

PS.02.01. Classify plants according to taxonomic systems.
PS.02.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.
PS.02.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.03. Propagate, culture, and harvest plants and plant products based on current industry standards.

PS.03.01 Demonstrate plant propagation techniques in plant system activities.
PS.03.02. Develop and implement a management plan for plant production.
PS.03.03. Develop and implement a plan for integrated pest management for plant production.
PS.03.04. Apply principles and practices of sustainable agriculture to plant production.
PS.03.05 Harvest, handle, and store crops according to current industry standards.

PS.04. Apply principles of design in plant systems to enhance an environment (e.g., floral, forest landscape, and farm).

PS.04.01. Evaluating, identifying, and preparing plants to enhance an environment.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.

PST.01.01. Apply physical science laws and engineering principles to assess and select energy sources for AFNR power, structural and technical systems.
PST.01.02. Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems in AFNR situations.
PST.01.03. Apply physical science principles to metal fabrication using a variety of welding and cutting processes (e.g., SMAW, GMAW, GTAW, fuel-oxygen and plasma arc torch, etc.).

PST.02. Operate and maintain AFNR mechanical equipment and power systems.
PST.02.01. Perform preventative maintenance and scheduled service to maintain equipment, machinery, and power units used in AFNR settings.
PST.02.02. Operate machinery and equipment while observing all safety precautions in AFNR settings.

PST.03. Service and repair AFNR mechanical equipment and power systems.
PST.03.01. Troubleshoot, service, and repair components of internal combustion engines using manufacturers' guidelines.
PST.03.02. Service electrical systems and components of mechanical equipment and power systems using a variety of troubleshooting and/or diagnostic methods.
PST.03.03. Utilize manufacturers' guidelines to diagnose and troubleshoot malfunctions in machinery, equipment, and power source systems (e.g., hydraulic, pneumatic, transmission, steering, suspension, etc.).

PST.04. Plan, build and maintain AFNR structures.
PST.04.01. Create sketches and plans for AFNR structures.
PST.04.02. Determine structural requirements, specifications and estimate costs for AFNR structures.
PST.04.03. Follow architectural and mechanical plans to construct and/or repair AFNR structures (e.g., material selection, site preparation and/or layout, plumbing, concrete/masonry, etc.).
PST.04.04. Apply electrical wiring principles in AFNR structures.

PST.05. Use control, monitoring, geospatial, and other technologies in AFNR power structural and technical systems.
PST.05.01. Apply computer and other technologies (e.g., robotics, CNC, UAS, etc.) to solve problems and increase the efficiency of AFNR systems.
PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot electronic control systems in AFNR settings.
PST.05.03. Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.

2016 Horticulture

Program CIP: 01.0601 – Applied Horticulture/Horticultural Operations, General

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~~The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.~~

Table of Contents

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Dr. Carey M. Wright, State Superintendent of Education

Dr. John R. Kelly, Chair

Mr. Richard Morrison, Vice-Chair

Dr. O. Wayne Gann

Mrs. Kami Bumgarner

Mr. William Harold Jones

Mr. Charles McClelland

Mrs. Rosemary G. Aultman

Mr. Johnny Franklin

Dr. Karen Elam

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Suzanne Tribble, PhD, Instructional Design Specialist for the Research and Curriculum Unit at Mississippi State University researched and authored this framework. suzanne.tribble@rcu.msstate.edu

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Scott Kolle, Project Manager for the Research and Curriculum Unit at Mississippi State University

Jolanda Young, Educational Technologist for the Research and Curriculum Unit at Mississippi State University

Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the Horticulture Curriculum Framework and supporting materials are based on the following:

National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards

The National Council for Agricultural Education (The Council) shapes and strengthens school-based agricultural education at all levels. The Council and the National AFNR Career Cluster Content Standards Committee have developed standards that provide state agricultural education leaders and teachers with a guide to cultivate well-planned curriculum in agriscience education for grades 9 through 14. The standards referenced in this curriculum are reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314. (800) 772-0939. Copyright © 2015. https://www.ffa.org/thecouncil/Documents/finalafnrstandardsv324609withisbn_000.pdf

College and Career-Ready Standards

The College and Career-Ready Standards emphasize critical thinking, teamwork and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College- and Career-Ready Standards (MCCRS) because they provide a consistent, clear understanding of what students are expected to learn so that teachers and parents know what they need to do to help them. Reprinted from http://www.mde.k12.ms.us/MCCRS

International Society for Technology in Education Standards (ISTE)

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21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and information and communication technology (ICT) literacy.

Preface

Secondary career and technical education programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at

The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

The secondary pathway in horticulture prepares individuals for entry-level employment or continuing education in a wide variety of fields in the horticulture industry. Students enrolled in the program participate in a variety of instructional activities including lectures, discussions, laboratory experiences at the school, and work-based learning activities in the field, such as field trips and shadowing experiences. Students also receive supplementary instruction and reinforcement of learning through activities in youth organizations. Topics covered in the two-year program include plant structure and growth; plant propagation; pest management; floristry; greenhouse crops and management; olericulture; plantscaping; landscape design, installation, and management; and turfgrass management. Student competencies and suggested objectives in the curriculum framework have been correlated to the knowledge and skill statements listed in Career Cluster Resources for Agriculture, Food, and Natural Resources (AFNR), as published by the National Association of State Directors of Career and Technical Education.

Industry Certification

No national industry-recognized certifications are known to exist at this time in the field of horticulture. Competencies and suggested performance indicators in the horticulture courses have been correlated, however, to the AFNR Career Cluster Content Standards that have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Assessment

The latest assessment blueprint for the curriculum can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx.

Student Prerequisites

In order for students to experience success in the program, the following student prerequisites are suggested:

4. C or higher in pre-algebra

or

5. TABE Math Computation and TABE Math Applied Score (eighth grade or higher)

or

6. Instructor approval

Applied Academic Credit

The content of the horticulture course has been aligned to the 2010 Mississippi Science Curriculum Framework. Students who complete horticulture will receive two electives and two science credits or four elective credits that will count toward high school science graduation requirements.

Teacher Licensure

The latest teacher licensure information can be found at:

http://www.mde.k12.ms.us/OEL.

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510.

Course Outlines

Option 1 – Four One-Carnegie-Unit Courses

This curriculum consists of four one-Carnegie-unit courses, which should be completed in the following sequence:

5. **Introduction to Horticulture – Course Code: 991402**
6. **Horticulture Plant Processes – Course Code: 991403**
7. **Horticulture Nursery – Course Code: 991404**
8. **Horticulture Landscape and Turfgrass – 991405**

Course Description: Introduction to Horticulture

This course teaches students about horticulture orientation and leadership development. Students are introduced to basic plant and soil science (plant structure and growth). This course also focuses on horticulture structures.

Course Description: Horticulture Plant Processes

This course focuses on plant propagation, principles of pest management, greenhouse crops, and olericulture production.

Course Description: Horticulture Nursery

This course is a comprehensive course that reviews leadership, careers, and safety. It also introduces students to nursery and landscape plant identification, horticulture marketing, and business procedures, as well as container and field crop production.

Course Description: Horticulture Landscape and Turfgrass

This course covers the concepts of landscape design, installation, construction, and maintenance. Students will learn skills and knowledge associated with turfgrass installation and maintenance, pomology production, and basic principles of floristry.

Introduction to Horticulture — Course Code: 991402

Unit	Unit Name	Hours
1	Horticulture Orientation and Leadership Development	15
2	Horticulture Safety	15
3	Basic Plant and Soil Science (Plant Structure and Growth)	52
4	Horticulture Structures	20
Total		102

~~Horticulture Plant Processes — Course Code: 991403~~

~~Unit~~	~~Unit Name~~	~~Hours~~
~~5~~	~~Plant Propagation~~	~~33.0~~
~~6~~	~~Principles of Pest Management~~	~~28.0~~
~~7~~	~~Greenhouse Crops and Olericulture Production~~	~~44.0~~
~~Total~~		~~105~~

~~Horticulture Nursery — Course Code: 991404~~

~~Unit~~	~~Unit Name~~	~~Hours~~
~~8~~	~~Leadership, Careers, and Safety~~	~~15~~
~~9~~	~~Nursery and Landscape Plant Identification~~	~~25.0~~
~~10~~	~~Horticulture Marketing and Business Procedures~~	~~27.5~~
~~11~~	~~Container and Field Crop Production~~	~~27.5~~
~~Total~~		~~95~~

~~Horticulture Landscape and Turfgrass — Course Code: 991405~~

~~Unit~~	~~Unit Name~~	~~Hours~~
~~12~~	~~Landscape Design, Installation, Construction, and Maintenance~~	~~57.5~~
~~13~~	~~Turfgrass Installation and Maintenance~~	~~25.0~~
~~14~~	~~Principles of Floristry~~	~~22.5~~
~~15~~	~~Pomology Production~~	~~10~~
~~Total~~		~~115~~

Option 2 — Two Two-Carnegie-Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

3. **Horticulture I — Course Code: 991400**

4. **Horticulture II — Course Code: 991401**

Course Description: Horticulture I

This course introduces students to basic plant and soil science (plant structure and growth). This course focuses on horticulture structures, plant propagation, and principles of pest management. This course also covers greenhouse crops and olericulture production.

Course Description: Horticulture II

This course reviews leadership, careers, and safety in the horticulture field. It introduces students to plant identification, horticulture marketing and business procedures, and container and field crop production. This course includes concepts of landscape design, installation, construction, and maintenance. Students are introduced to turfgrass installation and maintenance, pomology, and basic principles of floristry.

Horticulture I — Course Code: 991400

Unit	Unit Name	Hours
1	Horticulture Orientation and Leadership Development	15
2	Horticulture Safety	15
3	Basic Plant and Soil Science (Plant Structure and Growth)	52
4	Horticulture Structures	20.0
5	Plant Propagation	33.0
6	Principles of Pest Management	28.0
7	Greenhouse Crops and Olericulture Production	44.0
Total		207

Horticulture II — Course Code: 991401

Unit	Unit Name	Hours
8	Leadership, Careers, and Safety	15
9	Nursery and Landscape Plant Identification	25.0
10	Horticulture Marketing and Business Procedures	27.5

~~11~~	~~Container and Field Crop Production~~	~~27.5~~
~~12~~	~~Landscape Design, Installation, Construction, and Maintenance~~	~~57.5~~
~~13~~	~~Turfgrass Installation and Maintenance~~	~~25.0~~
~~14~~	~~Principles of Floristry~~	~~22.5~~
~~15~~	~~Pomology Production~~	~~10~~
~~Total~~		~~210~~

Research Synopsis

Introduction

Articles, books, websites, and other materials listed at the end of each course were considered during the revision process. The American Horticulture Society was especially useful in providing insight into trends and issues in the field. These references are suggested for use by instructors and students during the study of the topics outlined.

Industry advisory team members from colleges throughout the state were asked to give input related to changes to the curriculum framework. Instructors from colleges throughout the state were also asked to give input. Specific comments related to this program included statements from advisory committee members indicating this is a good program that covers the needs of industry. Changes suggested for the curriculum included providing the math skills necessary to complete the work and stressing employability skills.

Needs of the Future Workforce

Horticulture occupations are projected to grow 30% faster than average in Mississippi and 20% faster than average in the United States (EMSI, 2011). Job opportunities in this field are expected to be good. Opportunities vary based on the season and local conditions. Non-seasonal employment opportunities will be most abundant in regions with temperate climates where horticultural services are in demand year-round. Job opportunities will emerge as the industry grows and workers leave the industry.

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2013). Employment opportunities for each of the occupations are listed below:

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2010	Projected Jobs, 2020	Change (Number)	Change (Percent)	Average Hourly Earning
Conservation Scientists	1,270	1,330	60	4.7	$25.95
Soil and Plant Scientists	70	80	10	14.3	$35.19
Farmworkers and Laborers, Crop, Nursery, and Greenhouse	690	690	0	0.0	$9.84
Foresters	650	670	20	3.1	$21.46
Forest and Conservation Technicians	110	120	10	9.1	$20.47
Forest and Conservation Workers	70	80	10	14.3	$16.13

Landscaping and Groundskeeping Workers	4,320	5,240	920	21.3	$10.68
Landscape Architects	80	90	10	12.5	$25.85
First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	880	1,080	200	22.7	$19.31
First-Line Supervisors of Farming, Fishing, and Forestry Workers	300	310	10	3.3	$22.29

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed September 12, 2013).

Perkins IV Requirements

The horticulture curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations within the field of horticulture. It offers students a program of study including secondary, postsecondary, and higher education courses that will prepare them for occupations in these fields. Additionally, the horticulture curriculum is integrated with academic College and Career Readiness Standards. Lastly, the horticulture curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the horticulture curriculum are the standards from FFA, 21st Century Skills, the College and Career Readiness Standards for Mathematics and Science, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the College and Career Readiness Standards are designed to prepare students for success in community colleges, institutions of higher learning, and careers.

Academic Infusion

While using the horticulture curriculum, students will encounter history through learning about the horticulture field, and also science, math, and business. In addition, this curriculum prepares students for the workforce by incorporating the 21st Century Literacy Skills.

Transition to Postsecondary Education

The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board (MCCB) website: http://www.mccb.edu/.

Best Practices

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The horticulture teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a classroom set of desktop student computers and one teacher laptop. To make use of the latest online communication tools such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning management system, for example, the Horticulture Teacher Learning Management System, that introduces students to education in an online environment and places the responsibility for learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several in Mississippi that will foster the types of learning expected from the horticulture curriculum. FFA is the student organization for horticulture. FFA provides students with growth opportunities and competitive events. It also opens the doors to the world of agriculture and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the horticulture curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The horticulture curriculum provides opportunities for students to work together and help each other complete complex tasks.

Conclusions

Horticulture is one of Mississippi's most comprehensive curriculums. Students that complete these programs are well equipped for a variety of endeavors. Instructors are urged to encourage horticulture students to pursue educational opportunities at community colleges and universities in Mississippi.

Professional Organizations

National FFA Organization

The National FFA Organization is a research and support organization. Educational materials are developed by FFA in cooperation with the U.S. Department of Education as a service to state and local agricultural education agencies. The national FFA staff carries out the policies and provides services for the organization. www.ffa.org

Mississippi FFA Association

The Mississippi FFA Association functions within the constitution of the National FFA Organization. The Mississippi FFA Association offers career development events and contests and is open to students aged 14-21. The Junior FFA Association is for students in grades 4-9.

www.mississippiffa.org

International Technology Education Association (ITEA)

The *International Technology Education Association* (ITEA) is the professional organization for technology, innovation, design, and engineering educators. http://www.iteaconnect.org/.

Using This Document

Suggested Time on Task

This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives

A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References

A list of suggested references is provided. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Horticulture Orientation and Leadership Development

Competencies and Suggested Objectives
1. Identify school and program policies and procedures related to the horticulture program. DOK1 a. Describe local program and vocational–career technical center policies and procedures including dress code, attendance, academic requirements, discipline, the school technology acceptable use policy, and horticulture regulations.
2. Develop life and career skills for success in the 21st century. DOK3 a. Identify, describe, and apply essential life and career skills. b. Apply the concepts of team-building and team member participation. c. Demonstrate basic parliamentary procedures.
3. Explore the role of the FFA in promoting leadership, personal development, and human relations skills. DOK1 a. Explore the history and nature of the FFA in promoting and developing leadership, personal development, and human relations skills. b. Identify career-related values and ethics promoted through the FFA. c. Identify benefits of FFA membership. d. Select FFA activities that promote personal development and leadership skills.
4. Examine the concept of leadership. DOK3 a. Explain the role of effective leadership. b. Have students self-evaluate their personal leadership traits and develop a plan for improvement.
5. Describe the role of ethics and values in establishing and building a successful career. DOK3 a. Define and describe universally accepted ethics and values as applied to horticulture careers. b. Practice ethics and values in the horticulture classroom and lab.

Unit 2: Horticulture Safety

Competencies and Suggested Objectives
1. Demonstrate basic and fundamental safety practices related to horticulture enterprises. DOK1, ABS.03. a. Identify hazards that may be found in horticulture operations, laboratories, and activities, including: • poisons and other chemicals • sunburn • ladders and scaffolds • electrical shock • fire • poisonous insects and snakes • equipment and tool hazards • spills and slipping b. Identify and demonstrate the use of personal protection devices, including the following: • eye protection • hearing protection • foot protection • respiratory protection • clothing and body protection • fire extinguishers • eyewash and shower stations • first-aid kits • other general safety equipment

Unit 3: Basic Plant and Soil Science (Plant Structure and Growth)

Competencies and Suggested Objectives

1. Explore plant structure and their functions. DOK 2, ESS.01, ESS.02, ESS.03, NRS.01

   a. Draw a diagram of a flowering plant, and label and describe the major parts (roots, stems, leaves, and flowers) and functions as related to plant growth (cell division, cell elongation, and cell differentiation).

   b. Describe the process of respiration, photosynthesis, and transpiration.

   c. Describe the relationship of environmental and cultural factors to plant growth (water, light, temperature, soil, climatic zones).

2. Apply systems of plant classification. DOK1, PS.01, PS.02, PS.03

   a. Interpret the scientific classification of plants. Include the following:

- Adam's Needle (Yucca)
- American Arborvitae
- Bald Cypress
- Bayberry
- Bearded Iris
- Border Forsythia
- Bumalda Spirea
- Carpet Bugle
- Catawba Hybrid Rhododendron
- Cherry Laurel
- Chinese (Saucer) Magnolia
- Chinese Holly
- Chinese Juniper
- Chinese Wisteria
- Common Blanketflower
- Common Camellia
- Kwanzan Japanese Flowering Cherry
- Lily-of-the-Valley Bush
- Lily Turf
- Littleleaf Boxwood
- London Planetree
- Mentor Barberry
- Oakleaf Hydrangea
- Oregon Grape
- Pin Oak
- Plaintain Lily (Hosta)
- Common Gardenia
- Crape Myrtle
- Creeping Juniper
- Eastern White Pine
- Hybrid Azalea
- Firethorn
- Flowering Crabapple
- Flowering Dogwood
- Ginkgo, Maidenhair Tree
- Glossy Abelia
- Heavenly Bamboo (Nandina)
- Japanese (Flowering) Quince
- Japanese Holly
- Chinese Holly
- Japanese Maple
- River Birch
- Hybrid Tea Rose
- Sour (Black) Gum
- Southern Magnolia
- Southern Yew
- Sweet Gum
- Thornless Honeylocust
- Tuliptree
- Washington Hawthorn
- White Ash
- White Oak

- Red Maple
- Red Oak
- Redbud
- Wintercreeper
- Yew

b. Discuss variety and variety selection of plants.

c. Classify plants according to life cycle.

3. Describe and apply principles of plant growth media. DOK2, ESS.04, ESS.05, ESS.06, NRS.04, NRS.05

a. Identify and compare the components of natural soil and soil-less mix. List and explain the characteristics each one imparts to the root medium.

b. Prepare a growing media to specifications, or identify the components and proportions in a commercially-prepared root medium, and discuss/explain the advantages of a commercial root medium over media containing natural soil.

c. Identify macronutrients and micronutrients and their effects on plant growth.

d. Describe the effect of excesses and deficiencies.

e. Demonstrate the proper procedure for taking a soil sample.

f. Predict the effect various pH levels will have on plant nutrition and growth.

g. Analyze a soil sample for nutrient deficiencies by using the scientific method.

h. Calculate fertilizer application rates to meet nutritional requirements for a specific crop.

i. Select fertilizer application methods for different plant enterprises.

Unit 4: Horticulture Structures

Competencies and Suggested Objectives
1. Describe the characteristics and features of different types of greenhouses. DOK2, PS.01, PST.01, PST.02, PST.03, PST.04, PST.05 a. Identify and compare the greenhouse structures and coverings and auxiliary (shade house, hot beds, and cold frame) types: Quonset, ridge and furrow, even span, and shade houses. b. Describe the environmental controls including humidistat, thermostat, cooling, watering, and heating. c. Describe the importance of light in plant growth. d. Discuss water, fertigation, and chemigation management in growing plants. e. Identify and describe factors to consider in establishing a floor plan for a greenhouse, including: sanitation, benching, flooring, potting facilities, chemical and dry storage, and traffic patterns.

Unit 5: Plant Propagation

Competencies and Suggested Objectives
1. Distinguish between sexual and asexual reproduction. DOK2, PS.01, PS.02 a. Describe sexual reproduction in plants. b. Describe the conditions needed for good seed germination. c. Plan and conduct a seed germination test. d. Interpret information found on a seed tag. e. Describe, discuss, or demonstrate how to propagate plants from scarified or stratified seeds. f. Identify and describe asexual reproduction techniques using grafting, budding, cuttings (root, stem and leaf), layering, separation and division, and tissue culture methods. g. Identify common tools and chemicals used in asexual reproduction, and demonstrate their safe use and care.

Unit 6: Principles of Pest Management

Competencies and Suggested Objectives

1. Assess the effects of pests on plant production. DOK2, ESS.04

   a. Identify types of plant pests (insects, wildlife, diseases, and weeds), and describe how each type of pest affects production, control, and management practices for plant pests and concepts related to integrated pest management. Include the following:

Insects

- Aphid
- Bagworm
- Borer
- Leaf hopper
- Leaf miner
- Scale
- Spider mite
- Snail/slug
- Whitefly
- White grub

Diseases

- Anthracnose
- Apple scab
- Black spot
- Botrytis
- Canker
- Cedar-apple rust
- Crown gall
- Fireblight
- Powdery mildew
- Root rot

Weeds

- Annual Bluegrass
- Broadleaf Plantain
- Buckhorn Plantain
- Chickweed
- Crabgrass
- Dandelion
- Henbit
- Nutsedge
- Oxalis
- Purslane
- White Clover

Physiological problems

- Frost freeze injury
- Iron deficiency
- Leaf scorch (drought/winter burn)
- Nitrogen deficiency
- Pot-bound roots
- String trimmer injury
- 2, 4-D injury

   b. Design an integrated pest management plan for a designated horticulture crop

2. Identify, describe, and apply pesticide safety procedures. DOK1, ESS.04, ESS.05, ESS.06

   a. Interpret safety and first-aid precautions and formulations on pesticide labels (insecticide, herbicides, rodenticide, fungicide, miticide, molluscicide, and nematocides).

   b. Identify beneficial insects, and discuss how they benefit plants. Include the following:

- Assassin bug
- Beneficial nematode
- Big-eyed bug
- Mealybug destroyer
- Minute pirate bugs
- Praying mantis

- ~~Damsel bugs~~
- ~~Earwig~~
- ~~Green Lacewing~~
- ~~Ground beetles~~
- ~~Ichneumon wasp~~
- ~~Lady beetles~~
- ~~Predatory stink bugs~~
- ~~Soldier beetle~~
- ~~Syrphid flies~~
- ~~Tachinid fly~~
- ~~Trichogramma wasp~~

~~c. Discuss the relationship between biological, chemical, cultural, and mechanical control methods.~~

~~d. Discuss and apply general precautions for working with pesticides in relation to the requirements for pesticide applicator's certification/licensure.~~

Unit 7: Greenhouse Crops and Olericulture Production

Competencies and Suggested Objectives

1. Describe and apply principles of greenhouse crop production. DOK2, ABS.07, FPP.01, FPP.02, FPP.03, FPP.04, NRS.03, PS.01, PS.02

    a. Identify different types of greenhouse crops (bedding plants, vegetables, flowering plants, foliage plants, etc.) and common species of each type, to include cultural considerations for greenhouse crops including fertilizer, water, growing medium, pest control, temperature, natural and chemical growth control and stimulation, and light control for common crops. Include the following:

Bedding plants

- Coleus
- Dianthus
- Impatiens
- Marigold
- Pansy
- Petunia
- Salvia
- Snapdragon
- Verbena
- Vinca
- Viola
- Wax Begonia
- Zinnia

Vegetables

- Beans
- Broccoli
- Cabbage
- Carrots
- Cauliflower
- Corn
- Cucumber
- Eggplant
- Lettuce
- Peas
- Tomato
- Pepper
- Squash

Flowering plants

- Ferns
- Ficus
- Geraniums
- Hosta
- Impatiens
- Marigold
- Nephthytis
- Orchids
- Pansies
- Peace Lily
- Petunias
- Philodendron
- Poinsettias
- Pothos
- Rose
- Salvia
- Schefflera
- Snake Plant
- Spider Plant
- Zinnia

Foliage plants

- Angelica
- Aralia
- Chinese Evergreen
- Dracaena
- Dumbcane
- English Ivy
- Ferns
- Ficus
- Hosta

- African Violet
- Benjamin Fig
- Boston Ferns
- Cacti
- Caladiums
- Chinese Evergreen
- Chrysanthemums
- Coleus
- Dracaena
- Dumbcane
- Nephthytis
- Palms
- Peace Lily
- Philodendron
- Pothos
- Purple Sage
- Schefflera

b. Produce a greenhouse crop following accepted commercial practices (ongoing throughout the year). (Not on CPAS.)

2. Describe and apply principles of olericulture production. DOK2, ABS.07, FPP.01, FPP.02, FPP.03, FPP.04, NRS.03, PS.01, PS.02

a. Describe characteristics of common vegetables grown for commercial production including cultural requirements, direct seeding versus transplanting, plant growth style, and growing season; and distinguish between warm season and cool season crops. Include the following:

- Beans
- Broccoli
- Brussel sprouts
- Cabbage
- Carrots
- Chives
- Corn
- Cucumber
- Eggplant
- Garlic
- Lettuce
- Onions
- Peanuts
- Potatoes
- Pumpkin
- Squash

b. Identify and demonstrate the use of common tools and equipment used in gardening, including tillers, spreaders, sprayers, watering devices, rakes, hoes, and shovels.

c. Identify and describe factors to consider in preparing a seedbed, including soil class and texture, use of soil amendments, and characteristics of a properly prepared seedbed.

d. Develop a plan for an intensive culture garden including crop and variety selection, location and spacing of different crops, scheduling of crops, crop rotation, and harvesting and marketing of crops.

e. Discuss new and emerging technologies, trends, and issues concerning the production and marketing of vegetables in Mississippi. Identify and discuss the roles of agencies and organizations that regulate the production and marketing of vegetables.

Unit 8: Leadership, Careers and Safety (Review and Reinforcement-Ongoing)

Competencies and Suggested Objectives
1. Review program policies, procedures, and safety rules. DOK2, ABS.03 a. Review program operation policies and procedures, including general safety procedures.
2. Practice leadership skills. DOK2 a. Identify and discuss fundamental parliamentary procedures for participating in a public meeting and public speaking. b. Select FFA activities that promote personal development and leadership skills.
3. Complete school-to-careers activities related to horticulture. DOK1, ABS.03, NRS.02, PS.02 a. Identify employment and career opportunities in the horticulture industry. b. Investigate educational opportunities related to horticulture at the postsecondary level. c. Describe national standards and certification/licensing procedures, trade organizations, associations, and unions as related to horticulture.
4. Supervised Agricultural Project (SAE) a. Have each student complete an SAE.

Unit 9: Nursery and Landscape Plant Identification

Competencies and Suggested Objectives

1. Identify and describe the use of major plants associated with nursery and landscape operations. DOK1, PS.01

   a. Identify and describe the use of major nursery plants used in landscape operations including the following:

- Adam's Needle (Yucca)
- American Arborvitae
- Bald Cypress
- Bayberry
- Bearded Iris
- Border Forsythia
- Bumalda Spirea
- Carpet Bugle
- Catawba Hybrid Rhododendron
- Cherry Laurel
- Chinese (Saucer) Magnolia
- Chinese Holly
- Chinese Juniper
- Chinese Wisteria
- Common Blanketflower
- Common Camellia
- Kwanzan Japanese Flowering Cherry
- Lily-of-the-Valley Bush
- Lily-Turf
- Littleleaf Boxwood
- London Planetree
- Mentor Barberry
- Oakleaf Hydrangea
- Oregon Grape
- Pin Oak
- Plaintain Lily (Hosta)
- Red Maple
- Red Oak
- Redbud
- Common Gardenia
- Crape Myrtle
- Creeping Juniper
- Eastern White Pine
- Hybrid Azalea
- Firethorn
- Flowering Crabapple
- Flowering Dogwood
- Ginkgo, Maidenhair Tree
- Glossy Abelia
- Heavenly Bamboo (Nandina)
- Japanese (Flowering) Quince
- Japanese Holly
- Chinese Holly
- Japanese Maple
- River Birch
- Hybrid Tea Rose
- Sour (Black) Gum
- Southern Magnolia
- Southern Yew
- Sweet Gum
- Thornless Honeylocust
- Tuliptree
- Washington Hawthorn
- White Ash
- White Oak
- Wintercreeper
- Yew

Unit 10: Horticulture Marketing and Business Procedures

Competencies and Suggested Objectives
1. Describe and apply marketing and business practices associated with horticulture operations. DOK2, ABS.01, ABS.02, ABS.03, ABS.04, ABS.05, ABS.06, PS.01, PS.02, PS.03 a. Maintain an inventory of plants and supplies for the horticulture program (ongoing throughout the year). b. Develop an annual calendar of activities/enterprises for a horticulture business, including ordering materials/supplies for an enterprise. c. Describe factors to consider in pricing products of an enterprise, and complete a sales transaction including providing customer service. d. Describe factors to consider in marketing and advertising products.
2. Describe basic employee responsibilities and how to communicate effectively in on-the-job situations. a. Describe the following life skills: • Communication • Considerate • Cooperation • Delegator • Effective listener • Friendly personality • Get along with others • Good manners • Honesty • Human relations • Open-minded • Positive self-concept • Problem-solver • Rational thinker • Respect for others • Responsibility • Set priorities • Social interaction • Teamwork

Unit 11: Container and Field Crop Production

Competencies and Suggested Objectives

1. Describe and apply principles of container and field crop production. DOK2, ABS.07, FPP.01, FPP.02, FPP.03, FPP.04, NRS.03, PS.01, PS.02, PS.03

   a. Describe advantages and disadvantages of container crop production vs. field crop production.

   b. Identify and demonstrate the safe use of tools and equipment for container and field crop production. Include the following:

- Ball cart (B&B truck)
- Bark mulch
- Bow saw
- Broadcast (cyclone) spreader
- Burlap
- Compressed air sprayer
- Chain saw
- Drip emitter, irrigation
- Duster
- Dust mask
- Edger (power or hand)
- Edging
- Erosion netting
- Fertilizer tablet
- Galvanized pipe
- Garden (spading) fork
- Garden (bow) rake
- Gas mask
- Grafting tool
- Granular fertilizer
- Gravity (drop) spreader
- Ground/pelleted limestone
- Hearing protection
- Hedge shears
- Hoe
- Hook-and-blade pruners
- Hose-end repair fitting
- Hose-end sprayer
- Hose-end washer
- Hose repair coupling
- Impulse sprinkler
- Landscape fabric
- Nursery container
- Pick axe
- Planting/earth/soil auger
- Pole pruner
- Polyethylene pipe
- Pop-up irrigation head
- Post-hole digger
- Power blower
- Power hedge trimmer
- Pot-in-pot units
- Propagation mat
- Pruning saw
- PVC (polyvinylchloride) pipe
- Reel mower
- Resin-coated fertilizer
- Respirator
- Rotary mower
- Rototiller
- Round point shovel
- Safety goggles
- Scoop shovel
- Shade fabric
- Sharpening stone
- Siphon proportioner
- Soaker hose
- Soil sampling tube
- Solenoid valve
- Spade
- Spray suit
- Square point (flat) shovel
- String trimmer
- Tape measure

- ~~Leaf rake~~
- ~~Loppers~~
- ~~Mattock~~
- ~~Measuring wheel~~
- ~~Mist nozzle (mist bed)~~
- ~~Tree caliper~~
- ~~Tree wrap~~
- ~~Trowel~~
- ~~T-square~~
- ~~Water breaker~~

~~c. Produce container and field grown plants. Include the following:~~

- ~~Beans~~
- ~~Broccoli~~
- ~~Brussels sprouts~~
- ~~Cabbage~~
- ~~Carrots~~
- ~~Chives~~
- ~~Corn~~
- ~~Cucumber~~
- ~~Eggplant~~
- ~~Garlic~~
- ~~Lettuce~~
- ~~Onions~~
- ~~Peanuts~~
- ~~Potatoes~~
- ~~Pumpkin~~
- ~~Squash~~

~~d. Describe automation and plug production in the nursery industry.~~

Unit 12: Landscape Design, Installation, Construction, and Maintenance

Competencies and Suggested Objectives
1. Describe and apply principles of landscape design. DOK2, PS.03 a. Describe careers in the landscape design field. b. Identify and demonstrate the use of tools and equipment for landscape design, including computer-assisted landscape design hardware and software. c. Identify and demonstrate the methods of lettering and symbols used in landscape design plans. d. Describe principles of design associated with landscaping, including simplicity, balance, and proportion. e. Prepare site analysis/needs assessment for a given site. f. Prepare a simple landscape plan to scale for a given site, including plant selection and location.
2. Describe and apply basic principles of landscape installation and construction. DOK1, PS.03, PST.04 a. Discuss the essential elements of a landscape installation contract (to include warranty and an estimate). b. Develop a contract and pricing estimate for the landscape plan. c. Describe and discuss procedures for preparing a planting site, installing plants, and providing post-transplant care according to a landscape plan. d. Describe licensing requirements for landscape installation. e. Discuss installation and maintenance of a landscape irrigation system.
3. Describe and apply principles of landscape maintenance. DOK1, PS.03, PST.04 a. Identify and demonstrate the safe use of equipment and hand tools for landscape maintenance. b. Identify and discuss the proper procedures for pruning trees and shrubs. c. Determine and discuss a cost estimate for fertilizer needs, pest control, and maintenance needs of trees, shrubs, and beds.

Unit 13: Turfgrass Installation and Maintenance

Competencies and Suggested Objectives

1. Describe and apply principles of turfgrass installation. DOK2, PS.03

   a. Describe factors to consider in selecting a turfgrass for a specific area. Identify varieties of turfgrass, and describe their characteristics. Include the following:

   - Bentgrass
   - Bermuda grass
   - Carpet grass
   - Centipede grass
   - Kentucky bluegrass
   - St. Augustine grass
   - Tall fescue

   b. Describe installation practices for different turfgrasses, including site preparation and initial care.

2. Describe and apply principles of turfgrass maintenance. DOK1, PS.03

   a. Identify and demonstrate the safe use and maintenance of equipment and tools used for turfgrass maintenance, including mowers, dethatchers, aerators, and other equipment.

   b. Use mowers, sprayers, or spreaders for a specific grass.

   c. Identify and describe common pests of turfgrass, including insects, diseases, and weeds:

Turfgrass insects

- Army worms
- Chinch bug
- Japanese beetle
- Sod webworm
- White grubs

Turfgrass diseases

- Brown patch
- Damping off
- Dollar spot
- Fairy ring
- Grey leaf spot
- Melting out
- Pythium blight
- Slime mold
- Spring dead spot

Turfgrass weeds

- Annual Bluegrass
- Broadleaf Plantain
- Buckhorn Plantain
- Common Purslane
- Curly Dock
- Cutleaf Geranium
- Dallisgrass
- Dandelion
- Goose Grass
- Henbit
- Italian Ryegrass
- Large Crabgrass
- Lawn Burweed
- Mouse Ear Chickweed
- Purple Nutsedge
- Smooth Crabgrass
- Smutgrass
- White Clover
- Wild Garlic
- Wild Onion
- Woodsorrel
- Yellow Foxtail
- Yellow Nutsedge

- ~~Common Bermuda grass~~
- ~~Common Chickweed~~

~~d. Identify and describe common irrigation methods for turfgrass.~~

~~e. Perform repair/renovation practices, including aeration and dethatching.~~

~~f. Develop a plan/cost estimate for a turfgrass management program.~~

Unit 14: Principles of Floristry

Competencies and Suggested Objectives
1. Describe and apply principles of floristry. DOK2, PS.03 a. Demonstrate the procedures for receiving and storing (including rotation of inventory) of floral materials. b. Apply basic design principles, including balance, transition, rhythm, focal point, proportion, and scale. c. Receive and process orders for floral products. d. Identify and demonstrate the safe and proper use of tools and supplies used in floristry, including shears, tape, foam, and floral wire, to include plant materials used in floristry including potted, flower, and foliage materials.

Unit 15: Pomology Production

Competencies and Suggested Objectives
1. Describe and apply principles of fruit and berry production. DOK2, ABS.01, ABS.07, FPP.01, FPP.02, FPP.03, FPP.04, NRS.03, PS.01, PS.02 a. Identify, discuss, and prepare a planting and marketing plan of common fruits and berries produced in Mississippi. Include the following: • Apples • Blackberries • Blueberries • Cantaloupes • Figs • Melons • Oranges • Peaches • Pears • Persimmons • Plums • Pumpkins • Raspberries • Watermelons b. Provide or explain/describe how to provide cultural care for fruit or berry plants commonly grown in Mississippi, to include pruning, fertilizing, pest control, and harvesting. c. Identify, discuss, and describe marketing of fruits and vegetables as it relates to local, state, national, and international organizations that impact fruit and berry production.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Horticulture Orientation and Leadership Development		
	1.	Identify school and program policies and procedures related to the horticulture program.
	2.	Develop life and career skills for success in the 21st century.
	3.	Explore the role of the FFA in promoting leadership, personal development, and human relations skills.
	4.	Examine the concept of leadership.
	5.	Describe the role of ethics and values in establishing and building a successful career.
Unit 2: Horticulture Safety		
	1.	Demonstrate basic and fundamental safety practices related to horticulture enterprises.
Unit 3: Basic Plant and Soil Science (Plant Structure and Growth)		
	1.	Explore plant structure and their functions.
	2.	Apply systems of plant classification.
	3.	Describe and apply principles of plant growth media.
Unit 4: Horticulture Structures		
	1.	Describe the characteristics and features of different types of greenhouses.
Unit 5: Plant Propagation		
	1.	Distinguish between sexual and asexual reproduction.
Unit 6: Principles of Pest Management		
	1.	Assess the effects of pests on plant production.

	2	Identify, describe, and apply pesticide safety procedures.
Unit 7: Greenhouse Crops and Olericulture Production		
	1.	Describe and apply principles of greenhouse crop production.
	2.	Describe and apply principles of olericulture production.

~~Unit 8: Leadership, Careers, and Safety (Review and Reinforcement-Ongoing)~~		
	~~1.~~	~~Review program policies, procedures, and safety rules.~~
	~~2.~~	~~Practice leadership skills.~~
	~~3.~~	~~Complete school-to-careers activities related to horticulture.~~
	~~4.~~	~~Supervised Agricultural Project (SAE).~~
~~Unit 9: Nursery and Landscape Plant Identification~~		
	~~1.~~	~~Identify and describe the use of major plants associated with nursery and landscape operations.~~
~~Unit 10: Horticulture Marketing and Business Procedures~~		
	~~1.~~	~~Describe and apply marketing and business practices associated with horticulture operations.~~
	~~2.~~	~~Describe basic employee responsibilities and how to communicate effectively in on-the-job situations.~~
~~Unit 11: Container and Field Crop Production~~		
	~~1.~~	~~Describe and apply principles of container and field crop production.~~
~~Unit 12: Landscape Design, Installation, Construction, and Maintenance~~		
	~~1.~~	~~Describe and apply principles of landscape design.~~
	~~2.~~	~~Describe and apply basic principles of landscape installation and construction.~~
	~~3.~~	~~Describe and apply principles of landscape maintenance.~~
~~Unit 13: Turfgrass Installation and Maintenance~~		
	~~1.~~	~~Describe and apply principles of turfgrass installation.~~
	~~2.~~	~~Describe and apply principles of turfgrass maintenance.~~
~~Unit 14: Principles of Floristry~~		
	~~1.~~	~~Describe and apply principles of floristry.~~
~~Unit 15: Pomology Production~~		
	~~1.~~	~~Describe and apply principles of fruit and berry production.~~

Appendix A: Industry Standards

AFNR National Standards

Crosswalk for Horticulture

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15
ABS.01											X					X
ABS.02											X					
ABS.03			X						X		X					
ABS.04											X					
ABS.05											X					
ABS.06											X					
ABS.07								X				X				X
ESS.01				X												
ESS.02				X												
ESS.03				X												
ESS.04				X			X									
ESS.05				X			X									
ESS.06				X			X									
FPP.01								X				X				X
FPP.02								X				X				X
FPP.03								X				X				X
FPP.04								X				X				X
NRS.01				X												
NRS.02									X							
NRS.03								X				X				X
NRS.04				X												
NRS.05				X												
PS.01				X	X	X		X		X	X	X				X
PS.02				X		X		X			X	X				X
PS.03				X					X		X	X	X	X	X	
PS.04																
PST.01					X											
PST.02					X											
PST.03					X											
PST.04					X								X			
PST.05					X											

Agriculture, Food, and Natural Resources (AFNR) Pathway

Content Standards and Performance Elements

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria,

AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.

ABS.01.01. Apply principles of capitalism in the business environment.

ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.

ABS.02.01. Compose and analyze a business plan for an enterprise.

ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.

ABS.02.03. Apply appropriate management skills to organize a business.

ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.

ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.

ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.

ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.

ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.

ABS.06.01. Conduct appropriate market and marketing research.

ABS.06.02. Develop a marketing plan.

ABS.06.03. Develop strategies for marketing plan implementation.

ABS.06.04. Develop specific tactics to market AFNR products and services.

~~**ABS.07. Create a production system plan.**~~

~~ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.~~

~~ABS.07.02. Develop a production and operational plan.~~

~~ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.~~

~~ABS.07.04. Manage risk and uncertainty.~~

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

ESS.03.01. Apply meteorology principles to environmental service systems.

ESS.03.02. Apply soil science principles to environmental service systems.

ESS.03.03. Apply hydrology principles to environmental service systems.

ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.

ESS.03.05. Apply chemistry principles to environmental service systems.

ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

ESS.04.01. Use pollution control measures to maintain a safe facility environment.

ESS.04.02. Manage safe disposal of all categories of solid waste.

ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.

ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.

ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.

NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.

NRS.02.03. Measure and survey natural resource status to obtain planning data.

NRS.02.04. Demonstrate natural resource enhancement techniques.

NRS.02.05. Interpret laws related to natural resource management and protection.

NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.

NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.

NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.

PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.

PS.02.02. Prepare growing media for use in plant systems.

PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.

PS.03.02. Develop and implement a plant management plan for crop production.

PS.03.03. Develop and implement a plan for integrated pest management.

PS.03.04. Apply principles and practices of sustainable agriculture to plant production.

PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.

PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.

PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.

PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.

PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.

PST.03.03. Service and repair hydraulic and pneumatic systems.

PST.03.04. Troubleshoot and service electrical systems.

PST.03.05. Service vehicle heating and air conditioning systems.

PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.

PST.04.02. Apply structural plans, specifications, and building codes.

PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.

PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.

PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.

PST.05.03. Use geospatial technologies in agricultural applications.

Miss. Code Admin. 7-119

2021 Food Products (Meats)

Program CIP: 01.0401 – Agricultural and Food Products Processing

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Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Acknowledgments

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Dr. Carey M. Wright, state superintendent of education
Dr. Jason S. Dean, chair
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Mr. Glen East
Dr. Karen J. Elam
Mr. Omar G. Jamil, student representative
Ms. Amy Zhang, student representative

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Sam Watts, curriculum manager for the RCU
Melissa Luckett, an instructional design specialist with the RCU

Standards

Standards and alignment crosswalks are referenced in the appendix. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE food products (meats) curriculum is aligned to the following standards:

National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards

The National AFNR Career Cluster Content Standards were developed by the National Council on Agricultural Education to serve as a guide for what students should know or be able to do through a study of agriculture in grades 9–12 and two-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the agricultural industry, secondary and postsecondary instructors, and university specialists. The standards consist of a pathway content standard for each of the eight career pathways. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. A complete copy of the standards can be accessed at thecouncil.ffa.org/afnr/ The National AFNR Career Cluster Content Standards are copyrighted to the National Council for Agricultural Education and are used by permission.

International Society for Technology in Education Standards (ISTE)

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iste.org

College- and Career-Ready Standards

College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College and Career Ready Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/oae/college-and-career-readiness-standards

Framework for 21st Century Learning

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. 21 *Framework Definitions* (2019).
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
: Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource
: Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call the RCU at 662.325.2510.

Executive Summary

Pathway Description
Food products (meats) is a pathway in the agriculture, food, and natural resources career cluster. This program is designed for students who wish to seek employment or continued education in the meat cutting, packing, and processing professions.

College, Career, and Certifications
After successful completion and mastery of these competencies, students should be equipped with essential knowledge and skills necessary to secure educational and employment opportunities in meat processing, safety, sanitation, inspection, equipment, and facility maintenance. Competencies and suggested performance indicators in the Food Products (Meats) course have been correlated to the National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards. The AFNR standards have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Grade Level and Class Size Recommendations
It is recommended that students enter this program as a ninth grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and student maturity. A maximum of 25 students is recommended for classroom-based courses, while a maximum of 15 students is recommended for lab-based courses.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken, or the instructor can specify the level of math instruction needed)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest CTE teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning
If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

This curriculum consists of four 1-credit courses, which should be completed in the following sequence:

1. **Food Products (Meats): Fundamentals—Course Code: 991202**
2. **Food Products (Meats): Custom Operations—Course Code: 991203**
3. **Food Products (Meats): Basic Meats Processing—Course Code: 991204**
4. **Food Products (Meats): Advanced Meats Processing—Course Code: 991205**

Course Description: **Food Products (Meats): Fundamentals**
This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include orientation to meat processing, safety, sanitation, equipment, and facility maintenance.

Course Description: **Food Products (Meats): Custom Operations**
This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include custom livestock slaughter, pricing, wrapping, and marketing.

Course Description: Food Products (Meats): Basic Meats Processing
This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include identification and fabrication of carcass beef, box pork, carcass lamb and goat.

Course Description: Food Products (Meats): Advanced Meats Processing
This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include identification and fabrication of poultry and fish wild game, automated processing of meats quality and yield grading, curing, smoking, and sausage making.

Food Products (Meats): Fundamentals—Course Code: 991202

Unit	Unit Name	Hours
1	Careers and Leadership	35
2	Orientation to Meat Processing	15
3	Safety, Sanitation, Equipment, and Facility Maintenance	75
Total		125

Food Products (Meats): Custom Operations—Course Code: 991203

Unit	Unit Name	Hours
4	Custom Livestock Slaughter	40
5	Pricing, Wrapping, and Marketing	23
6	Special Topics in Food Products (Meats) I	32
Total		95

Food Products (Meats): Basic Meats Processing—Course Code: 991204

Unit	Unit Name	Hours
7	Identification and Fabrication of Carcass and Box Beef	60
8	Identification and Fabrication of Carcass and Box Pork	37
9	Identification and Fabrication of Carcass Lamb and Goat	15
Total		112

Food Products (Meats): Advanced Meats Processing—Course Code: 991205

Unit	Unit Name	Hours
10	Identification and Fabrication of Poultry and Fish	10
11	Identification and Fabrication of Wild Game	25
12	Automated Processing of Meats	10
13	Quality and Yield Grading	20
14	Curing, Smoking, and Sausage Making	15
15	Special Topics in Food Products (Meats) II	20
Total		100

Option 2—(Two) 2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses, which should be completed in the following sequence:

1. **Food Products (Meats) I—Course Code: 991200**
2. **Food Products (Meats) II—Course Code: 991201**

Course Description: Food Products (Meats) I
This course is an instructional program that orients an individual to the field of meat processing, marketing, and merchandising. This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include careers, leadership, and orientation, safety, sanitation, equipment, and facility maintenance, livestock slaughter procedures, and pricing, wrapping, and marketing meats.

Course Description: Food Products (Meats) II
This course is a continuation of Food Products (Meats) I. This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include meat cutting, automated processing, quality and yield grading, and curing, smoking, and sausage making.

Food Products (Meats) I—Course Code: 991200

Unit Number	Unit Name	Hours
1	Careers and Leadership	35
2	Orientation to Meat Processing	15
3	Safety, Sanitation, Equipment, and Facility Maintenance	75
4	Custom Livestock Slaughter	40
5	Pricing, Wrapping, and Marketing	23
6	Special Topics in Food Products (Meats) I	32
Total		220

Food Products (Meats) II—Course Code: 991201

Unit	Unit Title	Hours
7	Identification and Fabrication of Carcass and Box Beef	60
8	Identification and Fabrication of Carcass and Box Pork	37
9	Identification and Fabrication of Carcass Lamb and Goat	15
10	Identification and Fabrication of Poultry and Fish	10
11	Identification and Fabrication of Wild Game	25
12	Automated Processing of Meats	10
13	Quality and Yield Grading	20
14	Curing, Smoking, and Sausage Making	15
15	Special Topics in Food Products (Meats) II	20
Total		212

Career Pathway Outlook

Overview
The food products (meats) curriculum prepares students for various occupations involving food science and meat processing. Occupations in this field range from researching ways to improve the efficiency and safety of food production to cutting, trimming, and packaging meat for retail sale. Most butchers and meat cutters work in grocery stores. Training for simple meat cutting may take only a few weeks. However, more complicated cutting tasks generally require training that may last from several months to more than a year. Food scientists and technologists work in laboratories, in offices, and in the field. Food scientists need at least a bachelor's degree from an accredited postsecondary institution, although many get advanced degrees. Food science technicians typically need an associate degree in biology, chemistry, crop or animal science, or a related field.

Needs of the Future Workforce
Employment for food scientists and technologists in Mississippi is expected to grow by 25 percent by 2026. Data for this synopsis were compiled from employment projections prepared by the U.S. Census Bureau, the U.S. Bureau of Labor Statistics (2019), and the Mississippi Department of Employment Security (2019).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2016	Projected Jobs, 2026	Change (Number)	Change (Percent)	Average Hourly Earnings, 2019
Butchers and Meat Cutters	230	240	10	4.4	$13.15
Meat, Poultry, and Fish Cutters and Trimmers	6,340	6,410	70	1.1	$12.50
Slaughterers and Meat Packers	1,710	1,750	40	2.3	$12.39
Food Scientists and Technologists	40	50	10	25.0	$28.05

Source: Mississippi Department of Employment Security; mdes.ms.gov (2019).

Perkins V Requirements and Academic Infusion
The food products (meats) curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for careers in the food production industry. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, the curriculum focuses on ongoing and meaningful professional development for teachers, as well as relationships with industry.

Transition to Postsecondary Education
The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The food products (meats) educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the food products (meats) curriculum. FFA is the student organization with many outlets for Agriculture. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to the world of agricultural careers and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the food products (meats) curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The food products (meats) curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the food products (meats) curriculum that will allow and encourage collaboration with professionals currently in the food products (meats) field.

Work-Based Learning

Work-based learning is an extension of understanding competencies taught in the food products (meats) classroom. This curriculum is designed in a way that necessitates active involvement by the students in the community around them and the global environment. These real-world connections and applications link to all types of students to knowledge, skills, and professional dispositions. Work-based learning should encompass ongoing and increasingly more complex involvement with local companies and industry professionals. Thus, supervised collaboration and immersion into the industry around the students are keys to students' success, knowledge, and skills development.

Professional Organizations

American Association for Agricultural Education (AAAE)
aaaeonline.org

Mississippi ACTE
mississippiacte.com

Mississippi FFA/ Mississippi Association of Vocational Agriculture Teachers (MAVAT)
mississippiffa.org

National FFA Organization
ffa.org

National Association of Agricultural Educators (NAAE)
naae.org

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80% of the time in the course. The remaining percentage of class time will include instruction in non-tested material, review for end-of-course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Teacher Resources
Teacher resources for this curriculum may be found in multiple places. Many program areas have teacher resource documents that accompany the curriculum and can be downloaded from the same site as the curriculum. The teacher resource document contains references, lesson ideas, websites, teaching and assessment strategies, scenarios, skills to master, and other resources divided by unit. This document could be updated periodically by RCU staff. Please check the entire document, including the entries for each unit, regularly for new information. If you have something you would like to add or have a question about the document, call or email the RCU's instructional design specialist for your program. The teacher resource document can be downloaded at rcu.msstate.edu/curriculum/curriculumdownload.aspx. All teachers should request to be added to the Canvas Resource Guide for their course. This is where all resources will be housed in the future, if they are not already. To be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Many of the units include an enrichment section at the end. If the food products (meats) program is currently using the Mississippi Career Planning and Assessment System (MS-CPAS) as a measure of accountability, the enrichment section of material will not be tested. If this is the case, it is suggested to use the enrichment material when needed or desired by the teacher and if time allows in the class. This material will greatly enhance the learning experiences for students. If, however, the food products (meats) program is using a national certification or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be tested. It is the responsibility of the teacher to ensure all competencies for the selected assessment are covered throughout the year.

Unit 1: Careers and Leadership

Competencies and Suggested Objectives

1. Identify career opportunities in meat cutting, packing, and processing professions. DOK1
   a. Define *meat cutter*.
   b. Research the major categories of job classifications in the meat cutting, packing, and processing profession.
2. Explain the benefits of FFA participation. DOK 1
   a. Identify FFA organizational activities that promote and recognize achievements in meat cutting, packing, and processing. DOK1
   b. Identify FFA organizational activities that promote leadership development including career development events, leadership conferences, national and international exchange programs, education experience with industry, and personal and community development programs.
   c. Identify opportunities for members in FFA, including personal development, personal recognition, career exploration, and self-expression.
   d. Identify the benefits of FFA participation to an individual and to the meat cutting, packing, and processing industry, including personal growth and development, exposure to the meat industry environment, and multicultural experiences.
3. Demonstrate group leadership skills and personal traits. DOK 2

- Communication
- Considerate
- Cooperation
- Dependability
- Effective listening
- Empathy
- Enthusiasm
- Getting along with others
- Good manners
- Honesty
- Humility
- Interpersonal skills
- Loyalty
- Open-minded
- Positive self-concept
- Problem-solving
- Punctuality
- Rational thinking
- Resilience
- Respect for others
- Responsibility
- Responsible use of social media
- Safety conscious
- Self-motivated/determined
- Setting priorities
- Teamwork
- Trustworthy
- Work ethic

Enrichment

Future President Scenario

You are the FFA president and need to present to a group of middle school students on the FFA. Prepare a 2-3-minute speech on the benefits of FFA. Prepare the speech according to the FFA guidelines for speeches (impromptu, extemporaneous, etc.) The class will peer review the speech and discuss clarity and content. Use the oral report rubric in the teacher resource document.

Unit 2: Orientation to Meat Processing

Competencies and Suggested Objectives
1. Explain trends in slaughtering and processing in the past and in the future. DOK 1 a. Compare trends in slaughtering and processing 20 years in the past and in the future. b. Discuss emerging technologies related to slaughtering and meat processing.
2. Describe factors affecting consumer food spending. DOK 2 a. Describe factors affecting consumer food spending to include income, geographic area, ethnic groups, and religious groups. b. Discuss biological health hazards, such as chronic wasting disease (CWD), and their effects on consumer spending.
Enrichment
Market Scenario You just bought a retail meat market that is outdated. You need to research current trends and technologies to meet consumer demands and make your shop successful.

Unit 3: Safety, Sanitation, Equipment, and Facility Maintenance

Competencies and Suggested Objectives
1. Explain general meat laboratory safety requirements. DOK 2 a. List and practice safety rules and procedures.
2. Discuss sanitation as it applies to a meat cutting facility. DOK 3 a. Describe sanitary operation of a meat cutting facility. b. Describe proper donning and doffing of personal protective equipment while in the laboratory setting. c. Describe state and federal inspection guidelines as they apply to meat processing facilities, including ways to avoid fecal contamination. d. Identify correct temperatures for meat processing and storage and explain the importance of each. e. Describe the benefits of a rail system. f. Select and use proper aprons, disposable gloves, hard hats, eye protection, hair nets, rubber boots, etc. g. Disinfect aprons and rubber boots after each use.
3. Discuss federal regulations related to meat processing. DOK 2 a. Discuss HACCP (Hazards Analysis Critical Control Point) as a method to prevent foodborne illness. b. Discuss the role of the USDA Food Safety and Inspection Service related to quality assurance.
4. Identify and safely use equipment for meat cutting, packing, and processing. DOK 2 a. Identify equipment used in a meat laboratory, including a band saw, grinder, mixer, tenderizer, slicing machine, and stuffer. b. Safely assemble and disassemble equipment, including band saw, grinder, mixer, tenderizer, slicing machine, and stuffer. c. Identify, safely use, and sanitize other meat cutting equipment including knives, knife sharpener, steel and hone, stockinette, dead lock and tag, scales and weighing items, vacuum packer, salinometer, squeegee equipment, patty machine, heat seal, cooler, freezer, rail system, tables, hoist, skinning knife, and carcass split saw. d. Use sterilizer for knives and steel.
5. Demonstrate equipment maintenance used in a meat cutting facility. DOK 2 a. Maintain a sharp knife including boning and butcher knives. b. Perform equipment and maintenance procedures for grinder, slicer, and band saw. c. Use proper disinfection procedures for cleaning tables after use. d. Demonstrate proper hand washing procedure before and after working in the meat cutting laboratory.

6. Maintain a safe and sanitary facility. DOK 2
   a. Wash and disinfect walls and floors.
   b. Maintain a safe environment by wiping up spills, keeping aisles clear, and performing other tasks.

Enrichment

Safety and Sanitation

As the owner of a new meat market, the meat inspectors are disapproving because you do not have any safety or sanitation plans in place. You need to develop a HACCP plan to ensure your shop is safe and clean in order to open your business. Use the written report rubric from the teacher resource document for guidance.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 4: Custom Livestock Slaughter

Competencies and Suggested Objectives

1. Explain terms and procedures associated with livestock slaughter. DOK1
   a. Define terms and procedures associated with the slaughter of beef.
   b. Define terms and procedures associated with the slaughter of swine.
   c. Define terms and procedures associated with the slaughter of lamb and goat.
   d. Define terms and procedures associated with the slaughter of poultry.
   e. Define terms and procedures associated with the slaughter of fish.
   f. Define terms and procedures associated with dressing of wild game.
   g. Discuss the difference between antemortem and postmortem inspection.
2. Discuss types, cleaning, use, and maintenance of slaughter facility and equipment. DOK1
   a. Identify equipment, including immobilizer, skinning knives, rails and rail hooks, scales, dehairing machine, hoist, and carcass split saw.
   b. Discuss maintenance of a safe and sanitary facility.
   c. Identify what constitutes contamination from biologic and toxic sources.
3. Discuss procedures for slaughtering livestock and dressing wild game. DOK2
   a. Discuss procedures for slaughtering beef.
   b. Discuss procedures for slaughtering swine.
   c. Discuss procedures for slaughtering lamb and goat.
   d. Discuss procedures for dressing wild game.
   e. Discuss procedures for slaughtering livestock and recognize when to condemn part of a carcass.
   f. Describe methods of disposing of offal.

Enrichment

Byproducts Scenario

As a new owner of a beef slaughterhouse, you need to find out what you can sell of animal byproducts. You need to research what byproducts you can sell and the price of those byproducts. Use the presentation rubric from the teacher resource document for guidance.

Unit 5: Pricing, Wrapping, and Marketing

Competencies and Suggested Objectives
1. Compare and contrast consumer trends, supply and demand, and the effects on meat prices. DOK1 a. Discuss supply and demand and its effects on meat prices. b. Identify current consumer trends.
2. List the steps and perform a cutting test. DOK2 a. List the steps in a cutting test. b. Perform a cutting test.
3. Discuss techniques and wrap retail meat. DOK2 a. Discuss techniques of wrapping retail meats. b. Wrap and label meat for home freezing. c. Wrap, weigh, label, and price meat for retail sale. d. Describe the proper temperatures for maximum storage life of retail meats using a cooler, display case, or freezer. e. Vacuum seal various cuts of meat.
4. Describe marketing principles related to the display of meat. DOK2 a. Describe marketing principles related to the display of meat. b. Describe the effects vacuum sealing has on the shelf life of meat.
Enrichment
Meat Marketing Scenario You are working for a large grocery chain in the advertising department. The chain is planning a big sales event next month and they expect you to develop the marketing plan for the meat departments. Use the presentation or poster rubric from the teach resource document for guidance.

Unit 6: Special Topics in Food Products (Meats) I

Competencies and Suggested Objectives
1. Investigate new and emerging technologies, practices, trends, and issues associated with food products (meats). DOK3 a. Prepare and present a report on a new and emerging technology associated with food products (meats). b. Prepare and present a report on a current trend or issue associated with food products (meats).
2. Complete school-to-careers activities related to food products (meats). DOK2 a. Participate in a school-to-careers activity (shadowing, mentoring, career fair, etc.) related to food products (meats). b. Investigate educational opportunities related to food products (meats) at the postsecondary level. c. Describe national standards and certification/licensing procedures related to food products (meats). d. Describe the role of trade organizations, associations, and unions as related to food products (meats).
3. Demonstrate related academic skills and workplace skills associated with food products (meats). DOK2 a. Complete a cooperative project (paper, presentation, or demonstration) associated with an academic subject and food products (meats). b. Practice human relations skills (team participation, client/customer service, leadership, negotiation, working with culturally diverse groups, etc.) related to food products (meats). c. Research work ethics and employer expectations of employees in food products (meats).
4. Investigate the concepts of quality assurance as related to food products (meats). DOK3 a. Describe quality concepts and methods for measuring quality related to food products (meats). b. Apply quality concepts in the food products (meats) laboratory.
5. Examine trends and changes related to food products (meats) and global economic factors. DOK1 a. Define and discuss the concept of global economics and competition. b. Describe global economic factors and competition as related to food products (meats). c. Identify regions and other countries which compete in food products (meats).
Enrichment
Beef Trends Scenario: As a food science worker with a major livestock board, your job is to keep up with current trends affecting the beef industry. You will give a presentation to the group on current trends, technologies, and jobs available in today's market. Use the presentation rubric from the teacher resource document for guidance.

Unit 7: Identification and Fabrication of Carcass and Box Beef

Competencies and Suggested Objectives
1. Identify and safely fabricate cuts of beef. DOK2 a. Identify carcass break cuts of beef. b. Make retail cuts of round. c. Make retail cuts of loin. d. Make retail cuts of rib. e. Make retail cuts of chuck. f. Make retail cuts of foreshank. g. Make retail cuts of brisket. h. Make retail cuts of plate. i. Make retail cuts of flank.
2. Identify and safely fabricate variety cuts of beef. DOK2 a. Make retail cuts of tongue. b. Make retail cuts of heart. c. Make retail cuts of liver. d. Make retail cuts of kidney. e. Make retail cuts of brain.
Enrichment
Retail Cuts Poster (could be used with other units as well) You are the market manager at the local grocery store. You have just hired a new meat cutter, but you need to know how much she knows about cutting meat. You will need to develop a poster of retail cuts of beef to ensure your new butcher knows these cuts. Use poster rubric in teacher resource guide document for guidance.

Unit 8: Identification and Fabrication of Carcass and Box Pork

Competencies and Suggested Objectives
1. Identify and safely fabricate cuts of pork. DOK2 a. Identify carcass break cuts of pork. b. Make retail cuts of ham. c. Make retail cuts of loin. d. Make retail cuts of shoulder (Boston butt and picnic). e. Make retail cuts of side.
2. Identify and safely fabricate retail variety cuts of pork. DOK2 a. Make retail cuts of tongue. b. Make retail cuts of liver. c. Make retail cuts of chitterlings. d. Make retail cuts of stomach. e. Make retail cuts of kidneys. f. Make retail cuts of snouts.

Unit 9: Identification and Fabrication of Carcass Lamb and Goat

Competencies and Suggested Objectives
1. Identify and safely fabricate cuts of lamb and goat. DOK2 a. Identify carcass break cuts of lamb and goat. b. Identify retail cuts of leg. c. Identify retail cuts of loin. d. Identify retail cuts of rib. e. Identify retail cuts of shoulder. f. Identify retail cuts of foreshank and breast.

Unit 10: Identification and Fabrication of Poultry and Fish

Competencies and Suggested Objectives
1. Identify and safely fabricate cuts of poultry. DOK2 a. Identify carcass break cuts of poultry. b. Make retail cuts of breast quarter. c. Make retail cuts of leg quarter. d. Make retail cuts of back quarter.
2. Identify variety cuts of poultry. DOK2 a. Identify retail cuts of heart. b. Identify retail cuts of liver. c. Identify retail cuts of gizzard. d. Identify retail cuts of neck.
3. Identify retail cuts of fish. DOK2
Enrichment
Fry Cook You have been asked to demonstrate the correct way of cutting up a chicken for frying. Develop a presentation using visuals.

Unit 11: Identification and Fabrication of Wild Game

Competencies and Suggested Objectives
1. Identify and safely fabricate cuts of wild game. DOK2 a. Make cuts of top round. b. Make cuts of bottom round. c. Make cuts of tip roast. d. Make cuts of eye round. e. Make cuts of loin eye. f. Make cuts of ribs. g. Debone front shoulders.
2. Prepare wild game specialty products. DOK2 a. Prepare various sausage products. b. Prepare ground products. c. Discuss preparation of jerky products.
Enrichment
Deer Processing The local wildlife department is making health checks on the local deer herd. They want to take twenty deer out of the population and donate these deer to a local charity. They have asked your meats class to help process these deer. They want you to process as many different products as possible, for example: steaks, roast, and ground products. Please demonstrate how to prepare their deer for this project.

Unit 12: Automated Processing of Meats

Competencies and Suggested Objectives
1. Observe and discuss the automated processing of various types of meat. DOK2 a. Observe and discuss step-by-step procedures for the automated slaughtering and fabrication processing of beef, pork, lamb, poultry, and fish. b. Observe and discuss step-by-step procedures for the automated canning process of beef, pork, lamb, poultry, and fish.
Enrichment
Proper Processing Plan You are searching for ways to automate your custom processing plant. As you watch the presentation, keep a journal of how you could incorporate the various systems in your plant. To help, draw diagrams along with your writings. Use the journal rubric in the teacher resource document for guidance.

Unit 13: Quality and Yield Grading

Competencies and Suggested Objectives
1. Explain quality and yield grades for beef and determine classifications of beef. DOK2 a. Explain quality grades for beef. b. Explain yield grades of beef. c. Determine classification of beef. d. Estimate amount of kidney fat, pelvic fat, and age. e. Estimate amount of marbling in a ribeye.
2. Explain quality grades and determine classification of pork. DOK2 a. Explain quality grades for pork. b. Determine classification of pork.
3. Explain quality and yield grades for lamb and determine classifications of sheep. DOK2 a. Explain quality grades of lamb. b. Explain yield grades of lamb. c. Determine classification of sheep.
4. Explain grades in poultry. DOK2 a. Explain grades of poultry. b. Discuss poultry classifications.
Enrichment
Grade My Ribeye Please You are the food buyer for a major restaurant chain. You are presented four different high-end ribeye steaks to select from for the business. You will evaluate each ribeye, determine the quality grade, and select the best ribeye for your order. Use the job sheet/performance rubric in the teacher resource document for guidance.

Unit 14: Curing, Smoking, and Sausage Making

Competencies and Suggested Objectives

1. Explain and demonstrate meat curing and smoking processes. DOK2
   a. Define curing, smoking, and sausage making terms.
   b. Describe the functions of curing and smoking.
   c. Describe meat curing ingredients and calculate correct amount of each.
   d. Explain methods of meat curing.
   e. Identify and use equipment for the smoking and curing process.
   f. Describe the process of curing bacon in brine solution.
   g. Describe the process of curing jowl in brine solution.
   h. Pump shoulders.
   i. Pump hams.
   j. Pump loin.
   k. Discuss the process of smoking a shoulder, ham, loins, bacon, and jowls.
2. Explain and demonstrate the process of sausage making. DOK2
   a. Mix and grind sausage with cure and seasoning.
   b. Read a salinometer.
   c. Prepare a brine solution.
   d. Stuff sausage in casing.
   e. Smoke sausage in smoker.

Enrichment

Simply Sausage

You are a well-known sausage maker. Your company is very profitable because of your knowledge and skills. You have decided to take your claim to fame a step farther by creating a "how-to" sausage recipe book. You will need to include safety, sanitation, curing, stuffing, and smoking procedures.

Unit 15: Special Topics in Food Products (Meats) II

Competencies and Suggested Objectives

1. Investigate new and emerging technologies, practices, trends, and issues associated with food products (meats). DOK3
   a. Prepare a report on a new and emerging technology associated with food products (meats).
   b. Prepare a report on a current trend or issue associated with food products (meats).
2. Complete school-to-careers activities related to food products (meats). DOK2
   a. Participate in a school-to-careers activity (shadowing, mentoring, career fair, etc.) related to food products (meats).
   b. Investigate educational opportunities related to food products (meats) at the postsecondary level.
   c. Describe national standards and certification/licensing procedures related to food products (meats).
   d. Describe the role of trade organizations, associations, and unions as related to food products (meats).
3. Demonstrate related academic skills and workplace skills associated with food products (meats). DOK2
   a. Complete a cooperative project (paper, presentation, or demonstration) associated with an academic subject and food products (meats).
   b. Practice human relations skills (team participation, client/customer service, leadership, negotiation, working with culturally diverse groups, etc.) related to food products (meats).
   c. Research work ethics and employer expectations of employees in food products (meats).
4. Investigate the concepts of quality assurance as related to food products (meats). DOK3
   a. Describe concepts and methods for measuring quality related to food products (meats).
   b. Apply quality concepts in the food products (meats) laboratory.
5. Examine trends and changes related to food products (meats) and global economic factors. DOK2
   a. Define and discuss the concept of global economics and competition.
   b. Describe global economic factors and competition as related to food products (meats).
   c. Identify regions and other countries which compete in food products (meats).

Enrichment

Trending Now

As a food science worker with a major livestock board, your job is to keep up with current trends affecting the meat industry. You will give a presentation to this board (your peers) on current trends, technologies, and jobs available in today's market. Use the presentation rubric from the teacher resource document for guidance.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Careers and Leadership		
	1.	Identify career opportunities in meat cutting, packing, and processing professions.
	2.	Identify the leadership opportunities and activities which are beneficial to students in meat cutting, packing, and processing.
Unit 2: Orientation to Meat Processing		
	1.	Explain trends in slaughtering and processing in the past and in the future.
	2.	Describe factors affecting consumer food spending.
Unit 3: Safety, Sanitation, Equipment, and Facility Maintenance		
	1.	Explain general meat laboratory safety requirements.
	2.	Discuss sanitation as it applies to a meat cutting facility.
	3.	Discuss federal regulations related to meat processing.
	4.	Identify and safely use equipment for meat cutting, packing, and processing.
	5.	Demonstrate equipment maintenance used in a meat cutting facility.
	6.	Maintain a safe and sanitary facility.
Unit 4: Custom Livestock Slaughter		
	1.	Explain terms and procedures associated with livestock slaughter.
	2.	Discuss types, cleaning, use, and maintenance of slaughter facility and equipment.
	3.	Discuss procedures for slaughtering livestock and dressing wild game.

Unit 5: Pricing, Wrapping, and Marketing		
	1.	Compare and contrast consumer trends, supply and demand, and the effects on meat prices
	2.	List the steps and perform a cutting test.
	3.	Discuss techniques and wrap retail meat.
	4.	Describe marketing principles related to the display of meat.
Unit 6: Special Topics in Food Products (Meats) I		
	1.	Investigate new and emerging technologies, practices, trends, and issues associated with food products (meats).
	2.	Complete school-to-careers activities related to food products (meats).
	3.	Demonstrate related academic skills and workplace skills associated with food products (meats).
	4.	Investigate the concepts of quality assurance as related to food products (meats).
	5.	Examine trends and changes related to food products (meats) and global economic factors.
Unit 7: Identification and Fabrication of Carcass and Box Beef		
	1.	Identify and safely fabricate cuts of beef.
	2.	Identify and safely fabricate variety cuts of beef.
Unit 8: Identification and Fabrication of Carcass and Box Pork		
	1.	Identify and safely fabricate cuts of pork.
	2.	Identify and safely fabricate retail variety cuts of pork.
Unit 9: Identification and Fabrication of Carcass Lamb and Goat		
	1.	Identify and safely fabricate cuts of lamb and goat.
Unit 10: Identification and Fabrication of Poultry and Fish		
	1.	Identify and safely fabricate cuts of poultry.
	2.	Identify variety cuts of poultry.
	3.	Identify retail cuts of fish.
Unit 11: Identification and Fabrication of Wild Game		
	1.	Identify and safely fabricate cuts of wild game.
	2.	Prepare wild game specialty products.

Unit 12: Automated Processing of Meats		
	1.	Observe and discuss the automated processing of various types of meat.
Unit 13: Quality and Yield Grading		
	1.	Explain quality and yield grades for beef and determine classifications of beef.
	2.	Explain quality grades and determine classification of pork.
	3.	Explain quality and yield grades for lamb and determine classifications of sheep.
	4.	Explain grades in poultry.
Unit 14: Curing, Smoking, and Sausage Making		
	1.	Explain and demonstrate meat curing and smoking processes.
	2.	Explain and demonstrate the process of sausage making.
Unit 15: Special Topics in Food Products (Meats) II		
	1.	Investigate new and emerging technologies, practices, trends, and issues associated with food products (meats).
	2.	Complete school-to-careers activities related to food products (meats).
	3.	Demonstrate related academic skills and workplace skills associated with food products (meats).
	4.	Investigate the concepts of quality assurance as related to food products (meats).
	5.	Examine trends and changes related to food products (meats) and global economic factors.

Appendix A: Industry Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDS AND PERFORMANCE ELEMENTS

Crosswalk for Food Products (Meats)											
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
AFNR											
AF -FOOD PRODUCTS AND PROCESSING SYSTEMS		X	X	X	X	X	X	X	X	X	X
AFNR											
		Unit 11	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**					
		X	X	X	X	X					

AF - FOOD PRODUCTS AND PROCESSING SYSTEMS

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314, 800.772.0939. Copyright © 2015. A complete copy of the National Standards can be downloaded from the Team Ag Ed Learning Center at thecouncil.ffa.org/afnr/

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Develop and implement procedures to ensure safety, sanitation, and quality in food product and processing facilities.

- FPP.01.01 Analyze and manage operational and safety procedures in food products and processing facilities.
- FPP.01.02 Apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.
- FPP.01.03 Apply food safety procedures when storing food products to ensure food quality.

FPP.02. Apply principles of nutrition, biology, microbiology, chemistry, and human behavior to the development of food products.

- FPP.02.01 Apply principles of nutrition and biology to develop food products that provide a safe, wholesome, and nutritious food supply for local and global food systems.

FPP.02.02 Apply principles of microbiology and chemistry to develop food products to provide a safe, wholesome, and nutritious food supply for local and global food systems.

FPP.02.03 Apply principles of human behavior to develop food products to provide a safe, wholesome, and nutritious food supply for local and global food systems.

FPP.03 Select and process food products for storage, distribution, and consumption.

FPP.03.01 Implement selection, evaluation, and inspection techniques to ensure safe and quality food products.

FPP.03.02 Design and apply techniques of food processing, preservation, packaging and presentation for distribution and consumption of food products.

FPP.03.03 Create food distribution plans and procedures to ensure safe delivery of food products.

FPP.04. Explain the scope of the food industry and the historical and current developments of food product and processing.

FPP.04.01 Examine the scope of the food industry by evaluating local and global policies, trends, and customs for food production.

FPP.04.02 Evaluate the significance and implications of changes and trends in the food products and processing industry in the local and global food systems.

FPP.04.03 Identify and explain the purpose of industry organizations, groups and regulatory agencies that influence the local and global food systems.

2014 Food Products (Meats)

Mississippi Department of Education

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~~The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.~~

Table of Contents

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Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the Food Products (Meats) *Curriculum Framework and Supporting Materials* are based on the following:

National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards

The National AFNR Career Cluster Content Standards were developed by the National Council on Agricultural Education to serve as a guide for what students should know or be able to do through a study of agriculture in grades 9–12 and 2-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the agricultural industry, secondary and postsecondary instructors, and university specialists. The standards consist of a pathway content standard for each of the eight career pathways. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. A complete copy of the standards can be accessed at https://aged.learn.com. The National AFNR Career Cluster Content Standards are copyrighted to the National Council for Agricultural Education and are used by permission.

Common Core State Standards Initiative

The Common Core State Standards© provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. Copyright 2010. National Governors Association Center for Best Practices and Council of Chief State School Officers. All rights reserved. States and territories of the United States as well as the District of Columbia that have adopted the Common Core State Standards in whole are exempt from this provision and no attribution to the National Governors Association Center for Best Practices and Council of Chief State School Officers is required. Reprinted from http://www.corestandards.org/.

National Educational Technology Standards for Students

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~~21st Century Skills and Information and Communication Technologies Literacy Standards~~

~~In defining 21st century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and Information and Communication Technology (ICT) literacy.~~

~~Preface~~

~~Secondary career and technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.~~

~~The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).~~

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at

The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

My PLC: An online registration for all professional development sessions

To register for any session, teachers will need an account in the registration system, MyPLC, https://myplc.rcu.msstate.edu. To create an account, click on the link and navigate to the "Request a Guest ID" link. The ID should be the teacher's first initial and last name and the last four (4) digits of the social security number. Teachers should complete the entire form, which will then be sent to a secure server. Upon activation of the teacher's account, he or she will receive an e-mail with login instructions. The teacher may then browse for the available sessions and register for the desired courses.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

Food Products (Meats) is an instructional program that orients an individual to the field of meat processing, marketing, and merchandising. This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include careers, leadership, and orientation; safety, sanitation, equipment, and facility maintenance; livestock slaughter procedures; and pricing, wrapping, and marketing meats.

Industry Certification

Competencies and suggested performance indicators in the Food Products (Meats) course have been correlated, to the National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards. The AFNR standards have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Assessment

The latest assessment blueprint for the curriculum can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Student Prerequisites

In order for students to be able to experience success in the Food Products (Meats) program, the following student prerequisites are suggested:

4. C or higher in English (the previous year)
5. C or higher in Math (last course taken or the instructor can specify the math)
6. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

3. TABE Reading Score (eighth grade or higher)

4. Instructor Approval

or

2. Instructor Approval

Teacher Licensure

The latest teacher licensure information can be found at

http://www.mde.k12.ms.us/educator-licensure

Professional Learning

If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

Option 1—Four One-Carnegie-Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

5. **Food Products (Meats): Fundamentals—Course Code: 991202**
6. **Food Products (Meats): Custom Operations—Course Code: 991203**
7. **Food Products (Meats): Basic Meats Processing—Course Code: 991204**
8. **Food Products (Meats): Advanced Meats Processing—Course Code: 991205**

Course Description: Food Products (Meats): Fundamentals

This option allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include orientation to meat processing, safety, sanitation, equipment, and facility maintenance.

Course Description: Food Products (Meats): Custom Operations

This option allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include custom livestock slaughter, pricing, wrapping, and marketing.

Course Description: Food Products (Meats): Basic Meats Processing

This option allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include identification and fabrication of carcass beef, box pork, carcass lamb and goat.

Course Description: Food Products (Meats): Advanced Meats Processing

This option allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include identification and fabrication of poultry and fish wild game, automated processing of meats quality and yield grading, curing, smoking, and sausage making.

Food Products (Meats): Fundamentals—Course Code: 991202

Unit	Unit Name	Hours
1	Careers and Leadership	35
2	Orientation to Meat Processing	15
3	Safety, Sanitation, Equipment, and Facility Maintenance	75
Total		125

Food Products (Meats): Custom Operations—Course Code: 991203

Unit	Unit Name	Hours
4	Custom Livestock Slaughter	40
5	Pricing, Wrapping, and Marketing	23
6	Special Topics in Food Products (Meats) I	32
Total		95

Food Products (Meats): Basic Meats Processing—Course Code: 991204

Unit	Unit Name	Hours
7	Identification and Fabrication of Carcass and Box Beef	60
8	Identification and Fabrication of Carcass and Box Pork	37
9	Identification and Fabrication of Carcass Lamb and Goat	15
Total		112

Food Products (Meats): Advanced Meats Processing—Course Code: 991205

Unit	Unit Name	Hours
10	Identification and Fabrication of Poultry and Fish	10
11	Identification and Fabrication of Wild Game	20
12	Automated Processing of Meats	10
13	Quality and Yield Grading	20
14	Curing, Smoking, and Sausage Making	20
15	Special Topics in Food Products (Meats) II	20
Total		100

Option 2—Two Two-Carnegie-Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. **Food Products (Meats) I—Course Code: 991200**
2. **Food Products (Meats)II—Course Code: 991201**

Course Description: Food Products (Meats) I

Food Products (Meats) I is an instructional program that orients an individual to the field of meat processing, marketing, and merchandising. This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include careers, leadership, and orientation, safety, sanitation, equipment, and facility maintenance, livestock slaughter procedures, and pricing, wrapping, and marketing meats.

Course Description: Food Products (Meats) II

Food Products (Meats) II is a continuation of Food Products (Meats) I. This course allows an individual to prepare for employment or continued education in the meat cutting, packing, and processing professions. Topics include meat cutting, automated processing, quality and yield grading, and curing, smoking, and sausage making.

Food Products (Meats) I—Course Code: 991200

Unit	Unit Name	Hours
1	Careers and Leadership	35
2	Orientation to Meat Processing	15
3	Safety, Sanitation, Equipment, and Facility Maintenance	75
4	Custom Livestock Slaughter	40
5	Pricing, Wrapping, and Marketing	23
6	Special Topics in Food Products (Meats) I	32
Total		220

Food Products (Meats) II – Course Code: 991201

Unit	Unit Name	Hours
7	Identification and Fabrication of Carcass and Box Beef	60
8	Identification and Fabrication of Carcass and Box Pork	37
9	Identification and Fabrication of Carcass Lamb and Goat	15
10	Identification and Fabrication of Poultry and Fish	10
11	Identification and Fabrication of Wild Game	20
12	Automated Processing of Meats	10
13	Quality and Yield Grading	20
14	Curing, Smoking, and Sausage Making	20
15	Special Topics in Food Products (Meats) II	20
Total		212

Research Synopsis

Introduction

The Food Products (Meats) Cluster curriculum prepares students for various occupations involving food science and meat processing. The occupations listed below are all projected to grow by at least 10% by 2020 (US Bureau of Labor Statistics, 2010). Within the Manufacturing industry sector, Meat, Poultry, and Fish Cutters and Trimmers is listed as the fastest growing occupation while Slaughterers and Meat Packers is listed as the third fastest growing occupation (US Bureau of Labor Statistics, 2010). Food Preparation Workers is also listed in the top ten fastest growing occupations in the Accommodation and Food Services industry sector (US Bureau of Labor Statistics, 2010).

Needs of the Future Workforce

These statistics bode well for students who are preparing to enter the workforce after completion of this program. This industry offers competitive and growing job opportunities for the incoming workforce within the state of Mississippi. Not only are these occupations growing within the state, but they are all projected to grown nationwide, as well.

Source: US Bureau of Labor Statistics, 2010

Description	**Current Jobs (2010)**	**Projected Jobs (2020)**	**Change (Number)**	**Change (Percent)**	**Median Hourly Earning**
Butchers and Meat Cutters	13	15	2	15.00	$12
Food Preparation Workers	11,410	12,563	1,153	10.00	$8
Food Scientists and Technologists	40	48	8	20.00	$22

Meat, Poultry, Fish Cutters and Trimmers	185	216	31	17.00	$10
Slaughterers and Meat Packers	4,030	4,719	689	17.00	$9

Perkins IV Requirements

The Food Products (Meats) curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. It also offers students a program of study including secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the Food Products (Meats) curriculum is integrated with academic common core standards. Lastly, the Food Products (Meats) curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the Food Products (Meats) curriculum are the Common Core Standards for Mathematics and Science, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the Common Core Standards are designed to prep students for success in community colleges, Institutions of Higher Learning and careers.

Academic Credit

If academic credit is awarded, please review the Research and Curriculum Unit link at https://www.rcu.msstate.edu/MDE/PathwaystoSuccess.aspx.

Click *"Curriculum Enhancement List"*. Check this site often as it is updated frequently.

Transition to Postsecondary Education

The latest articulation information for Secondary to Postsecondary can be found at the Mississippi Community College Board (MCCB) website http://www.mccb.edu/

Best Practices

Experiential Learning (SAE)

The Experiential Learning (SAE) has long been and continues to be the backbone of every agriculture program. The experiential learning projects can be used in a variety of situations to reinforce and compliment classroom theory and content. The experiential learning project consists of entrepreneurship, placement, research/experimentation and exploratory.

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The Food Products (Meats) teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a classroom set of desktop student computers and one teacher laptop. To make use of the latest online communication tools such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning management system, for example, the Agriculture Teacher Learning Content Management System, that introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. Many activities are graded by rubrics that allow students to choose the type of product they will produce. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the Food Products (Meats) curriculum. The FFA is the student's organization for Food Products (Meats). The FFA provides students with growth opportunities and competitive events. It also opens the doors to the world of agriculture and scholarships opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Food Products (Meats) curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The Food Products (Meats) curriculum provides opportunities for students to work together and help each other to complete complex tasks.

Conclusions

~~Students that complete the Food Products (Meats) programs are well equipped for a variety of endeavors. Instructors are urged to encourage Food Products (Meats) students to pursue educational opportunities at community colleges and universities in Mississippi.~~

Professional Organizations

American Association for Agricultural Education. May be found at http://aaaeonline.org/

Mississippi ACTE. May be found at http://www.mississippiacte.com/

Mississippi FFA/ Mississippi Association of Vocational Agriculture Teachers (MAVAT).May be found at www.mississippiffa.org

National FFA Organization

P.O. Box 68960, 6060 FFA Drive

Indianapolis, IN 46268

317-802-6060

http://www.ffa.org

National Association of Agricultural Educators

300 Garrigus Building- University of Kentucky

Lexington, KY 40546

800 - 509 - 0204

http://www.naae.org/

Using this Document

Suggested Time on Task

An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives

A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References

A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Careers and Leadership

Competencies and Suggested Objectives
1. Identify career opportunities in meat cutting, packing, and processing professions. DOK1, AF a. Define meat cutter. b. Research the major categories of job classifications in the meat cutting, packing, and processing profession.
2. Identify the leadership opportunities and activities which are beneficial to students in meat cutting, packing, and processing. DOK1, AF a. Identify and describe leadership opportunities available from student youth organizations in the school and community, including FFA and 4-H. b. Describe activities available to students in meat cutting, packing, and processing programs including leadership development, competitions, club meetings, fund raisers, field trips, elected office leadership positions, and service projects.

Scenario

Unit 1

The Future President

You are the FFA president and need to present to a group of junior- high students on the FFA. Prepare a 2-3 minute speech on the benefits of FFA. Prepare the speech according to the FFA guidelines for speeches (impromptu, extemporaneous, etc.) The class will peer review the speech and discuss clarity and content.

Attachments for Performance Task

Use Oral Report Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 2: Orientation to Meat Processing

Competencies and Suggested Objectives
1. Explain trends in slaughtering and processing in the past and in the future. DOK2, AF a. Compare trends in slaughtering and processing in the past 20 years and in the future. b. Discuss emerging technologies related to slaughtering and meat processing.
2. Describe factors affecting consumer food spending. DOK2, AF a. Describe factors affecting consumer food spending to include income, geographic area, ethnic group, and religious group. b. Discuss biological health hazards affecting consumer spending.

Scenario

Unit 2

Market Street

You just bought a retail meat market that is outdated. You need to research current trends and technologies in order to meet consumer demands and make your shop successful.

Attachments for Performance Task

Use Written Report Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 3: Safety, Sanitation, Equipment, and Facility Maintenance

Competencies and Suggested Objectives
1. Explain general meat laboratory safety requirements. DOK2, AF a. List and practice safety rules and procedures. b. Use meat processing equipment safely.
2. Discuss sanitation as it applies to a meat cutting facility. DOK2, AF a. Describe sanitary operations of a meat cutting facility. b. Describe state and federal inspection guidelines as they apply to meat processing facilities, including ways to avoid fecal contamination. c. Identify correct temperatures for meat processing and storage and explain the importance of each. d. Describe the benefits of a rail system. e. Select and use proper aprons, disposable gloves, hard hats, eye protection, hair nets, rubber boots, etc. f. Disinfect aprons and rubber boots after each use.
3. Discuss federal regulations relating to meat processing. DOK2, AF a. Discuss HACCP (Hazards Analysis Critical Control Point) as a method to prevent foodborne illness. b. Discuss the role of the USDA Food Safety and Inspection Service relating to quality assurance.
4. Identify and use equipment for meat cutting, packing, and processing. DOK2, AF a. Identify equipment used in a meat laboratory including a band saw, grinder, mixer, tenderizer, slicing machine, stuffer, and pickle pump. b. Assemble and disassemble equipment including band saw, grinder, mixer, tenderizer, slicing machine, stuffer, and pickle pump. c. Identify, use, and sanitize other meat cutting equipment including knives, knife sharpener, steel and hone, stockinette, dead lock and tag, scales and weighing items, vacuum packer, salinometer, squeegee equipment, patty machine, heat seal, cooler, freezer, rail system, tables, immobilizer, hoist, dehairing machine, skinning knife, and carcass split saw.

d. Use sterilizer for knives and steel.
5. Demonstrate equipment maintenance used in a meat cutting facility. DOK2, AF a. Maintain a sharp knife including boning and butcher knives. b. Perform equipment and maintenance procedures for grinder, slicer, and band saw. c. Use proper disinfection procedures for cleaning tables after use. d. Demonstrate proper hand washing procedure before and after working in the meat cutting laboratory.
6. Maintain a safe and sanitary facility. DOK2, AF a. Wash and disinfect walls and floors. b. Maintain a safe environment by wiping up spills, keeping aisles clear, and performing other tasks.

Scenario

Unit 3

Safety and Sanitation

As the owner of a new meat market, the meat inspectors are giving you a hard time because you do not have any safety or sanitation plans in place. You need to develop a HACCP plan to ensure your shop is safe and clean to get the meat inspectors off your back!

Attachments for Performance Task

See the Written Report Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 4: Custom Livestock Slaughter

Competencies and Suggested Objectives
1. Explain terms and procedures associated with livestock slaughter. DOK2, AF a. Define terms and procedures associated with the slaughter of beef. b. Define terms and procedures associated with the slaughter of swine. c. Define terms and procedures associated with the slaughter of lamb and goat. d. Define terms and procedures associated with the slaughter of poultry. e. Define terms and procedures associated with the slaughter of fish. f. Define terms and procedures associated with dressing of wild game. g. Discuss the difference between antemortem and postmortem inspection.
2. Discuss types, cleaning, use, and maintenance of slaughter facility and equipment. DOK2, AF a. Identify equipment including immobilizer, skinning knives, rails and rail hooks, scales, dehairing machine, hoist, and carcass split saw. b. Discuss maintenance of a safe and sanitary facility. c. Identify what constitutes contamination from biologic and toxic sources.
3. Discuss procedures for slaughtering livestock and dressing wild game. DOK2, AF a. Discuss procedures for slaughtering a beef. b. Discuss procedures for slaughtering a swine. c. Discuss procedures for slaughtering a lamb and goat. d. Discuss procedures for dressing wild game. e. Discuss procedures for slaughtering livestock and recognize when to condemn part of a carcass. f. Describe methods of disposing of offal.

Scenario

~~**Unit 4**~~

~~**Why Buy By Products?**~~

~~As a new owner of a beef slaughter house, you need to find out what you can sell of animal by-products. You need to research what by-products you can sell and the price of their by-products.~~

~~**Attachments for Performance Task**~~

~~See the Presentation Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx~~

Unit 5: Pricing, Wrapping, and Marketing

Competencies and Suggested Objectives
1. Compare and contrast consumer trends, supply and demand, and the effects on meat prices. DOK2, AF a. Discuss supply and demand and its effects on meat prices. b. Identify current consumer trends.
2. List the steps and perform a cutting test. DOK1, AF a. List the steps in a cutting test. b. Perform a cutting test.
3. Discuss techniques and wrap retail meat. DOK2, AF a. Discuss techniques of wrapping retail meats. b. Wrap and label meat for home freezing. c. Wrap, weigh, label, and price meat for retail sale. d. Describe the proper temperatures for maximum storage life of retail meats using a cooler, display case, or freezer. e. Vacuum seal various cuts of meat.
4. Describe marketing principles related to the display of meat. DOK2, AF a. Describe marketing principles related to the display of meat. b. Describe the effects vacuum sealing has on shelf life of meat.

Scenario

Unit 5

Meat Market ing

You are working for a large grocery chain in the advertising department. The chain is planning a big sales event next month and they expect you to develop the marketing plan for the meat departments.

Attachments for Performance Task

See the Presentation or Poster Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 6: Special Topics in Food Products (Meats) I

Competencies and Suggested Objectives
1. Investigate new and emerging technologies, practices, trends, and issues associated with Food Products (Meats). DOK3, AF a. Prepare a report on a new and emerging technology associated with Food Products (Meats). b. Prepare a report on a current trend or issue associated with Food Products (Meats).
2. Complete school-to-careers activities related to Food Products (Meats). DOK2, AF a. Participate in a school-to-careers activity (shadowing, mentoring, career fair, etc.) related to Food Products (Meats). b. Investigate educational opportunities related to Food Products (Meats) at the postsecondary level. c. Describe national standards and certification/licensing procedures related to Food Products (Meats). d. Describe the role of trade organizations, associations, and unions as related to Food Products (Meats).
3. Demonstrate related academic skills and workplace skills associated with Food Products (Meats). DOK2, AF a. Complete a cooperative project (paper, presentation, or demonstration) associated with an academic subject and Food Products (Meats). b. Practice human relations skills (team participation, client/customer service, leadership, negotiation, working with culturally diverse groups, etc.) related to Food Products (Meats). c. Research work ethics and employer expectations of employees in Food Products (Meats).
4. Investigate the concepts of quality assurance as related to Food Products (Meats). DOK3, AF a. Describe quality concepts and methods for measuring quality related to Food Products (Meats). b. Apply quality concepts in the Food Products (Meats) laboratory.
5. Examine trends and changes related to Food Products (Meats) and global economic factors. DOK2, AF a. Define and discuss the concept of global economics and competition. b. Describe global economic factors and competition as related to Food Products (Meats).

c. Identify regions and other countries which compete in Food Products (Meats).

Scenario

Unit 6

Beef Trends

As a food science worker with a major livestock board, your job is to keep up with current trends affecting the beef industry. You will give a presentation to the group on current trends, technologies, and jobs available in today's market.

Attachments for Performance Task

See the Present Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 7: Identification and Fabrication of Carcass and Box Beef

Competencies and Suggested Objectives
1. Identify and fabricate cuts of beef. DOK2, AF a. Identify carcass break cuts of beef. b. Make retail cuts of round. c. Make retail cuts of loin. d. Make retail cuts of rib. e. Make retail cuts of chuck. f. Make retail cuts of foreshank. g. Make retail cuts of brisket. h. Make retail cuts of plate. i. Make retail cuts of flank.
2. Identify and fabricate variety cuts of beef. DOK2, AF a. Make retail cuts of tongue. b. Make retail cuts of heart. c. Make retail cuts of liver. d. Make retail cuts of kidney. e. Make retail cuts of brain.

Scenario

Unit 7

Poster Worker

You are the market manager at the local grocery store. You have just hired a new meat cutter, but you need to know how much she knows about cutting meat. You will need to develop a poster of retail cuts of beef to ensure your new butcher knows these cuts.

Attachments for Performance Task

See the Poster Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 8: Identification and Fabrication of Carcass and Box Pork

Competencies and Suggested Objectives
1. Identify and fabricate cuts of pork. DOK2, AF a. Identify carcass break cuts of pork. b. Make retail cuts of ham. c. Make retail cuts of loin. d. Make retail cuts of shoulder (Boston butt and picnic). e. Make retail cuts of side.
2. Identify and fabricate retail variety cuts of pork. DOK2, AF a. Make retail cuts of tongue. b. Make retail cuts of liver. c. Make retail cuts of chitterlings. d. Make retail cuts of stomach. e. Make retail cuts of kidneys. f. Make retail cuts of snouts.

Scenario

Unit 8

Poster Worker

You are the market manager at the local grocery store. You have just hired a new meat cutter, but you need to know how much she knows about cutting meat. You will need to develop a poster of retail cuts of beef to ensure your new butcher knows these cuts.

~~**Attachments for Performance Task**~~

~~See the Poster Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx~~

Unit 9: Identification and Fabrication of Carcass Lamb and Goat

Competencies and Suggested Objectives
1. Identify and fabricate cuts of lamb and goat. DOK2, AF a. Identify carcass break cuts of lamb and goat. b. Identify retail cuts of leg. c. Identify retail cuts of loin. d. Identify retail cuts of rib. e. Identify retail cuts of shoulder. f. Identify retail cuts of foreshank and breast.

Scenario

Unit 9

Poster Worker

You are the market manager at the local grocery store. You have just hired a new meat cutter, but you need to know how much she knows about cutting meat. You will need to develop a poster of retail cuts of beef to ensure your new butcher knows these cuts.

Attachments for Performance Task

See the Poster Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 10: Identification and Fabrication of Poultry and Fish

Competencies and Suggested Objectives
1. Identify and fabricate cuts of poultry. DOK2, AF a. Identify carcass break cuts of poultry. b. Make retail cuts of breast quarter. c. Make retail cuts of leg quarter. d. Make retail cuts of back quarter.
2. Identify variety cuts of poultry. DOK2, AF a. Identify retail cuts of heart. b. Identify retail cuts of liver. c. Identify retail cuts of gizzard. d. Identify retail cuts of neck.
3. Identify retail cuts of fish. DOK2, AF

Scenario

Unit 10

Fry Cook

You have been asked to demonstrate the correct way of cutting up a chicken for frying. You will be presenting this to a local home economist group. Develop a presentation using visuals.

Attachments for Performance Task

~~See the Presentation Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx~~

Unit 11: Identification and Fabrication of Wild Game

Competencies and Suggested Objectives
1. Identify and fabricate cuts of wild game. DOK2, AF a. Make cuts of top round. b. Make cuts of bottom round. c. Make cuts of tip roast. d. Make cuts of eye round. e. Make cuts of loin eye. f. Make cuts of ribs. g. Debone front shoulders.
2. Prepare wild game specialty products. DOK2, AF a. Prepare various sausage products. b. Prepare ground products. c. Prepare jerky products.

Scenario

Unit 11

Deer John

The local wildlife department is making health checks on the local deer herd. They want to take twenty deer out of the population and donate these deer to a local charity. They have asked your meats class to help process these deer. They want you to process as many different products as possible, for example: steaks, roast, and ground products. Please demonstrate how to prepare their deer for this project.

~~**Attachments for Performance Task**~~

~~See the Presentation Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx~~

Unit 12: Automated Processing of Meats

Competencies and Suggested Objectives
1. Observe the automated processing of various types of meat. DOK2, AF a. Observe step-by-step procedures for the automated slaughtering and fabrication processing of beef, pork, lamb, poultry, and fish. b. Observe step-by-step procedures for the automated canning processing of beef, pork, poultry, and fish.

Scenario

Unit 12

Proper Process Plan

You are searching for ways to automate your custom processing plant. As you watch the presentation, keep a journal of how you could incorporate the various systems in your plant. To help, draw diagrams along with your writings.

Attachments for Performance Task

See the Journal Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 13: Quality and Yield Grading

Competencies and Suggested Objectives
1. Explain quality and yield grades for beef and determine classifications of beef. DOK2, AF a. Explain quality grades for beef. b. Explain yield grades of beef. c. Determine classification of beef. d. Estimate amount of kidney fat, pelvic fat, and age. e. Estimate amount of marbling in a ribeye.
2. Explain quality grades and determine classification of pork. DOK2, AF a. Explain quality grades for pork. b. Determine classification of pork.
3. Explain quality and yield grades for lamb and determine classifications of sheep. DOK2, AF a. Explain quality grades of lamb. b. Explain yield grades of lamb. c. Determine classification of sheep.
4. Explain grades in poultry. DOK2, AF a. Explain grades of poultry. b. Discuss poultry classifications.

Scenario

Unit 13

Grade My Ribeye Please

You are the food buyer for a major restaurant chain. You are presented four different high end ribeye steaks to select from for the business. You will evaluate each ribeye, determine the quality grade, and select the best ribeye for your order.

Attachments for Performance Task

See the Job Sheet/Performance Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 14: Curing, Smoking, and Sausage Making

Competencies and Suggested Objectives
1. Explain and demonstrate meat curing and smoking processes. DOK2, AF a. Define curing, smoking, and sausage making terms. b. Describe the functions of curing and smoking. c. Describe meat curing ingredients and calculate correct amount of each. d. Explain methods of meat curing. e. Identify and use equipment used in smoking and curing process. f. Cure bacon in brine solution. g. Cure jowl in brine solution. h. Pump shoulders. i. Pump hams. j. Pump loin. k. Smoke shoulder, ham, loins, bacon, and jowls in smoker.
2. Explain and demonstrate sausage making. DOK2, AF a. Mix and grind sausage with cure and seasoning. b. Read a salinometer. c. Prepare a brine solution. d. Stuff sausage in casing. e. Smoke sausage in smoker.

Scenario

Unit 14

~~Simply Sausage~~

~~You are a well-known sausage maker. Your company is very profitable because of your knowledge and skills. You have decided to take your claim to fame a step farther by creating a "How-to" sausage recipe book. You will need to include: safety, sanitation, curing, stuffing, and smoking procedures.~~

~~Attachments for Performance Task~~

~~See the Written Report Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx~~

Unit 15: Special Topics in Food Products (Meats) II

Competencies and Suggested Objectives
1. Investigate new and emerging technologies, practices, trends, and issues associated with Food Products (Meats). DOK3, AF a. Prepare a report on a new and emerging technology associated with Food Products (Meats). b. Prepare a report on a current trend or issue associated with Food Products (Meats).
2. Complete school-to-careers activities related to Food Products (Meats). DOK2, AF a. Participate in a school-to-careers activity (shadowing, mentoring, career fair, etc.) related to Food Products (Meats). b. Investigate educational opportunities related to Food Products (Meats) at the postsecondary level. c. Describe national standards and certification/licensing procedures related to Food Products (Meats). d. Describe the role of trade organizations, associations, and unions as related to Food Products (Meats).
3. Demonstrate related academic skills and workplace skills associated with Food Products (Meats). DOK2, AF a. Complete a cooperative project (paper, presentation, or demonstration) associated with an academic subject and Food Products (Meats). b. Practice human relations skills (team participation, client/customer service, leadership, negotiation, working with culturally diverse groups, etc.) related to Food Products (Meats). c. Research work ethics and employer expectations of employees in Food Products (Meats).
4. Investigate the concepts of quality assurance as related to Food Products (Meats). DOK3, AF a. Describe quality concepts and methods for measuring quality related to Food Products (Meats). b. Apply quality concepts in the Food Products (Meats) laboratory.
5. Examine trends and changes related to Food Products (Meats) and global economic factors. DOK2, AF a. Define and discuss the concept of global economics and competition. b. Describe global economic factors and competition as related to Food Products (Meats).

c. Identify regions and other countries which compete in Food Products (Meats).

Scenario

Unit 15

Trending Now

As a food science worker with a major livestock board, your job is to keep up with current trends affecting the meat industry. You will give a presentation to this board (your peers) on current trends, technologies and jobs available in today's market.

Attachments for Performance Task

See the Presentation Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Careers and Leadership		
	1.	Identify career opportunities in meat cutting, packing, and processing professions.
	2.	Identify the leadership opportunities and activities which are beneficial to students in meat cutting, packing, and processing.
Unit 2: Orientation to Meat Processing		
	1.	Explain trends in slaughtering and processing in the past and in the future.
	2.	Describe factors affecting consumer food spending.
Unit 3: Safety, Sanitation, Equipment, and Facility Maintenance		
	1.	Explain general meat laboratory safety requirements.
	2.	Discuss sanitation as it applies to a meat cutting facility.
	3.	Discuss federal regulations relating to meat processing.
	4.	Identify and use equipment for meat cutting, packing, and processing.
	5.	Demonstrate equipment maintenance used in a meat cutting facility.
	6.	Maintain a safe and sanitary facility.
Unit 4: Custom Livestock Slaughter		
	1.	Explain terms and procedures associated with livestock slaughter.
	2.	Discuss types, cleaning, use, and maintenance of slaughter facility and equipment.
	3.	Discuss procedures for slaughtering livestock and dressing wild game.

~~Unit 5: Pricing, Wrapping, and Marketing~~		
	~~1.~~	~~Compare and contrast consumer trends, supply and demand, and the effects on meat prices.~~
	~~2.~~	~~List the steps and perform a cutting test.~~
	~~3.~~	~~Discuss techniques and wrap retail meat.~~
	~~4.~~	~~Describe marketing principles related to the display of meat.~~
~~Unit 6: Special Topics in Food Products (Meats) I~~		
	~~1.~~	~~Investigate new and emerging technologies, practices, trends, and issues associated with Food Products (Meats).~~
	~~2.~~	~~Complete school-to-careers activities related to Food Products (Meats).~~
	~~3.~~	~~Demonstrate related academic skills and workplace skills associated with Food Products (Meats).~~
	~~4.~~	~~Investigate the concepts of quality assurance as related to Food Products (Meats).~~
	~~5.~~	~~Examine trends and changes related to Food Products (Meats) and global economic factors.~~
~~Unit 7: Identification and Fabrication of Carcass and Box Beef~~		
	~~1.~~	~~Identify and fabricate cuts of beef.~~
	~~2.~~	~~Identify and fabricate variety cuts of beef.~~
~~Unit 8: Identification and Fabrication of Carcass and Box Pork~~		
	~~1.~~	~~Identify and fabricate cuts of pork.~~
	~~2.~~	~~Identify and fabricate retail variety cuts of pork.~~
~~Unit 9: Identification and Fabrication of Carcass Lamb and Goad~~		
	~~1.~~	~~Identify and fabricate cuts of lamb and goat.~~
~~Unit 10: Identification and Fabrication of Poultry and Fish~~		
	~~1.~~	~~Identify and fabricate cuts of poultry.~~
	~~2.~~	~~Identify variety cuts of poultry.~~
	~~3.~~	~~Identify retail cuts of fish.~~
~~Unit 11: Identification and Fabrication of Wild Game~~		

	1.	Identify and fabricate cuts of wild game.
	2.	Prepare wild game specialty products.
Unit 12: Automated Processing of Meats		
	1.	Observe the automated processing of various types of meat.
Unit 13: Quality and Yield Grading		
	1.	Explain quality and yield grades for beef and determine classifications of beef.
	2.	Explain quality grades and determine classification of pork.
	3.	Explain quality and yield grades for lamb and determine classifications of sheep.
	4.	Explain grades in poultry.
Unit 14: Curing, Smoking, and Sausage Making		
	1.	Explain and demonstrate meat curing and smoking processes.
	2.	Explain and demonstrate sausage making.
Unit 15: Special Topics in Food Products (Meats) II		
	1.	Investigate new and emerging technologies, practices, trends, and issues associated with Food Products (Meats).
	2.	Complete school-to-careers activities related to Food Products (Meats).
	3.	Demonstrate related academic skills and workplace skills associated with Food Products (Meats).
	4.	Investigate the concepts of quality assurance as related to Food Products (Meats).
	5.	Examine trends and changes related to Food Products (Meats) and global economic factors.

Appendix A: Unit References

Many of the Food Products (Meats) units use the same resources for each unit. You will find suggested resources listed below.

Unit 1

Aberle, E. D., Forrest, J. C., Gerrard, D. E., & Mills, E. W. (2001). *Principles of meat science* (4th ed.). Dubuque, IA: Kendall/Hunt.

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Weiss, E., & Weiss, H. (1991). *Catering handbook*. New York: John Wiley & Sons.

Unit 3

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state.edu%2FDesktopModules%2FViewDocument.aspx%3FDocumentID%3D4294&ei=2xLnUKHTMoLy9gTjyIGICg&usg=AFQjCNG2KrluLLGaNQVSVD_UsD-DxDhALA&sig2=de0DqTk6vdCgu2OtCE3rWg&bvm=bv.1355534169,d.eWU

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Unit 5

Aberle, E. D., Forrest, J. C., Gerrard, D. E., & Mills, E. W. (2001). *Principles of meat science* (4th ed.). Dubuque, IA: Kendall/Hunt.

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Unit 7

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Davis, G. W. (n.d.). *Beef retail cut ID* [Video]. Lubbock, TX: Creative Education Video.

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Appendix C: Industry Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY

CONTENT STANDARDS AND PERFORMANCE ELEMENTS

Crosswalk for Food Products (Meats)											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
AFNR											
AF - FOOD PRODUCTS AND PROCESSING SYSTEMS		X	X	X	X	X	X	X	X	X	X
AFNR											
		Unit 12	Unit 12	Unit 13	Unit 14	Unit 15					
		X	X	X	X	X					

AF - FOOD PRODUCTS AND PROCESSING SYSTEMS

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314, 800.772.0939. Copyright © 2009. A complete copy of the National Standards can be downloaded from the Team Ag Ed Learning Center at https://aged.learn.com.

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.01. Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.

FPP.01.01 Analyze and manage operational and safety procedures in food products and processing facilities.

FPP.01.02 Apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

FPP.01.03 Apply food safety procedures when storing food products to ensure food quality.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.02. Apply principles of nutrition, biology, microbiology, chemistry and human behavior to the development of food products.

FPP.02.01 Apply principles of nutrition and biology to develop food products that provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.02.02 Apply principles of microbiology and chemistry to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.02.03 Apply principles of human behavior to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.03 Select and process food products for storage, distribution and consumption.

FPP.03.01 Implement selection, evaluation and inspection techniques to ensure safe and quality food products.

FPP.03.02 Design and apply techniques of food processing, preservation, packaging and presentation for distribution and consumption of food products.

FPP.03.03 Create food distribution plans and procedures to ensure safe delivery of food products.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

FPP.04. Explain the scope of the food industry and the historical and current developments of food product and processing.

FPP.04.01 Examine the scope of the food industry by evaluating local and global policies, trends and customs for food production.

FPP.04.02 Evaluate the significance and implications of changes and trends in the food products and processing industry in the local and global food systems.

FPP.04.03 Identify and explain the purpose of industry organizations, groups and

~~regulatory agencies that influence the local and global food systems.~~

2021 Heating, Ventilation, and Air Conditioning (HVAC)

Program CIP: 47.0201— Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician

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The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Acknowledgments

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Betsey Smith, director for the RCU
Sam Watts, curriculum manager for the RCU
Melissa Luckett, instructional design specialist for the RCU

Standards

Standards and alignment crosswalks are referenced in the appendix. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE HVAC curriculum is aligned to the following standards:

National Center for Construction Education and Research (NCCER) Learning Series

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International Society for Technology in Education Standards (ISTE)
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iste.org

College- and Career-Ready Standards
College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College and Career Ready Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/oae/college-and-career-readiness-standards

Framework for 21st Century Learning
In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. 21 *Framework Definitions* (2019).
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
: Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource
: Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call the RCU at 662.325.2510.

Executive Summary

Pathway Description
The HVAC pathway is an instructional program that prepares students for employment or continued education in the occupations of heating, ventilation, and air-conditioning. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the National Center for Construction Education and Research (NCCER).

Grade Level and Class Size Recommendations
It is recommended that students enter this program as a 10th grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and student maturity. A maximum of 25 students is recommended for classroom-based courses, while a maximum of 15 students is recommended for lab-based courses.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest CTE teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning
If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

This curriculum consists of four 1-credit courses, which should be completed in the following sequence:

1. **Fundamentals of HVAC—Course Code: 993018**
2. **Applications of HVAC—Course Code: 993019**
3. **Theory of HVAC—Course Code: 993022**
4. **Advanced HVAC—Course Code: 993023**

Course Description: Fundamentals of HVAC
This course includes an introduction to the field as well as fundamentals of safety, math, and hand and power tools.

Course Description: Applications of HVAC
This course provides an introduction to blueprints, materials handling, introduction to HVAC, copper and plastic piping, soldering and brazing, basic electricity, and trade math. It gives students real-world, hands-on practice in these areas. This course should only be taken after students successfully complete Fundamentals of HVAC.

Course Description: Theory of HVAC
This course includes an in-depth study of the heating, ventilation, and air-conditioning profession, carbon steel piping practice, introduction to cooling, and introduction to heating. The course also reinforces safety related to the installation and service of HVAC applications. This course should only be taken after students successfully complete Applications of HVAC.

Course Description: Advanced HVAC
This course includes an in-depth study of the heating, ventilation, and air conditioning profession, air distribution systems, leak detection evacuation recovery and charging, alternating current, and basic electronics. The course also reinforces safety related to the installation and service of HVAC applications. It should only be taken after students successfully complete Theory of HVAC. Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed. Safety is reinforced and tested at the beginning of each course.

Fundamentals of HVAC—Course Code: 993018

Unit	Title	Hours
1	Introduction and Orientation	3
2	Employability Skills	7.5
3	Fundamentals of Student Organizations	4.5
4	Communication Skills	7.5
5	Basic Safety	35
6	Introduction to Construction Math	25
7	Hand Tools	15
8	Power Tools	15
9	Introduction to Construction Drawings	20
Total		132.5

Applications of HVAC—Course Code: 993019

Unit	Title	Hours
10	Introduction to Materials Handling	20
11	Introduction to HVAC	10
12	Copper and Plastic Piping	15
13	Soldering and Brazing	15
14	Basic Electricity (HVAC)	30
Total		90

Theory of HVAC—Course Code: 993022

Unit	Title	Hours
15	Orientation and Safety	17
16	Trade Math	24
17	Basic Carbon Steel Piping Practice	34
18	Introduction to Cooling	50
Total		125

Advanced HVAC—Course Code: 993023

Unit	Title	Hours
19	Introduction to Heating	40
20	Air Distribution Systems	35
21	Leak Detection Evacuation Recovery and Charging	30
22	Alternating Current	30
Total		135

Option 2—Two 2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses, which should be completed in the following sequence:

1. **HVAC I—Course Code: 993020**
2. **HVAC II—Course Code: 993021**

Course Description: HVAC I
This course emphasizes heating, ventilation, and air-conditioning. Topics include employability skills, safety, construction math, construction drawings, materials handling, copper and piping, soldering and brazing, and basic electricity.

Course Description: HVAC II
This course emphasizes heating, ventilation, and air-conditioning. Topics include employability skills, safety, carbon steel piping, introduction to cooling, introduction to heating, air distribution, leak detection evacuation recovery and charging, alternating current, and basic electronics. This course should be taken after the student has successfully completed HVAC I. Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed. Safety is reinforced and tested at the beginning of each course.

HVAC I—Course Code: 993020

Unit		Title	Hours
1		Orientation	3
2		Employability Skills	7.5
3		Fundamentals of Student Organizations	4.5
4		Communication Skills	7.5
5		Basic Safety	35
6		Introduction to Construction Math	25
7		Hand Tools	15
8		Power Tools	15
9		Introduction to Construction Drawings	20
10		Introduction to Materials Handling	20
11		Introduction to HVAC	10
12		Basic Copper and Plastic Piping	15
13		Soldering and Brazing	15
14		Basic Electricity (HVAC)	30
Total			222.5

HVAC II—Course Code: 993021

Unit		Title	Hours
15		Orientation and Safety	17
16		Trade Math	24
17		Basic Carbon Steel Piping Practice	34
18		Introduction to Cooling	50
20		Introduction to Heating	40
21		Air Distribution Systems	35
22		Leak Detection, Evacuation Recovery, and Charging	30
23		Alternating Current	30
Total			260

Career Pathway Outlook

Overview
Employment of HVAC mechanics and installers is projected to grow 13% by 2028 in the U.S. and 10% in Mississippi—much faster than the average for all occupations. HVAC systems can be found in most buildings; therefore, employment opportunities are readily available for qualified HVAC technicians. Because of the increasing development and complexity of HVAC technology, success in this field requires continuous education to stay current with the latest equipment and skills. In addition to technical skills, having good listening, speaking, time management, and critical thinking skills can also contribute to success in this occupation. In the secondary HVAC program, students can earn NCCER HVAC Level 1 certification, which will give students a head start on obtaining industry-recognized credentials and better prepare them for a postsecondary HVAC program.

Needs of the Future Workforce
Data for this synopsis were compiled from employment projections prepared by the U.S. Census Bureau, the U.S. Bureau of Labor Statistics (2019), and the Mississippi Department of Employment Security (2019).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2016	Projected Jobs, 2026	Change (Number)	Change (Percent)	Average Hourly Earnings, 2019
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	2,130	2,340	210	9.9%	$19. 66
Helpers—Installation, Maintenance, and Repair Workers	1,400	1,510	110	7.9%	$15.80
Installation, Maintenance, and Repair Workers, All Other	730	760	30	4.1%	$20.88

Source: Mississippi Department of Employment Security; mdes.ms.gov (2019).

Perkins V Requirements and Academic Infusion
The HVAC curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in HVAC fields. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for HVAC careers. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, the curriculum focuses on ongoing and meaningful professional development for teachers, as well as relationships with industry.

Transition to Postsecondary Education
The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The HVAC educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that can foster the types of learning expected from the HVAC curriculum. SkillsUSA is an example of a student organization with many outlets for HVAC. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to the world of HVAC careers and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the HVAC curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The HVAC curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the HVAC curriculum that allow and encourage collaboration with professionals currently in the HVAC field.

Work-Based Learning

Work-based learning is an extension of understanding competencies taught in the HVAC classroom. This curriculum is designed in a way that necessitates active involvement by the students in the community around them and the global environment. These real-world connections and applications link all types of students to knowledge, skills, and professional dispositions. Work-based learning should encompass ongoing and increasingly more complex involvement with local companies and industry professionals. Thus, supervised collaboration and immersion into the industry around the students are keys to students' success, knowledge, and skills development.

Professional Organizations

Association for Career and Technical Education (ACTE)
acteonline.org

SkillsUSA
skillsusa.org/

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80% of the time in the course. The remaining percentage of class time will include instruction in non-tested material, review for end-of-course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Teacher Resources
Teacher resources for this curriculum may be found in multiple places. Many program areas have teacher resource documents that accompany the curriculum and can be downloaded from the same site as the curriculum. The teacher resources document contains references, lesson ideas, websites, teaching and assessment strategies, scenarios, skills to master, and other resources divided by unit. This document could be updated periodically by RCU staff. Please check the entire document, including the entries for each unit, regularly for new information. If you have something you would like to add to or have a question about the document, call or email the RCU's instructional design specialist for your program. The teacher resource document can be downloaded at rcu.msstate.edu/curriculum/curriculumdownload.aspx. All teachers should request to be added to the Canvas Resource Guide for their course. This is where all resources will be housed in the future, if they are not already. To be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Many of the units include an enrichment section at the end. If the HVAC program is currently using the Mississippi Career Planning and Assessment System (MS-CPAS) as a measure of accountability, the enrichment section of material will not be tested. If this is the case, it is suggested to use the enrichment material when needed or desired by the teacher and if time allows in the class. This material will greatly enhance the learning experiences for students. If, however, the HVAC program is using a national certification or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be tested. It is the responsibility of the teacher to ensure all competencies for the selected assessment are covered throughout the year.

Unit 1: Orientation

Competencies and Suggested Objectives
1. Describe local program and center expectations, policies, and procedures. DOK 1 a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. b. Give a brief overview of the course. Explain to students what HVAC is, why it is important, and how it will be delivered. c. Compare and contrast local program and school policies to the expectations of employers. d. Preview course objectives, program policy, and industry standards.
2. Discuss work-based learning (WBL) opportunities related to program areas. DOK 1 a. Define WBL. b. Explore the opportunities available through the program areas below. • CPE • Job shadowing • Apprenticeship programs • On-the-job training • Other opportunities.

Unit 2: Employability Skills

Competencies and Suggested Objectives
1. Describe employment opportunities in the construction industry. DOK 1 a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training. b. Discuss the guidelines for developing a proper résumé. c. Demonstrate completing job applications.
2. Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities. DOK 1 a. Perform various searches through the MDES website, such as: • Number of jobs available for a specific area of expertise • Hourly wage • Percentage of jobs in the county • Percentage of jobs in the state
3. Demonstrate appropriate interviewing skills. DOK 1 a. Identify interviewing skills such as speaking, dress, professionalism, and punctuality. b. Simulate a job interview.
4. Describe basic employee responsibilities and appropriate work ethics. DOK 1 a. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. b. Define effective relationship skills. c. Describe workplace issues, including, but not limited to, sexual harassment, stress, and substance abuse.

Unit 3: Fundamentals of Student Organizations

Competencies and Suggested Objectives
1. Discuss the history, mission, and purpose of student organizations, including SkillsUSA.[DOK 1] a. Trace the history of the program area's student organization. b. Identify the mission, purpose, and/or goals of the program area's student organization.
2. Explore the advantages of membership in a student organization. [DOK 1] a. Discuss the membership process for the program area's student organization. b. Explain the activities related to the local chapter and the state and national organizations.
3. Discuss the organization's brand resources. [DOK 1] a. Identify the motto, creed, and/or pledge and discuss their meanings. b. Recognize related brand resources, such as: • Emblem • Colors • Official attire • Logos • Graphic standards
4. Describe the importance of effective communication skills. [DOK 1] a. Demonstrate verbal and nonverbal communication skills. b. Apply appropriate speaking and listening skills to class- and work-related situations.
5. Apply leadership skills to class- and work-related situations and 21st century skills. [DOK 2] a. Define leadership. b. Discuss the attributes of a leader. c. Identify the roles a leader can assume.
6. Utilize team-building skills in class- and work-related situations. [DOK 2] a. Define team-building. b. Discuss the attributes of a team. c. Identify the roles included in a team.
7. Discuss the various competitions offered through the program area's student organization.[DOK 1] a. Describe each of the competitions and the skills needed to accomplish the tasks. b. Perform the tasks needed to complete an assigned requirement for a competition.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 4: Communication Skills

Competencies and Suggested Objectives
1. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK 2 a. Follow basic written and verbal instructions. b. Effectively communicate in on-the-job situations using verbal, written, or electronic communication.
2. Discuss the importance of good listening skills in on-the-job situations. DOK 2 a. Apply the tips for developing good listening skills.

Unit 5: Basic Safety

Competencies and Suggested Objectives
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry. DOK 2 a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies according to OSHA standards. d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain the causes of accidents and the impact of accident costs. g. Compare and contrast shop/lab safety rules to industry safety rules.
2. Identify and apply safety around welding operations. DOK 1 a. Use proper safety practices when welding or working around welding operations. b. Use proper safety practices when welding in or near trenches and excavations. c. Explain the term "proximity work."
3. Display appropriate safety precautions to take around common jobsite hazards. DOK 1 a. Explain the safety requirements for working in confined areas. b. Explain the different barriers and barricades and how they are used.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). DOK 1 a. Identify commonly used PPE items. b. Understand proper use of PPE. c. Demonstrate appropriate care for PPE.
5. Explain fall protection and ladder, stair, and scaffold procedures and requirements. DOK 1 a. Explain the use of proper fall protection. b. Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the safety data sheet (SDS). DOK 1 a. Explain the function of the SDS. b. Interpret the requirements of the SDS. c. Discuss hazardous material exposures.
7. Display appropriate safety procedures related to fires. DOK 1 a. Explain the process by which fires start. b. Explain fire prevention of various flammable liquids. c. Explain the classes of fire and the types of extinguishers. d. Illustrate the proper steps to follow when using a fire extinguisher. e. Demonstrate the proper techniques for putting out a fire.
8. Explain safety in and around electrical situations. DOK 1 a. Explain the injuries that can result when electrical contact occurs. b. Explain safety around electrical hazards. c. Explain actions to take when an electrical shock occurs.
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Unit 6: Introduction to Construction Math

Competencies and Suggested Objectives
1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. DOK 2 a. Define basic geometric shapes used in the construction industry. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions and convert fractions to whole numbers. d. Convert decimals to percentages and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and a tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 7: Hand Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of hand tools. DOK 2 a. Identify, visually inspect, and discuss the safe use of common hand tools. b. Discuss safety rules. c. Select and demonstrate the use of hand tools. d. Explain the procedures for maintenance.

Unit 8: Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of power tools. DOK 2 a. Identify, visually inspect, and discuss the safe use of common power tools. b. Discuss safety rules. c. Select and demonstrate the use of power tools. d. Explain the procedures for maintenance.

Unit 9: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand basic components of a drawing. DOK 3 a. Recognize and identify terms, components, and symbols commonly used on drawings. b. Relate information on construction drawings to actual locations on the drawings. c. Recognize different types of drawings. d. Interpret and use drawing dimensions.

Unit 10: Introduction to Materials Handling

Competencies and Suggested Objectives
1. Safely handle and store materials. DOK 1 a. Define a load. b. Establish a pre-task plan prior to moving a load. c. Demonstrate proper materials-handling techniques. d. Choose the appropriate materials-handling equipment for a task. e. Recognize hazards and follow safety procedures required for materials handling. f. Identify and demonstrate commonly used knots.

Unit 11: Introduction to HVAC

Competencies and Suggested Objectives
1. Identify and explain heating, ventilation, air-conditioning, and refrigeration (HVAC/R) systems, HVAC/R environmental law, and job opportunities that are available in the HVAC/R profession. DOK2 a. Explain the basic principles of HVAC/R. b. Describe the principles that guide HVAC/R installation and service techniques.

Unit 12: Basic Copper and Plastic Piping

Competencies and Suggested Objectives
1. Identify and discuss the tools used in the piping trade, discuss the materials and methods used in connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and HVAC environment. DOK2 a. Discuss and demonstrate how to use copper tubing in HVAC. b. Discuss and demonstrate how to use plastic tubing in HVAC.

Unit 13: Soldering and Brazing

Competencies and Suggested Objectives
1. Identify and utilize PPE, tools, and materials required to solder and braze copper tubing. DOK1
2. Prepare and solder/braze copper tubing systems in various industrial and HVAC applications and properly clean and install fittings. DOK2

Unit 14: Basic Electricity (HVAC)

Competencies and Suggested Objectives
1. Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits. DOK2 a. Describe how voltage, current, resistance, and power are mathematically related. b. Describe the difference between series and parallel circuits and calculate loads in each. c. Describe the purpose and operation of the various electrical components used in equipment.

Unit 15: Orientation and Safety

Competencies and Suggested Objectives
1. Describe local program and vocational/career technical center policies and procedures. DOK2
2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. DOK2 a. Describe employer expectations in the workplace.
3. Explore leadership skills and personal development opportunities provided for students by student organizations, including SkillsUSA. DOK2 a. Demonstrate effective team-building and leadership skills. b. Practice appropriate work ethics.
4. Describe general safety rules for working in a shop/lab and industry. DOK2 a. Discuss safety issues and prevention associated with the HVAC shop area. b. Explain fire safety and prevention in the workplace.

Unit 16: Trade Math

Competencies and Suggested Objectives
1. Identify proper math to use for problem-solving; use English and metric measurement; use powers, algebra, and geometric calculation to solve for HVAC problems; and convert Fahrenheit to Celsius. DOK2 a. Demonstrate how to calculate mathematic problems found in the HVAC trade.

Unit 17: Basic Carbon Steel Piping Practice

Competencies and Suggested Objectives
1. Recognize the types and sizes of carbon steel piping and pipe fittings, and demonstrate the tools used to cut, ream, and thread carbon steel pipe in the HVAC trade. DOK2 a. Explain the uses of carbon steel pipes in the HVAC trade. b. Assemble and install carbon steel pipes and fittings.

Unit 18: Introduction to Cooling

Competencies and Suggested Objectives
1. Explain the basic cooling systems, heat transfer, trade terms, refrigerants, components, controls, and proper piping of the cooling system. DOK2 a. Explain how an HVAC system removes heat from the air-conditioned area of an HVAC system. b. Identify the major components, accessories, refrigerants, and control devices available for cooling systems, and explain how each works. c. Discuss Environmental Protection Agency (EPA) standards.

Unit 19: Introduction to Heating

Competencies and Suggested Objectives
1. Explain methods of heat transfer and characteristics of combustion; identify types of fuels and furnaces and components of electric, hydronic, and gas furnaces; identify and safely use meters in gas measurement; and perform maintenance on electric and gas furnaces.[DOK2] a. Explain how a heating system operates. b. Perform basic furnace preventive maintenance procedures, such as cleaning and filter replacement, with supervision.

Unit 20: Air Distribution Systems

Competencies and Suggested Objectives
1. Demonstrate the design and installation of HVAC duct systems. DOK2, ADS a. Discuss the patterns of airflow and pressures in an HVAC duct. b. Identify types of duct systems and explain where each is used in HVAC applications. c. Describe the mechanical equipment and materials used to create air distribution systems.
2. Discuss the installation of ductwork. DOK1 a. Identify, select, and use fasteners. b. Discuss connecting rectangular, round, and spiral ductwork. c. Explain how to properly seal ductwork.

Unit 21: Leak Detection, Evacuation, Recovery, and Charging

Competencies and Suggested Objectives
1. Identify leaks in an HVAC system and perform the proper steps to repair the leak, restoring the unit to operation. DOK2 a. Describe what the Clean Air Act means to the HVAC trade. b. Define and perform a leak test on an HVAC system. c. Use nitrogen to purge a system, and charge refrigerant into a system by the methods below. • Weight • Superheat • Subcooling • Charging pressure
2. Identify/install a basic vacuum pump service operation. DOK2 a. Describe the safety procedures for using a vacuum pump. b. Install and use a vacuum pump on a system.
3. Explain the procedures for evacuation and recovery. DOK 1

Unit 22: Alternating Current

Competencies and Suggested Objectives
1. Explain how single- and three-phase AC power is generated and transmitted for use. DOK1
2. Examine the safe operation of electrical transformers, motors, and single- and three-phase HVAC devices. DOK2 a. Explain and demonstrate the safe operation of various types of transformers. b. Describe the types of capacitors and motors found in the HVAC unit. c. State and demonstrate the safety precautions that must be followed when working with electrical equipment and testing AC components, including capacitors, transformers, and motors.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Discuss work-based learning (WBL) opportunities related to program areas.
Unit 2: Employability Skills		
	1.	Describe employment opportunities in the construction industry.
	2.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	3.	Demonstrate appropriate interviewing skills.
	4.	Describe basic employee responsibilities and appropriate work ethics.
Unit 3: Fundamentals of Student Organizations		
	1.	Discuss the history, mission, and purpose of student organizations, including SkillsUSA.
	2.	Explore the advantages of membership in a student organization.
	3.	Discuss the organization's brand resources.
	4.	Describe the importance of effective communication skills.
	5.	Apply leadership skills to class- and work-related situations and 21st century skills.
	6.	Utilize team-building skills in class- and work-related situations.
	7.	Discuss the various competitions offered through the program area's student organization.
Unit 4: Communication Skills		
	1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	2.	Discuss the importance of good listening skills in on-the-job situations.
Unit 5: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry.
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.

	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection, ladder, stair, and scaffold procedures and requirements.
	6.	Explain the safety data sheet (SDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 6: Introduction to Construction Math		
	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
Unit 7: Hand Tools		
	1.	Demonstrate the use and maintenance of hand tools.
Unit 8: Power Tools		
	1.	Demonstrate the use and maintenance of power tools.
Unit 9: Introduction to Construction Drawings		
	1.	Read, analyze, and understand basic components of a drawing.
Unit 10: Introduction to Materials Handling		
	1.	Safely handle and store materials.
Unit 11: Introduction to HVAC		
	1.	Identify and explain heating, ventilation, air-conditioning, and refrigeration (HVAC/R) systems, HVAC/R environmental law, and job opportunities that are available in the HVAC/R profession.
Unit 12: Basic Copper and Plastic Piping		
	1.	Identify and discuss the tools used in the piping trade, discuss the materials and methods used in connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and HVAC environment.
Unit 13: Soldering and Brazing		
	1.	Identify and utilize PPE, tools, and materials required to solder and braze copper tubing.
	2.	Prepare and solder/braze copper tubing systems in various industrial and HVAC applications and properly clean and install fittings.
Unit 14: Basic Electricity (HVAC)		
	1.	Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits.
Unit 15: Orientation and Safety		
	1.	Describe local program and vocational/career technical center policies and procedures.
	2.	Describe employment opportunities and responsibilities of the industrial and HVAC mechanic.

	3.	Explore leadership skills and personal development opportunities provided for students by student organizations, including SkillsUSA.
	4.	Describe general safety rules for working in a shop/lab and industry.
Unit 16: Trade Math		
	1.	Identify proper math to use for problem solving; use English and metric measurement; use powers, algebra, and geometric calculation to solve for HVAC problems; and convert Fahrenheit to Celsius.
Unit 17: Basic Carbon Steel Piping Practice		
	1.	Recognize the types and sizes of carbon steel piping and pipe fittings, and demonstrate the tools used to cut, ream, and thread carbon steel pipe in the HVAC trade.
Unit 18: Introduction to Cooling		
	1.	Explain the basic cooling systems, heat transfer, trade terms, refrigerants, components, controls, and proper piping of the cooling system.
Unit 19: Introduction to Heating		
	1.	Explain methods of heat transfer and characteristics of combustion; identify types of fuels and furnaces and components of electric, hydronic, and gas furnaces; identify and safely use meters in gas measurement; and perform maintenance on electric and gas furnaces.
Unit 20: Air Distribution Systems		
	1.	Demonstrate the design and installation of HVAC duct systems.
	2.	Discuss the installation of ductwork.
Unit 21: Leak Detection, Evacuation, Recovery, and Charging		
	1.	Identify leaks in an HVAC system and perform the proper steps to repair the leak, restoring the unit to operation.
	2.	Identify/install a basic vacuum pump service operation.
	3.	Explain the procedures for evacuation and recovery.
Unit 22: Alternating Current		
	1.	Explain how single- and three-phase AC power is generated and transmitted for use.
	2.	Examine the safe operation of electrical transformers, motors, and single- and three-phase HVAC devices.

Appendix A: Industry Standards

HVAC PATHWAY

CONTENT STANDARDS AND PERFORMANCE ELEMENTS[1]

Crosswalk for HVAC

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
CORE											
BSM						X					
ICM							X				
IHT								X			
IPT									X		
BLU										X	
COM					X						
EMP			X								
IMH											X
LEVEL 1- HVAC											
		Unit 11	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**	**Unit 17**	**Unit 18**	**Unit 19**	**Unit 20**
INT		X									
CPP			X								
SBR				X							
BEL					X						
TMA							X				
BAS						X					
EMP						X					
BCP								X			
ITC									X		
ITH										X	
ADS											X

	Units	Unit 21	Unit 22								
HVAC Level 2											
LDE		X									
ALT			X								

[1] *NCCER learning series.* Retrieved October 31, 2019, from http://www.nccer.org/

NCCER CORE

BSM – BASIC SAFETY (00101-15)

ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-15)

IHT – INTRODUCTION TO HAND TOOLS (00103-15)

IPT – INTRODUCTION TO POWER TOOLS (00104-15)

BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-15)

COM – BASIC COMMUNICATION SKILLS (00107-15)

EMP – BASIC EMPLOYABILITY SKILLS (00108-15)

IMH – INTRODUCTION TO MATERIALS HANDLING (00109-15)

NCCER HVAC

LEVEL ONE

Level One

INT – Introduction to HVAC (03101-V5)

TMA – Trade Mathematics (03102- V5)

CPP – Basic Copper and Plastic Piping Practices (03103- V5)

SBR – Soldering and Brazing (03104- V5)

BCP – Basic Carbon Steel Piping Practices (03105- V5)

BEL – Basic Electricity (03106- V5)

ITC – Introduction to Cooling (03107- V5)

ITH – Introduction to Heating (03108- V5)

ADS – Air Distribution Systems (03109- V5)

Level 2

LDE – Leak Detection, Evacuation, Recovery, and Charging (03205- V5)

ALT – Alternating Current (03206- V5)

2016 Heating, Ventilation, and Air Conditioning (HVAC)

Program CIP: 47.0201 Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician

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~~Research and Curriculum Unit~~

~~Mississippi State University~~

~~Mississippi State, MS 39762~~

~~The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.~~

Table of Contents

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The following persons were serving on the state board at the time:

Dr. Carey M. Wright, State Superintendent of Education

Dr. John R. Kelly, Chair

Mr. Richard Morrison, Vice-Chair

Dr. O. Wayne Gann

Mrs. Kami Bumgarner

Mr. William Harold Jones

Mr. Charles McClelland

Mrs. Rosemary G. Aultman

Mr. Johnny Franklin

Dr. Karen Elam

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Jo Ann Watts, Instructional Design Specialist for the Research and Curriculum Unit at Mississippi State University researched and authored this framework. jo.watts@rcu.msstate.edu

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~~Betsey Smith, Associate Director for the Research and Curriculum Unit at Mississippi State University~~

~~Scott Kolle, Project Manager for the Research and Curriculum Unit at Mississippi State University~~

~~Jolanda Young, Educational Technologist for the Research and Curriculum Unit at Mississippi State University~~

Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the HVAC *Curriculum Framework and Supporting Materials* are based on the following:

NCCER Learning Series from the National Center for Construction Education and Research

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College and Career-Ready Standards

The College and Career-Ready Standards emphasize critical thinking, teamwork and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College- and Career-Ready Standards (MCCRS) because they provide a consistent, clear understanding of what students are expected to learn so that teachers and parents know what they need to do to help them. Reprinted from http://www.mde.k12.ms.us/MCCRS

International Society for Technology in Education Standards (ISTE)

Reprinted with permission from *National Educational Technology Standards for Students: Connecting Curriculum and Technology*, Copyright 2007, International Society for Technology in Education (ISTE), 800.336.5191 (U.S. and Canada) or 541.302.3777 (International), iste@iste.org, www.iste.org. All rights reserved. Permission does not constitute an endorsement by ISTE.

21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and information and communication technology (ICT) literacy.

Preface

Secondary career and technical education programs in Mississippi face with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at

The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

The HVAC pathway is an instructional program that prepares students for employment or continued education in the occupations of heating, ventilation, and air-conditioning. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the National Center for Construction Education and Research (NCCER).

Industry Certification

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the **NCCER Learning Series.** When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the accreditation process, all Mississippi Construction Technology instructors will be required to successfully complete the **Instructor Certification Training Program**. This program ensures that instructors possess a deep knowledge of content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi **NCCER Accredited Training and Education Facilities (ATEF)**. In order to become an NCCER ATEF program, school districts must meet a set of guidelines including the following:

1. Use the approved curriculum.
2. All instructors must be NCCER certified.
3. All completed Form 200s and release forms on all student completions are to be forwarded to MCEF for proper approval. MCEF will in turn forward to NCCER for processing.
4. Follow NCCER guidelines on test security and performance profiles.
5. Have an active advisory committee with at least two commercial contractors involved.
6. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
7. Involve commercial contractors in class presentations or field trips.
8. All construction programs must be included in the accreditation process.
9. Show active involvement in student leadership development (e.g., SkillsUSA).
10. Provide demonstrated placement into construction-related occupations, and provide timely reports to MCEF.

Districts will be required to complete a self-evaluation of all programs and host a site visit from industry to ensure proper lab, safety, and instructional procedures are in place.

Assessment

The latest assessment blueprint for the curriculum can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Student Prerequisites

In order for students to be able to experience success in the HVAC program, the following student prerequisites are suggested:

4. C or higher in English (the previous year)
5. C or higher in Math (last course taken or the instructor can specify the math)
6. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

3. TABE Reading Score (eighth grade or higher)
4. Instructor Approval

or

2. Instructor Approval

Teacher Licensure

The latest teacher licensure information can be found at

http://www.mde.k12.ms.us/educator-licensure

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for a professional learning specialist.

Course Outlines

Option 1 – Four, One-Carnegie-Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

5. **Fundamentals of HVAC- Course Code: 993018**
6. **Applications of HVAC- Course Code: 993019**
7. **Theory of HVAC – Course Code: 993022**
8. **Advanced HVAC – Course Code: 993023**

Course Description: Fundamentals of HVAC

Fundamentals of HVAC includes an introduction to the field as well as fundamentals of safety, math, and hand and power tools. This is a one-Carnegie-unit course.

Course Description: Applications of HVAC

Applications of HVAC provides an introduction to blueprints, materials handling, introduction to HVAC, copper and plastic piping, soldering and brazing, basic electricity and Trade Math. This course gives students real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully complete Fundamentals of HVAC.

Course Description: Theory of HVAC

Theory of HVAC includes an in-depth study of the heating, ventilation, and air-conditioning profession, carbon steel piping practice, introduction to cooling, and introduction to heating. This course also reinforces safety related to the installation and service of HVAC applications. This one-Carnegie-unit course should only be taken after students successfully complete Application of HVAC.

Course Description: Advanced HVAC

Advanced HVAC includes an in-depth study of the heating, ventilation, and air conditioning profession, air distribution systems, leak detection evacuation recovery and charging, alternating current, and basic electronics. This course also reinforces safety related to the installation and service of HVAC applications. This one-Carnegie-unit course should only be taken after students successfully complete Theory of HVAC.

- ~~Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.~~
- ~~Safety will be reinforced and tested at the beginning of each course.~~

~~Fundamentals of HVAC–Course Code: 993018~~

~~Unit~~		~~Title~~	~~Hours~~
~~1~~		~~Introduction and Orientation~~	~~20~~
~~2~~		~~Basic Safety~~	~~35~~
~~3~~		~~Introduction to Construction Math~~	~~25~~
~~4~~		~~Hand and Power Tools~~	~~30~~
~~5~~		~~Introduction to Construction Drawings~~	~~20~~
			~~130~~

~~Applications of HVAC–Course Code: 993019~~

~~Unit~~		~~Title~~	~~Hours~~
~~6~~		~~Introduction to Materials Handling~~	~~20~~
~~7~~		~~Introduction to HVAC, Copper and Plastic Piping, Soldering and Brazing~~	~~50~~
~~8~~		~~Basic Electricity (HVAC)~~	~~30~~
~~9~~		~~Basic Refrigeration Gauges~~	~~40~~
			~~140~~

~~Theory of HVAC—Course Code: 993022~~

~~Unit~~		~~Title~~	~~Hours~~
~~10~~		~~Orientation and Safety~~	~~20~~
~~11~~		~~Trade Math~~	~~20~~
~~12~~		~~Basic Carbon Steel Piping Practice~~	~~50~~
~~13~~		~~Introduction to Cooling, and Introduction to Heating~~	~~50~~
			~~140~~

~~Advanced HVAC—Course Code: 993023~~

~~Unit~~		~~Title~~	~~Hours~~

~~14~~		~~Air Distribution Systems~~	~~45~~
~~15~~		~~Leak Detection Evacuation Recovery and Charging~~	~~45~~
~~16~~		~~Alternating Current~~	~~40~~
			~~130~~

~~Option 2 – Two, Two-Carnegie-Unit Courses~~

~~This curriculum consists of two, two-credit courses, as follows:~~

8. **~~HVAC I – Course Code: 993020~~**

9. **~~HVAC II – Course Code: 993021~~**

~~Course Description: HVAC I~~

~~HVAC I (Heating, Ventilation and Air-Conditioning) is an emphasis on Heating, Ventilation, and Air-Conditioning. Topics include employability skills, safety, construction math, construction drawings, materials handling, copper and piping, soldering and brazing, and basic electricity.~~

~~Course Description: HVAC II~~

~~HVAC II (Heating, Ventilation and Air-Conditioning) is an emphasis on Heating, Ventilation, and Air-Conditioning. Topics include employability skills, safety, carbon steel piping, introduction to cooling, introduction to heating, air distribution, leak detection evacuation recovery and charging, alternating current, and basic electronics. The course should be taken after the student has successfully completed HVAC I.~~

- ~~Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.~~
- ~~Safety will be reinforced and tested at the beginning of each course.~~

HVAC I – Course Code: 993020

Unit		Title	Hours
1		Introduction and Orientation	20
2		Basic Safety	35
3		Introduction to Construction Math	25
4		Hand and Power Tools	30
5		Introduction to Construction Drawings	20
6		Introduction to Materials Handling	20
7		Introduction to HVAC, Copper and Plastic Piping, and Soldering and Brazing	50
8		Basic Electricity (HVAC)	30
9		Basic Refrigeration Gauges	40
			270

HVAC II – Course Code: 993021

Unit		Title	Hours
10		Orientation and Safety	20
11		Trade Math	20
12		Basic Carbon Steel Piping Practice	50
13		Introduction to Cooling and Introduction to Heating	50
14		Air Distribution Systems	45
15		Leak Detection, Evacuation Recovery, and Charging	45
16		Alternating Current	40
			270

Research Synopsis

Needs of the Future Workforce

Occupations in the HVAC fields are projected to have about as fast as average to faster than average growth in Mississippi between 2008 and 2018. Heating, Air Conditioning, and Refrigeration Mechanic and Installer occupations are projected to have the fastest growth rate at 26.7% over the projection date. The U.S. Bureau of Labor Statistics reports that job prospects will be excellent for technicians in this field, particularly those who have received training at accredited technical schools.

Table 1.1: Current and Projected Occupation Report for Heating Ventilation and Air Conditioning Technology

Description	Jobs, 2008	Projected Jobs, 2018	Change (Number)	Change (Percent)	Average Hourly Wage
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	2,400	3,040	640	26.7	$16.61
Helpers—Installation, Maintenance, and Repair Workers	1,850	2,100	250	13.5	$11.90
Installation, Maintenance, and Repair Workers, All Other	450	500	50	11.1	$21.03

Source: Mississippi Department of Employment Security; www.mdes.ms.gov

(accessed March 8, 2013).

Perkins IV Requirements

The HVAC curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. It also offers students a program of study including secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the HVAC curriculum is integrated with academic College and Career Ready standards. Lastly, the HVAC curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the HVAC curriculum are the College and Career Ready Standards for Mathematics and Science, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the College and Career Ready Standards are designed to prep students for success in community colleges, Institutions of Higher Learning, and careers.

Academic Credit

If academic credit is awarded, please review the Research and Curriculum Unit link at https://www.rcu.msstate.edu/MDE/PathwaystoSuccess.aspx.

Click "*Curriculum Enhancement List."* Check this site often as it is updated frequently.

Transition to Postsecondary Education

The latest articulation information for Secondary to Postsecondary can be found at the Mississippi Community College Board (MCCB) website http://www.mccb.edu/

Best Practices

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The HVAC teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a classroom set of desktop student computers and one teacher laptop. To make use of the latest online communication tools such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning management system.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the HVAC curriculum.

SkillsUSA is the student's organization for HVAC. Skills USA provides students with growth opportunities and competitive events. It also opens the doors to the world of HVAC and scholarships opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the HVAC curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict.

Conclusions

HVAC is one of Mississippi's most comprehensive installation management curriculums. Students that complete these programs are well equipped for a variety of endeavors. Instructors are urged to encourage HVAC students to pursue educational opportunities at community colleges and universities in Mississippi.

Professional Organizations

Association for Career and Technical Education (ACTE)
1410 King Street
Alexandria, VA 22314
800.826.9972
http://www.acteonline.org

SkillsUSA
14001 SkillsUSA Way
Leesburg, VA 20176
703.777.8810
FAX: 703.777.8999
http://www.skillsusa.org/

Using This Document

Suggested Time on Task

This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives

A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References

A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Introduction and Orientation

Competencies and Suggested Objectives
1. Describe local program and center expectations, policies, and procedures. DOK 1, EMP a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. b. Give a brief overview of the course. Explain to students what HVAC is, why it is important, and how it will be delivered. c. Compare and contrast local program and school policies to expectations of employers. d. Preview course objectives, program policy, and the industry standards.
2. Describe employment opportunities and responsibilities. DOK 1, EMP a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training. b. Describe basic employee responsibilities and appropriate work ethics. c. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. d. Demonstrate computer systems and their uses in the manufacturing industry. e. Define effective relationship skills and workplace issues to include but not limited to sexual harassment, stress, and substance abuse.
3. Research, design, and conduct a project that will apply the knowledge and skills learned in the course in a real-world, unpredictable environment. DOK3, EMP a. Demonstrate effective team-building and leadership skills. b. Explore leadership skills and personal-development opportunities provided to students through student organizations such as SkillsUSA. c. Work as a team to design a community service project for which the knowledge and skills learned in the course can be used to improve the lives of others.
4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK 2, COM a. Follow basic written and verbal instructions. b. Effectively communicate in on-the-job situations using verbal, written, or electronic communication.

Unit 2: Basic Safety

Competencies and Suggested Objectives
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the manufacturing industry. DOK 2, BSM a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies according to OSHA standards, including addressing General Duty Clause and *1926 CFR Subpart C.* d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain causes of accidents and the impact of accident costs. g. Compare and contrast shop/lab safety rules to industry safety rules. **Note:** Safety is to be taught as an ongoing part of the program. Students are required to complete the written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
2. Identify and apply safety around welding operations. DOK 1, BSM a. Use proper safety practices when welding or working around welding operations. b. Use proper safety practices when welding in or near trenches and excavations. c. Explain the term "proximity work."
3. Display appropriate safety precautions to take around common jobsite hazards. DOK 1, BSM a. Explain the safety requirements for working in confined areas. b. Explain the different barriers and barricades and how they are used.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). DOK 1, BSM a. Identify commonly used PPE items. b. Understand proper use of PPE. c. Demonstrate appropriate care for PPE.
5. Explain fall protection, ladder, stair, and scaffold procedures and requirements. DOK 1, BSM a. Explain the use of proper fall protection. b. Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the material safety data sheet (MSDS). DOK 1, BSM a. Explain the function of the MSDS. b. Interpret the requirements of the MSDS. c. Discuss hazardous material exposures.

~~7. Display appropriate safety procedures related to fires.~~ ~~DOK 1, BSM~~ ~~a. Explain the process by which fires start.~~ ~~b. Explain fire prevention of various flammable liquids.~~ ~~c. Explain the classes of fire and the types of extinguishers.~~ ~~d. Illustrate the proper steps to follow when using a fire extinguisher.~~ ~~e. Demonstrate the proper techniques for putting out a fire.~~
~~8. Explain safety in and around electrical situations.~~ ~~DOK 1, BSM~~ ~~a. Explain injuries that can result when electrical contact occurs.~~ ~~b. Explain safety around electrical hazards.~~ ~~c. Explain action to take when an electrical shock occurs.~~

Unit 3: Introduction to Construction Math

Competencies and Suggested Objectives
1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. DOK 2, ICM a. Define basic geometric shapes used in the manufacturing industry. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions, and convert fractions to whole numbers. d. Convert decimals to percentages, and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 4: Hand and Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of hand and power tools. DOK 2, IHT, IPT a. Identify, visually inspect, and discuss the safe use of common hand and power tools. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance.

Unit 5: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand basic components of a blueprint. DOK 3, BLU a. Recognize and identify terms, components, and symbols commonly used on blueprints. b. Relate information on construction drawings to actual locations on the print. c. Recognize different classifications of drawing. d. Interpret and use drawing dimensions.

Unit 6: Introduction to Materials Handling

Competencies and Suggested Objectives
2. Safely handle and store materials. DOK 2, IMH a. Define a load. b. Establish a pre-task plan prior to moving a load. c. Use proper materials-handling techniques. d. Choose appropriate materials-handling equipment for the task. e. Recognize hazards and follow safety procedures required for materials handling.

Unit 7: Introduction to HVAC, Copper and Plastic Piping, and Soldering and Brazing

Competencies and Suggested Scenarios
1. Identify and explain heating, ventilation, air-conditioning, and refrigeration systems, HVAC/R environmental law, and job opportunities that are available in the HVAC/R profession. DOK2, INT a. Explain the basic principles of heating, ventilating, and air-conditioning. b. Describe the principles that guide HVAC/R installation and service techniques.
2. Demonstrate the safe use and routine maintenance of hand and power tools used in the HVAC trade. DOK2, IHT, IPT a. Demonstrate the safe use and maintenance of hand and power tools used in HVAC.
3. Identify and discuss the tools used in the piping trade, discuss the materials and methods of connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and HVAC environment. DOK2, CPP a. Discuss and demonstrate how to use copper tubing in HVAC. b. Discuss and demonstrate how to use plastic tubing in HVAC.
4. Prepare and solder copper piping systems in various industrial and HVAC applications and properly clean, install fittings, and braze piping (silver solder). DOK2, SBR a. Solder copper pipe in HVAC. b. Braze copper pipe in HVAC.

~~Unit 8: Basic Electricity (HVAC)~~

~~Competencies and Suggested Objectives~~
~~1. Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits. DOK2, BEL~~ ~~a. Describe how voltage, current, resistance, and power are mathematically related.~~ ~~b. Describe the difference between series and parallel circuits, and calculate loads in each.~~ ~~c. Describe the purpose and operation of the various electrical components used in equipment.~~

~~Unit 9: Basic Refrigeration Gauges~~

~~Competencies and Suggested Objectives~~
~~1. Discuss refrigeration gauges and their use.~~ ~~DOK1, ITC~~ ~~a. Discuss the suction and discharge side.~~ ~~b. Maintain the refrigeration gauges to include calibration.~~

Unit 10: Orientation and Safety

Review and Reinforcement

Competencies and Suggested Objectives
1. Describe local program and vocational/career technical center policies and procedures. DOK2, a. Describe local program and vocational/career technical center policies and procedures.
2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. DOK2, EMP a. Describe employer expectations in the workplace.
3. Explore leadership skills and personal development opportunities provided for students by student organizations including SkillsUSA. DOK2 a. Demonstrate effective team-building and leadership skills. b. Demonstrate through practice appropriate work ethics.
4. Describe general safety rules for working in a shop/lab and industry. DOK2, BAS a. Discuss safety issues and prevention associated with the HVAC shop area. b. Explain fire safety and prevention in the workplace.
NOTE: Review and reinforce the year one content. (Ongoing)

~~Unit 11: Trade Math~~

~~Competencies and Suggested Objectives~~
~~1. Identify proper math to use for problem solving; use English and metric measurement; use powers, algebra, and geometric calculation to solve for HVAC problems; and convert Fahrenheit to Celsius.~~ ~~DOK2, TMA~~ ~~a. Demonstrate how to calculate mathematic problems found in the HVAC area.~~

~~Unit 12 Basic Carbon Steel Piping Practice~~

~~Competencies and Suggested Objectives~~
~~1. Recognize types and sizes of carbon steel piping and pipe fittings, and also recognize and use tools used to cut, ream, and thread carbon steel pipe in the HVAC application.~~ ~~DOK2, BCP~~ ~~a. Explain the uses of carbon steel pipes in the HVAC trade.~~

Unit 13: Introduction to Cooling and Introduction to Heating

Competencies and Suggested Objectives
1. Explain the basic cooling systems, heat transfer, trade terms, refrigerants, components of the cooling system, controls, and proper piping of the cooling system. DOK2, ITC a. Explain how an HVAC system removes heat from an air-conditioned area of an HVAC system. b. Identify the major components, accessories, refrigerants, and control devices available for cooling systems, and explain how each works. c. Discuss EPA standards.
2. Explain methods of heat transfer and characteristics of combustion, identify types of fuels and types of furnaces and components of the electric, hydronic, and gas furnace, identify and safely use meters in gas measurement, and perform maintenance on electric and gas furnaces. DOK2, ITH a. Explain how an HVAC heating system operates. b. Describe how an electric furnace works. c. With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

Unit 14: Air Distribution Systems

Competencies and Suggested Objectives
1. Demonstrate designing and installing HVAC duct and piping systems. DOK2, ADS a. Discuss and explain the patterns of airflow and pressures in an HVAC duct. b. Identify types of duct systems and explain where each is used in HVAC applications. c. Describe the mechanical equipment and materials used to create air distribution systems.
2. Examine sheet metal layout and processes. DOK1 MLP a. Define sheet metal layout and terminology. b. Discuss selection and use of layout and marking tools. c. Select and use cutting and forming tools. d. Demonstrate constructing seams, edges, and duct connectors.
3. Discuss the installation of ductwork. DOK1 IOD a. Identify, select, and use fasteners. b. Examine the common methods of supporting air system components. c. Install duct fasteners, hangers, and supports. d. Discuss connecting rectangular, round, and spiral ductwork. e. Explain how to properly seal ductwork.

Unit 15: Leak Detection Evacuation Recovery and Charging

Competencies and Suggested Objectives
1. Identify leaks in an HVAC system and perform the proper steps to repair the leak, restoring the unit to operation. DOK2, LDE a. Describe what the Clean Air Act means to the HVAC trade. b. Define and perform a leak test on an HVAC system. c. Use nitrogen to purge a system and charge refrigerant into a system by the following methods. • Weight • Superheat • Subcooling • Charging pressure
2. Identify/install a basic vacuum pump service operation. DOK2, LDE a. Describe safety procedures using a vacuum pump. b. Install a vacuum pump on a system. c. Pull the vacuum to 500 mic.

~~Unit 16: Alternating Current~~

~~Competencies and Suggested Objectives~~
~~1. Gain an understanding of the safe operation of electrical transformers, motors, and single- and three-phase HVAC devices.~~ ~~DOK2, ALT~~ ~~a. Explain and demonstrate the safe operation of various types of transformers.~~ ~~b. Describe the types of capacitors and motors found in the HVAC unit.~~ ~~c. State and demonstrate the safety precautions that must be followed when working with electrical equipment and testing AC components, including capacitors, transformers, and motors.~~

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Introduction and Orientation		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Describe employment opportunities and responsibilities.
	3.	Research, design, and conduct a project that will apply the knowledge and skills learned in the course in a real-world, unpredictable environment.
	4.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
Unit 2: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the manufacturing industry.
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.
	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection, ladder, stair, and scaffold procedures and requirements.
	6.	Explain the material safety data sheet (MSDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 3: Introduction to Construction Math		

	1.	~~Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.~~
~~Unit 4: Hand and Power Tools~~		
	1.	~~Demonstrate the use and maintenance of hand and power tools.~~
~~Unit 5: Introduction to Construction Drawings~~		
	1.	~~Read, analyze, and understand basic components of a blueprint.~~
~~Unit 6: Introduction to Materials Handling~~		
	1.	~~Safely handle and store materials.~~

~~Unit 7: Introduction to HVAC, Copper and Plastic Piping, and Soldering and Brazing~~		
	~~1.~~	~~Identify and explain heating, ventilation, air-conditioning, and refrigeration systems, HVAC/R environmental law, and job opportunities that are available in the HVAC/R profession.~~
	~~2.~~	~~Demonstrate the safe use and routine maintenance of hand and power tools used in the HVAC trade.~~
	~~3.~~	~~Identify and discuss the tools used in the piping trade, discuss the materials and methods of connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and HVAC environment.~~
	~~4.~~	~~Prepare and solder copper piping systems in various industrial and HVAC applications and properly clean, install fittings, and braze piping (silver solder).~~
~~Unit 8 Basic Electricity~~		
	~~1.~~	~~Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits.~~
~~Unit 9 Basic Refrigeration Gauges~~		
	~~1.~~	~~Discuss refrigeration gauges and their use.~~
~~Unit 10: Orientation and Safety~~		
	~~1.~~	~~Describe local program and vocational/career technical center policies and procedures.~~
	~~2.~~	~~Describe employment opportunities and responsibilities of the industrial and HVAC mechanic.~~
	~~3.~~	~~Explore leadership skills and personal development opportunities provided for students by student organizations including SkillsUSA.~~
	~~4.~~	~~Describe general safety rules for working in a shop/lab and industry.~~
~~Unit 11 Trade Math~~		
	~~1.~~	~~Identify proper math to use for problem solving; use English and metric measurement; use powers, algebra, and geometric calculation to solve for HVAC problems; and convert Fahrenheit to Celsius.~~
~~Unit 12: Basic Carbon Steel Piping Practice~~		
	~~1.~~	~~Recognize types and sizes of carbon steel piping and pipe fittings, and also recognize and use tools used to cut, ream, and thread carbon steel pipe in the HVAC application.~~

~~Unit 13: Introduction to Cooling, and Introduction to Heating~~		
	~~1.~~	~~Explain the basic cooling systems, heat transfer, trade terms, refrigerants, components of the cooling system, controls, and proper piping of the cooling system.~~
	~~2.~~	~~Explain methods of heat transfer and characteristics of combustion, identify types of fuels and types of furnaces and components of the electric, hydronic, and gas furnace, identify and safely use meters in gas measurement, and perform maintenance on electric and gas furnaces.~~

~~Unit 14: Air Distribution Systems~~		
	~~1.~~	~~Demonstrate designing and installing HVAC duct and piping systems.~~
	~~2.~~	~~Examine sheet metal layout and processes.~~
	~~3.~~	~~Discuss the installation of ductwork.~~
~~Unit 15: Leak Detection Evacuation Recovery and Charging~~		
	~~1.~~	~~Identify leaks in an HVAC system and perform the proper steps to repair the leak, restoring the unit to operation.~~
	~~2.~~	~~Identify/install a basic vacuum pump service operation.~~
~~Unit 16: Alternating Current~~		
	~~1.~~	~~Gain an understanding of the safe operation of electrical transformers, motors, and single- and three-phase HVAC devices.~~
	~~2.~~	~~Explain and apply basic electrical theory to HVAC applications and how to troubleshoot common electronic devices found in HVAC systems.~~

Appendix A: Unit References

General Books and Trade Publications

All of the Construction Core references listed under General Books and Trade Publications are used for multiple units. Unit-specific references are listed under the appropriate unit number.

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Appendix B: Industry Standards

HVAC PATHWAY

CONTENT STANDARDS AND PERFORMANCE ELEMENTS[2]

Crosswalk for HVAC

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	
CORE											
BSM			X								
ICM				X							
IHT					X						
IPT					X						
BLU						X					
COM		X									
EMP		X									
IMH							X				
LEVEL 1 HVAC											
INT								X			
IHT								X			
IPT								X			
CPP								X			
SBR								X			
BEL									X		
ITC										X	

[2] *NCCER learning series.* Retrieved April 22, 2013, from http://www.nccer.org/

	Units	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16			
HVAC											
TMA			X								
BAS		X									
EMP		X									
BCP				X							
ITG					X						
ITH					X						
ADS						X					
LDE							X				
ALT								X			
MLP						X					
IOD						X					

NCCER CORE

BSM – BASIC SAFETY (00101-09)

ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-09)

IHT – INTRODUCTION TO HAND TOOLS (00103-09)

~~IPT – INTRODUCTION TO POWER TOOLS (00104-09)~~

~~BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-09)~~

~~COM – BASIC COMMUNICATION SKILLS (00107-09)~~

~~EMP – BASIC EMPLOYABILITY SKILLS (00108-09)~~

~~IMH – INTRODUCTION TO MATERIALS HANDLING (00109-09)~~

~~NCCER HVAC~~

~~LEVEL ONE~~

~~Level One~~

~~INT – Introduction to HVAC (03101-13)~~

~~TMA – Trade Mathematics (03102-13)~~

~~CPP – Basic Copper and Plastic Piping Practices (03103-13)~~

~~AC~~

~~SBR – Soldering and Brazing (03104-13)~~

~~BCP – Basic Carbon Steel Piping Practices (03105-13)~~

~~BEL – Basic Electricity (03106-13)~~

~~ITC – Introduction to Cooling (03107-13)~~

~~ITH – Introduction to Heating (03108-13)~~

~~ADS – Air Distribution Systems (03109-13)~~

~~Level 2~~

~~LDE - LEAK DETECTION, EVACUATION, RECOVERY, AND CHARGING (03205-13)~~

~~ALT - ALTERNATING CURRENT (03206-13)~~

~~Sheet Metal Level 1~~

~~MLP - Introduction to Sheet Metal Layout and Processes (04103-08)~~

~~IOD - Installation of Ductwork (04106-08)~~

Appendix C: 21st Century Skills[3]

21st Century Crosswalk for HVAC

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
21st Century Standards										
CS1		X								
CS2		X		X						X
CS3		X								
CS4		X	X		X		X	X		
CS5		X	X		X		X	X		
CS6		X	X	X	X	X	X	X	X	
CS7		X	X	X	X	X	X	X	X	X
CS8		X	X	X	X	X	X	X		X
CS9		X		X		X	X	X		X
CS10		X				X				X
CS11		X			X	X		X		
CS12		X	X			X			X	X
CS13		X	X	X	X	X	X	X	X	X
CS14		X	X		X	X	X	X		
CS15		X	X	X	X	X		X	X	
CS16		X	X		X	X	X	X	X	X

	Units	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16			
21st Century Standards											
CS1		X		X		X					
CS2		X	X	X	X	X	X	X			
CS3		X				X					
CS4		X		X	X		X	X			
CS5		X		X		X					
CS6		X		X		X					
CS7		X	X	X	X	X	X	X			
CS8		X	X	X	X	X	X	X			
CS9		X	X	X	X	X	X	X			
CS10		X	X	X	X	X	X	X			
CS11				X	X	X	X	X			
CS12		X	X	X	X	X	X	X			
CS13		X	X	X	X	X	X	X			
CS14		X		X	X		X	X			

[3] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

CS15				X	X	X	X	X			
CS16		X	X	X	X	X	X	X			

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2-Learning and Innovation Skills

- **CS6 Creativity and Innovation**
  1. Think Creatively
  2. Work Creatively with Others
  3. Implement Innovations
- **CS7 Critical Thinking and Problem Solving**
  1. Reason Effectively
  2. Use Systems Thinking
  3. Make Judgments and Decisions
  4. Solve Problems
- **CS8 Communication and Collaboration**
  1. Communicate Clearly
  2. Collaborate with Others

CSS3 Information, Media and Technology Skills

- **CS9 Information Literacy**
  1. Access and Evaluate Information
  2. Use and Manage Information
- **CS10 Media Literacy**
  1. Analyze Media
  2. Create Media Products
- **CS11 ICT Literacy**
  1. Apply Technology Effectively

CSS4 Life and Career Skills

- **CS12 Flexibility and Adaptability**
  1. Adapt to change
  2. Be Flexible
- **CS13 Initiative and Self Direction**
  1. Manage Goals and Time
  2. Work Independently
  3. Be Self-directed Learners
- **CS14 Social and Cross-Cultural Skills**
  1. Interact Effectively with others
  2. Work Effectively in Diverse Teams
- **CS15 Productivity and Accountability**
  1. Manage Projects
  2. Produce Results
- **CS16 Leadership and Responsibility**
  1. Guide and Lead Others
  2. Be Responsible to Others

Appendix D: College and Career Ready Standards

English Standards											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
RL.9.1		X									
WHST.9-10.4		X									
WHST.9-10.5		X									
WHST.9-10.6		X									
RL.11.1		X		X		X					
RL.11.2		X									
RL.11.3		X									
RL.11.8						X					
W.11.3		X		X							
W.11.4		X									
W.11.5		X									
SL.11.1		X					X	X	X	X	X
SL.11.2		X					X				
RH.11-12.3							X				

English Standards											
	Units	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16				
RL.11.1		X	X	X	X	X	X				
RL.11.2		X	X	X	X	X	X				
RL.11.3		X	X	X	X	X	X				
W.11.3		X	X	X	X	X	X				
W.11.4		X	X	X	X	X	X				
W.11.5		X	X	X	X	X	X				
SL.11.1		X	X	X	X	X	X				
SL.11.2		X	X	X	X	X	X				
WHST.11-12.1		X	X	X	X	X	X				
WHST.11-12.2		X	X	X	X	X	X				
WHST.11-12.6		X	X	X	X	X	X				

College and Career Readiness English I
Reading Literature Key Ideas and Details

RL.9.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
RL.9.2 Determine a theme or central idea of a text and analyze in detail its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.
RL.9.3 Analyze how complex characters (e.g., those with multiple or conflicting motivations) develop over the course of a text, interact with other characters, and advance the plot or develop the theme.

Craft and Structure

RL.9.4 Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language evokes a sense of time and place; how it sets a formal or informal tone).
RL.9.5 Analyze how an author's choices concerning how to structure a text, order events within it (e.g., parallel plots), and manipulate time (e.g., pacing, flashbacks) create such effects as mystery, tension, or surprise.
RL.9.6 Analyze a particular point of view or cultural experience reflected in a work of literature from outside the United States, drawing on a wide reading of world literature.

Integration of Knowledge and Ideas

RL.9.7 Analyze the representation of a subject or a key scene in two different artistic mediums, including what is emphasized or absent in each treatment (e.g., Auden's "Musée des Beaux Arts" and Breughel's Landscape with the Fall of Icarus).

RL.9.8 Not applicable to literature.

College and Career Readiness English I

RL.9.9 Analyze how an author draws on and transforms source material in a specific work (e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare).

Range of Reading and Level of Text Complexity

RL.9.10 By the end of grade 9, read and comprehend literature, including stories, dramas, and poems, in the grades 9-10 text complexity band proficiently, with scaffolding as needed at the high end of the range.

College and Career Readiness English I

Reading Informational Text Key Ideas and Details

RI.9.3 Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.

Craft and Structure

RI.9.5 Analyze in detail how an author's ideas or claims are developed and refined by particular sentences, paragraphs, or larger portions of a text (e.g., a section or chapter).
RI.9.6 Determine an author's point of view or purpose in a text and analyze how an author uses rhetoric to advance that point of view or purpose.

Integration of Knowledge and Ideas

RI.9.7 Analyze various accounts of a subject told in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.
RI.9.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.
RI.9.9 Analyze seminal U.S. documents of historical and literary significance (e.g., Washington's Farewell Address, the Gettysburg Address, Roosevelt's Four Freedoms speech, King's "Letter from Birmingham Jail"), including how they address related themes and concepts.

College and Career Readiness English I

Writing Text Types and Purposes

W.9.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
W.9.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.
W.9.1b Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.
W.9.1c Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
W.9.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
W.9.1e Provide a concluding statement or section that follows from and supports the argument presented.
W.9.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

W.9.2a Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
W.9.2b Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
W.9.2c Use appropriate and varied transitions to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

College and Career Readiness English I

W.9.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic.
W.9.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
W.9.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
W.9.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W.9.3a Engage and orient the reader by setting out a problem, situation, or observation, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.
W.9.3b Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.
W.9.3c Use a variety of techniques to sequence events so that they build on one another to create a coherent whole.
W.9.3d Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
W.9.3e Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.9.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)
W.9.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10.)
W.9.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

W.9.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

College and Career Readiness English I

W.9.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
W.9.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
W.9.9a Apply grades 9–10 Reading standards to literature (e.g., "Analyze how an author draws on and transforms source material in a specific work [e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare]").

W.9.9b Apply grades 9–10 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning").

Range of Writing

W.9.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audience.

College and Career Readiness English I

SL.9.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
SL.9.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
SL.9.1b Work with peers to set rules for collegial discussions and decision making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.
SL.9.1c Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
SL.9.1d Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.
SL.9.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.
SL.9.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence.

Presentation of Knowledge and Ideas

SL.9.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

College and Career Readiness English I

SL.9.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
SL.9.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grades 9–10 Language standards 1 and 3 for specific expectations.)

College and Career Readiness English I

Language

Conventions of Standard English

L.9.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
L.9.1a Use parallel structure.*
L.9.1b Use various types of phrases (noun, verb, adjectival, adverbial, participial, prepositional, absolute) and clauses (independent, dependent; noun, relative, adverbial) to convey specific meanings and add variety and interest to writing or presentations.

L.9.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
L.9.2a Use a semicolon (and perhaps a conjunctive adverb) to link two or more closely related independent clauses.
L.9.2b Use a colon to introduce a list or quotation.
L.9.2c Spell correctly

Knowledge of Language

L.9.3 Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening
L.9.3a Write and edit work so that it conforms to the guidelines in a style manual (e.g., MLA Handbook, Turabian's Manual for Writers) appropriate for the discipline and writing type.

Vocabulary Acquisition and Use

L.9.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies.
L.9.4a Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.
L.9.4b Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., analyze, analysis, analytical; advocate, advocacy).

College and Career Readiness English I

L.9.4c Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, or its etymology.
L.9.4d Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
L.9.5 Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
L.9.5a Interpret figures of speech (e.g., euphemism, oxymoron) in context and analyze their role in the text.
L.9.5b Analyze nuances in the meaning of words with similar denotations.
L.9.6 Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

College and Career Readiness English II

Range of Reading and Level of Text Complexity

RL.10.10 By the end of grade 10, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 9–10 text complexity band independently and proficiently.

Grades 9-10: Literacy in History/SS

Reading in History/Social Studies Key Ideas and Details

RH.9-10.1 Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.
RH.9-10.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.
RH.9-10.3 Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.

Craft and Structure

RH.9-10.4 Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.
RH.9-10.5 Analyze how a text uses structure to emphasize key points or advance an explanation or analysis.
RH.9-10.6 Compare the point of view of two or more authors for how they treat the same or similar topics, including which details they include and emphasize in their respective accounts.

Integration of Knowledge and Ideas

RH.9-10.7 Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
RH.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claims.
RH.9-10.9 Compare and contrast treatments of the same topic in several primary and secondary sources.

Range of Reading and Level of Text Complexity

RH.9-10.10 By the end of grade 10, read and comprehend history/social studies texts in the grades 9-10 text complexity band independently and proficiently.

Grades 9-10: Literacy in Science and Technical Subjects

Reading in Science and Technical Subjects Key Ideas and Details

RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
RST.9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts

Range of Reading and Level of Text Complexity

RST.9-10.10 By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Grades 9-10: Writing in History/SS, Science, and Technical Subjects

Writing Text Types and Purposes

WHST.9-10.1 Write arguments focused on discipline-specific content.
WHST.9-10.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
WHST.9-10.1b Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
WHST.9-10.1c Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
WHST.9-10.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
WHST.9-10.1e Provide a concluding statement or section that follows from or supports the argument presented.
WHST.9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.9-10.2a Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
WHST.9-10.2b Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

Grades 9-10

Writing in History/SS, Science, and Technical Subjects

WHST.9-10.2c Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
WHST.9-10.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
WHST.9-10.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
WHST.9-10.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
WHST.9-10.3 Not Applicable

Production and Distribution of Writing

WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
WHST.9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
WHST.9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

WHST.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.

Grades 9-10

Writing in History/SS, Science, and Technical Subjects

Range of Writing

WHST.9-10.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

English III

Reading Literature Key Ideas and Details

RL.11.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
RL.11.2 Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
RL.11.3 Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4 Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)
RL.11.5 Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.
RL.11.6 Analyze a case in which grasping a point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7 Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)
RL.11.8 Not applicable to literature.
RL.11.9 Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10 By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

English III

Reading Informational Text Key Ideas and Details

Rl.11.3 Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure

Rl.11.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
Rl.11.5 Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.
Rl.11.6 Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.

Integration of Knowledge and Ideas

Rl.11.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.
Rl.11.8 Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).
Rl.11.9 Analyze seventeenth , eighteenth , and nineteenth century foundational U.S. documents of historical and literary significance (including Them Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity

Rl.11.10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

English III

Writing

W.11.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
W.11.1a Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.
W.11.1b Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.
W.11.1c Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
W.11.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
W.11.1e Provide a concluding statement or section that follows from and supports the argument presented.
W.11.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

W.11.2a Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

English III

W.11.2b Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
W.11.2c Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
W.11.2d Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.
W.11.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
W.11.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
W.11.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W.11.3a Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.
W.11.3b Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.
W.11.3c Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).
W.11.3d Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
W.11.3e Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

English III

W.11.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12.)
W.11.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
W.11.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
W.11.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

W.11.9a Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").
W.11.9b Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

English III

Speaking and Listening

Comprehension and Collaboration

SL.11.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
SL11.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
SL.11.1b Work with peers to promote civil, democratic discussions and decision making, set clear goals and deadlines, and establish individual roles as needed.
SL.11.1c Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.
SL.11.1d Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.
SL.11.2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
SL.11.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4 Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

English III

SL11.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
SL.11.6 Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 for specific expectations.)

English III

Language

Conventions of Standard English

L.11.1a Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.
L.11.1b Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.
L.11.2a Observe hyphenation conventions.
L.11.3a Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.
L.11.4b Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

English IV

Range of Reading and Level of Text Complexity

RL.12.10 By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Grades 11-12: Literacy in History/SS

Reading in History/Social Studies Key Ideas and Details

RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.
RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.
RH.11-12.3 Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain. Craft and Structure
RH.11-12.4 Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
RH.11-12.5 Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.
RH.11-12.6 Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence. Integration of Knowledge and Ideas
Rh.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.
RH.11-12.8 Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.
RH.11-12.9 Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources. Range of Reading and Level of Text Complexity
RH.11-12.10 By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Grades 11-12: Literacy in Science and Technical Subjects

Reading in Science and Technical Subjects Key Ideas and Details

RST. 11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RST.11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
RST.11-12.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11-12.10 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Grades 11-12: Writing I History/SS, Science and Technical Subjects

Writing

Text Types and Purposes

WHST.11-12.1a Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
WHST.11-12.1b Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
WHST.11-12.1c Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
WHST.11-12.2a Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

Grades 11-12: Writing I History/SS, Science and Technical Subjects

WHST.11-12.2d Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

Production and Distribution of Writing

~~WHST.11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.~~
~~WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.~~

Appendix D: College and Career Ready Standards

Mathematics Standards											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
N-Q.1				X		X					
N-Q.2				X		X					
N-Q.3				X		X					
A-CED.1				X							
A-CED.2				X							
A-CED.3				X							
A-CED.4				X							
A-REI.2				X							

Mathematics Standards											
	Units	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16				
N-Q.1		X									
N-Q.2		X									
N-Q.3		X									
A-CED.1		X									
A-CED.2		X									
A-CED.3		X									
A-CED.4		X									
A-REI.2		X									
G-CO.1				X							
G-CO.12						X					
N-RN.1		X									
N-RN.2		X									
N-RN.3		X									
G-SRT.8				X							
G-GMD.3				X							
G-GMD.4						X					
G-MG.1						X					
G-MG.2				X							
G-MG.3				X							

Number and Quantity

Reason quantitatively and use unites to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Analyze and solve linear equations and pairs of simultaneous linear equations

8.EE.8 Analyze and solve pairs of simultaneous linear equations.

a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.

c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)n$ as the product of P and a factor not depending on P.

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression $1.15t$ can be rewritten as $[1.151/12] 12t \approx 1.01212t$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Creating equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R.*

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Define, evaluate, and compare functions

8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. 1

8.F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

8.F.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function $A = s2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

Use functions to model relationships between quantities

8.F.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.* Analyze functions using different representations Supporting

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

~~F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.* Interpret expressions for functions in terms of the situation they model Supporting~~

~~F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*~~

~~Geometry~~

~~Understand and apply the Pythagorean Theorem~~

~~8.G.6 Explain a proof of the Pythagorean Theorem and its converse.~~

~~8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.~~

~~8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.~~

~~Experiment with transformations in the plane~~

~~G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.~~

~~G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).~~

~~G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.~~

~~G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.~~

~~G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.~~

~~Understand congruence in terms of rigid motions~~

~~G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.~~

~~G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.~~

~~G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.~~

~~Prove geometric theorems~~

~~G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.~~

~~G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.~~

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Statistics and Probability

Investigate patterns of association in bivariate data

8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

8.SP.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Algebra I

Number and Quantity

Use properties of rational and irrational numbers

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 − y 4 as (x2) 2 − (y2) 2 thus recognizing it as a difference of squares that can be factored as (x2 − y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

a. Factor a quadratic expression to reveal the zeros of the function it defines.

b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra I

Perform arithmetic operations on polynomials

A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Understand the relationship between zeros and factors of polynomials

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x − p) 2 = q that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Algebra I

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Algebra I

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum. B

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

~~Algebra I~~

~~Interpret expressions for functions in terms of the situation they model~~

~~F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*~~

~~Statistics and Probability *~~

~~Summarize, represent, and interpret data on a single count or measurement variable~~

~~S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*~~

~~S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*~~

~~S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*~~

~~Summarize, represent, and interpret data on two categorical and quantitative variables~~

~~S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*~~

~~S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*~~

~~a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.~~

~~b. Informally assess the fit of a function by plotting and analyzing residuals.~~

~~c. Fit a linear function for a scatter plot that suggests a linear association.~~

~~Interpret linear models~~

~~S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*~~

~~S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*~~

~~S-ID.9 Distinguish between correlation and causation.*~~

~~Geometry Course~~

~~Geometry~~

~~Experiment with transformations in the plane~~

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Geometry Course

Make geometric constructions

G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:

a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems involving similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar

G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section A

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Algebra II

Number and Quantity

Extend the properties of exponents to rational exponents

N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.

N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = −1, and every complex number has the form a + bi with a and b real.

N-CN.2 Use the relation i 2 = −1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra

Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 − y 4 as (x2) 2 − (y2) 2, thus recognizing it as a difference of squares that can be factored as

(x2 − y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.* c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra II

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

~~Understand the relationship between zeros and factors of polynomials~~

~~A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).~~

~~A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.~~

~~Use polynomial identities to solve problems~~

~~A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 – y 2) 2 + (2xy)2 can be used to generate Pythagorean triples.~~

~~Rewrite rational expressions~~

~~A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.~~

~~Create equations that describe numbers or relationships~~

~~A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*~~

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable. b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Algebra II

Solve systems of equations

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = −3x and the circle x2 + y2 = 3.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Functions

Understand the concept of a function and use function notation

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Algebra II

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)t$, $y = (0.97)t$, $y = (1.01)12t$, $y = (1.2)t/10$, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Algebra II

Extend the domain of trigonometric functions using the unit circle

F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity sin (Θ)2 + cos (Θ)2 = 1 and use it to find sin (Θ), cos (Θ), or tan (Θ), given sin (Θ), cos (Θ), or tan (Θ) and the quadrant of the angle.

Geometry

Translate between the geometric description and the equation for a conic section

G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Statistics and Probability

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

Algebra II

Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.*

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics

Number and Quantity

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Integrated Mathematics I

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Integrated Mathematics I

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

~~Integrated Mathematics I~~

~~Geometry~~

~~Experiment with transformations in the plane~~

~~G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.~~

~~G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).~~

~~G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.~~

~~G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.~~

~~G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.~~

~~Understand congruence in terms of rigid motions~~

~~G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.~~

~~G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.~~

~~G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.~~

~~Prove geometric theorems~~

~~G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.~~

~~G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.~~

~~G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.~~

~~Integrated Mathematics I~~

~~Statistics and Probability~~

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Integrated Mathematics I

Number and Quantity

Extend the properties of exponents to rational exponents

N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.

N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Use properties of rational and irrational numbers

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = −1, and every complex number has the form a + bi with a and b real.

N-CN.2 Use the relation i 2 = −1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.* b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Integrated Mathematics II

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 − y 4 as (x2) 2 − (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 − y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

a. Factor a quadratic expression to reveal the zeros of the function it defines.

b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Perform arithmetic operations on polynomials

A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning M

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x − p) 2 = q that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Solve systems of equations

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = −3x and the circle x2 + y2 = 3.

Functions

Interpret functions that arise in applications in terms of the context M

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

c. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Integrated Mathematics II

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Geometry

Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:

a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems using similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.

Integrated Mathematics II

G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Statistics and Probability*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

Integrated Mathematics II

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics III

Number and Quantity

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Algebra

Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.

Write expressions in equivalent forms to solve problems

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Use polynomial identities to solve problems

A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 – y 2) 2 + (2xy)2 can be used to generate Pythagorean triples.

Rewrite rational expressions

A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

Integrated Mathematics III

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the

relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2x3 or f(x) = (x+1)/(x−1) for x ≠ 1.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Extend the domain of trigonometric functions using the unit circle

F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity sin (Θ)2 + cos (Θ)2 = 1 and use it to find sin (Θ), cos (Θ), or tan (Θ), given sin (Θ), cos (Θ), or tan (Θ) and the quadrant of the angle.

Integrated Mathematics III

Geometry

Make geometric constructions

G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar.

G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

Integrated Mathematics III

G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Statistics and Probability*

Summarize, represent, and interpret data on a single count or measurement variable S

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Integrated Mathematics III

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Advanced Mathematics Plus

Number and Quantity

Perform arithmetic operations with complex numbers

N-CN.3 Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

Represent complex numbers and their operations on the complex plane

N-CN.4 Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

N-CN.5 Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}\, i)3 = 8$ because $(-1 + \sqrt{3}\, i)$ has modulus 2 and argument 120°.

N-CN.6 Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Use complex numbers in polynomial identities and equations

N-CN.8 Extend polynomial identities to the complex numbers. For example, rewrite $x2 + 4$ as $(x + 2i)(x - 2i)$.

N-CN.9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials

~~Represent and model with vector quantities~~

~~N-VM.1 Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).~~

~~N-VM.2 Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.~~

~~N-VM.3 Solve problems involving velocity and other quantities that can be represented by vectors.~~

~~Advanced Mathematics Plus~~

~~Perform operations on vectors~~

~~N-VM.4 Add and subtract vectors.~~

~~a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.~~

~~b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.~~

~~c. Understand vector subtraction v − w as v + (−w), where −w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.~~

~~N-VM.5 Multiply a vector by a scalar.~~

~~a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy).~~

~~b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).~~

~~Perform operations on matrices and use matrices in applications~~

~~N-VM.6 Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.~~

~~N-VM.7 Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.~~

~~N-VM.8 Add, subtract, and multiply matrices of appropriate dimensions.~~

~~N-VM.9 Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.~~

~~N-VM.10 Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.~~

~~N-VM.11 Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.~~

~~N-VM.12 Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.~~

~~Algebra~~

~~Use polynomial identities to solve problems~~

~~A-APR.5 Know and apply the Binomial Theorem for the expansion of (x + y) n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.~~

~~Advanced Mathematics Plus~~

~~Rewrite rational expressions~~

~~A-APR.7 Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.~~

~~Solve systems of equations~~

~~A-REI.8 Represent a system of linear equations as a single matrix equation in a vector variable.~~

~~A-REI.9 Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).~~

~~Functions~~

~~Analyze functions using different representations~~

~~F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*~~

~~d. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.~~

~~Build a function that models a relationship between two quantities~~

~~F-BF.1 Write a function that describes a relationship between two quantities. *~~

~~c. Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.~~

~~Build new functions from existing functions~~

~~F-BF.4 Find inverse functions.~~

~~b. Verify by composition that one function is the inverse of another.~~

~~c. Read values of an inverse function from a graph or a table, given that the function has an inverse.~~

d. Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Advanced Mathematics Plus

Extend the domain of trigonometric functions using the unit circle

F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π−x, π+x, and 2π−x in terms of their values for x, where x is any real number.

F-TF.4 Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

Model periodic phenomena with trigonometric functions

F-TF.6 Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7 Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. *

Prove and apply trigonometric identities

F-TF.9 Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Apply trigonometry to general triangles

G-SRT.9 Derive the formula A = ½ ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10 Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11 Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Understand and apply theorems about circles

G-C.4 Construct a tangent line from a point outside a given circle to the circle.

Translate between the geometric description and the equation for a conic section

Advanced Mathematics Plus

G-GPE.3 Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

Explain volume formulas and use them to solve problems

G-GMD.2 Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

Statistics and Probability*

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.8 Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.*

S-CP.9 Use permutations and combinations to compute probabilities of compound events and solve problems.*

Calculate expected values and use them to solve problems

S-MD.1 Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.*

S-MD.2 Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.*

S-MD.3 Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.*

S-MD.4 Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*

Advanced Mathematics Plus

Use probability to evaluate outcomes of decisions

S-MD.5 Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. *

a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.

~~b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*~~

~~S-MD.6 Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).*~~

~~S-MD.7 Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).*~~

Appendix E: International Society for Technology in Education Standards (ISTE)

ISTE Crosswalk for HVAC									
	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
NETS Standards									
T1		X				X		X	
T2		X				X	X	X	X
T3		X	X	X	X	X	X	X	X
T4		X	X	X	X	X	X	X	X
T5		X	X	X	X			X	X
T6		X	X				X	X	X
			X						

ISTE Crosswalk for HVAC									
	Course	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16
ISTE Standards									
T1		X	X	X	X	X	X	X	X
T2		X	X	X	X	X	X	X	X
T3		X	X	X	X	X	X	X	X
T4		X		X	X	X	X	X	X
T5		X		X	X	X	X	X	X
T6		X	X	X	X	X	X	X	X

T1 – Creativity and Innovation

T2 – Communication and Collaboration

T3 Research and Information Fluency

T4 Critical Thinking, Problem Solving, and Decision Making

T5 Digital Citizenship

T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.

b. Create original works as a means of personal or group expression.

c. Use models and simulations to explore complex systems and issues.

d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.

b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.

c. Develop cultural understanding and global awareness by engaging with learners of other cultures.

d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.

b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.

d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.

b. Plan and manage activities to develop a solution or complete a project.

c. Collect and analyze data to identify solutions and/or make informed decisions.

d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.

b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.

c. Demonstrate personal responsibility for lifelong learning.

d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.

b. Select and use applications effectively and productively.

c. Troubleshoot systems and applications.

d. Transfer current knowledge to learning of new technologies.

Miss. Amin. Code 7-158

2021 Industrial Maintenance

Program CIP: 47.0303 – Industrial Mechanics and Maintenance Technology

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Mississippi State, MS 39762

The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

Table of Contents

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Standards

Standards and alignment crosswalks are referenced in the appendix. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE industrial maintenance curriculum is aligned to the following standards:

National Center for Construction Education and Research (NCCER) Learning Series
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nccer.org/index.asp

International Society for Technology in Education Standards (ISTE)
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iste.org

College- and Career-Ready Standards
College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College and Career Ready Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/oae/college-and-career-readiness-standards

Framework for 21st Century Learning
In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. 21 *Framework Definitions* (2019).
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
: Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource
: Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call the RCU at 662.325.2510.

Executive Summary

Pathway Description
Industrial maintenance is an instructional program that prepares students for employment or continued education in the occupations of installation, maintenance, and repair work. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the NCCER.

Grade Level and Class Size Recommendations
It is recommended that students enter this program as a 10th grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and student maturity. A maximum of 25 students is recommended for classroom-based courses, while a maximum of 15 students is recommended for lab-based courses.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning
If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

This curriculum consists of four 1-credit courses, which should be completed in the following sequence:

1. **Fundamentals of Industrial Maintenance—Course Code: 993002**
2. **Application of Industrial Maintenance—Course Code: 993003**
3. **Theory of Industrial Maintenance—Course Code: 993012**
4. **Advanced Skills of Industrial Maintenance—Course Code: 993013**

Course Description: Fundamentals of Industrial Maintenance
This course includes an introduction to the field as well as fundamentals of safety, math, and hand and power tools.

Course Description: Application of Industrial Maintenance
This course provides an introduction to blueprints, materials handling, orientation to the trade, tools of the trade, fasteners and anchors, oxy-fuel cutting, and craft-related mathematics. This course gives students real-world, hands-on practice in these areas.

Course Description: **Theory of Industrial Maintenance**
This course includes an in-depth study of the industrial maintenance profession, test equipment, gaskets and packing, pumps and pump drivers, types of valves, and machine lubrication. This course also reinforces safety related to the industrial maintenance industry.

Course Description: **Advanced Skills of Industrial Maintenance**
This course includes an in-depth study of material handling and rigging, mobile and support equipment, electrical theory, conductor terminations and splices, and hydraulic and pneumatic systems.

Fundamentals of Industrial Maintenance—Course Code: 993002

Unit		Title	Hours
1		Orientation	3
2		Employability Skills	7.5
3		Fundamentals of Student Organizations	4.5
4		Communication Skills	7.5
5		Basic Safety	35
6		Introduction to Construction Math	15
7		Hand Tools	22.5
8		Power Tools	22.5
Total			**117.5**

Application of Industrial Maintenance—Course Code: 993003

Unit		Title	Hours
9		Introduction to Construction Drawings	15
10		Introduction to Materials Handling	7.5
11		Tools of the Trade	15
12		Fasteners and Anchors	15
13		Oxy-Fuel Cutting	22.5
14		Basic Electrical (Industrial Maintenance)	15
15		Soldering and Brazing Copper and Plastic Piping	22.5
Total			**112.5**

Theory of Industrial Maintenance—Course Code: 993012

Unit		Title	Hours
16		Safety Review and Orientation to the Trade	22.5
17		Craft – related Mathematics	15
18		Gaskets and Packing	22.5
19		Pumps and Drivers	15
20		Introduction to Valves	15
21		Lubrication	15
22		Construction Drawings	15
23		Test Equipment	15
Total			**135**

Advanced Skills of Industrial Maintenance—Course Code: 993013

Unit		Title	Hours
24		Material Handling and Rigging	20
25		Mobile and Support Equipment	15
26		Hydraulic Systems	15
27		Pneumatic Systems	15
28		Electrical Theory and Conductor Terminations and Splices	25
29		SMAW-Groove Welds with Backing	47.5
Total			**137.5**

Option 2—Two 2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses, which should be completed in the following sequence:

1. **Industrial Maintenance I—Course Code: 993001**
2. **Industrial Maintenance II—Course Code: 993011**

Course Description: **Industrial Maintenance I**
This course introduces students to fundamentals of safety, tools, math, blueprint reading, materials handling, fasteners and anchors, and oxy-fuel cutting.

Course Description: **Industrial Maintenance II**
This course is a continuation of Industrial Maintenance I, with the emphasis on employability skills, safety, gaskets, packing, pumps, drivers, valves, lubrication, construction drawings, test equipment, material handling and rigging, mobile and support equipment, electrical theory, conductor termination and splices, hydraulic and pneumatic systems, and welding.

Industrial Maintenance I—Course Code: 993001

Unit		Title	Hours
1		Orientation	3
2		Employability Skills	7.5
3		Fundamentals of Student Organizations	4.5
4		Communication Skills	7.5
5		Basic Safety	35
6		Introduction to Construction Math	15
7		Hand Tools	22.5
8		Power Tools	22.5
9		Introduction to Construction Drawings	15
10		Introduction to Materials Handling	7.5
11		Tools of the Trade	15
12		Fasteners and Anchors	15
13		Oxy-Fuel Cutting	22.5
14		Basic Electrical (Industrial Maintenance)	15
15		Soldering and Brazing Copper and Plastic Piping	22.5
Total			**230**

Industrial Maintenance II—Course Code: 993011

Unit		Title	Hours
16		Safety Review and Orientation to the Trade	22.5
17		Craft – related Mathematics	15
18		Gaskets and Packing	22.5
19		Pumps and Drivers	15
20		Introduction to Valves	15
21		Lubrication	15
22		Construction Drawings	15
23		Test Equipment	15
24		Material Handling and Rigging	20
25		Mobile and Support Equipment	15
26		Hydraulic Systems	15
27		Pneumatic Systems	15
28		Electrical Theory and Conductor Terminations and Splices	25
29		SMAW-Groove Welds with Backing	47.5
Total			**272.5**

Career Pathway Outlook

Overview

Industrial machinery mechanics and machinery maintenance workers install, maintain, and repair manufacturing equipment and other industrial machineries such as conveying systems, production machinery, and packaging equipment. Millwrights install, dismantle, repair, reassemble, and move machinery in factories, power plants, and construction sites. Workers in this occupation must follow safety precautions and use protective equipment such as hardhats, safety glasses, and hearing protectors. Most work full time in manufacturing facilities; however, they may be on call and work night or weekend shifts. Overtime is common.

Industrial machinery mechanics, machinery maintenance workers, and millwrights typically need a high school diploma. Industrial machinery mechanics and machinery maintenance workers also usually need at least a year of on-the-job training. Most millwrights go through an apprenticeship program that may last up to four years.

Needs of the Future Workforce

In Mississippi, employment of industrial machinery mechanics, machinery maintenance workers, and millwrights is projected to grow faster than average for all occupations. The need to keep increasingly sophisticated machinery functioning and efficient will continue to create demand for these workers. Data for this synopsis were compiled from employment projections prepared by the U.S. Census Bureau, the U.S. Bureau of Labor Statistics (2020), and the Mississippi Department of Employment Security (2020).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2016	Projected Jobs, 2026	Change (Number)	Change (Percent)	Average Hourly Earnings, 2019
Industrial Machinery Mechanics	4,350	4,880	530	12.2	$23.86
Maintenance Workers, Machinery	1,480	1,660	180	12.2	$20.99
Millwrights	1,270	1,390	120	9.5	$20.83
Installation, Maintenance, and Repair Workers—All Other	730	760	30	4.1	$20.88
Helpers—Installation, Maintenance, and Repair Workers	1,400	1,510	110	7.9	$15.80

Source: Mississippi Department of Employment Security; mdes.ms.gov (2019).

Perkins V Requirements and Academic Infusion

The industrial maintenance curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in industrial maintenance fields. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for industrial maintenance careers. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, the curriculum focuses on ongoing and meaningful professional development for teachers, as well as relationships with industry.

Transition to Postsecondary Education

The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The industrial maintenance educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' backgrounds, emotional health, and circumstances—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the industrial maintenance curriculum. SkillsUSA is an example of a student organization with many outlets for industrial maintenance. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to the world of industrial maintenance careers and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the industrial maintenance curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The industrial maintenance curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the industrial maintenance curriculum that will allow and encourage collaboration with professionals currently in the field.

Work-Based Learning

Work-based learning is an extension of understanding competencies taught in the industrial maintenance classroom. This curriculum is designed in a way that necessitates active involvement by the students in the community around them and the global environment. These real-world connections and applications link all types of students to knowledge, skills, and professional dispositions. Work-based learning should encompass ongoing and increasingly more complex involvement with local companies and industry professionals. Thus, supervised collaboration and immersion into the industry around the students are keys to students' success, knowledge, and skills development.

Professional Organizations

Association for Career and Technical Education (ACTE)
acteonline.org

SkillsUSA
skillsusa.org

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80% of the time in the course. The remaining percentage of class time will include instruction in non-tested material, review for end-of-course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Teacher Resources
Teacher resources for this curriculum may be found in multiple places. Many program areas have teacher resource documents that accompany the curriculum and can be downloaded from the same site as the curriculum. The teacher resource document contains references, lesson ideas, websites, teaching and assessment strategies, scenarios, skills to master, and other resources divided by unit. This document could be updated periodically by RCU staff. Please check the entire document, including the entries for each unit, regularly for new information. If you have something you would like to add or have a question about the document, call or email the RCU's instructional design specialist for your program. The teacher resource document can be downloaded at rcu.msstate.edu/curriculum/curriculumdownload.aspx. All teachers should request to be added to the Canvas Resource Guide for their course. This is where all resources will be housed in the future, if they are not already. To be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Many of the units include an enrichment section at the end. If the industrial maintenance program is currently using the Mississippi Career Planning and Assessment System (MS-CPAS) as a measure of accountability, the enrichment section of material will not be tested. If this is the case, it is suggested to use the enrichment material when needed or desired by the teacher and if time allows in the class. This material will greatly enhance the learning experiences for students. If, however, the industrial maintenance program is using a national certification or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be tested. It is the responsibility of the teacher to ensure all competencies for the selected assessment are covered throughout the year.

Unit 1: Orientation

Competencies and Suggested Objectives
1. Describe local program and center expectations, policies, and procedures. DOK 1 a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. b. Give a brief overview of the course. Explain to students what industrial maintenance is, why it is important, and how it will be delivered. c. Compare and contrast local program and school policies to the expectations of employers. d. Preview course objectives, program policy, and industry standards.
2. Discuss work-based learning (WBL) opportunities related to program areas. DOK 1 a. Define WBL. b. Explore the opportunities available through program areas such as WBL, job shadowing, apprenticeship programs, on-the-job training, and so forth.

Unit 2: Employability Skills

Competencies and Suggested Objectives
1. Describe employment opportunities in the construction industry. DOK 1 a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training. b. Discuss the guidelines for developing a proper résumé. c. Demonstrate completing job applications.
2. Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities. DOK 1 a. Perform various searches through the MDES website, such as: • Number of jobs available for a specific area of expertise • Hourly wage • Percentage of jobs in the county • Percentage of jobs in the state
3. Demonstrate appropriate interviewing skills. DOK 1 a. Identify interviewing skills such as speaking, dress, professionalism, and punctuality. b. Simulate a job interview.
4. Describe basic employee responsibilities and appropriate work ethics. DOK 1 a. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. b. Define effective relationship skills and identify workplace issues, including, but not limited to, sexual harassment, stress, and substance abuse.

Unit 3: Fundamentals of Student Organizations

Competencies and Suggested Objectives
1. Discuss the history, mission, and purpose of career and technical student organizations (CTSOs) for industrial maintenance, including SkillsUSA. DOK 1 a. Trace the history of the CTSO for industrial maintenance. b. Identify the mission, purpose, and/or goals of the CTSO for industrial maintenance.
2. Explore the advantages of membership in a CTSO. DOK 1 a. Discuss the membership process for the CTSO for industrial maintenance. b. Explain the activities related to the local chapter and the state and national organizations.
3. Discuss the organization's brand resources. DOK 1 a. Identify the motto, creed, and/or pledge and discuss their meanings. b. Recognize related brand resources, such as: • Emblem • Colors • Official attire • Logos • Graphic standards
4. Describe the importance of effective communication skills. DOK 1 a. Demonstrate verbal and nonverbal communication skills. b. Apply appropriate speaking and listening skills to class- and work-related situations.
5. Apply leadership skills to class- and work-related situations and 21st century skills. DOK 2 a. Define leadership. b. Discuss the attributes of a leader. c. Identify the roles a leader can assume.
6. Utilize team-building skills in class- and work-related situations. DOK 2 a. Define team-building. b. Discuss the attributes of a team. c. Identify the roles included in a team.
7. Discuss various competitions offered through the CTSO for industrial maintenance. DOK1 a. Describe each of the competitions and the skills needed to accomplish the tasks. b. Perform the tasks needed to complete an assigned requirement for a competition.

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 4: Communication Skills

Competencies and Suggested Objectives
1. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK 2 a. Follow basic written and verbal instructions. b. Effectively communicate in on-the-job situations using verbal, written, or electronic communication.
2. Discuss the importance of good listening skills in on-the-job situations. DOK 2 a. Apply the tips for developing good listening skills.

Unit 5: Basic Safety

Competencies and Suggested Objectives
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry. DOK 2 a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies according to OSHA standards. d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain the causes of accidents and the impact of accident costs. g. Compare and contrast shop/lab safety rules to industry safety rules.
2. Identify and apply safety around welding operations. DOK 1 a. Use proper safety practices when welding or working around welding operations. b. Use proper safety practices when welding in or near trenches and excavations. c. Explain the term "proximity work."
3. Display appropriate safety precautions to take around common jobsite hazards. DOK1 a. Explain the safety requirements for working in confined areas. b. Explain the different barriers and barricades and how they are used.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). DOK1 a. Identify commonly used PPE. b. Understand proper use of PPE. c. Demonstrate appropriate care for PPE.
5. Explain fall protection and ladder, stair, and scaffold procedures and requirements. DOK1 a. Explain the use of proper fall protection. b. Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the safety data sheet (SDS). DOK1 a. Explain the function of the SDS. b. Interpret the requirements of the SDS. c. Discuss hazardous material exposures.
7. Display appropriate safety procedures related to fires. DOK 1 a. Explain the process by which fires start. b. Explain fire prevention of various flammable liquids. c. Explain the classes of fire and the types of extinguishers. d. Illustrate the proper steps to follow when using a fire extinguisher. e. Demonstrate the proper techniques for putting out a fire.

8. Explain safety in and around electrical situations. DOK 1
   a. Explain the injuries that can result when electrical contact occurs.
   b. Explain safety around electrical hazards.
   c. Explain actions to take when an electrical shock occurs.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Unit 6: Introduction to Construction Math

Competencies and Suggested Objectives
1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. DOK 2 a. Define basic geometric shapes used in the construction industry. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions and convert fractions to whole numbers. d. Convert decimals to percentages and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and a tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 7: Hand Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of hand tools. DOK 2 a. Identify, visually inspect, and discuss the safe use of common hand tools. b. Discuss safety rules. c. Select and demonstrate the use of hand tools. d. Explain the procedures for maintenance.

Unit 8: Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of power tools. DOK 2 a. Identify, visually inspect, and discuss the safe use of common power tools. b. Discuss safety rules. c. Select and demonstrate the use of power tools. d. Explain the procedures for maintenance.

Unit 9: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand the basic components of a drawing. DOK 3 a. Recognize and identify terms, components, and symbols commonly used on drawings. b. Relate information on construction drawings to actual locations on the drawings. c. Recognize different types of drawings. d. Interpret and use drawing dimensions.

Unit 10: Introduction to Materials Handling

Competencies and Suggested Objectives
1. Safely handle and store materials. DOK 1 a. Define a load. b. Establish a pre-task plan prior to moving a load. c. Demonstrate proper materials-handling techniques. d. Choose the appropriate materials-handling equipment for a task. e. Recognize hazards and follow safety procedures required for materials handling. f. Identify and demonstrate commonly used knots.

Unit 11: Tools of the Trade

Competencies and Suggested Objectives
1. Identify and use tools found in the industrial maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools. DOK2 a. Illustrate the use of tools used in the industrial maintenance profession. b. Identify and use common hand and power tools used in the industrial maintenance profession.

Unit 12: Fasteners and Anchors

Competencies and Suggested Objectives
1. Identify various fasteners and anchors found in the industrial maintenance trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application. DOK2 a. Identify and install threaded fasteners, non-threaded fasteners, and anchors. b. Identify various grades of bolt hardness.

Unit 13: Oxy-Fuel Cutting

Competencies and Suggested Objectives
1. Identify and describe the basic equipment, setup, and safety rules for proper use of oxy-fuel equipment. DOK2 a. Identify and explain the use of oxy-fuel equipment. b. Demonstrate how to use an oxy-fuel torch. c. Perform the following types of oxy-fuel cutting. • Straight line and square shapes • Piercing and slot cutting • Bevels • Washing

Unit 14: Basic Electrical (Industrial Maintenance)

Competencies and Suggested Objectives
1. Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits. DOK2 a. Describe how voltage, current, resistance, and power are mathematically related. b. Describe the difference between series and parallel circuits and calculate loads in each. c. Describe the purpose and operation of the various electrical components used in equipment.
2. Explore the various electrical codes and standards such as National Electrical Code (NEC) and Underwriters Laboratories (UL). DOK2

Unit 15: Soldering, Brazing, and Copper and Plastic Piping

Competencies and Suggested Objectives
1. Identify and discuss the tools used in the piping trade, discuss the materials and methods used in connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance environment. DOK2 a. Discuss and demonstrate how to use copper tubing in industrial maintenance. b. Discuss and demonstrate how to use plastic tubing in industrial maintenance.
2. Prepare and solder copper piping systems in various industrial maintenance applications and properly clean, install fittings, and braze piping (silver solder). DOK2 a. Solder copper pipe in industrial maintenance. b. Braze copper pipe in industrial maintenance.

Unit 16: Safety Review and Orientation to the Trade

Competencies and Suggested Objectives
1. Describe local program and career technical center policies and procedures. DOK2 a. Describe local program and career technical center policies and procedures.
2. Explore leadership skills and personal development opportunities provided for students by student organizations, including SkillsUSA. DOK2 a. Demonstrate effective team-building and leadership skills. b. Practice appropriate work ethics.
3. Discuss orientation to the trade. DOK2 a. Describe the types of work performed by industrial maintenance craftworkers. b. Identify career opportunities available to industrial maintenance craftworkers. c. Explain the purpose and objectives of an apprentice training program. d. Explain the responsibilities and characteristics of good industrial maintenance craftworkers. e. Explain the importance of safety in relation to industrial maintenance craftworkers. f. Explain the role of NCCER in the training process.
4. Describe general safety rules for working in a shop/lab and industry. DOK2 a. Discuss safety issues and prevention associated with the industrial maintenance shop area. b. Explain fire safety and prevention in the workplace.

Unit 17: Craft-Related Mathematics

Competencies and Suggested Objectives
1. Identify and explain measuring devices, solve geometric mathematical problems, and use weight and measurement standards. DOK2 a. Discuss mathematics used in the industrial maintenance industry.

Unit 18: Gaskets and Packing

Competencies and Suggested Objectives
1. Identify different types of gaskets and packing materials, list their applications, and install gaskets and packing. DOK2 a. Identify the various types and materials of gaskets. b. Describe the use of O-rings in the industrial maintenance trade. c. Describe the uses and methods of packing in the industrial maintenance trade.

Unit 19: Pumps and Drivers

Competencies and Suggested Objectives
1. Identify types of pumps and prime movers and explain pressure differential between the inlet and outlet of pumps. DOK2 a. Identify and explain centrifugal, rotary, reciprocating, metering, and vacuum pumps. b. Explain net positive suction head and cavitation. c. Identify types of drivers.

Unit 20: Introduction to Valves

Competencies and Suggested Objectives
1. Identify types of valves and explain how to store and properly install valves. DOK2 a. Identify types of valves that start, stop, regulate, relieve pressure, and regulate direction of flow. b. Explain how to properly store, handle, and mount valves in various locations and positions.

Unit 21: Lubrication

Competencies and Suggested Objectives
1. Describe and explain lubricant classification, additives, uses, and environmental regulations regarding the disposal of oils and greases. DOK2 a. Explain regulatory laws regarding industrial lubricants. b. Explain how lubricants protect mechanical machinery. c. Explain the properties and handling of lubricants and grease.

Unit 22: Construction Drawings

Competencies and Suggested Objectives
1. Identify components of blueprints and scales and perform projects from blueprints. DOK2 a. Read and draw a basic blueprint found in industrial maintenance.

Unit 23: Test Equipment

Competencies and Suggested Objectives
1. Identify and explain the use of various test equipment used in the trade, differentiate between analog and digital meter readouts, and properly test circuits and mechanisms using available school metering devices. DOK2 a. Explain the operation of the following pieces of test equipment: • Tachometer • Pyrometers • Multimeters • Automated diagnostics tools • Wiggy voltage tester • Stroboscope • Frequency meter b. Explain how to read and convert from one scale to another using the test equipment above.

Unit 24: Material Handling and Rigging

Competencies and Suggested Objectives
1. Identify and explain safe rigging practices, load distribution, hand signals, and rigging equipment. DOK2 a. Identify, describe the uses of, inspect, and maintain common rigging hardware and equipment, including the following: • Jacks • Block and tackle • Chain hoists • Come-alongs b. Tie knots used in rigging. c. Identify basic rigging and crane safety procedures and use the correct hand signals to guide a crane operator.

Unit 25: Mobile and Support Equipment

Competencies and Suggested Objectives
1. Recognize types of mobile and support equipment found in the trade, explain the application for each device, and demonstrate the safe use of the equipment. DOK2 a. State and explain the safety precautions, operation, and application associated with the use of motor-driven equipment commonly used in industrial plants, including the following: • Portable generators • Air compressors • Aerial lifts • Forklifts • Mobile cranes b. Operate and perform preventive maintenance on the following equipment: • Portable generators • Air compressors • Aerial lifts

Unit 26: Hydraulic Systems

Competencies and Suggested Objectives
1. Explain the principles of hydraulic systems. DOK2 a. Discuss safety procedures as applied to hydraulic systems. b. Explore the principles of industrial hydraulics.

Unit 27: Pneumatic Systems

Competencies and Suggested Objectives
1. Explain the principles of pneumatic systems. DOK2 a. Discuss safety procedures as applied to pneumatic systems. b. Discuss the principles of industrial pneumatics.

Unit 28: Electrical Theory and Conductor Terminations and Splices

Competencies and Suggested Objectives
1. Describe the units of measurement of electricity and the types of circuits, define Ohm's and Kirchhoff's laws, and troubleshoot a simple circuit. DOK2 a. Discuss the properties and physical laws of electricity. b. Identify the meters used to measure voltage, current, and resistance. c. Discuss the properties of a series and a parallel circuit. d. Discuss the properties of alternating currents. e. Discuss basic conduit-bending procedures.
2. Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices. DOK2 a. Describe how to make a conductor termination. b. Prepare cable ends for terminations and splices and connect the ends using lugs or connectors. c. Train cable at termination points. d. Describe the NEC requirements for making cable terminations and splices.

Unit 29: SMAW – Groove Welds with Backing

Competencies and Suggested Objectives
1. Perform basic Shielded Metal Arc Welding (SMAW) welding operations. DOK2 a. Practice safety procedures for SMAW welding operations. b. Prepare base metal for SMAW welding. c. Demonstrate basic elements and techniques used in SMAW welding. d. Fabricate a welding project to specifications.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Discuss work-based learning (WBL) opportunities related to program areas.
Unit 2: Employability Skills		
	1.	Describe employment opportunities in the construction industry.
	2.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	3.	Demonstrate appropriate interviewing skills.
	4.	Describe basic employee responsibilities and appropriate work ethics.
Unit 3: Fundamentals of Student Organizations		
	1.	Discuss the history, mission, and purpose of career and technical student organizations (CTSOs), including SkillsUSA.
	2.	Explore the advantages of membership in a CTSO.
	3.	Discuss the organization's brand resources.
	4.	Describe the importance of effective communication skills.
	5.	Apply leadership skills to class- and work-related situations and 21st century skills.
	6.	Utilize team-building skills in class- and work-related situations.
	7.	Discuss the various competitions offered through the program area's CTSO.
Unit 4: Communication Skills		
	1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	2.	Discuss the importance of good listening skills in on-the-job situations.

Unit 5: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry.
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.
	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection and ladder, stair, and scaffold procedures and requirements.
	6.	Explain the safety data sheet (SDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 6: Introduction to Construction Math		
	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
Unit 7: Hand Tools		
	1.	Demonstrate the use and maintenance of hand tools.
Unit 8: Power Tools		
	1.	Demonstrate the use and maintenance of power tools.
Unit 9: Introduction to Construction Drawings		
	1.	Read, analyze, and understand the basic components of a drawing.
Unit 10: Introduction to Materials Handling		
	1.	Safely handle and store materials.
Unit 11: Tools of the Trade		
	1.	Identify and use tools found in the industrial maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools.
Unit 12: Fasteners and Anchors		
	1.	Identify various fasteners and anchors found in the industrial maintenance trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application.
Unit 13: Oxy-Fuel Cutting		
	1.	Identify and describe the basic equipment, setup, and safety rules for proper use of oxy-fuel equipment.
Unit 14: Basic Electrical (Industrial Maintenance)		
	1.	Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits.
	2.	Explore the various electrical codes and standards such as National Electrical Code (NEC) and Underwriters Laboratories (UL).

Unit 15: Soldering, Brazing, and Copper and Plastic Piping		
	1.	Identify and discuss the tools used in the piping trade, discuss the materials and methods used in connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance environment.
	2.	Prepare and solder copper piping systems in various industrial maintenance applications and properly clean, install fittings, and braze piping (silver solder).
Unit 16: Safety Review and Orientation to the Trade		
	1.	Describe local program and career technical center policies and procedures.
	2.	Explore leadership skills and personal development opportunities provided for students by student organizations, including SkillsUSA.
	3.	Discuss orientation to the trade.
	4.	Describe general safety rules for working in a shop/lab and industry.
Unit 17: Craft-Related Mathematics		
	1.	Identify and explain measuring devices, solve geometric mathematical problems, and use weight and measurement standards.
Unit 18: Gaskets and Packing		
	1.	Identify different types of gaskets and packing materials, list their applications, and install gaskets and packing.
Unit 19: Pumps and Drivers		
	1.	Identify types of pumps and prime movers and explain pressure differential between the inlet and outlet of pumps.
Unit 20: Introduction to Valves		
	1.	Identify types of valves and explain how to store and properly install valves.
Unit 21: Lubrication		
	1.	Describe and explain lubricant classification, additives, uses, and environmental regulations regarding the disposal of oils and greases.
Unit 22: Construction Drawing		
	1.	Identify components of blueprints and scales and perform projects from blueprints.
Unit 23: Test Equipment		
	1.	Identify and explain the use of various test equipment used in the trade, differentiate between analog and digital meter readouts, and properly test circuits and mechanisms using available school metering devices.
Unit 24: Material Handling and Rigging		
	1.	Identify and explain safe rigging practices, load distribution, hand signals, and rigging equipment.

Unit 25: Mobile and Support Equipment		
	1.	Recognize types of mobile and support equipment found in the trade, explain the application for each device, and demonstrate the safe use of the equipment.
Unit 26: Hydraulic Systems		
	1.	Explain the principles of hydraulic systems.
Unit 27: Pneumatic Systems		
	1.	Explain the principles of pneumatic systems.
Unit 28: Electrical Theory and Conductor Terminations and Splices		
	1.	Describe the units of measurement of electricity and the types of circuits, define Ohm's and Kirchhoff's laws, and troubleshoot a simple circuit.
	2.	Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices.
Unit 29: SMAW Groove Welds with Backing		
	1.	Perform basic Shielded Metal Arc Welding (SMAW) welding operations.

Appendix A: Industry Standards

INDUSTRIAL SERVICES PATHWAY

CONTENT STANDARDS AND PERFORMANCE ELEMENTS[1]

Crosswalk for Industrial Maintenance (Units 1-10)											
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
BSM						X					
ICM							X				
IHT								X			
IPT									X		
BLU										X	
COM					X						
EMP		X									
IMH											X
OTT											
TOT											
GAP											
FAA											
OXY											
CRM											
CDI											
PAD											
ITV											
ITE											
MHR											
MSE											
LUB											
IME & INSTRUMENTATION TECHNICIAN LEVEL 2											
NEC											
ETO											
CON											
HDC											
PNC											
Welding Level 1											
WES											
BMP											
GWB – SMAW											
HVAC LEVEL 1											
CPP											
SAB											

	Units	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**	**Unit 17**	**Unit 18**	**Unit 19**
BSM							X			
ICM										
IHT										
IPT										
BLU										
COM										
EMP										
IMH										
OTT							X			
TOT		X								

[1] *NCCER learning series.* Retrieved April 22, 2013, from http://www.nccer.org/

GAP									X	
FAA			X							
OXY				X						
CRM								X		
CDI										
PAD										X
ITV										
ITE										
MHR										
MHR										
MSE										
LUB										
IME & INSTRUMENTATION TECHNICIAN LEVEL 2										
NEC					X					
ETO					X					
CON										
HDC									X	
PNC									X	
Welding Level 1										
WES			X							
BMP			X							
GWB – SMAW										
HVAC LEVEL 1										
CPP						X				
SAB						X				

	Units	**Unit 20**	**Unit 21**	**Unit 22**	**Unit 23**	**Unit 24**	**Unit 25**	**Unit 26**	**Unit 27**	**Unit 28**	**Unit 29**
BSM											
ICM											
IHT											
IPT											
BLU											
COM											
EMP											
IMH											
OTT											
TOT											
GAP											
FAA											
OXY											
CRM											
CDI				X							
PAD											
ITV		X									
ITE					X						
MHR						X					
MSE							X				
LUB			X								
IME & INSTRUMENTATION TECHNICIAN LEVEL 2											
NEC										X	
ETO										X	
CON										X	
HDC								X			
PNC									X		
Welding Level 1											
WES											X
BMP											X
GWB – SMAW											X
HVAC LEVEL 1											
CPP											
SAB											

NCCER Core

BSM – BASIC SAFETY (00101-09)
ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-09)
IHT – INTRODUCTION TO HAND TOOLS (00103-09)
IPT – INTRODUCTION TO POWER TOOLS (00104-09)
BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-09)
COM – BASIC COMMUNICATION SKILLS (00107-09)
EMP – BASIC EMPLOYABILITY SKILLS (00108-09)
IMH – INTRODUCTION TO MATERIALS HANDLING (00109-09)

IM E&I Technician Level 1
OTT -– ORIENTATION TO THE TRADE
TOT – TOOLS OF THE TRADE
GAP -– GASKETS AND PACKING
FAA – FASTNERS AND ANCHORS
OXY – OXYFUEL CUTTING
CRM -– CRAFT-RELATED MATHEMATICS
CDI -– CONSTRUCTION DRAWINGS
PAD -– PUMPS AND DRIVERS
ITV -– INTRODUCTIONTO VALVES
ITE -– INTRODUCTIONTOTEST EQUIPMENT
MHR -– MATERIAL HANDLING AND HAND RIGGING
MSE -– MOBILE AND SUPPORT EQUIPMENT
LUB -– LUBRICATION

Industrial Maintenance E&I Technician Level 2
NEC – Introduction to the National Electrical Code
ETO – Electrical Theory
CON – Conductor Terminations and Splices

Industrial Maintenance E&I Technician Level 3
HDC – Hydraulic Controls
PNC – Pneumatic Controls

Welding Level 1
WES –Welding Safety
BMP - Base Metal Preparation
GWB – SMAW – Groove Welds with Backing

HVAC – LEVEL 1

CPP – COPPER AND PLASTIC PIPING

SAB – SOLDERING AND BRAZING

2016 Industrial Maintenance

Program CIP: 47.0303 – Industrial Mechanics and Maintenance Technology

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Mississippi State University

~~Mississippi State, MS 39762~~

~~The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.~~

Table of Contents

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Dr. Carey M. Wright, State Superintendent of Education

Dr. John R. Kelly, Chair

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~~Jolanda Young, Educational Technologist for the Research and Curriculum Unit at Mississippi State University~~

Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the Industrial Maintenance *Curriculum Framework and Supporting Materials* are based on the following:

NCCER Learning Series from the National Center for Construction Education and Research
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College and Career Ready Standards

The College and Career Ready Standards emphasize critical thinking, teamwork and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College- and Career-Ready Standards (MCCRS) because they provide a consistent, clear understanding of what students are expected to learn so that teachers and parents know what they need to do to help them. Reprinted from http://www.mde.k12.ms.us/MCCRS

International Society for Technology in Education Standards (ISTE)
Reprinted with permission from *National Educational Technology Standards for Students: Connecting Curriculum and Technology*, Copyright 2007, International Society for Technology in Education (ISTE), 800.336.5191 (U.S. and Canada) or 541.302.3777 (International), iste@iste.org, www.iste.org. All rights reserved. Permission does not constitute an endorsement by ISTE.

21st Century Skills and Information and Communication Technologies Literacy Standards
In defining 21st century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and information and communication technology (ICT) literacy.

Preface

Secondary career and technical education programs in Mississippi face with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at

The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

Industrial Maintenance is an instructional program that prepares students for employment or continued education in the occupations of installation, maintenance, and repair work. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the National Center for Construction Education and Research (NCCER).

When developing this curriculum, the authors recognized the importance of incorporating differentiated instruction and the needs of the 21st century learners. Therefore, teaching strategies include a blend of online and face-to-face instruction that align with NCCER Connect e-books, online lectures, video presentations, online quizzes, active figures, and Spanish content. Students will have access to this information to learn new content as well as to review, reinforce, or revise their work.

Industry Certification

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the **NCCER *Learning Series*.** When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the certification process, all Mississippi Manufacturing Technology instructors will be required to successfully complete the **Instructor Certification Training Program**. This program ensures that instructors possess a deep knowledge of content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi **NCCER Accredited Training and Education Facilities (ATEF)**. School districts must meet a set of guidelines to become an NCCER ATEF program including the following:

1. Use the approved curriculum.
2. All instructors must be NCCER certified.
3. All completed Form 200s and release forms on all student completions are to be forwarded to MCEF for proper approval. MCEF will in turn forward to NCCER for processing.
4. Follow NCCER guidelines on test security and performance profiles.
5. Have an active advisory committee with at least two commercial contractors involved.
6. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
7. Involve commercial contractors in class presentations or field trips.
8. All construction programs must be included in the accreditation process.
9. Show active involvement in student leadership development (e.g., VICA and SkillsUSA).
10. Provide demonstrated placement into construction-related occupations, and provide timely reports to MCEF.

Districts will be required to complete a self-evaluation of all programs and host a site visit from industry to ensure proper lab, safety, and instructional procedures are in place.

Assessment

The latest assessment blueprint for the curriculum can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Student Prerequisites

In order for students to be able to experience success in the Industrial Maintenance program, the following student prerequisites are suggested:

4. C or higher in English (the previous year)
5. C or higher in Math (last course taken or the instructor can specify the math)
6. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

7. TABE Reading Score (eighth grade or higher)

or

8. Instructor Approval

Teacher Licensure

The latest teacher licensure information can be found at

http://www.mde.k12.ms.us/educator-licensure

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for a professional learning specialist.

Course Outlines

It is recommended that the courses should be taken in sequence.

- Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
- Safety will be reinforced and tested at the beginning of each course.
- Students must complete Installation and Service Core with a score of 80/C or higher in class work to advance to the next level.

Option 1—Four, One-Carnegie-Unit Courses

Upon completion of this option, the student will be prepared to take the **Industrial Maintenance Level 1 certification** exams. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

5. **Fundamentals of Industrial Maintenance —Course Code: 993002**
6. **Application of Industrial Maintenance—Course Code: 993003**
7. **Theory of Industrial Maintenance—Course Code: 993012**
8. **Advanced Skills of Industrial Maintenance—Course Code: 993013**

Course Description: Fundamentals of Industrial Maintenance

Fundamentals of Industrial Maintenance includes an introduction to the field as well as fundamentals of safety, math, and hand and power tools.

Course Description: Application of Industrial Maintenance

Application of Industrial Maintenance provides an introduction to blueprints, materials handling, orientation to the trade, tools of the trade, fasteners and anchors, oxy-fuel cutting, introduction to National Electrical Code, and craft related mathematics. This course gives students real-world, hands-on practice in these areas.

Course Description: Theory of Industrial Maintenance

~~Theory of Industrial Maintenance includes an in-depth study of the industrial maintenance profession, test equipment, gaskets and packing, pumps and pump drivers, types of valves, and machine lubrication. This course also reinforces safety related to the industrial maintenance industry.~~

Course Description: Advanced Skills of Industrial Maintenance

Advanced Skills of Industrial Maintenance includes an in-depth study of material handling and rigging, and mobile and support equipment, electrical theory, conductor terminations and splices, and hydraulic and pneumatic controls.

Fundamentals of Industrial Maintenance—Course Code: 993002

Unit		Title	Hours
1		Introduction and Orientation	25
2		Basic Safety	25
3		Introduction to Construction Math	20
4		Hand and Power Tools	40
5		Introduction to Construction Drawings	30
			140

Application of Industrial Maintenance—Course Code: 993003

Unit		Title	Hours
6		Introduction to Materials Handling	25
7		Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting	50
8		Introduction to the National Electrical Code	15
9		Basic Electrical	25
10		Copper and Plastic Piping, and Soldering and Brazing	25
			140

~~Theory of Industrial Maintenance—Course Code: 993012~~

~~Unit~~		~~Title~~	~~Hours~~
~~11~~		~~Safety Review and Orientation to the Trade~~	~~10~~
~~12~~		~~Craft Related Mathematics~~	~~15~~
~~13~~		~~Gaskets and Packing, Pumps and Drivers, Introduction to Valves, and Lubrication~~	~~65~~
~~14~~		~~Construction Drawings, Test Equipment, Material Handling and Rigging, and Mobile and Support Equipment~~	~~50~~
			~~140~~

~~Advanced Skills of Industrial Maintenance—Course Code: 993013~~

~~Unit~~		~~Title~~	~~Hours~~
~~15~~		~~Conduit Bending~~	~~10~~
~~16~~		~~Electrical Theory, Conductor Terminations and Splices, and Hydraulic and Pneumatic Controls~~	~~65~~
~~17~~		~~Shielded Metal Arc Welding~~	~~65~~
			~~140~~

Option 2—Two, Two-Carnegie-Unit Course

Upon completion of this option, the student will be eligible to take the **NCCER Core Level 1 Certification** exam.

This curriculum consists of two, two-credit courses as follows:

1. **Industrial Maintenance I—Course Code: 993001**
2. **Industrial Maintenance II—Course Code: 993011**

Course Description: Industrial Maintenance I

The Industrial Maintenance I course introduces students to fundamentals of safety, tools, math, blueprint reading, materials handling, fasteners and anchors, oxy-fuel cutting, and an introduction to the National Electrical Code.

Industrial Maintenance I—Course Code: 993001

Unit		**Title**	**Hours**
1		Introduction and Orientation	25
2		Basic Safety	25
3		Introduction to Construction Math	20
4		Hand and Power Tools	40
5		Introduction to Construction Drawings	30
6		Introduction to Materials Handling	25
7		Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting	50
8		Introduction to the National Electrical Code	15
9		Basic Electrical	25
10		Copper and Plastic Piping, and Soldering and Brazing	25
			280

Course Description: Industrial Maintenance II

Industrial Maintenance II is a continuation of Industrial Maintenance I with the emphasis on employability skills, safety, gaskets, packing, pumps, drivers, valves, lubrication, construction drawings, test equipment, material handling and rigging, mobile and support equipment, electrical theory, conductor termination and splices, hydraulic and pneumatic controls, and welding.

Industrial Maintenance II—Course Code: 993011

Unit		Title	Hours
11		Safety Review and Orientation to the Trade	10
12		Craft Related Mathematics	15
13		Gaskets and Packing, Pumps and Drivers, Introduction to Valves, and Lubrication	65
14		Construction Drawings, Test Equipment, Material Handling and Rigging, and Mobile and Support Equipment	50
15		Conduit Bending	10
16		Electrical Theory, Conductor Terminations and Splices, and Hydraulic and Pneumatic Controls	65
17		Shielded Metal Arc Welding	65
			280

Research Synopsis

Introduction

By implementing the National Center for Construction Education and Research in the construction skills standards to the Maintenance, Installation & Repair Pathway, students who successfully master the curriculum should have the skills required to enter the workforce or pursue an advanced degree. These skills are based on industry-validated performance indicators. The pathway will include applied instruction designed to articulate with programs offered in Mississippi's community and junior colleges.

Needs of the Future Workforce

Occupations in the Industrial Maintenance fields are projected to have about as fast as average to faster than average growth in Mississippi between 2008 and 2018. The U.S. Bureau of Labor Statistics reports that job prospects will be excellent for technicians in this field, particularly those who have received training at accredited technical schools.

Table 1.1: Current and Projected Occupation Report for Installation and Service Technology

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed March 8, 2013).

Description	Jobs, 2008	Projected Jobs, 2018	Change(Number)	Change (Percent)	Average Hourly Wage
Helpers—Installation, Maintenance, and Repair Workers	1,850	2,100	250	13.5	$11.90
Installation, Maintenance, and Repair Workers, All Other	450	500	50	11.1	$21.03

Perkins IV Requirements

The Industrial Maintenance curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. It also offers students a program of study including secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the Industrial Maintenance curriculum is integrated with academic College and Career Readiness standards. Lastly, the Industrial Maintenance curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the Industrial Maintenance curriculum are the College and Career Readiness Standards for Mathematics and Science, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the College and Career Readiness Standards are designed to prep students for success in community colleges, Institutions of Higher Learning and careers.

Transition to Postsecondary Education

~~The latest articulation information for Secondary to Postsecondary can be found at the Mississippi Community College Board (MCCB) website http://www.mccb.edu/~~

Best Practices

Experiential Learning (SAE)

The Experiential Learning (SAE) has long been and continues to be the backbone of every industrial maintenance program. The experiential learning projects can be used in a variety of situations to reinforce and compliment classroom theory and content. The experiential learning project consists of entrepreneurship, placement, research/experimentation and exploratory.

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The Industrial Maintenance teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a classroom set of desktop student computers and one teacher laptop. To make use of the latest online communication tools such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning management system, for example, the Industrial Maintenance Teacher Learning Management System, that introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. Many activities are graded by rubrics that allow students to choose the type of product they will produce. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the Industrial Maintenance curriculum. SkillsUSA is the student's organization for Industrial Maintenance. SkillsUSA provides students with growth opportunities and competitive events. It also opens the doors to the world of agriculture and scholarships opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Industrial Maintenance curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The Industrial Maintenance curriculum provides opportunities for students to work together and help each other to complete complex tasks.

~~**Conclusions**~~

~~The Industrial Maintenance curriculum is one of Mississippi's most comprehensive manufacturing curriculums. Students that complete these programs are well equipped for a variety of endeavors. Instructors are urged to encourage Industrial Maintenance students to pursue educational opportunities at community colleges and universities in Mississippi.~~

~~Professional Organizations~~

~~Association for Career and Technical Education (ACTE)~~

~~1410 King Street~~

~~Alexandria, VA 22314~~

~~800.826.9972~~

~~http://www.acteonline.org~~

~~SkillsUSA~~

~~14001 SkillsUSA Way~~

~~Leesburg, VA 20176~~

~~703.777.8810~~

~~FAX: 703.777.8999~~

~~http://www.skillsusa.org/~~

Using This Document

Suggested Time on Task

This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives

A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References

A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Introduction and Orientation

Competencies and Suggested Objectives
1. Describe local program and center expectations, policies, and procedures. DOK 1, EMP a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. b. Give a brief overview of the course. Explain to students what Manufacturing Technology is, why it is important, and how it will be delivered. c. Compare and contrast local program and school policies to expectations of employers. d. Preview course objectives, program policy, and the industry standards.
2. Describe employment opportunities and responsibilities. DOK 1, EMP a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training. b. Describe basic employee responsibilities and appropriate work ethics. c. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. d. Demonstrate computer systems and their uses in the manufacturing industry. e. Define effective relationship skills and workplace issues to include but not limited to sexual harassment, stress, and substance abuse.
3. Research, design, and conduct a project that will apply the knowledge and skills learned in the Maintenance, Installation & Repair Pathway course in a real-world, unpredictable environment. DOK3, EMP a. Demonstrate effective team-building and leadership skills. b. Explore leadership skills and personal development opportunities provided to students through student organizations such as SkillsUSA. c. Work as a team to design a community service project for which the knowledge and skills learned in the course can be used to improve the lives of others.
4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK 2, COM a. Follow basic written and verbal instructions. b. Effectively communicate in on-the-job situations using verbal, written, or electronic communication.

Unit 2: Basic Safety

Competencies and Suggested Objectives
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the manufacturing industry. DOK 2, BSM a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies according to OSHA standards, including addressing General Duty Clause and *1926 CFR Subpart C.* d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain causes of accidents and the impact of accident costs. g. Compare and contrast shop/lab safety rules to industry safety rules. **Note:** Safety is to be taught as an ongoing part of the program. Students are required to complete the written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
2. Identify and apply safety around welding operations. DOK 1, BSM a. Use proper safety practices when welding or working around welding operations. b. Use proper safety practices when welding in or near trenches and excavations. c. Explain the term "proximity work."
3. Display appropriate safety precautions to take around common jobsite hazards. DOK 1, BSM a. Explain the safety requirements for working in confined areas. b. Explain the different barriers and barricades and how they are used.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). DOK 1, BSM a. Identify commonly used PPE items. b. Understand proper use of PPE. c. Demonstrate appropriate care for PPE.
5. Explain fall protection, ladder, stair, and scaffold procedures and requirements. DOK 1, BSM a. Explain the use of proper fall protection. b. Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the material safety data sheet (MSDS). DOK 1, BSM a. Explain the function of the MSDS. b. Interpret the requirements of the MSDS. c. Discuss hazardous material exposures.
7. Display appropriate safety procedures related to fires. DOK 1, BSM a. Explain the process by which fires start.

b. Explain fire prevention of various flammable liquids. c. Explain the classes of fire and the types of extinguishers. d. Illustrate the proper steps to follow when using a fire extinguisher. e. Demonstrate the proper techniques for putting out a fire.
8. Explain safety in and around electrical situations. DOK 1, BSM a. Explain injuries that can result when electrical contact occurs. b. Explain safety around electrical hazards. c. Explain action to take when an electrical shock occurs.

Unit 3: Introduction to Construction Math

Competencies and Suggested Objectives
1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. [DOK 2, ICM] a. Define basic geometric shapes used in the manufacturing industry. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions, and convert fractions to whole numbers. d. Convert decimals to percentages, and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 4: Hand and Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of hand and power tools. DOK 2, IMT, IPT a. Identify, visually inspect, and discuss the safe use of common hand and power tools. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance.

Unit 5: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand basic components of a blueprint. DOK 3, BLU a. Recognize and identify terms, components, and symbols commonly used on blueprints. b. Relate information on construction drawings to actual locations on the print. c. Recognize different classifications of drawing. d. Interpret and use drawing dimensions.

Unit 6: Introduction to Materials Handling

Competencies and Suggested Objectives
1. Safely handle and store materials. DOK 2, IMH a. Define a load. b. Establish a pre-task plan prior to moving a load. c. Use proper materials-handling techniques. d. Choose appropriate materials-handling equipment for the task. e. Recognize hazards and follow safety procedures required for materials handling.

Unit 7:Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting

Competencies and Suggested Scenarios
1. Identify and use tools found in the Industrial Maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools. DOK2, TTI a. Illustrate the use of tools used in the Industrial Maintenance profession. b. Identify and use common hand and power tools used in the Industrial Maintenance trade.
2. Identify various fasteners and anchors found in the Industrial Maintenance trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application. DOK2, FAN a. Identify and install threaded fasteners, non-threaded fasteners, and anchors. b. Identify various grades of bolt hardness.
3. Identify and describe the basic equipment, setup, and safety rules for proper use of oxy-fuel equipment. DOK2, OXC a. Identify and explain the use of oxy-fuel equipment. b. Demonstrate how to use an oxy-fuel torch. c. Perform oxy-fuel cutting: • Straight line and square shapes • Piercing and slot cutting • Bevels • Washing

Unit 8: Introduction to the National Electrical Code

Competencies and Suggested Objectives
1. Describe the purpose of the NEC, reference NEC code, and explain current applications of the NEC. DOK2, NEC a. Explain the purpose and history of the National Electrical Code (NEC). b. Use the NEC to reference industrial applications. c. Explain the role of nationally recognized testing laboratories.

Unit 9: Basic Electrical

Competencies and Suggested Objectives
1. Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits. DOK2, BEL a. Describe how voltage, current, resistance, and power are mathematically related. b. Describe the difference between series and parallel circuits, and calculate loads in each. c. Describe the purpose and operation of the various electrical components used in equipment.

Unit 10: Copper and Plastic Piping, and Soldering and Brazing

Competencies and Suggested Scenarios
1. Demonstrate the safe use and routine maintenance of hand and power tools used in the Industrial Maintenance trade. DOK2, IHT, IPT a. Demonstrate the safe use and maintenance of hand and power tools used in Industrial Maintenance.
2. Identify and discuss the tools used in the piping trade, discuss the materials and methods of connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and Industrial Maintenance environment. DOK2, CPP a. Discuss and demonstrate how to use copper tubing in Industrial Maintenance. b. Discuss and demonstrate how to use plastic tubing in Industrial Maintenance.
3. Prepare and solder copper piping systems in various industrial and Industrial Maintenance applications and properly clean, install fittings, and braze piping (silver solder) DOK2, SBR a. Solder copper pipe in Industrial Maintenance. b. Braze copper pipe in Industrial Maintenance.

Unit 11: Safety Review and Orientation to the Trade

Review and Reinforcement

Competencies and Suggested Objectives
1. Describe local program and vocational/career technical center policies and procedures. DOK2 a. Describe local program and vocational/career technical center policies and procedures.
2. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. DOK2 a. Demonstrate effective team-building and leadership skills. b. Demonstrate through practice appropriate work ethics.
3. Orientation to the Trade. DOK2, OTT, EMP a. Describe the types of work performed by industrial maintenance craftworkers. g. Identify career opportunities available to industrial maintenance craftworkers. h. Explain the purpose and objectives of an apprentice training program. i. Explain the responsibilities and characteristics of a good industrial maintenance craftworker. j. Explain the importance of safety in relation to industrial maintenance craftworkers. k. Explain the role of NCCER in the training process.

Unit 12: Craft Related Mathematics

Competencies and Suggested Objectives
1. Identify and explain measuring devices, solve geometric mathematical problems, and use weights and measurement standards. DOK2, CRM a. Discuss mathematics used in the installation and services industry.

Unit 13: Gaskets and Packing, Pumps and Drivers, Introduction to Valves, and Lubrication

Competencies and Suggested Objectives
1. Identify different types of gasket and packing materials, list their applications, and install gaskets and packing. DOK2, GAP a. Identify the various types and materials of gaskets. b. Describe the use of O-rings in the installation and service trade. c. Describe the uses and methods of packing in the installation and service trade.
2. Identify types of pumps and prime movers, and explain pressure differential between inlet and outlet of pumps. DOK2, PAD a. Identify and explain centrifugal, rotary, reciprocating, metering, and vacuum pumps. b. Explain net positive suction head and cavitation. c. Identify types of drivers.
3. Identify types of valves, and explain how to store and properly install valves. DOK2, ITV a. Identify types of valves that start, stop, regulate, relieve pressure, and regulate direction of flow. b. Explain how to properly store, handle, and mount valves in various locations and positions.
4. Describe and explain lubricant classification, additives, uses, and environments regulation regarding disposal of oils and greases. DOK2, LUB a. Explain regulatory law regarding industrial lubricants. b. Explain how lubricants protect mechanical machinery. c. Explain the properties and handling of lubricants and grease.

Unit 14: Construction Drawings, Test Equipment, Material Handling and Rigging, Mobile and Support Equipment

Competencies and Suggested Objectives
1. Identify and explain measuring devices, solve geometric mathematical problems, and use weights and measurement standards. DOK2, CRM a. Discuss mathematics used in the installation and services industry.
2. Identify components of the blueprint and scales, and perform projects from blueprints. DOK2, CDI a. Read and draw a basic blueprint found in the installation and service area.
3. Identify and explain the use of various test equipment used in the trade, differentiate between analog and digital meter readouts, and properly test circuits and mechanisms using available school metering devices. DOK2, ITE a. Explain the operation of the following pieces of test equipment: • Tachometer • Pyrometers • Multimeters • Automated diagnostics tools • Wiggy voltage tester • Stroboscope • Frequency meter b. Explain how to read and convert from one scale to another using the above test equipment.
4. Identify and explain safe rigging practices, load distribution, hand signals, and rigging equipment. DOK2, MHR a. Identify, describe the uses of, inspect, and maintain common rigging hardware and equipment, including the following: 2. • Jacks 3. • Block and tackle 4. • Chain hoists 5. • Come-alongs b. Tie knots used in rigging. c. Identify basic rigging and crane safety procedures, and use the correct hand signals to guide a crane operator.

5. Recognize types of mobile and support equipment found in the trade, explain the application for each device, and safely use equipment. DOK2, MSE

   a. State and explain the safety precautions, operation, and application associated with the use of motor-driven equipment commonly used in industrial plants, such as the following:

      6. • Portable generators
      7. • Air compressors
      8. • Aerial lifts
      9. • Forklifts
      10. • Mobile cranes

   b. Operate and perform preventive maintenance on the following equipment:

      11. • Portable generators
      12. • Air compressors
      13. • Aerial lifts

Unit 15: Conduit Bending

Competencies and Suggested Objectives
1. Identify types of conduit and sizes, bend various radiuses, and properly install conduit according to National Electrical Code. DOK2, HBE a. Identify the methods for hand bending and installing conduit.

Unit 16: Electrical Theory, Conductor Terminations and Splices, Hydraulic & Pneumatic Controls

Competencies and Suggested Objectives
1. Describe the units of measure of electricity and the types of circuits, define Ohm's and Kirchhoff's laws, and troubleshoot a simple circuit. DOK2, ETO, ALT a. Discuss the properties and physical laws of electricity. b. Identify the meters used to measure voltage, current, and resistance. c. Discuss the properties of a series and parallel circuit. d. Discuss the properties of alternating current.
2. Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices. DOK2, CON a. Describe how to make a conductor termination. b. Prepare cable ends for terminations and splices, and connect the ends using lugs or connectors. c. Train cable at termination points. d. Describe the National Electrical Code requirements for making cable terminations and splices.
3. Explain the principles of hydraulic and pneumatic systems. DOK2, HDC, PNC a. Discuss the principles of industrial hydraulics. b. Discuss the principles of industrial pneumatics.

Unit 17: Shielded Metal Arc Welding (SMAW)

Competencies and Suggested Scenarios
1. Perform basic SMAW welding operations. DOK2, WES, BMP, SMA a. Practice safety procedures for SMAW welding operations. b. Prepare base metal for SMAW welding. c. Demonstrate basic elements and techniques used in SMAW welding. d. Fabricate welding project to specifications.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Introduction and Orientation		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Describe employment opportunities and responsibilities.
	3.	Research, design, and conduct a project that will apply the knowledge and skills learned in the Maintenance, Installation & Repair Pathway course in a real-world, unpredictable environment.
	4.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
Unit 2: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the manufacturing industry. DOK
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.
	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection, ladder, stair, and scaffold procedures and requirements.
	6.	Explain the material safety data sheet (MSDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 3: Introduction to Construction Math		

	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
Unit 4: Hand and Power Tools		
	1.	Demonstrate the use and maintenance of hand and power tools.
Unit 5: Introduction to Construction Drawings		
	1.	Read, analyze, and understand basic components of a blueprint.
Unit 6: Introduction to Materials Handling		
	1.	Safely handle and store materials.
Unit 7: Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting		
		Identify and use tools found in the Industrial Maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools.
	2.	Identify various fasteners and anchors found in the Industrial Maintenance trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application.
	3.	Identify and describe the basic equipment, setup, and safety rules for proper use of oxy-fuel equipment.
Unit 8: Introduction to the National Electrical Code		
	1.	Describe the purpose of the NEC, reference NEC code, and explain current applications of the NEC.
Unit 9: Basic Electrical		
	1.	Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits.
Unit 10: Copper and Plastic Piping, and Soldering and Brazing		
	1.	Demonstrate the safe use and routine maintenance of hand and power tools used in the Industrial Maintenance trade.
	2.	Identify and discuss the tools used in the piping trade, discuss the materials and methods of connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and Industrial Maintenance environment.

	3.	Prepare and solder copper piping systems in various industrial and Industrial Maintenance applications and properly clean, install fittings, and braze piping (silver solder)
Unit 11: Safety Review and Orientation to the Trade (Review and Reinforcement)		
	1.	Describe local program and vocational/career technical center policies and procedures.
	2.	Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA.
	3.	Orientation to the Trade.
Unit 12: Craft Related Mathematics		
	1.	Identify and explain measuring devices, solve geometric mathematical problems, and use weights and measurement standards.

Unit 13: Gaskets and Packing, Pumps and Drivers, Introduction to Valves, and Lubrication		
	1.	Identify different types of gasket and packing materials, list their applications, and install gaskets and packing.
	2.	Identify types of pumps and prime movers, and explain pressure differential between inlet and outlet of pumps.
	3.	Identify types of valves, and explain how to store and properly install valves.
	4.	Describe and explain lubricant classification, additives, uses, and environments regulation regarding disposal of oils and greases.
Unit 14: Construction Drawings, Test Equipment, Material Handling and Rigging, Mobile and Support Equipment		
	1.	Identify and explain measuring devices, solve geometric mathematical problems, and use weights and measurement standards.
	2.	Identify components of the blueprint and scales, and perform projects from blueprints.
	3.	Identify and explain the use of various test equipment used in the trade, differentiate between analog and digital meter readouts, and properly test circuits and mechanisms using available school metering devices.
	4.	Identify and explain safe rigging practices, load distribution, hand signals, and rigging equipment.
	5	Recognize types of mobile and support equipment found in the trade, explain the application for each device, and safely use equipment.
Unit 15: Conduit Bending		
	1.	Identify types of conduit and sizes, bend various radiuses, and properly install conduit according to National Electrical Code.
Unit 16: Electrical Theory, Conductor Terminations and Splices, Hydraulic & Pneumatic Controls		
	1.	Describe the units of measure of electricity and the types of circuits, define Ohm's and Kirchhoff's laws, and troubleshoot a simple circuit.
	2.	Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices.
	3.	Explain the principles of hydraulic and pneumatic systems.
Unit 17: Shielded Metal Arc Welding (SMAW)		
	1.	Perform basic SMAW welding operations.

Appendix A: Unit References

General Books and Trade Publications

All of the Construction Core references listed under General Books and Trade Publications are used for multiple units. Unit-specific references are listed under the appropriate unit number.

Choices [Computer software]. (n.d.). Ogdensburg, NY: Careerware, IMS Information Systems Management.

Davies, D. (1997). *Grammar? No problem!* Mission, KS: SkillPath.

Gould, M. C. (2002). *Developing literacy and workplace skills*. Bloomington, IN: National Education Service. Local District Policy Handbook.

National Center for Construction Education and Research. (2009). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.

National Center for Construction Education and Research. (2007). *Industrial maintenance level I*. Upper Saddle River, NJ: Pearson Prentice Hall.

National Center for Construction Education and Research. (2007). *Industrial maintenance level II*. Upper Saddle River, NJ: Pearson Prentice Hall.

National Center for Construction Education and Research. (2009). *Tools for success*. Upper Saddle River, NJ: Pearson Prentice Hall.

SkillsUSA. (2002). *Leadership and competition curricula.* Tinley Park, IL: Goodheart-Willcox.

Unit 1

Green, D., & Gosse, J. (2000). *Industrial maintenance.* Homewood, IL: American Technical.

Kibbe, R. (2002). *Mechanical systems for industrial maintenance*. Upper Saddle River, NJ: Pearson Prentice Hall.

Unit 2

American Association for Vocational Instructional Materials. (2002). *Developing safety skills for shop or home.* Winterville, GA: Author.

Bevelacqua, A., & Stilp, R. (2007). *Hazardous materials field guide.* Albany, NY: Delmar.

The Construction Safety Council. (n.d.). Retrieved August 30, 2012, from http://www.buildsafe.org/

Earth Communications. (2004). *Safety on the job part 1: Standards of personal protection and health care* [Videotape]. (Available from Earth Communications, 2370 Proffit Rd., Charlottesville, VA 22911)

Earth Communications. (2004). *Safety on the job part 2: Fire protection, warnings and power tools* [Videotape]. (Available from Earth Communications, 2370 Proffit Rd., Charlottesville, VA 22911)

Goetsch, D. (2000). *The safety and health handbook.* Upper Saddle River, NJ: Pearson Prentice Hall.

Unit 3

Barrows, R., & Jones, B. (2002). *Fundamentals of math with career applications*. Upper Saddle River, NJ: Pearson Prentice Hall.

Boyce, J., Margolis, L., & Slade, S. (2000). *Mathematics for technical and vocational students*. Upper Saddle River, NJ: Prentice Hall.

Carman, R., & Saunders, H. (2011). *Mathematics for the trades: A guided approach*. Upper Saddle River, NJ: Pearson Prentice Hall.

Cook, N. (2004). *Introductory mathematics.* Upper Saddle River, NJ: Pearson Prentice Hall.

Cook, N. (2004). *Mathematics for technical trades.* Upper Saddle River, NJ: Pearson Prentice Hall.

Unit 10

American Association for Vocational Instructional Materials. (2002). *Developing safety skills for shop or home.* Winterville, GA: Author.

Bevelacqua, A., & Stilp, R. (2007). *Hazardous materials field guide.* Albany, NY: Delmar.

The Construction Safety Council. (n.d.). Retrieved August 30, 2012, from http://www.buildsafe.org/

Earth Communications. (2004). *Safety on the job part 1: Standards of personal protection and health care* [Videotape]. (Available from Earth Communications, 2370 Proffit Rd., Charlottesville, VA 22911)

Earth Communications. (2004). *Safety on the job part 2: Fire protection, warnings and power tools* [Videotape]. (Available from Earth Communications, 2370 Proffit Rd., Charlottesville, VA 22911)

Goetsch, D. (2000). *The safety and health handbook.* Upper Saddle River, NJ: Pearson Prentice Hall.

Appendix B: Industry Standards

INDUSTRIAL SERVICES PATHWAY

CONTENT STANDARDS AND PERFORMANCE ELEMENTS[2]

Crosswalk for Industrial Maintenance (Units 1-8)									
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**
OTT - MODULE 40101-07 – ORIENTATION TO THE TRADE		X							
GAP - MODULE 40105-07 – GASKETS AND PACKING			X						
CRM - MODULE 40106-07 – CRAFT-RELATED MATHEMATICS				X			X		X
CDI - MODULE 40107-07 – CONSTRUCTION DRAWINGS				X		X			
PAD - MODULE 40108-07 – PUMPS AND DRIVERS			X						
ITV - MODULE 40109-07 – INTRODUCTIONTO VALVES			X						
ITE - MODULE 40110-07 – INTRODUCTIONTOTEST EQUIPMENT				X			X		
MHR - MODULE 40111-07 – MATERIAL HANDLING AND HAND RIGGING				X			X	X	
MSE - MODULE 40112-07 – MOBILE AND SUPPORT EQUIPMENT				X			X	X	
LUB - MODULE 40113-07 – LUBRICATION			X						
IME & INSTRUMENTATION TECHNICIAN LEVEL 2									
WEL - MODULE 29101-09, MODULE 29105-09, MODULE 29109-09,			X					X	
NEC - MODULE 40202-08 Introduction to the National Electrical Code					X	X		X	X
ETO - MODULE 40203-08 Electrical Theory					X			X	X
ALT - MODULE 40204-08 Alternating Current					X			X	X
HBE - MODULE 40208-08 Hand Bending				X				X	
CON - MODULE 40213-08 Conductor Terminations and Splices					X			X	
HDC - MODULE 40311-09 Hydraulic Controls					X				

[2] *NCCER learning series.* Retrieved April 22, 2013, from http://www.nccer.org/

~~PNC – MODULE 40312-09 Pneumatic Controls~~					~~X~~			~~X~~	

	Crosswalk for Industrial Maintenance (Units 9-17)									
	Units	Unit 9	Unit 10	Unit 10	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17
OTT - MODULE 40101-07 - ORIENTATION TO THE TRADE				X						
GAP - MODULE 40105-07 - GASKETS AND PACKING						X				
CRM - MODULE 40106-07 - CRAFT-RELATED MATHEMATICS		X	X		X	X	X		X	
CDI - MODULE 40107-07 - CONSTRUCTION DRAWINGS			X				X			
PAD - MODULE 40108-07 - PUMPS AND DRIVERS						X				
ITV - MODULE 40109-07 - INTRODUCTIONTO VALVES						X				
ITE - MODULE 40110-07 - INTRODUCTIONTOTEST EQUIPMENT							X			
MHR - MODULE 40111-07 - MATERIAL HANDLING AND HAND RIGGING				X		X	X			
MSE - MODULE 40112-07 - MOBILE AND SUPPORT EQUIPMENT			X	X		X	X			
LUB - MODULE 40113-07 - LUBRICATION						X	X			
IME & INSTRUMENTATION TECHNICIAN LEVEL 2										
WEL - MODULE 29101-09, MODULE 29105-09, MODULE 29109-09,			X							X
NEC - MODULE 40202-08 Introduction to the National Electrical Code		X	X		X					
ETO - MODULE 40203-08 Electrical Theory		X	X		X				X	
ALT - MODULE 40204-08 Alternating Current		X							X	
HBE - MODULE 40208-08 Hand Bending			X				X	X		
CON - MODULE 40213-08 Conductor Terminations and Splices									X	
HDC - MODULE 40311-09 Hydraulic Controls							X		X	
PNC - MODULE 40312-09 Pneumatic Controls			X						X	

~~NCCER CORE~~

~~BAS – 00101-09 – Introduction to Basic Safety~~

~~EMP – 00108-09 – Basic Employability Skills~~

~~IM E&I Technician Level 1~~

~~OTT - MODULE 40101-07 – ORIENTATION TO THE TRADE~~

~~GAP - MODULE 40105-07 – GASKETS AND PACKING~~

~~CRM - MODULE 40106-07 – CRAFT-RELATED MATHEMATICS~~

~~CDI - MODULE 40107-07 – CONSTRUCTION DRAWINGS~~

~~PAD - MODULE 40108-07 – PUMPS AND DRIVERS~~

~~ITV - MODULE 40109-07 – INTRODUCTIONTO VALVES~~

~~ITE - MODULE 40110-07 – INTRODUCTIONTOTEST EQUIPMENT~~

~~MHR - MODULE 40111-07 – MATERIAL HANDLING AND HAND RIGGING~~

~~MSE - MODULE 40112-07 – MOBILE AND SUPPORT EQUIPMENT~~

~~LUB - MODULE 40113-07 – LUBRICATION~~

~~Industrial Maintenance E&I Technician Level 2~~

~~NEC – MODULE 40202-08 Introduction to the National Electrical Code~~

~~ETO – MODULE 40203-08 Electrical Theory~~

~~ALT – MODULE 40204-08 Alternating Current~~

~~HBE – MODULE 40208-08 Hand Bending~~

~~CON – MODULE 40213-08 Conductor Terminations and Splices~~

~~Industrial Maintenance E&I Technician Level 3~~

~~HDC – MODULE 40311-09 Hydraulic Controls~~

~~PNC – MODULE 40312-09 Pneumatic Controls~~

~~Welding Level 1~~

~~WES – MODULE 29101-09 Welding Safety~~

~~BMP - MODULE 29105-09 Base Metal Preparation~~

~~SMA - MODULE 29109-09 SMAW Beads and Fillet Welds~~

Appendix C: 21st Century Skills[3]

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
21st Century Standards									
CS1		X				X	X	X	X
CS2		X	X			X		X	
CS3		X				X	X		
CS4		X	X	X	X			X	X
CS5		X	X	X	X			X	X
CS6		X	X	X	X	X	X	X	X
CS7		X	X	X	X	X	X	X	X
CS8		X	X	X	X	X	X	X	X
CS9		X		X		X			
CS10		X		X					
CS11		X		X	X	X	X	X	X
CS12		X	X	X	X	X	X	X	X
CS13		X	X	X	X	X	X	X	X
CS14		X	X	X	X	X	X	X	X
CS15		X	X	X	X	X	X	X	X
CS16		X	X	X	X	X	X	X	X

	Units	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17
21st Century Standards										
CS1		X	X	X	X					
CS2				X	X	X				X
CS3				X	X					
CS4		X	X	X		X	X		X	X
CS5		X	X	X	X	X	X		X	X
CS6		X	X	X	X	X	X	X	X	X
CS7		X	X	X	X	X	X	X	X	X
CS8		X	X	X	X	X	X	X	X	X
CS9				X	X		X			
CS10				X	X		X			
CS11		X	X	X	X		X		X	
CS12		X	X	X	X	X	X		X	X
CS13		X	X	X	X	X	X		X	X
CS14		X	X	X	X	X	X		X	X
CS15		X	X	X	X	X	X		X	X
CS16		X	X	X	X	X	X		X	X

CSS1 21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices

[3] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2 Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3 Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix D: College and Career Ready Standards

English Standards					
	Units	Unit 1	Unit 2	Unit 3	Unit 4
RL.11.1		X			
RL.11.4				X	
RI.11.4				X	X
RI.11.7				X	
SL.11.4				X	
SL.11.5				X	
L.11.2				X	

College and Career Readiness English I

Reading Literature Key Ideas and Details

RL.9.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

RL.9.2 Determine a theme or central idea of a text and analyze in detail its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.

RL.9.3 Analyze how complex characters (e.g., those with multiple or conflicting motivations) develop over the course of a text, interact with other characters, and advance the plot or develop the theme.

Craft and Structure

RL.9.4 Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language evokes a sense of time and place; how it sets a formal or informal tone).

RL.9.5 Analyze how an author's choices concerning how to structure a text, order events within it (e.g., parallel plots), and manipulate time (e.g., pacing, flashbacks) create such effects as mystery, tension, or surprise.

RL.9.6 Analyze a particular point of view or cultural experience reflected in a work of literature from outside the United States, drawing on a wide reading of world literature.

Integration of Knowledge and Ideas

RL.9.7 Analyze the representation of a subject or a key scene in two different artistic mediums, including what is emphasized or absent in each treatment (e.g., Auden's "Musée des Beaux Arts" and Breughel's Landscape with the Fall of Icarus).

RL.9.8 Not applicable to literature.

College and Career Readiness English I

RL.9.9 Analyze how an author draws on and transforms source material in a specific work (e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare).

~~Range of Reading and Level of Text Complexity~~

~~RL.9.10 By the end of grade 9, read and comprehend literature, including stories, dramas, and poems, in the grades 9-10 text complexity band proficiently, with scaffolding as needed at the high end of the range.~~

College and Career Readiness English I

Reading Informational Text Key Ideas and Details

RI.9.3 Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.

Craft and Structure

RI.9.5 Analyze in detail how an author's ideas or claims are developed and refined by particular sentences, paragraphs, or larger portions of a text (e.g., a section or chapter).
RI.9.6 Determine an author's point of view or purpose in a text and analyze how an author uses rhetoric to advance that point of view or purpose.

Integration of Knowledge and Ideas

RI.9.7 Analyze various accounts of a subject told in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.
RI.9.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.
RI.9.9 Analyze seminal U.S. documents of historical and literary significance (e.g., Washington's Farewell Address, the Gettysburg Address, Roosevelt's Four Freedoms speech, King's "Letter from Birmingham Jail"), including how they address related themes and concepts.

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Writing Text Types and Purposes

W.9.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
W.9.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.
W.9.1b Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.
W.9.1c Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
W.9.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
W.9.1e Provide a concluding statement or section that follows from and supports the argument presented.
W.9.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
W.9.2a Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
W.9.2b Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
W.9.2c Use appropriate and varied transitions to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

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W.9.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic.
W.9.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

W.9.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
W.9.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W.9.3a Engage and orient the reader by setting out a problem, situation, or observation, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.
W.9.3b Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.
W.9.3c Use a variety of techniques to sequence events so that they build on one another to create a coherent whole.
W.9.3d Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
W.9.3e Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.9.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)
W.9.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10.)
W.9.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

W.9.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

College and Career Readiness English I

W.9.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
W.9.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
W.9.9a Apply grades 9–10 Reading standards to literature (e.g., "Analyze how an author draws on and transforms source material in a specific work [e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare]").
W.9.9b Apply grades 9–10 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning").

Range of Writing

W.9.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audience.

College and Career Readiness English I

SL.9.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
SL.9.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
SL.9.1b Work with peers to set rules for collegial discussions and decision making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.
SL.9.1c Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
SL.9.1d Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.
SL.9.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.
SL.9.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence.

Presentation of Knowledge and Ideas

SL.9.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

College and Career Readiness English I

SL.9.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
SL.9.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grades 9–10 Language standards 1 and 3 for specific expectations.)

College and Career Readiness English I

Language

Conventions of Standard English

L.9.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
L.9.1a Use parallel structure.*
L.9.1b Use various types of phrases (noun, verb, adjectival, adverbial, participial, prepositional, absolute) and clauses (independent, dependent; noun, relative, adverbial) to convey specific meanings and add variety and interest to writing or presentations.
L.9.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
L.9.2a Use a semicolon (and perhaps a conjunctive adverb) to link two or more closely related independent clauses.
L.9.2b Use a colon to introduce a list or quotation.
L.9.2c Spell correctly

Knowledge of Language

L.9.3 Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening

L.9.3a Write and edit work so that it conforms to the guidelines in a style manual (e.g., MLA Handbook, Turabian's Manual for Writers) appropriate for the discipline and writing type.

Vocabulary Acquisition and Use

L.9.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies.
L.9.4a Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.
L.9.4b Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., analyze, analysis, analytical; advocate, advocacy).

College and Career Readiness English I

L.9.4c Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, or its etymology.
L.9.4d Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
L.9.5 Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
L.9.5a Interpret figures of speech (e.g., euphemism, oxymoron) in context and analyze their role in the text.
L.9.5b Analyze nuances in the meaning of words with similar denotations.
L.9.6 Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

College and Career Readiness English II

Range of Reading and Level of Text Complexity

RL.10.10 By the end of grade 10, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 9-10 text complexity band independently and proficiently.

Grades 9-10: Literacy in History/SS

Reading in History/Social Studies Key Ideas and Details

RH.9-10.1 Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.
RH.9-10.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.
RH.9-10.3 Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.

Craft and Structure

RH.9-10.4 Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.
RH.9-10.5 Analyze how a text uses structure to emphasize key points or advance an explanation or analysis.
RH.9-10.6 Compare the point of view of two or more authors for how they treat the same or similar topics, including which details they include and emphasize in their respective accounts.

Integration of Knowledge and Ideas

RH.9-10.7 Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
RH.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claims.
RH.9-10.9 Compare and contrast treatments of the same topic in several primary and secondary sources.

Range of Reading and Level of Text Complexity

RH.9-10.10 By the end of grade 10, read and comprehend history/social studies texts in the grades 9-10 text complexity band independently and proficiently.

Grades 9-10: Literacy in Science and Technical Subjects

Reading in Science and Technical Subjects Key Ideas and Details

RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
RST.9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts

Range of Reading and Level of Text Complexity

RST.9-10.10 By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Grades 9-10: Writing in History/SS, Science, and Technical Subjects

Writing Text Types and Purposes

WHST.9-10.1 Write arguments focused on discipline-specific content.
WHST.9-10.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
WHST.9-10.1b Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

WHST.9-10.1c Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
WHST.9-10.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
WHST.9-10.1e Provide a concluding statement or section that follows from or supports the argument presented.
WHST.9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.9-10.2a Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
WHST.9-10.2b Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

Grades 9-10

Writing in History/SS, Science, and Technical Subjects

WHST.9-10.2c Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
WHST.9-10.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
WHST.9-10.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
WHST.9-10.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
WHST.9-10.3 Not Applicable

Production and Distribution of Writing

WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
WHST.9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
WHST.9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

WHST.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.

Grades 9-10

Writing in History/SS, Science, and Technical Subjects

Range of Writing

WHST.9-10.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

English III

Reading Literature Key Ideas and Details

RL.11.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
RL.11.2 Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
RL.11.3 Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4 Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)
RL.11.5 Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.
RL.11.6 Analyze a case in which grasping a point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7 Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)
RL.11.8 Not applicable to literature.
RL.11.9 Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10 By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

English III

Reading Informational Text Key Ideas and Details

Rl.11.3 Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure

RI.11.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
RI.11.5 Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.
RI.11.6 Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.

Integration of Knowledge and Ideas

RI.11.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.
RI.11.8 Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).
RI.11.9 Analyze seventeenth , eighteenth , and nineteenth century foundational U.S. documents of historical and literary significance (including Them Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity

RI.11.10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11 *CCR* text complexity band proficiently, with scaffolding as needed at the high end of the range.

English III

Writing

W.11.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
W.11.1a Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.
W.11.1b Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.
W.11.1c Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
W.11.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
W.11.1e Provide a concluding statement or section that follows from and supports the argument presented.
W.11.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
W.11.2a Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

English III

W.11.2b Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

W.11.2c Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
W.11.2d Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.
W.11.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
W.11.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
W.11.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W.11.3a Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.
W.11.3b Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.
W.11.3c Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).
W.11.3d Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
W.11.3e Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

English III

W.11.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12.)
W.11.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
W.11.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
W.11.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
W.11.9a Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").
W.11.9b Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

English III

Speaking and Listening

Comprehension and Collaboration

SL.11.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
SL11.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
SL.11.1b Work with peers to promote civil, democratic discussions and decision making, set clear goals and deadlines, and establish individual roles as needed.
SL.11.1c Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.
SL.11.1d Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.
SL.11.2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
SL.11.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4 Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

English III

SL11.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
SL.11.6 Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 for specific expectations.)

English III

Language

Conventions of Standard English

L.11.1a Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.
L.11.1b Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.
L.11.2a Observe hyphenation conventions.
L.11.3a Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.
L.11.4b Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

English IV

Range of Reading and Level of Text Complexity

RL.12.10 By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Grades 11-12: Literacy in History/SS

Reading in History/Social Studies Key Ideas and Details

RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.
RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.
RH.11-12.3 Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain. Craft and Structure
RH.11-12.4 Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
RH.11-12.5 Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.
RH.11-12.6 Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence. Integration of Knowledge and Ideas
Rh.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.
RH.11-12.8 Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.
RH.11-12.9 Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources. Range of Reading and Level of Text Complexity
RH.11-12.10 By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Grades 11-12: Literacy in Science and Technical Subjects

Reading in Science and Technical Subjects Key Ideas and Details

RST. 11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

RST.11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
RST.11-12.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11-12.10 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Grades 11-12: Writing | History/SS, Science and Technical Subjects

Writing

Text Types and Purposes

WHST.11-12.1a Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
WHST.11-12.1b Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
WHST.11-12.1c Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
WHST.11-12.2a Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

Grades 11-12: Writing | History/SS, Science and Technical Subjects

WHST.11-12.2d Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

Production and Distribution of Writing

WHST.11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Appendix D: College and Career Ready Standards

Mathematics Standards					
	Units	Unit 1	Unit 2	Unit 3	Unit 4
N-Q.1				X	
N-Q.2				X	
N-Q.3				X	
A-CED.1				X	
A-CED.2				X	
A-CED.3				X	
A-CED.4				X	
G-CO.1				X	
G-CO.12			X	X	
G-SRT.8				X	
G-GMD.3				X	
G-GMD.4				X	
G-MG.1				X	
G-MG.2				X	
G-MG.3				X	

Number and Quantity

Reason quantitatively and use unites to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Analyze and solve linear equations and pairs of simultaneous linear equations

8.EE.8 Analyze and solve pairs of simultaneous linear equations.

a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, 3x + 2y = 5 and 3x + 2y = 6 have no solution because 3x + 2y cannot simultaneously be 5 and 6.

c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Creating equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Define, evaluate, and compare functions

8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. 1

8.F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

8.F.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function A = s2 giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

Use functions to model relationships between quantities

8.F.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

~~Understand the concept of a function and use function notation~~

~~F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).~~

~~F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.~~

~~F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.~~

~~Interpret functions that arise in applications in terms of the context~~

~~F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*~~

~~F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*~~

~~F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.* Analyze functions using different representations Supporting~~

~~F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* a. Graph linear and quadratic functions and show intercepts, maxima, and minima.~~

~~F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.~~

~~Build a function that models a relationship between two quantities~~

~~F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.~~

~~F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*~~

~~Construct and compare linear, quadratic, and exponential models and solve problems~~

~~F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*~~

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.* Interpret expressions for functions in terms of the situation they model Supporting

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Geometry

Understand and apply the Pythagorean Theorem

8.G.6 Explain a proof of the Pythagorean Theorem and its converse.

8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Statistics and Probability

Investigate patterns of association in bivariate data

8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

8.SP.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Algebra I

Number and Quantity

Use properties of rational and irrational numbers

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2 thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

a. Factor a quadratic expression to reveal the zeros of the function it defines.

b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra I

Perform arithmetic operations on polynomials

A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Understand the relationship between zeros and factors of polynomials

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x – p) 2 = q that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Algebra I

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Algebra I

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum. B

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Algebra I

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Statistics and Probability *

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Geometry Course

Geometry

Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Geometry Course

Make geometric constructions

G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:

a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems involving similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar

G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section A

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

~~Use coordinates to prove simple geometric theorems algebraically~~

~~G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).~~

~~G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).~~

~~G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.~~

~~G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*~~

~~Explain volume formulas and use them to solve problems~~

~~G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.~~

~~G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*~~

~~Visualize relationships between two-dimensional and three-dimensional objects~~

~~G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.~~

~~Apply geometric concepts in modeling situations~~

~~G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*~~

~~G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*~~

~~G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*~~

~~Algebra II~~

~~Number and Quantity~~

~~Extend the properties of exponents to rational exponents~~

~~N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational~~

exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.

N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = –1, and every complex number has the form a + bi with a and b real.

N-CN.2 Use the relation i 2 = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra

Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.* c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra II

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

~~Use polynomial identities to solve problems~~

~~A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 – y 2) 2 + (2xy)2 can be used to generate Pythagorean triples.~~

~~Rewrite rational expressions~~

~~A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.~~

~~Create equations that describe numbers or relationships~~

~~A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*~~

~~Understand solving equations as a process of reasoning and explain the reasoning~~

~~A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.~~

~~A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.~~

~~Solve equations and inequalities in one variable~~

~~A-REI.4 Solve quadratic equations in one variable. b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.~~

~~Algebra II~~

~~Solve systems of equations~~

~~A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.~~

~~A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = -3x and the circle x2 + y2 = 3.~~

~~Represent and solve equations and inequalities graphically~~

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Functions

Understand the concept of a function and use function notation

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Algebra II

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t , y = (0.97)t , y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2x 3 or f(x) = (x+1)/(x 1) for x ≠ 1.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Algebra II

Extend the domain of trigonometric functions using the unit circle

F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity sin (Θ)2 + cos (Θ)2 = 1 and use it to find sin (Θ), cos (Θ), or tan (Θ), given sin (Θ), cos (Θ), or tan (Θ) and the quadrant of the angle.

Geometry

Translate between the geometric description and the equation for a conic section

G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Statistics and Probability

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

Algebra II

Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.*

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics

Number and Quantity

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Integrated Mathematics I

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Integrated Mathematics I

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Integrated Mathematics I

~~Geometry~~

~~Experiment with transformations in the plane~~

~~G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.~~

~~G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).~~

~~G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.~~

~~G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.~~

~~G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.~~

~~Understand congruence in terms of rigid motions~~

~~G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.~~

~~G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.~~

~~G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.~~

~~Prove geometric theorems~~

~~G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.~~

~~G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.~~

~~G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.~~

~~Integrated Mathematics I~~

~~Statistics and Probability~~

~~Summarize, represent, and interpret data on a single count or measurement variable~~

~~S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*~~

~~S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*~~

~~S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*~~

~~Summarize, represent, and interpret data on two categorical and quantitative variables~~

~~S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*~~

~~S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*~~

~~a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.~~

~~c. Fit a linear function for a scatter plot that suggests a linear association.~~

~~Interpret linear models~~

~~S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*~~

~~S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*~~

~~S-ID.9 Distinguish between correlation and causation.*~~

~~Integrated Mathematics I~~

~~Number and Quantity~~

~~Extend the properties of exponents to rational exponents~~

~~N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.~~

~~N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.~~

~~Use properties of rational and irrational numbers~~

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = −1, and every complex number has the form a + bi with a and b real.

N-CN.2 Use the relation i 2 = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.* b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Integrated Mathematics II

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

a. Factor a quadratic expression to reveal the zeros of the function it defines.

b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Perform arithmetic operations on polynomials

A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning M

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x − p) 2 = q that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Solve systems of equations

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = -3x and the circle x2 + y2 = 3.

Functions

Interpret functions that arise in applications in terms of the context M

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

c. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Integrated Mathematics II

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

~~Geometry~~

~~Understand similarity in terms of similarity transformations~~

~~G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:~~

~~a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.~~

~~b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.~~

~~G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.~~

~~G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.~~

~~Prove theorems using similarity~~

~~G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.~~

~~G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.~~

~~Define trigonometric ratios and solve problems involving right triangles~~

~~G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.~~

~~G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.~~

~~Integrated Mathematics II~~

~~G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*~~

~~Explain volume formulas and use them to solve problems~~

~~G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.~~

~~G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*~~

~~Statistics and Probability*~~

~~Summarize, represent, and interpret data on two categorical and quantitative variables~~

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

Integrated Mathematics II

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics III

Number and Quantity

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Algebra

Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2 , thus recognizing it as a difference of squares that can be factored as (x2 – y 2)(x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Use polynomial identities to solve problems

A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 – y 2) 2 + (2xy)2 can be used to generate Pythagorean triples.

Rewrite rational expressions

A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

Integrated Mathematics III

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2x3 or f(x) = (x+1)/(x-1) for x ≠ 1.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

~~Extend the domain of trigonometric functions using the unit circle~~

~~F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.~~

~~F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.~~

~~Model periodic phenomena with trigonometric functions~~

~~F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*~~

~~Prove and apply trigonometric identities~~

~~F-TF.8 Prove the Pythagorean identity sin (Θ)2 + cos (Θ)2 = 1 and use it to find sin (Θ), cos (Θ), or tan (Θ), given sin (Θ), cos (Θ), or tan (Θ) and the quadrant of the angle.~~

~~Integrated Mathematics III~~

~~Geometry~~

~~Make geometric constructions~~

~~G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.~~

~~G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.~~

~~Understand and apply theorems about circles~~

~~G-C.1 Prove that all circles are similar.~~

~~G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.~~

~~G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.~~

~~Find arc lengths and areas of sectors of circles~~

~~G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.~~

~~Translate between the geometric description and the equation for a conic section~~

~~G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.~~

~~G-GPE.2 Derive the equation of a parabola given a focus and directrix.~~

~~Use coordinates to prove simple geometric theorems algebraically~~

~~G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).~~

~~G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).~~

Integrated Mathematics III

G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Statistics and Probability*

Summarize, represent, and interpret data on a single count or measurement variable S

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Integrated Mathematics III

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Advanced Mathematics Plus

Number and Quantity

Perform arithmetic operations with complex numbers

N-CN.3 Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

Represent complex numbers and their operations on the complex plane

N-CN.4 Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

N-CN.5 Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}\, i)^3 = 8$ because $(-1 + \sqrt{3}\, i)$ has modulus 2 and argument 120°.

N-CN.6 Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Use complex numbers in polynomial identities and equations

N-CN.8 Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.

N-CN.9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials

Represent and model with vector quantities

N-VM.1 Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).

N-VM.2 Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N-VM.3 Solve problems involving velocity and other quantities that can be represented by vectors.

Advanced Mathematics Plus

Perform operations on vectors

N-VM.4 Add and subtract vectors.

a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

c. Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

N-VM.5 Multiply a vector by a scalar.

a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy).

b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).

Perform operations on matrices and use matrices in applications

N-VM.6 Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

N-VM.7 Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

N-VM.8 Add, subtract, and multiply matrices of appropriate dimensions.

N-VM.9 Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.

N-VM.10 Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

N-VM.11 Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

N-VM.12 Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra

Use polynomial identities to solve problems

A-APR.5 Know and apply the Binomial Theorem for the expansion of (x + y) n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

Advanced Mathematics Plus

Rewrite rational expressions

A-APR.7 Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Solve systems of equations

A-REI.8 Represent a system of linear equations as a single matrix equation in a vector variable.

A-REI.9 Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

Functions

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

d. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities. *

c. Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

Build new functions from existing functions

F-BF.4 Find inverse functions.

b. Verify by composition that one function is the inverse of another.

c. Read values of an inverse function from a graph or a table, given that the function has an inverse.

d. Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Advanced Mathematics Plus

Extend the domain of trigonometric functions using the unit circle

F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π − x, π+x, and 2π − x in terms of their values for x, where x is any real number.

F-TF.4 Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

Model periodic phenomena with trigonometric functions

F-TF.6 Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7 Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. *

Prove and apply trigonometric identities

F-TF.9 Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Apply trigonometry to general triangles

G-SRT.9 Derive the formula A = ½ ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10 Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11 Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Understand and apply theorems about circles

G-C.4 Construct a tangent line from a point outside a given circle to the circle.

Translate between the geometric description and the equation for a conic section

Advanced Mathematics Plus

G-GPE.3 Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

Explain volume formulas and use them to solve problems

G-GMD.2 Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

Statistics and Probability*

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.8 Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.*

S-CP.9 Use permutations and combinations to compute probabilities of compound events and solve problems.*

Calculate expected values and use them to solve problems

S-MD.1 Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.*

S-MD.2 Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.*

S-MD.3 Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.*

S-MD.4 Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*

Advanced Mathematics Plus

~~Use probability to evaluate outcomes of decisions~~

~~S-MD.5 Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. *~~

~~a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.~~

~~b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*~~

~~S-MD.6 Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).*~~

~~S-MD.7 Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).*~~

Appendix E: International Society for Technology in Education Standards (ISTE)

ISTE Crosswalk for Industrial Maintenance									
	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
ISTE Standards									
T1		X	X	X	X				
T2		X	X	X	X		X		
T3		X		X	X				X
T4		X	X	X	X				
T5		X	X						
T6		X	X	X	X				

	ISTE Crosswalk for Industrial Maintenance									
	Course	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17
ISTE Standards										
T1				X			X			
T2		X	X	X	X	X	X	X	X	X
T3										
T4										
T5										
T6									X	X

~~**T1** Creativity and Innovation~~

~~**T2** Communication and Collaboration~~

~~**T3** Research and Information Fluency~~

~~**T4** Critical Thinking, Problem Solving, and Decision Making~~

~~**T5** Digital Citizenship~~

~~**T6** Technology Operations and Concepts~~

~~**T1** Creativity and Innovation~~

~~Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:~~

~~a. Apply existing knowledge to generate new ideas, products, or processes.~~

~~b. Create original works as a means of personal or group expression.~~

~~c. Use models and simulations to explore complex systems and issues.~~

~~d. Identify trends and forecast possibilities.~~

~~**T2** Communication and Collaboration~~

~~Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:~~

~~a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.~~

~~b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.~~

~~c. Develop cultural understanding and global awareness by engaging with learners of other cultures.~~

~~d. Contribute to project teams to produce original works or solve problems.~~

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.

b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.

d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.

b. Plan and manage activities to develop a solution or complete a project.

c. Collect and analyze data to identify solutions and/or make informed decisions.

d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.

b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.

c. Demonstrate personal responsibility for lifelong learning.

d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.

b. Select and use applications effectively and productively.

c. Troubleshoot systems and applications.

d. Transfer current knowledge to learning of new technologies.

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Miss. Admin. Code 7-79

2021 Television Broadcasting and Production

Program CIP: 09.0402 – Broadcasting Journalism

Direct inquiries to:

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Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

Table of Contents

Acknowledgments

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Dr. Carey M. Wright, state superintendent of education
Dr. Jason S. Dean, chair
Ms. Rosemary G. Aultman
Mr. Glen East
Dr. Karen J. Elam
Mr. Omar G. Jamil, student representative
Ms. Amy Zhang, student representative

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Standards

Standards and alignment crosswalks are referenced in the appendix. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE television broadcasting and production curriculum is aligned to the following standards:

National Career Clusters
The standards were extensively researched and reviewed by industry leaders, secondary and postsecondary instructors, and university specialists. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. A complete copy of the standards can be accessed at careertech.org/arts.

International Society for Technology in Education Standards (ISTE)
Reprinted with permission from *ISTE Standards for Students* (2016). All rights reserved. Permission does not constitute an endorsement by ISTE.
iste.org

College- and Career-Ready Standards
College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College and Career Ready Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/oae/college-and-career-readiness-standards

Framework for 21st Century Learning
In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. 21 *Framework Definitions* (2019).
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
: Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource
: Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call the RCU at 662.325.2510.

Executive Summary

Pathway Description
The television broadcasting and production program is designed to provide the foundation, skills, and knowledge for developing and producing broadcast-quality materials. Students will learn the skills necessary to work in a television and broadcasting production facility. They will acquire basic and advanced writing and video skills and the ability to provide support in all facets of a production studio. The program will provide hands-on experience in the areas of writing, editing, shooting, directing, and producing for commercial-grade broadcasts.

Grade Level and Class Size Recommendations
It is recommended that students enter this program as a ninth grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and student maturity. A maximum of 25 students is recommended for classroom-based courses, while a maximum of 15 students is recommended for lab-based courses.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning
If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

This curriculum consists of four 1-credit courses, which should be completed in the following sequence:

1. **Television Broadcasting and Production I—Course Code: 994602**
2. **Television Broadcasting and Production II—Course Code: 994603**
3. **Television Broadcasting and Production III—Course Code: 994604**
4. **Television Broadcasting and Production IV—Course Code: 994605**

Course Description: Television Broadcasting and Production I
This course introduces students to television broadcasting and production. Students will leave the class with a firm foundation of knowledge in the areas of employability skills, safety, and basic production knowledge.

Course Description: Television Broadcasting and Production II
This course identifies additional operational areas and their roles within the television and broadcasting production industry. Students will learn how the audio and editing features are incorporated within the industry and the proper techniques to use. Students will also gain an understanding of how to edit, produce, and direct a broadcast production. This course should only be taken after students successfully complete Television Broadcasting and Production I.

Course Description: Television Broadcasting and Production III
This course introduces students to advanced television broadcasting and production. Students will leave the class with further knowledge in the areas of employability skills, safety, and basic production knowledge. Additionally, students will learn advanced scriptwriting fundamentals. This course should only be taken after students successfully complete Television Broadcasting and Production II.

Course Description: Television Broadcasting and Production IV
This course provides a more in-depth view of the production process for video in broadcasting. Students are also introduced to adding music to a production as well as the ethical requirements in the field. This course should only be taken after students successfully complete Television Broadcasting and Production III.

Television Broadcasting and Production I—Course Code: 994602

Unit	Unit Name	Hours
1	Orientation, Safety, and Leadership	7
2	Employability Skills	15
3	Introduction to Television and the Production Industry	22
4	Camera Operation and Shot Composition	30
5	Audio for Film and Video	15
6	Basic Television Editing I	18
Total		107

Television Broadcasting and Production II—Course Code: 994603

Unit	Unit Title	Hours
7	Basic Television Editing II	18
8	Audio and Television Announcing	15
9	Scriptwriting	24
10	Producing/Directing a Television Program	36
11	Studio/Control Room Equipment	20
Total		113

Television Broadcasting and Production III—Course Code: 994604

Unit	Unit Name	Hours
12	Orientation, Safety, and Leadership	7
13	Employability Skills	15
14	Social Media	22
15	Advanced Scriptwriting	30
16	Oral Communication and Public Speaking	24
17	Advanced Video Production I	35
Total		133

Television Broadcasting and Production IV—Course Code: 994605

Unit	Unit Name	Hours
18	Advanced Video Production II	35
19	Music in Broadcasting	22
20	Ethics in Journalism	10
21	Senior Project	35
Total		102

Option 2—Two 2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses, which should be completed in the following sequence:

1. **Broadcasting Journalism I —Course Code:994600**
2. **Broadcasting Journalism II—Course Code: 994601**

Course Description: Broadcasting Journalism I
This course introduces students to television broadcasting and production. Students will leave the class with a firm foundation of knowledge in the areas of employability skills, safety, and basic production knowledge. Additionally, students will learn scriptwriting fundamentals.
This course identifies additional operational areas and their roles within the television and broadcasting production industry. Students will learn how the audio and editing features are incorporated within the industry and the proper techniques to use. Students will also gain an understanding of how to edit, produce, and direct a broadcast production.

Course Description: Broadcasting Journalism II
This course introduces students to advanced television broadcasting and production. Students will leave the class with further knowledge in the areas of employability skills, safety, and basic production knowledge. Additionally, students will learn advanced scriptwriting fundamentals. This course provides a more in-depth view of the production process for video in broadcasting. Students are also introduced to adding music to a production as well as the ethical requirements in the field. This course should be taken after the student has successfully completed Broadcasting Journalism I.

Broadcasting Journalism I—Course Code 994600

Unit	Unit Name	Hours
1	Orientation, Safety, and Leadership	7
2	Employability Skills	15
3	Introduction to Television and the Production Industry	22
4	Camera Operation and Shot Composition	30
5	Audio for Film and Video	15
6	Basic Television Editing I	18
7	Basic Television Editing II	18
8	Audio and Television Announcing	15
9	Scriptwriting	24
10	Producing/Directing a Television Program	36
11	Studio/Control Room Equipment	20
Total		220

Broadcasting Journalism II—Course Code: 994601

Unit	Unit Name	Hours
12	Orientation, Safety, and Leadership	7
13	Employability Skills	15
14	Social Media	22
15	Advanced Scriptwriting	30
16	Oral Communication and Public Speaking	24
17	Advanced Video Production I	35
18	Advanced Video Production II	35
19	Music in Broadcasting	22
20	Ethics in Journalism	10
21	Senior Project	35
Total		235

Career Pathway Outlook

Overview
Television broadcasters operate studios and facilities that program and deliver audiovisual content to the public using over-the-air transmission. Shifts in consumer viewing habits are expected to continuously prompt adjustments by broadcasters. Digital distribution will likely remain an important component of the industry's strategy as consumers' relationship to TV content continues to evolve. Although traditional TV viewership is on the decline, the industry is expected to continue growing as it begins shifting to digital streaming platforms.

Broadcast and sound technicians typically need postsecondary education. Depending on the work they do, they may need either a postsecondary nondegree award or an associate degree. Employers generally prefer to hire broadcast news analysts who have a bachelor's degree in journalism or communications along with an internship or work experience in the field.

Needs of the Future Workforce
Employment in the TV broadcasting industry is expected to grow at a faster rate than the average for other occupations. Data for this synopsis were compiled from employment projections prepared by the U.S. Census Bureau, the U.S. Bureau of Labor Statistics (2019), and the Mississippi Department of Employment Security (2019).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2016	Projected Jobs, 2026	Change (Number)	Change (Percent)	Average Hourly Earnings, 2019
Audio and Video Equipment Technicians	160	170	10	6.3	$15.97
Broadcast News Analysts	80	90	10	12.5	$36.00
Broadcast Technicians	170	180	10	5.9	$17.79
Producers and Directors	310	350	40	12.9	$21.30

Source: Mississippi Department of Employment Security; mdes.ms.gov (2019).

Perkins V Requirements and Academic Infusion
The television broadcasting and production curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in the television broadcasting and production field. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for careers in television broadcasting and production. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, the curriculum focuses on ongoing and meaningful professional development for teachers, as well as relationships with industry.

Transition to Postsecondary Education
The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The television broadcasting and production educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances, for example—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. In Mississippi, SkillsUSA and Technology Student Association (TSA) foster the types of learning expected from the television broadcasting and production curriculum. SkillsUSA and TSA prepare emerging leaders and entrepreneurs for careers in the television broadcasting and production industry.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the television broadcasting and production curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The television broadcasting and production curriculum provides opportunities for students to work together and help each other to complete complex tasks.

Work-Based Learning

Work-based learning is an extension of understanding competencies taught in the HVAC classroom. This curriculum is designed in a way that necessitates active involvement by the students in the community around them and the global environment. These real-world connections and applications link all types of students to knowledge, skills, and professional dispositions. Work-based learning should encompass ongoing and increasingly more complex involvement with local companies and industry professionals. Thus, supervised collaboration and immersion into the industry around the students are keys to students' success, knowledge, and skills development.

Professional Organizations

Association for Career and Technical Education (ACTE)
acteonline.org

SkillsUSA
skillsusa.org

Technology Student Association (TSA)
tsaweb.org

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80% of the time in the course. The remaining percentage of class time will include instruction in non-tested material, review for end-of-course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Teacher Resources
Teacher resources for this curriculum may be found in multiple places. Many program areas have teacher resource documents that accompany the curriculum and can be downloaded from the same site as the curriculum. The teacher resource document contains references, lesson ideas, websites, teaching and assessment strategies, scenarios, skills to master, and other resources divided by unit. This document could be updated periodically by RCU staff. Please check the entire document, including the entries for each unit, regularly for new information. If you have something you would like to add or have a question about the document, call or email the RCU's instructional design specialist for your program. The teacher resource document can be downloaded at rcu.msstate.edu/curriculum/curriculumdownload.aspx. All teachers should request to be added to the Canvas Resource Guide for their course. This is where all resources will be housed in the future, if they are not already. To be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Many of the units include an enrichment section at the end. If the television broadcasting and production program is currently using the Mississippi Career Planning and Assessment System (MS-CPAS) as a measure of accountability, the enrichment section of material will not be tested. If this is the case, it is suggested to use the enrichment material when needed or desired by the teacher and if time allows in the class. This material will greatly enhance the learning experiences for students. If, however, the television broadcasting and production program is using a national certification or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be tested. It is the responsibility of the teacher to ensure all competencies for the selected assessment are covered throughout the year.

Unit 1: Orientation, Safety, and Leadership

Competencies and Suggested Objectives
1. Describe local program and career center policies and procedures. DOK1 a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, and transportation regulations.
2. State procedures of leadership used to reach an agreement in an orderly manner and personal development opportunities provided to students by student organizations. DOK1 a. State procedures of leadership used in organizational meetings to reach an agreement in an orderly manner. b. Describe the purposes of the appropriate student organization.
3. Identify legal requirements for participation in the occupation. DOK1 a. Describe ways to avoid legal liability problems in the occupation.
4. Describe personal safety rules for working in the audio and television broadcasting industry. DOK1 a. Identify and apply terms and definitions for safety. b. Identify provisions of the OSHA Act of 1970. c. Identify OSHA inspections and citations. d. Identify why citations are given. e. Identify accidents, their causes, and prevention. f. Identify general safety procedures. g. Identify causes of electrical hazards. h. Identify proper methods for moving heavy items. i. Identify and apply emergency first aid, if necessary. j. Identify and apply the ABCs of CPR.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Unit 2: Employability Skills

Competencies and Suggested Objectives
1. Describe employment opportunities in the television broadcasting industry. DOK 1 a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training.
2. Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities. DOK 1 a. Perform various searches through the MDES website, such as: • Number of jobs available for a specific area of expertise • Hourly wage • Percentage of jobs in the county • Percentage of jobs in the state
3. Describe basic employee responsibilities and appropriate work ethics. DOK 1 a. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. b. Define effective relationship skills. c. Describe workplace issues, including, but not limited to, sexual harassment, stress, and substance abuse.
4. Analyze desirable behavior and characteristics in the workplace. DOK1 a. Model desirable personality traits when serving the public. b. Exhibit desirable personality traits when communicating with employees, supervisors, and other employees. c. Demonstrate desirable characteristics of personal work ethic.

Unit 3: Introduction to the Television and Production Industry

Competencies and Suggested Objectives
1. Analyze the development of broadcasting as an industry. DOK2 a. Discuss the history of the television production and broadcasting industry. b. Explain the difference between linear and nonlinear video editing . c. Analyze past, present, and future trends in the television industry. d. Differentiate between various TV formats.
2. Compare and contrast the components of the broadcasting industry. DOK2 a. Explain, compare, and contrast program types. b. Explore various news sources such as digital, television (local and national), and nontraditional methods. c. Identify occupations in the television production industry.

Unit 4: Camera Operation and Shot Composition

Competencies and Suggested Objectives
1. Identify uses of the video camera. DOK2 a. Demonstrate the basic fundamentals of camera setup and operation. b. Identify and demonstrate the effective use of various camera shots, angles, and movements for video production. c. Experience field recording using portable video equipment; operate television cameras. d. Demonstrate on-camera performance techniques necessary in TV production e.g. hand-held shooting, tripod shooting, etc.
2. Apply advanced camera operations in a real-world setting. DOK2 a. Exemplify how white balancing affects the picture. b. Demonstrate how depth-of-field contributes to composing a good picture. c. Experience remote shooting vs. studio shooting.

Unit 5: Audio for Film and Video

Competencies and Suggested Objectives
1. Demonstrate the audio setup for a production. DOK2
2. Utilize microphone techniques used by television broadcasting talent. DOK2 a. Identify different types of microphones and techniques used by television broadcasting talent.
3. Explain the purpose and use of music in a production. DOK2, a. Demonstrate an understanding of copyright law and fair use practices. b. Create personal music (using audio production software) for film/video, television shows, commercials, public service announcements (PSAs), and documentaries.

Unit 6: Basic Television Editing I

Competencies and Suggested Objectives
1. Explain the purpose of editing digital video for a television broadcast. DOK2 a. Identify editing terms. b. Identify the purpose of editing a video file. c. Identify the tools used for editing.

Unit 7: Basic Television Editing II

Competencies and Suggested Objectives
1. Demonstrate the ability to operate nonlinear television editing equipment. DOK2 a. Identify the parts of a nonlinear television editing system. b. Demonstrate an ability to edit a video file using a nonlinear editing system.

Unit 8: Audio and Television Announcing

Competencies and Suggested Objectives
1. Demonstrate the ability to announce effectively. DOK2 a. Identify and demonstrate the speech process. b. Perform voice and diction exercises. c. Read scripts (both with and without a teleprompter) in front of a microphone and on camera using your professional voice.
2. Demonstrate effective communication techniques. DOK2 a. Explain and discuss how to ad-lib, interview guests, and read news stories in front of the camera. b. Demonstrate an ability to ad-lib during a production, interview guests, and read news stories on camera.

Unit 9: Scriptwriting

Competencies and Suggested Objectives
1. Demonstrate the ability to write audio and television production scripts. DOK2 a. Analyze professional audio and television broadcasting scripts. b. Research a chosen subject. c. Identify an audience. d. Use appropriate language. e. Assemble audio cues, video cues, and spoken words into a rough draft. f. Revise the script to fit the time allotted. g. Edit the script to remove mechanical, grammatical, and usage errors. h. Write a complete script for various productions, including a newscast, talk show, sports show, interview show, commercials (30 seconds and 60 seconds), and public service announcements (30 seconds and 60 seconds).
2. Demonstrate the ability to write for television productions. DOK2 a. Describe the five Ws and one H. b. Demonstrate how to create a lead. c. Describe the inverted pyramid writing style. d. Demonstrate how to create a story headline. e. Compare and contrast hard news vs. soft news. f. Compare and contrast national, world, and local news.

Unit 10: Producing/Directing a Television Program

Competencies and Suggested Objectives
1. Demonstrate the ability to produce a television program. DOK2 a. Review professional productions. b. Identify production types, formats of programs, and productions. c. Define an audience and assess its role. d. Formulate a program idea. e. Collect ideas and materials for the program. f. Produce a script for various types and formats. g. Convert a script to final production.
2. Demonstrate the procedures for directing television productions. DOK2 a. Identify and use a director's terminology. b. Analyze a script. c. Plan a program to meet time constraints. d. Direct a rehearsal. e. Direct a program for recording. f. Utilize various hand signals used in television broadcasting to cue on-camera talent. g. Evaluate program performance.

Unit 11: Studio/Control Room Equipment

Competencies and Suggested Objectives
1. Demonstrate the ability to use basic television production equipment. DOK2 a. Identify the functions of studio cameras, camera control units, teleprompters, video switchers, character generators, and studio intercom systems. b. Identify the different types of lighting for television production. c. Operate studio cameras, camera control units, teleprompters, video switchers, character generators, and studio intercom systems. d. Demonstrate appropriate lighting for television studio productions and field productions.
2. Demonstrate the ability to operate audio control room equipment. DOK2 a. Identify the functions of an audio control console, microphone mixer, and waveform. b. Operate an audio control console, microphone mixer, and waveform. c. Identify the various microphones used in television broadcasting and production. d. Demonstrate how to use various microphones. e. Apply the techniques of a beginning audio control operator.

Unit 12: Orientation, Safety, and Leadership

Competencies and Suggested Objectives
1. Describe local program and career center policies and procedures. DOK1 a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, and transportation regulations.
2. State procedures of leadership used to reach an agreement in an orderly manner and personal development opportunities provided to students by student organizations. DOK1 a. State procedures of leadership used in organizational meetings to reach an agreement in an orderly manner. b. Describe the purposes of the appropriate student organization.
3. Identify legal requirements for participation in the occupation. DOK1 a. Describe ways to avoid legal liability problems in the occupation.
4. Describe personal safety rules for working in the audio and television broadcasting industry. DOK1 a. Identify and apply terms and definitions for safety. b. Identify provisions of the OSHA Act of 1970. c. Identify OSHA inspections and citations. d. Identify why citations are given. e. Identify accidents, their causes, and prevention. f. Identify general safety procedures. g. Identify causes of electrical hazards. h. Identify proper methods for moving heavy items. i. Identify and apply emergency first aid, if necessary. j. Identify and apply the ABCs of CPR.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Unit 13: Employability Skills

Competencies and Suggested Objectives
1. Develop and emphasize employability skills. DOK2 a. Analyze a résumé. b. Describe the parts of a résumé. c. Prepare a résumé containing essential information. d. Complete a job application form
2. Describe employment opportunities in the television broadcasting industry. DOK 1 a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training.
3. Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities. DOK 1 a. Perform various searches through the MDES website, such as: • Number of jobs available for a specific area of expertise • Hourly wages • Percentage of jobs in the county • Percentage of jobs in the state
4. Demonstrate appropriate interview skills. DOK 1 a. Identify interview skills such as speaking, dress, professionalism, and punctuality. b. Simulate a job interview.
5. Describe basic employee responsibilities and appropriate work ethics. DOK 1 a. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. b. Define effective relationship skills and workplace issues, including, but not limited to sexual harassment, stress, and substance abuse.
6. Analyze desirable behavior and characteristics in the workplace. DOK1 a. Model desirable personality traits when serving the public. b. Exhibit desirable personality traits when communicating with employees, supervisors, and other employees. c. Demonstrate desirable characteristics of personal work ethic.
7. Create a digital portfolio of student products to include a résumé, videos, a demo reel, a senior project, etc. (Ongoing throughout the year)

Unit 14: Social Media and Nontraditional Media

Competencies and Suggested Objectives
1. Describe social media and its use in television. DOK2 a. Describe how social media is used in our society. b. Describe the historical perspective of social media. c. Compare and contrast different social media platforms, including Facebook, Twitter, and Instagram. d. Demonstrate writing for social media. e. Conduct a media analysis to discover how companies use social media. f. Describe the First Amendment and social media. g. Analyze the future of social media.
2. Explore nontraditional media opportunities. DOK2 a. Produce a video for a YouTube audience. b. Investigate freelance videography opportunities. c. Produce a vlog for a given audience.

Unit 15: Advanced Scriptwriting

Competencies and Suggested Objectives
1. Demonstrate writing for news outlets. DOK2 a. Explain careers in news. b. Demonstrate story organization. c. Demonstrate writing the lead. d. Demonstrate writing using the inverted pyramid.
2. Demonstrate writing for the screen. DOK2 a. Explain careers in film. b. Demonstrate structuring the story. c. Demonstrate writing a short script.

Unit 16: Oral Communication and Public Speaking

Competencies and Suggested Objectives
1. Discuss and demonstrate uses of oral communication skills. DOK2 a. Discuss the importance of good speech. b. Discuss the elements of communication. c. Discuss oral communication techniques. d. Discuss aspects of speaking on camera, including articulation, delivery, and transitioning.
2. Produce a segment that demonstrates communication techniques. DOK2 a. Talk show b. Debate c. Hot topic

Unit 17: Advanced Video Production I

Competencies and Suggested Objectives
1. Demonstrate the ability to produce a news package. DOK2 a. Describe the parts of a news package. b. Writing for a news package. c. Producing a news package.
2. Demonstrate the ability to produce a PSA. DOK2 a. Describe a PSA. b. Write a PSA. c. Produce a PSA.

Unit 18: Advanced Video Production II

Competencies and Suggested Objectives
1. Demonstrate the ability to produce a commercial/promo. DOK2 a. Describe a commercial/promo. b. Write a commercial/promo. c. Produce a commercial/promo.
2. Demonstrate the ability to produce a news segment. DOK2 a. Write a news story. b. Organize the news stories. c. Produce a news segment.

Unit 19: Music in Broadcasting

Competencies and Suggested Objectives
1. Analyze the use of music in film and video projects. DOK2 a. Contrast background music with foreground music. b. Describe copyrighted and recorded music.
2. Demonstrate composing music for film using audio production software. DOK2 a. Complete a music composition for a promo. b. Create, produce, and direct a music video.

Unit 20: Ethics in Journalism

Competencies and Suggested Objectives
1. Identify the rights and limitations of the First Amendment. DOK2 a. Demonstrate ethical decision-making. b. Discuss censorship, libel, privacy laws, and copyright law. c. Discuss the code of ethics for journalists. d. Discuss accuracy, objectivity, and credibility.
2. Discuss current cases of ethics in broadcasting. DOK2

Unit 21: Senior Project

Competencies and Suggested Objectives
1. Demonstrate the production and broadcasting skills acquired throughout the two-year program.[DOK2] a. Produce a project based on your production/broadcasting skills. b. Present a project based on your production/broadcasting skills.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation, Safety, and Leadership		
	1.	Describe local program and career center policies and procedures.
	2.	State procedures of leadership used to reach an agreement in an orderly manner and personal development opportunities provided to students by student organizations.
	3.	Identify legal requirements for participation in the occupation.
	4.	Describe personal safety rules for working in the audio and television broadcasting industry.
Unit 2: Employability Skills		
	1.	Describe employment opportunities in the television broadcasting industry.
	2.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	3.	Describe basic employee responsibilities and appropriate work ethics.
	4.	Analyze desirable behavior and characteristics in the workplace.
Unit 3: Introduction to Television and the Production Industry		
	1.	Analyze the development of broadcasting as an industry.
	2.	Compare and contrast the components of the broadcasting industry.
Unit 4: Camera Operation and Shot Composition		
	1.	Identify uses of the video camera.
	2.	Apply advanced camera operations in a real-world setting.
Unit 5: Audio for Film and Video		
	1.	Demonstrate the audio setup for a production.
	2.	Utilize microphone techniques used by television broadcasting talent.
	3.	Explain the purpose and use of music in a production.
Unit 6: Basic Television Editing I		
	1.	Explain the purpose of editing digital video for a television broadcast.

Unit 7: Basic Television Editing II		
	1.	Demonstrate the ability to operate nonlinear television editing equipment.
Unit 8: Audio and Television Announcing		
	1.	Demonstrate the ability to announce effectively.
	2.	Demonstrate effective communication techniques.
Unit 9: Scriptwriting		
	1.	Demonstrate the ability to write audio and television production scripts.
	2.	Demonstrate the ability to write for television productions.
Unit 10: Producing/Directing a Television Program		
	1.	Demonstrate the ability to produce a television program.
	2.	Demonstrate the procedures for directing television productions.
Unit 11: Studio/Control Room Equipment		
	1.	Demonstrate the ability to use basic television production equipment.
	2.	Demonstrate the ability to operate audio control room equipment.
Unit 12: Orientation, Safety, and Leadership		
	1.	Describe local program and career center policies and procedures.
	2.	State procedures of leadership used to reach an agreement in an orderly manner and personal development opportunities provided to students by student organizations.
	3.	Identify legal requirements for participation in the occupation.
	4.	Describe personal safety rules for working in the audio and television broadcasting industry.
Unit 13: Employability Skills		
	1.	Develop and emphasize employability skills.
	2.	Describe employment opportunities in the television broadcasting industry.
	3.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	4.	Demonstrate appropriate interview skills.
	5.	Describe basic employee responsibilities and appropriate work ethics.
	6.	Analyze desirable behavior and characteristics in the workplace.
	7.	Create a digital portfolio of student products to include a résumé, videos, a demo reel, a senior project, etc. (Ongoing throughout the year)
Unit 14: Social Media and Nontraditional Media		
	1.	Describe social media and its use in television.
	2.	Explore nontraditional media opportunities.

Unit 15: Advanced Scriptwriting		
	1.	Demonstrate writing for news outlets.
	2.	Demonstrate writing for the screen.
Unit 16: Oral Communication and Public Speaking		
	1.	Discuss and demonstrate uses of oral communication skills.
	2.	Produce a segment that demonstrates communication techniques.
Unit 17: Advanced Video Production I		
	1.	Demonstrate the ability to produce a news package.
	2.	Demonstrate the ability to produce a PSA.
Unit 18: Advanced Video Production II		
	1.	Demonstrate the ability to produce a commercial/promo.
	2.	Demonstrate the ability to produce a news segment.
Unit 19: Music in Broadcasting		
	1.	Analyze the use of music in film and video projects.
	2.	Demonstrate composing music for film using audio production software.
Unit 20: Ethics in Journalism		
	1.	Identify the rights and limitations of the First Amendment.
	2.	Discuss current cases of ethics in broadcasting.
Unit 21: Senior Project		
	1.	Demonstrate the production and broadcasting skills acquired throughout the two-year program.

Appendix A: Industry Standards

National Career Clusters

Crosswalk for Television Broadcasting and Production												
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**
AVT1				X			X	X			X	
AVT2		X			X	X	X	X	X	X	X	
AVT3					X	X	X	X	X	X	X	X
AVT4							X	X		X	X	X
JBC1			X	X								
JBC2										X		
JBC3						X				X		
JBC4					X		X	X	X	X	X	
WDC1												X
WDC2												
WDC3												
WDC4												
WDC5												
WDC6												
WDC7												
WDC8												
WDC9												
WDC10											X	

		Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	Unit 20	Unit 21	
AVT1		**X**	**X**			X	X	X	X		X	
AVT2				X			X	X			X	
AVT3							X	X	X		X	
AVT4							X	X	X		X	
JBC1						X	X	X			X	
JBC2					X	X	X	X			X	
JBC3							X	X			X	
JBC4							X	X			X	
WDC1											X	
WDC2											X	
WDC3											X	
WDC4					X						X	
WDC5											X	
WDC6											X	
WDC7											X	
WDC8											X	
WDC9											X	
WDC10					X				X	X	X	

A/V Technology & Film Career Pathway (AR-AV)

AVT1. Describe the history, terminology, occupations and value of audio, video and film technology.

AVT2. Demonstrate the use of basic tools and equipment used in audio, video and film production.

AVT3. Demonstrate technical support skills for audio, video and/or film productions.

AVT4. Design an audio, video and/or film production.

Journalism & Broadcasting Career Pathway (AR-JB)

JBC1. Describe the diversity of functions within the Journalism & Broadcasting Career Pathway.

JBC2. Demonstrate writing processes used in journalism and broadcasting.

JBC3. Plan and deliver a media production (e.g., broadcast, video, Internet, mobile).

JBC4. Demonstrate technical support related to media production (e.g., broadcast, video, Internet, mobile).

Web & Digital Communications Career Pathway (IT-WD)

WDC1. Analyze customer requirements to design and develop a Web or digital communication product.

WDC 2. Apply the design and development process to produce user-focused Web and digital communications solutions.

WDC 3. Write product specifications that define the scope of work aligned to customer requirements.

WDC4. Demonstrate the effective use of tools for digital communication production, development and project management.

WDC5. Develop, administer and maintain Web applications.

WDC6. Design, create and publish a digital communication product based on customer needs.

WDC7. Evaluate the functionality of a digital communication product using industry accepted techniques and metrics.

WDC8. Implement quality assurance processes to deliver quality digital communication products and services.

WDC9. Perform maintenance and customer support functions for digital communication products.

WDC10. Comply with intellectual property laws, copyright laws and ethical practices when creating Web/digital communications.

2015 Television Broadcasting and Production

Mississippi Department of Education

Program CIP: 09.0402 – Broadcast Journalism

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Published by

Office of Career and Technical Education
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

~~The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.~~

Table of Contents

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Dr. Carey M. Wright, State Superintendent of Education

Dr. John R. Kelly, Chair

Mr. Richard Morrison, Vice-Chair

Dr. O. Wayne Gann

Mrs. Kami Bumgarner

Mr. William Harold Jones

Mr. Charles McClelland

Mrs. Rosemary G. Aultman

Mr. Danny J. Spreitler

Mr. Johnny Franklin

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Lemond Irvin, Instructional Design Specialist for the Research and Curriculum Unit at Mississippi State University, researched and authored this framework. Lemond.irvin@rcu.msstate.edu

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Scott Kolle, Project Manager for the Research and Curriculum Unit at Mississippi State University

Jolanda Young, Educational Technologist for the Research and Curriculum Unit at Mississippi State University

Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the *Television Broadcasting and Production Curriculum Framework and Supporting Materials* are based on the following:

The Common Career Technical Core (CCTC)

The standards were extensively researched and reviewed by leaders in the industry, secondary and postsecondary instructors, and university specialists. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. A complete copy of the standards can be accessed http://www.careertech.org/career-technical-education/cctc/ .

Common Core State Standards Initiative

The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy.

National Educational Technology Standards for Students

21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and information and communication technology (ICT) literacy.

Preface

Secondary career and technical education programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at

The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

My PLC: An online registration for all professional development sessions

To register for any session, teachers will need an account in the registration system, MyPLC, https://myplc.rcu.msstate.edu. To create an account, click on the link and navigate to the "Request a Guest ID" link. The ID should be the teacher's first initial and last name and the last four (4) digits of the social security number. Teachers should complete the entire form, which will then be sent to a secure server. Upon activation of the teacher's account, he or she will receive an e-mail with login instructions. The teacher may then browse for the available sessions and register for the desired courses.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

The Television Broadcasting and Production program is designed to provide the basic foundation, skills, and knowledge for developing and producing broadcast-quality materials. Students will learn the skills necessary to work in a television and broadcasting production facility. They will acquire basic and advanced writing and video skills and the ability to provide support in all facets of a production studio. The program will provide hands-on experience in the areas of writing, editing, shooting, directing and producing for commercial-grade broadcasts.

Industry standards referenced are from the *The Common Career Technical Core (CCTC)* coordinated by the National Association of State Directors of Career Technical Education Consortium (NASDCTEc). See more at: http://www.careertech.org/career-technical-education/cctc/. The CCTC includes a set of standards for each of the 16 Career Clusters® and their corresponding Career Pathways that define what students should know and be able to do after completing instruction in a program of study. Additional research data used in the development of this publication were collected from a review of related literature and from surveys of local experts in business, industry, and education.

Assessment

The latest assessment blueprint for the curriculum can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Student Prerequisites

In order for students to be able to experience success in the program, the following student prerequisites are suggested:

4. C or higher in English (the previous year)
5. C or higher in Math (last course taken or the instructor can specify the math)
6. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

3. TABE Reading Score (eighth grade or higher)
4. Instructor Approval

or

2. Instructor Approval

Teacher Licensure

The latest teacher licensure information can be found at

http://www.mde.k12.ms.us/educator-licensure

~~**Professional Learning**~~

~~If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510~~

Course Outlines

Option 1 – Four One-Carnegie-Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

5. **Television Broadcasting and Production I – Course Code: 994602**
6. **Television Broadcasting and Production II – Course Code: 994603**
7. **Television Broadcasting and Production III – Course Code: 994604**
8. **Television Broadcasting and Production IV – Course Code: 994605**

Course Description: Television Broadcasting and Production I

This course introduces students to television broadcasting and production. Students will leave the class with a firm foundation of knowledge in the areas of employability skills, safety, and basic production knowledge. Additionally, students will learn scriptwriting fundamentals.

Course Description: Television Broadcasting and Production II

This course identifies additional operational areas and their role within the television and broadcasting production industry. Students will learn how the audio and editing features are incorporated within the industry and the proper techniques to use. Students will also gain an understanding of how to edit, produce and direct a broadcast production.

Course Description: Television Broadcasting and Production III

This course introduces students to advanced television broadcasting and production. Students will leave the class with further knowledge in the areas of employability skills, safety, and basic production knowledge. Additionally, students will learn advanced scriptwriting fundamentals.

Course Description: Television Broadcasting and Production IV

This course provides a more in-depth view of the production process for video in broadcasting. Students are also introduced to adding music to a production as well as the ethical requirements in the field.

Television Broadcasting and Production I – Course Code: 994602

Unit	Unit Name	Hours
1	Orientation, Safety, and Leadership	15
2	Introduction to Television and the Production Industry	32
3	Basic Camera Operation and Shot Composition	25
4	Studio/Control Room Equipment	20
5	Scriptwriting	24
Total		116

Television Broadcasting and Production II — Course Code: 994603

Unit	Unit Name	Hours
6	Audio and Television Announcing	20
7	Producing/Directing a Television Program	36
8	Audio for Film and Video	15
9	Basic Television Editing	36
Total		107

Television Broadcasting and Production III — Course Code: 994604

Unit	Unit Name	Hours
10	Orientation, Safety, and Leadership	15
11	Employability Skills	7
12	Advanced Camera Operation	30
13	Social Media	18
14	Advanced Scriptwriting	35
Total		105

Television Broadcasting and Production IV — Course Code: 994605

Unit	Unit Name	Hours
15	Advanced Video Production and Editing	70
16	Music in Broadcasting	12
17	Ethics in Journalism	10
18	Senior Project	25
19	Oral Communication and Public Speaking	8
Total		125

Option 2 – Two Two-Carnegie-Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. **Broadcast Journalism I – Course Code:994600**

2. **Broadcast Journalism II – Course Code: 994601**

Course Description: Broadcast Journalism I

This course introduces students to television broadcasting and production. Students will leave the class with a firm foundation of knowledge in the areas of employability skills, safety, and basic production knowledge. Additionally, students will learn scriptwriting fundamentals.

This course identifies additional operational areas and their roles within the television and broadcasting production industry. Students will learn how the audio and editing features are incorporated within the industry and the proper techniques to use. Students will also gain an understanding of how to edit, produce, and direct a broadcast production.

Course Description: Broadcast Journalism II

This course introduces students to advanced television broadcasting and production. Students will leave the class with further knowledge in the areas of employability skills, safety, and basic production knowledge. Additionally, students will learn advanced scriptwriting fundamentals.

This course provides a more in-depth view of the production process for video in broadcasting. Students are also introduced to adding music to a production as well as the ethical requirements in the field.

Broadcast Journalism I – Course Code 994600

Unit	Unit Name	Hours
1	Orientation, Safety, and Leadership	15
2	Introduction to Television and the Production Industry	32
3	Basic Camera Operation and Shot Composition	25
4	Studio/Control Room Equipment	20
5	Scriptwriting	24
6	Audio and Television Announcing	20
7	Producing/Directing a Television Program	36
8	Audio for Film and Video	15
9	Basic Television Editing	36
Total		223

~~Broadcast Journalism II — Course Code: 994601~~

~~Unit~~	~~Unit Name~~	~~Hours~~
~~10~~	~~Orientation, Safety, and Leadership~~	~~15~~
~~11~~	~~Employability Skills~~	~~7~~
~~12~~	~~Advanced Camera Operation~~	~~30~~
~~13~~	~~Social Media~~	~~18~~
~~14~~	~~Advanced Scriptwriting~~	~~35~~
~~15~~	~~Advanced Video Production and Editing~~	~~70~~
~~16~~	~~Music in Broadcasting~~	~~12~~
~~17~~	~~Ethics in Journalism~~	~~10~~
~~18~~	~~Senior Project~~	~~25~~
~~19~~	~~Oral Communication and Public Speaking~~	~~8~~
~~Total~~		~~230~~

Research Synopsis

Introduction

The National Center for Education Statistics (NCES) defines the Broadcast Journalism program as follows:

> A program that focuses on the methods and techniques for reporting, producing, and delivering news and news programs via radio, television, and video/film media; and that prepares individuals to be professional broadcast journalists, editors, producers, directors, and managers. Includes instruction in the principles of broadcast technology; broadcast reporting; on- and off-camera and microphone procedures and techniques; program, sound, and video/film editing; program design and production; media law and policy; and professional standards and ethics.

Accessed 2/3/14 from http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cip=09.0402

Needs of the Future Workforce

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2013). Employment opportunities for each of the occupations listed below are

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2010	Projected Jobs, 2020	Change (Number)	Change (Percent)	Average Hourly Earning
Audio and Video Equipment Technicians	190	210	20	15.5	$14.71
Broadcast News Analyst	40	40	0	0	$23.88
Broadcast Technicians	210	220	10	4.8	$13.11
Sound Engineering Technicians	20	20	0	0	$18.95
Camera Operators, Television, Video, and Motion Picture	90	90	0	0	$14.71
Media and Communication Equipment Workers, All	20	20	0	0	$27.76

Other					
Producers and Directors	250	260	10	4.0	$19.46
Radio and Television Announcers	380	380	0	0	$15.81

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed September 12, 2013).

Perkins IV Requirements

The Television and Broadcast Production curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. Additionally, the Television and Broadcast Production curriculum is integrated with academic common core standards. Lastly, the curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the Secondary Television Broadcasting and Production curriculum are the Common Career Technical Core (CCTC), the Common Core State Standards (CCSS), National Educational Technology Standards for Students, and 21st Century Skills and Information and Communication Technologies Literacy Standards. Aligning the curriculum content to these standards will result in students who are highly skilled, well-rounded, more academically proficient, and more likely to be successful in community colleges, Institutions of Higher Learning and the workforce.

Academic Infusion

The Television Broadcasting and Production curriculum is aligned to the CCSS for high school Language Arts and Mathematics. The CCSS are aligned with college and work expectations and include rigorous content and application of knowledge through high-order skills. This applied approach to learning academic skills has long been the practice in career and technical education and brings relevance and enhances and reinforces these academic skills. Throughout the Television Broadcasting and Production curriculum, students will be required to perform calculations and use strategic and critical thinking skills to solve real-world problems.

Transition to Postsecondary Education

The latest articulation information for Secondary to Postsecondary can be found at the Mississippi Community College Board (MCCB) website http://www.mccb.edu/

Best Practices

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The Television Broadcasting and Production instructor's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools and introduce students to education in an online environment, the classroom teacher is encouraged to use a learning management system. An online learning management system allows students to work collaboratively, and also enables the teacher to connect more effectively with students by keeping them informed and involved.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. Many activities are graded by rubrics that allow students to choose the type of product they will produce. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. In Mississippi, Skills USA fosters the types of learning expected from the Television Broadcasting and Production curriculum. Skills USA prepares emerging leaders and entrepreneurs for careers in the television broadcasting and production industries. The mission of Skills USA is to help its members become world-class workers, leaders, and responsible American citizens.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Television Broadcasting and Production curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The Television Broadcasting and Production curriculum provides opportunities for students to work together and help each other to complete complex tasks.

Conclusions

Television Broadcasting and Production is a driving force in the Mississippi's economic development efforts. A workforce trained to work in this industry will not only sustain existing television broadcasting and production, but it will also attract new businesses to the state. Students who complete this program

~~are well equipped to enter the workforce or to pursue educational opportunities at community colleges and universities in Mississippi.~~

Professional Organizations

Association for Supervision and Curriculum Development (ASCD)
1703 North Beauregard Street
Alexandria, VA 22311-1714
(800) 933-ASCD
http://www.ascd.org

Association for Career and Technical Education (ACTE)
1410 King Street
Alexandria, VA 22314
(800) 826-9972
http://www.acteonline.org

Mississippi Association for Supervision and Curriculum Development (MASCD)
P.O. Box 13576
Jackson, MS 39236
(601) 591-2210
http://www.mascd.com

Mississippi Department of Education (MDE)
Office of Vocational Education and Workforce Development
P.O. Box 771
Jackson, MS 39205
(601) 359-3940
http://www.mde.k12.ms.us/vocational/news/

SkillsUSA
14001 SkillsUSA Way
Leesburg, VA 20176
703-777-8810
FAX: 703-777-8999
http://www.skillsusa.org/

Using This Document

Suggested Time on Task

This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives

A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References

A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Orientation, Safety, and Leadership

Competencies and Suggested Objectives
1. Describe local program and vocational center policies and procedures. DOK1, AVT1 a. Describe local program and vocational center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations.
2. Describe employment opportunities and responsibilities. DOK1, AVT1 a. Describe employment opportunities including potential earnings, employee benefits, job availability, places of employment, working conditions, and educational requirements. b. Describe basic employee responsibilities.
3. State procedures of leadership used to reach an agreement in an orderly manner and personal development opportunities provided to students by SkillsUSA. DOK1, AVT1 a. State procedures of leadership used in organizational meetings to reach an agreement in an orderly manner. b. Describe the purposes of SkillsUSA.
4. Identify desirable personal behavior and characteristics. DOK1, AVT1 a. Identify desirable personality traits when serving the public. b. Identify desirable personality traits when communicating with employees, supervisors, and other employees. c. Identify desirable characteristics of the personal work ethic.
5. Identify legal requirements for participation in the occupation. DOK1, AVT1 a. Describe ways to avoid legal liability problems in the occupation.
6. Describe personal safety rules for working in the audio and television broadcasting industry. DOK1, AVT1 a. Identify and apply terms and definitions for safety. b. Identify provisions of the OSHA Act of 1970. c. Identify OSHA inspections and citations. d. Identify why citations are given. e. Identify accidents, their causes, and prevention.

f. Identify general safety procedures.

g. Identify causes of electrical hazards.

h. Identify proper methods for moving heavy items.

i. Identify and apply emergency first aid, if necessary.

j. Identify and apply ABC's of CPR.

Unit 2: Introduction to Television and the Production Industry

Competencies and Suggested Objectives
1. Demonstrate the ability to utilize basic television broadcasting skills. DOK2, AVT2, AVT3, JBC4 a. Outline the qualifications and requirements of a television newscaster. b. Demonstrate the skills of a television newscaster. c. Outline the qualifications and requirements of a television news reporter. d. Demonstrate the skills of a television news reporter. e. Explain the differences among news, commentaries, and editorials. f. Demonstrate the ability to mark, edit, and present news. g. Demonstrate the ability to use the equipment in the newsroom. h. Explain the news sources. i. Explain and discuss how to ad-lib, interview guests, and read news stories in front of the camera. j. Demonstrate an ability to ad-lib during a production, interview guests, and read news stories on camera. k. Identify occupations in the television production industry. l. Discuss the history of the television production and broadcasting industry. m. Analyze past, present and future trends in the television industry. n. Differentiate between various TV formats

Unit 3: Basic Camera Operation and Shot Composition

Competencies and Suggested Objectives
1. Identify uses of the video camera. DOK2, AVT2, AVT3, JBC4 a. Demonstrate the basic fundamentals of camera setup and operation. b. Identify camera shots and angles. c. Demonstrate effective use of various camera shots, angles, and movements for video production. d. Experience field recording using portable video equipment; operate television cameras. e. Identify on-camera performance techniques necessary in TV production. f. Demonstrate on-camera performance techniques necessary in TV production (hand-held shooting vs. tripod shooting).

Unit 4: Studio/Control Room Equipment

Competencies and Suggested Objectives
1. Demonstrate the ability to use basic television production equipment. DOK2, AVT1, AVT2, AVT3, JBC1, JBC4 a. Identify the functions of studio cameras, camera control units, teleprompters, and studio intercom systems. b. Identify the different types of lighting for television production. c. Operate studio cameras, camera control units, teleprompters, and studio intercom systems. d. Demonstrate appropriate lighting for television studio productions and field productions.
2. Demonstrate the ability to operate audio control room equipment. DOK2, AVT1, AVT2, AVT3, JBC1, JBC4 a. Identify the functions of an audio control console, microphone mixer, video switchers, character generator, and waveform/vector scope/oscilloscope monitor. b. Operate an audio control console, microphone mixer, video switchers, character generator, and waveform/vector scope/oscilloscope monitor. c. Identify the various microphones used in television broadcasting and production d. Demonstrate how to use various microphones. e. Apply the techniques of a beginning audio control operator.

Unit 5: Scriptwriting

Competencies and Suggested Objectives
1. Demonstrate the ability to write audio and television production scripts. DOK2, AVT2, AVT3, AVT4, JBC2, JBC3, JBC4 a. Analyze professional audio and television broadcasting scripts. b. Identify program types. c. Research a chosen subject. d. Identify an audience. e. Use appropriate language. f. Assemble audio cues, video cues, and spoken words into a rough draft. g. Revise the script to fit the time allotted. h. Edit the script to remove mechanical, grammatical, and usage errors. i. Write a complete script for various productions including the following: 1) Newscast 2) Talk show 3) Sports show 4) Interview show 5) Commercials (30-sec. and 60-sec.) 6) Public service announcements (30-sec. and 60-sec.)
2. Demonstrate the ability to understand and write for television news. DOK2, AVT2, AVT3, AVT4, JBC2, JBC3, JBC4 a. Describe the 5 W's and 1 H. b. Demonstrate how to create a lead. c. Describe the inverted-pyramid writing style. d. Demonstrate how to create a story headline. e. Compare and contrast hard news versus soft news. f. Compare and contrast national, world, and local news.

Unit 6: Audio and Television Announcing

Competencies and Suggested Objectives
1. Demonstrate the ability to announce effectively. DOK2, AVT2, AVT3, JBC2 a. Identify and demonstrate the speech process. b. Perform voice and diction exercises. c. Read scripts (both without a teleprompter and with a teleprompter) in front of microphone and on camera using your professional voice.
2. Utilize microphone and hand signal techniques used for television broadcasting talent. DOK2, AVT2 a. Identify different types and techniques of microphones used by television broadcasting talent. b. Identify the various hand signals used in television broadcasting for the talent in front of the camera.

Unit 7: Producing/Directing a Television Program

Competencies and Suggested Objectives
1. Demonstrate the ability to produce a television program. DOK2, AVT1, AVT3, AVT4, JBC4 a. Define an audience and assess its role. b. Compare and contrast program types. c. Formulate a program idea. d. Identify production types. e. Collect ideas and materials for the program. f. Review professional productions. g. Identify the role of ethics in television production.
2. Demonstrate the procedures for directing television productions. DOK2, AVT1, AVT3, AVT4, JBC4 a. Identify and use a director's terminology. b. Analyze a script. c. Plan a program to meet time constraints. d. Direct a rehearsal. e. Direct a program for recording. f. Evaluate a program.

Unit 8: Audio for Film and Video

Competencies and Suggested Objectives
1. Demonstrate the audio setup for a production. DOK2, AVT2, AVT3, JBC3
2. Explain the purpose and use of music in a production. DOK2, AVT2, a. Demonstrate an understanding copyright law. b. Create personal music (using Garage Band software) for: 1) film/video 2) television shows 3) commercials 4) games

Unit 9: Basic Television Editing

Competencies and Suggested Objectives
1. Explain the purpose of editing videotape for television broadcast. DOK2, AVT 1, AVT2, AVT3, AVT4, JBC4 a. Identify editing terms. b. Identify the purpose of editing a tape. c. Identify the tools of editing. d. Explain the difference between linear and non-linear editing videotape.
2. Demonstrate the ability to operate linear television editing equipment. DOK2, AVT 1, AVT2, AVT3, AVT4, JBC4 a. Identify the parts to a linear television editing system. b. Identify the editing system's control track, time-code editing, and editing modes. c. Demonstrate an ability to edit videotape using the linear editing system.
3. Demonstrate the ability to operate non-linear television editing equipment. DOK2, AVT 1, AVT2, AVT3, AVT4, JBC4 a. Identify the parts to a non-linear television editing system. b. Demonstrate an ability to edit videotape using the non-linear editing system.

Audio and Television Broadcasting II
Unit 10: Orientation, Safety, and Leadership

Competencies and Suggested Objectives
1. Describe local program and vocational center policies and procedures. DOK2, AVT1 a. Describe local program and vocational center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations.
2. Describe employment opportunities and responsibilities. DOK2, AVT2 a. Describe employment opportunities including potential earnings, employee benefits, job availability, places of employment, working conditions, and educational requirements. b. Describe basic employee responsibilities.
3. Develop advanced leadership and organizational skills. DOK2, AVT2 a. Identify SkillsUSA leadership and skills competition activities. b. Identify similarities between SkillsUSA leadership skills and workplace leadership skills.
4. Describe personal safety rules for working in the audio and television broadcasting industry. DOK2, AVT3 a. Identify and apply terms and definitions for safety. b. Identify provisions of the OSHA Act of 1970. c. Identify OSHA inspections and citations. d. Identify why citations are given. e. Identify accidents, their causes, and prevention. f. Identify general safety procedures. g. Identify causes of electrical hazards. h. Identify proper methods for moving heavy items. i. Identify and apply emergency first aid, if necessary. j. Identify and apply ABC's of CPR.

Unit 11: Employability Skills

Competencies and Suggested Objectives
1. Develop and emphasize employability skills. DOK2, AVT1 a. Analyze a resume. b. Describe the parts of a resume. c. Prepare a resume containing essential information. d. Complete a job application form. e. Explain procedures for job interviews using correct job etiquette. f. Demonstrate the role of an applicant in a job interview. g. Interview questions/responses. h. Complete mock interviews.

Unit 12: Advanced Camera Operation

Competencies and Suggested Objectives
1. Advanced camera operation. DOK2, AVT2, AVT3, JBC1 a. Demonstrate operation of a video camera. b. Identify and define different camera angles and composition. c. Understand how white balancing affects the picture. d. Explain how depth-of-field contributes to composing a good picture. e. Remote Shooting vs. Studio Shooting.

Unit 13: Social Media

Competencies and Suggested Objectives
1. Describe social media and its use in television. DOK2, JBC2, WDC4, WDC10 a. Describe how social media is used in our society. b. Describe the historical perspective of social media. c. Compare and contrast different social media platforms. 1) Facebook 2) Twitter 3) Blogs d. Demonstrate writing for social media. e. Conduct a media analysis—discover how companies use social media. f. Describe the First Amendment and social media. g. Analyze the future of social media.

Unit 14: Advanced Scriptwriting

Competencies and Suggested Objectives
1. Demonstrate writing for news outlets. DOK2, AVT1, JBC1, JBC2 a. Demonstrate story organization. b. Demonstrate writing the lead. c. Demonstrate the inverted pyramid. d. Explain careers in news.
2. Demonstrate writing for print. DOK2, AVT1, JBC1, JBC2 a. Demonstrate writing effective headlines. b. Demonstrate writing the lead. c. Explain careers in print media. d. Demonstrate the use of sources.
3. Demonstrate writing for the screen. DOK2, AVT1, JBC1, JBC2 a. Demonstrate structuring the story. b. Demonstrate writing a short script. c. Explain careers in film.

Unit 15: Advanced Video Production and Editing

Competencies and Suggested Objectives
1. Demonstrate the ability to produce a news package. DOK2, AVT1, AVT2, AVT3, AVT4, JBC1, JBC2, JBC3, JBC4 a. Describe the parts of a news package. b. Writing for a news package. c. Producing a news package.
2. Demonstrate the ability to produce a PSA. DOK2, AVT1, AVT2, AVT3, AVT4, JBC1, JBC2, JBC3, JBC4 a. Describe a PSA. b. Write a PSA. c. Produce a PSA.
3. Demonstrate the ability to produce a commercial/promo. DOK2, AVT1, AVT2, AVT3, AVT4, JBC1, JBC2, JBC3, JBC4 a. Describe a commercial/promo. b. Write a commercial/promo. c. Produce a commercial/promo.
4. Demonstrate the ability to produce a news segment. DOK2, AVT1, AVT2, AVT3, AVT4, JBC1, JBC2, JBC3, JBC4 a. Write a news story. b. Organize the news stories. c. Produce a news segment.

Unit 16: Music in Broadcasting

Competencies and Suggested Objectives
1. Analyze the use of music in film and video projects. DOK2, AVT1, AVT3, AVT4, WDC10 a. Contrast background music with foreground music. b. Describe copyrighted and recorded music
2. Demonstrate composing music for film using Garageband software. DOK2, AVT1, AVT3, AVT4, WDC10 a. Complete a music composition for a promo.

Unit 17: Ethics in Journalism

Competencies and Suggested Objectives
1. Identify the rights and limitations of the First Amendment. DOK2, WDC10 a. Demonstrate ethical decision-making. b. Discuss censorship, libel, privacy laws, and copyright law. c. Discuss code of ethics for journalists. d. Discuss accuracy, objectivity, and credibility.
2. Discuss cases of ethics. DOK2, WDC10 a. Tinker vs. Des Moines b. Hazelwood vs. Kuhlmeier

Unit 18: Senior Project

Competencies and Suggested Objectives
1. Demonstrate the production and broadcasting skills acquired throughout the two-year program. DOK2, AVT2 a. Produce a project based on your production/broadcasting skills. b. Present a project based on your production/broadcasting skills.

Unit 19: Oral Communication and Public Speaking

Competencies and Suggested Objectives
1. Discuss and demonstrate uses of oral communication skills. [DOK2, AVT2,] a. Discuss the importance of good speech. b. Discuss the elements of communication. c. Discuss oral communication techniques. d. Discuss speaking on camera. 1) articulation 2) delivery 3) transitioning

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation, Safety, and Leadership		
	1.	Describe local program and vocational center policies and procedures.
	2.	Describe employment opportunities and responsibilities.
	3.	State procedures of leadership used to reach an agreement in an orderly manner and personal development opportunities provided to students by SkillsUSA.
	4.	Identify desirable personal behavior and characteristics.
	5.	Identify legal requirements for participation in the occupation.
	6.	Describe personal safety rules for working in the audio and television broadcasting industry.
Unit 2: Introduction to Television and the Production Industry		
	1.	Demonstrate the ability to utilize basic television broadcasting skills.
Unit 3: Basic Camera Operation and Shot Composition		
	1.	Identify uses of the video camera.
Unit 4: Studio/Control Room Equipment		
	1.	Demonstrate the ability to use basic television production equipment.
	2.	Demonstrate the ability to operate audio control room equipment.
Unit 5: Scriptwriting		
	1.	Demonstrate the ability to write audio and television production scripts.

	2.	Demonstrate the ability to understand and write for television news.
Unit 6: Audio and Television Announcing		
	1.	Demonstrate the ability to announce effectively.
	2.	Utilize microphone and hand-signal techniques used for television broadcasting talent.
Unit 7: Producing/Directing a Television Program		
	1.	Demonstrate the ability to produce a television program.
	2.	Demonstrate the procedures for directing television productions.
Unit 8: Audio for Film and Video		
	1.	Demonstrate the audio setup for a production.
	2.	Explain the purpose and use of music in a production.
Unit 9: Basic Television Editing		
	1.	Explain the purpose of editing videotape for television broadcast.
	2.	Demonstrate the ability to operate linear television editing equipment.
	3.	Demonstrate the ability to operate non-linear television editing equipment.
Audio and Television Broadcasting II **Unit 10: Orientation, Safety, and Leadership**		
	1.	Describe local program and vocational center policies and procedures.
	2.	Describe employment opportunities and responsibilities.
	3.	Develop advanced leadership and organizational skills.
	4.	Describe personal safety rules for working in the audio and television broadcasting industry.
Unit 11: Employability Skills		
	1.	Develop and emphasize employability skills.
Unit 12: Advanced Camera Operation		
	1.	Advanced camera operation.
Unit 13: Social Media		
	1.	Describe social media and its use in television.

~~Unit 14: Advanced Scriptwriting~~		
	~~1.~~	~~Demonstrate writing for news outlets.~~
	~~2.~~	~~Demonstrate writing for print.~~
	~~3.~~	~~Demonstrate writing for the screen.~~
~~Unit 15: Advanced Video Production and Editing~~		
	~~1.~~	~~Demonstrate the ability to produce a news package.~~
	~~2.~~	~~Demonstrate the ability to produce a PSA.~~
	~~3.~~	~~Demonstrate the ability to produce a commercial/promo.~~
	~~4.~~	~~Demonstrate the ability to produce a news segment.~~
~~Unit 16: Music in Broadcasting~~		
	~~1.~~	~~Analyze the use of music in film and video projects.~~
	~~2.~~	~~Demonstrate composing music for film using Garageband software.~~
~~Unit 17: Ethics in Journalism~~		
	~~1.~~	~~Identify the rights and limitations of the First Amendment.~~
	~~2.~~	~~Discuss cases of ethics.~~
~~Unit 18: Senior Project~~		
	~~1.~~	~~Demonstrate the production and broadcasting skills acquired throughout the two-year program.~~
~~Unit 19: Oral Communication and Public Speaking~~		
	~~1.~~	~~Discuss and demonstrate uses of oral communication skills.~~

Appendix A: Unit References

All of the Television Broadcasting and Production units use the same resources for each unit.

Books

Harris, P. (2012). *Television Production and Broadcast Journalism*: Second Edition. Goodheart-Willcox Company, Inc. ISBN: 978-1-60525-350-3

Kyker, K. and Curchy, C. (n.d.). *Educators Survival Guide for Television Production and Activities,* Libraries Unlimited. ISBN 1563089831

Websites

http://www.soc.org

http://www.hsbj.org/

http://www.schooljournalism.org/

http://www.schooltv.com/

http://www.video101course.com/

http://www.studentfilmmakers.com/

http://www.careerpage.org/

Appendix B: Industry Standards

The Common Career Technical Core (CCTC)

Crosswalk for Television Broadcasting and Production

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
AVT1			X		X			X		X	
AVT2				X	X	X	X		X	X	
AVT3				X	X	X	X	X	X	X	
AVT4						X		X		X	
JBC1			X		X						
JBC2						X	X				
JBC3						X			X		
JBC4				X	X	X		X		X	
WDC1											
WDC2											
WDC3											
WDC4											
WDC5											
WDC6											
WDC7											
WDC8											
WDC9											
WDC10									X		

		Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	
AVT1			X		X	X	X				
AVT2			X			X					
AVT3			X			X	X				
AVT4						X	X				

JBC1			X		X	X					
JBC2				X	X	X					
JBC3						X					
JBC4						X					
WDC1											
WDC2											
WDC3											
WDC4				X							
WDC5											
WDC6											
WDC7											
WDC8											
WDC9											
WDC10				X			X				

A/V Technology & Film Career Pathway (AR-AV)

AVT1. Describe the history, terminology, occupations and value of audio, video and film technology.

AVT2. Demonstrate the use of basic tools and equipment used in audio, video and film production.

AVT3. Demonstrate technical support skills for audio, video and/or film productions.

AVT4. Design an audio, video and/or film production.

Journalism & Broadcasting Career Pathway (AR-JB)

JBC1. Describe the diversity of functions within the Journalism & Broadcasting Career Pathway.

JBC2. Demonstrate writing processes used in journalism and broadcasting.

JBC3. Plan and deliver a media production (e.g., broadcast, video, Internet, mobile).

JBC4. Demonstrate technical support related to media production (e.g., broadcast, video, Internet, mobile).

Web & Digital Communications Career Pathway (IT-WD)

~~WDC1. Analyze customer requirements to design and develop a Web or digital communication product.~~

~~WDC 2. Apply the design and development process to produce user-focused Web and digital communications solutions.~~

~~WDC 3. Write product specifications that define the scope of work aligned to customer requirements.~~

~~WDC4. Demonstrate the effective use of tools for digital communication production, development and project management.~~

~~WDC5. Develop, administer and maintain Web applications.~~

~~WDC6. Design, create and publish a digital communication product based on customer needs.~~

~~WDC7. Evaluate the functionality of a digital communication product using industry accepted techniques and metrics.~~

~~WDC8. Implement quality assurance processes to deliver quality digital communication products and services.~~

~~WDC9. Perform maintenance and customer support functions for digital communication products.~~

~~WDC10. Comply with intellectual property laws, copyright laws and ethical practices when creating Web/digital communications.~~

Appendix C: 21st Century Skills[1]

21st Century Crosswalk for Television Broadcasting and Production											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
21st Century Standards											
CS1											
CS2											
CS3											
CS4											
CS5											
CS6			X	X							
CS7											
CS8			X		X	X	X	X			
CS9											
CS10						X		X			
CS11				X	X		X		X	X	
CS12											
CS13			X	X	X	X	X		X	X	
CS14							X		X		
CS15						X		X	X	X	
CS16		X						X			X

		Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	
CS1											
CS2											
CS3											
CS4											
CS5											
CS6						X	X				
CS7											

[1] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

CS8					X	X				X	
CS9									X		
CS10				X	X	X	X	X			
CS11			X				X		X		
CS12											
CS13		X	X		X				X		
CS14				X						X	
CS15			X	X		X			X		
CS16		X						X			

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.

2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2 Learning and Innovation Skills

CS6 Creativity and Innovation
1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving
1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration
1. Communicate Clearly
2. Collaborate with Others

CSS3 Information, Media and Technology Skills

CS9 Information Literacy
1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy
1. Analyze Media
2. Create Media Products

CS11 ICT Literacy
1. Apply Technology Effectively

CSS4 Life and Career Skills

CS12 Flexibility and Adaptability
1. Adapt to change
2. Be Flexible

CS13 Initiative and Self Direction
1. Manage Goals and Time
2. Work Independently
3. Be Self directed Learners

CS14 Social and Cross Cultural Skills
1. Interact Effectively with others
2. Work Effectively in Diverse Teams

~~**CS15 Productivity and Accountability**~~

~~1. Manage Projects~~

~~2. Produce Results~~

~~**CS16 Leadership and Responsibility**~~

~~1. Guide and Lead Others~~

~~2. Be Responsible to Others~~

Appendix D: Common Core Standards

Common Core Crosswalk for English/Language Arts (11-12)											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
Common Core Standards											
RL.11.1.											
RL.11.2.											
RL.11.3.											
RL.11.4.											
RL.11.5.											
RL.11.6.											
RL.11.7.											
RL.11.8.											
RL.11.9.											
RL.11.10.											
RI.11.1.											
RI.11.2.											
RI.11.3.											
RI.11.4.											
RI.11.5.											
RI.11.6.											
RI.11.7.											
RI.11.8.											
RI.11.9.											
RI.11.10.											
W.11.1.											
W.11.2.											
W.11.3.											
W.11.4.						X					
W.11.5.						X					
W.11.6.											
W.11.7.											

W.11.8.											
W.11.9.											
W.11.10.											
SL.11.1.			X	X	X	X	X				
SL.11.2.						X					
SL.11.3.											
SL.11.4.											
SL.11.5.								X	X	X	
SL.11.6.											
L.11.1.							X				
L.11.2.											
L.11.3.											
L.11.4.											
L.11.5.											
L.11.6.											
RH.11.1.											
RH.11.2.											
RH.11.3.											
RH.11.4.											
RH.11.5.											
RH.11.6.											
RH.11.7.											
RH.11.8.											
RH.11.9.											
RH.11.10.											
RST.11.1.											
RST.11.2.											
RST.11.3.											
RST.11.4.											
RST.11.5.											
RST.11.6.											
RST.11.7.											
RST.11.8.											

~~RST.11.9.~~											
~~RST.11.10.~~											
~~WHST.11.1.~~											
~~WHST.11.2.~~											
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Reading Standards for Literature (11-12)

College and Career Readiness Anchor Standards for *Reading Literature*

Key Ideas and Details

RL.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RL.11.2. Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

RL.11.3. Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4. Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)

RL.11.5. Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.

RL.11.6. Analyze a case in which grasping point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7. Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)

RL.11.8. (Not applicable to literature)

RL.11.9. Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10. By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Informational Text (11-12)

College and Career Readiness Anchor Standards for *Informational Text*

~~Key Ideas and Details~~

~~RI.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.~~

~~RI.11.2. Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.~~

~~RI.11.3. Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.~~

~~Craft and Structure~~

~~RI.11.4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).~~

~~RI.11.5. Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.~~

~~RI.11.6. Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness, or beauty of the text.~~

~~Integration of Knowledge and Ideas~~

~~RI.11.7. Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.~~

~~RI.11.8. Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).~~

~~RI.11.9. Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including The Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.~~

~~Range of Reading and Level of Text Complexity~~

~~RI.11.10. By the end of grade 11, read and comprehend literary nonfiction in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.~~
~~By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11–CCR text complexity band independently and proficiently.~~

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

W.11.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from and supports the argument presented.

W.11.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

W.11.3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

a. Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.

b. Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters

c. Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).

d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

W.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12 on page 54.)

W.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

W.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

W.11.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

a. Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").

b. Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

College and Career Readiness Anchor Standards for *Speaking and Listening*

Comprehension and Collaboration

SL.11.1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SL.11.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11.3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4. Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

SL.11.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11.6. Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 on page 54 for specific expectations.)

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

L.11.1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

a. Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

b. Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

L.11.2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

a. Observe hyphenation conventions.

b. Spell correctly.

Knowledge of Language

L.11.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

a. Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.

a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

b. Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.

d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

L.11.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

a. Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.
b. Analyze nuances in the meaning of words with similar denotations.

L.11.6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Reading Standards for Literacy in History/Social Studies (11-12)

Key Ideas and Details

RH.11.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

RH.11.2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas

RH.11.3. Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain

Craft and Structure

RH.11.4. Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RH.11.5. Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

RH.11.6. Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.

Integration of Knowledge and Ideas

RH.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

RH.11.8. Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

RH.11.9. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Range of Reading and Level of Text Complexity

RH.11.10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Literacy in Science and Technical Subjects (11-12)

Key Ideas and Details

RST.11.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

RST.11.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

RST.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

RST.11.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (11-12)

Text Types and Purposes

WHST.11.1. Write arguments focused on discipline-specific content.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST.11.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11.3. (Not applicable as a separate requirement)

Production and Distribution of Writing

WHST.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

WHST.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

~~WHST.11.9. Draw evidence from informational texts to support analysis, reflection, and research.~~

~~Range of Writing~~

~~WHST.11.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.~~

Common Core Crosswalk for Mathematics (11-12)											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
Common Core Standards											
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~~Mathematics (High School)~~

~~Number and Quantity~~

~~The Real Number System~~

~~N-RN.1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.~~

~~N-RN.2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.~~

~~N-RN.3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.~~

~~Quantities~~

~~N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.~~

~~N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.~~

~~N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.~~

~~The Complex Number System~~

~~N-CN.1. Know there is a complex number i such that i2= −1, and every complex number has the form a + bi with a and b real.~~

~~N-CN.2. Use the relation i2= −1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.~~

~~N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.~~

~~N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.~~

N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, (−1 + √3 i)3= 8 because (−1 + √3 i) has modulus 2 and argument 120°.

N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

N-CN.7. Solve quadratic equations with real coefficients that have complex solutions.

N-CN.8. (+) Extend polynomial identities to the complex numbers. For example, rewrite x2+ 4 as (x + 2i)(x − 2i).

N-CN.9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Vector and Matrix Quantities

N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).

N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.

N-VM.4. (+) Add and subtract vectors

N-VM.4.a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

N-VM.4.b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

N-VM.4.c. Understand vector subtraction v − w as v + (−w), where −w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

N-VM.5. (+) Multiply a vector by a scalar.

N-VM.5.a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy).

N-VM.5.b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v ≠ 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).

N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

N-VM.7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

N-VM.8. (+) Add, subtract, and multiply matrices of appropriate dimensions.

N-VM.9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties

N-VM.10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

N-VM.11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

N-VM.12. (+) Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra

Seeing Structure in Expressions

A-SSE.1. Interpret expressions that represent a quantity in terms of its context.

A-SSE.1.a. Interpret parts of an expression, such as terms, factors, and coefficients.

A-SSE.1.b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

A-SSE.2. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-SSE.3.a. Factor a quadratic expression to reveal the zeros of the function it defines.

A-SSE.3.b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

A-SSE.3.c. Use the properties of exponents to transform expressions for exponential functions.

A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.

Arithmetic with Polynomials and Rational Expressions

A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials

A-APR.2. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

A-APR.4. Prove polynomial identities and use them to describe numerical relationships.

A-APR.5. (+) Know and apply the Binomial Theorem for the expansion of (x+ y)n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x)in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Creating Equations

A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

A-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V =IR to highlight resistance R.

Reasoning with Equations and Inequalities

A-REI.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

~~A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.~~

~~A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.~~

~~A-REI.4. Solve quadratic equations in one variable.~~

> ~~A-REI.4.a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.~~
>
> ~~A-REI.4.b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.~~

~~A-REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.~~

~~A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.~~

~~A-REI.7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x^2+y^2 = 3$.~~

~~A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.~~

~~A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3×3 or greater).~~

~~A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).~~

~~A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.~~

A-REI.12.Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Interpreting Functions

F-IF.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.

F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

F-IF.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F-IF.7.a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.7.b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.7.c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

F-IF.7.d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

F-IF.7.e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

F-IF.8.a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.8.b. Use the properties of exponents to interpret expressions for exponential functions.

F-IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Building Functions

~~F-BF.1. Write a function that describes a relationship between two quantities.~~

~~F-BF.1.a. Determine an explicit expression, a recursive process, or steps for calculation from a context.~~

~~F-BF.1.b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.~~

~~F-BF.1.c. (+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.~~

~~F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.~~

~~F-BF.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.~~

~~F-BF.4. Find inverse functions.~~

~~F-BF.4.a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse.~~

~~F-BF.4.b. (+) Verify by composition that one function is the inverse of another.~~

~~F-BF.4.c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.~~

F-BF.4.d. (+) Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Linear, Quadratic, and Exponential Models

F-LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

F-LE.1.a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.

F-LE.1.b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

F-LE.1.c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another

F-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

F-LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

F-LE.4. For exponential models, express as a logarithm the solution to ab ct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

F-LE.5. Interpret the parameters in a linear or exponential function in terms of a context.

Trigonometric Functions

F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π−x, π+x, and 2π−x in terms of their values for x, where x is any real number.

F-TF.4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.

F-TF.8. Prove the Pythagorean identity sin2 (θ) + cos 2 (θ) = 1 and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle.

F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Congruence

G-CO.1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

~~G-CO.2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).~~

~~G-CO.3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.~~

~~G-CO.4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.~~

~~G-CO.5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.~~

~~G-CO.6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.~~

~~G-CO.7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.~~

~~G-CO.8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.~~

~~G-CO.9. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.~~

~~G-CO.10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.~~

G-CO.11. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Similarity, Right Triangles, and Trigonometry

G-SRT.1. Verify experimentally the properties of dilations given by a center and a scale factor:

G-SRT.1.a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

G-SRT.1.b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2. Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

G-SRT.4. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

G-SRT.6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7. Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

G-SRT.9. (+) Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Circles

G-C.1. Prove that all circles are similar.

G-C.2. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

G-C.4. (+) Construct a tangent line from a point outside a given circle to the circle.

G-C.5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Expressing Geometric Properties with Equations

G-GPE.1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

G-GPE.2. Derive the equation of a parabola given a focus and directrix.

G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

G-GPE.4. Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

G-GPE.6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

~~Geometric Measurement and Dimension~~

~~G-GMD.1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.~~

~~G-GMD.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.~~

~~G-GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.~~

~~G-GMD.4. Identify the shapes of two-dimensional cross-sections of three dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.~~

~~Modeling with Geometry~~

~~G-MG.1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).~~

~~G-MG.2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).~~

~~G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).~~

~~**Statistics and Probability**~~

~~Interpreting Categorical and Quantitative Data~~

~~S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots).~~

~~S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.~~

~~S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).~~

~~S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate.~~

~~Use calculators, spreadsheets, and tables to estimate areas under the normal curve.~~

~~S-ID.5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.~~

~~S-ID.6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.~~

> ~~S-ID.6.a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.~~
>
> ~~S-ID.6.b. Informally assess the fit of a function by plotting and analyzing residuals.~~
>
> ~~S-ID.6.c. Fit a linear function for a scatter plot that suggests a linear association.~~

~~S-ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.~~

S-ID.8. Compute (using technology) and interpret the correlation coefficient of a linear fit.

S-ID.9. Distinguish between correlation and causation.

Making Inferences and Justifying Conclusions

S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

S-IC.3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

S-IC.4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

S-IC.5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

S-IC.6. Evaluate reports based on data.

Conditional Probability and the Rules of Probability

S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").

S-CP.2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

S-CP.3. Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

S-CP.4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For

example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

S-CP.6. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.

S-CP.7. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.

S-CP.8. (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.

S-CP.9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Using Probability to Make Decisions

S-MD.1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.

S-MD.3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.

S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and

~~calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?~~

~~S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.~~

~~S-MD.5.a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.~~

~~S-MD.5.b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.~~

~~S-MD.6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).~~

~~S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).~~

Appendix E: International Society for Technology in Education Standards (ISTE)

ISTE Crosswalk for Television Broadcasting and Production											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
ISTE Standards											
T1						X	X	X	X		
T2			X	X		X	X	X			
T3					X				X	X	
T4			X	X				X			
T5		X									X
T6					X					X	
		Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	
T1					X				X		
T2		X		X	X					X	
T3			X								
T4						X					
T5		X		X			X	X			
T6			X			X	X		X		

T1 – Creativity and Innovation

T2 – Communication and Collaboration

T3 – Research and Information Fluency

T4 – Critical Thinking, Problem Solving, and Decision Making

T5 – Digital Citizenship

T6 – Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.

b. Create original works as a means of personal or group expression.

c. Use models and simulations to explore complex systems and issues.

d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.

b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.

c. Develop cultural understanding and global awareness by engaging with learners of other cultures.

d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.

b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.

d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.

b. Plan and manage activities to develop a solution or complete a project.

c. Collect and analyze data to identify solutions and/or make informed decisions.

d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.

b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.

c. Demonstrate personal responsibility for lifelong learning.

d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.

b. Select and use applications effectively and productively.

c. Troubleshoot systems and applications.

d. Transfer current knowledge to learning of new technologies.

Miss. Admin. Code 7-141

2021 Keystone

Program CIP: 37.0103 Personal Decision-Making Skills

Direct inquiries to:

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Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

Table of Contents

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Standards

Standards and alignment crosswalks are referenced in the appendices. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE Keystone curriculum is aligned to the following standards:

International Society for Technology in Education Standards (ISTE)
Reprinted with permission from *ISTE Standards for Students* (2016). All rights reserved. Permission does not constitute an endorsement by ISTE.
iste.org

College- and Career-Ready Standards
College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College and Career Ready Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mde.k12.ms.us/mccrs

Framework for 21st Century Learning
In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. 21 *Framework Definitions* (2019).
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
: Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource
: Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call the RCU at 662.325.2510.

Executive Summary

Course Description
Keystone is a course to be taught in either seventh, eighth, or ninth grade and is to be used as an introduction to career pathways and career decision-making. The course was developed specifically to meet the needs of those schools participating in career academies. This introductory course includes content in self-development, career clusters, pathways, and choices, as well as financial planning. The course is designed to be taught in a "flipped" classroom environment where students are introduced to the content outside of class and experience the content during class.

Grade Level and Class Size
Students should be enrolled in seventh, eighth, or ninth grade in order to take Keystone. Exceptions to this are a district-level decision based on class size, enrollment numbers, and student maturity. A maximum of 25 students is recommended for classroom-based courses such as this.

Teacher Licensure
The latest teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning
If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outline

Keystone—Course Code: 990002

Unit	Unit Name	Hours
1	Orientation, Course Introduction, and Ethics	15
2	Learning and Personality Styles	5
3	The 16 National Career Clusters: Agriculture, Food and Natural Resources	5
4	The 16 National Career Clusters: Architecture and Construction	5
5	The 16 National Career Clusters: Arts, A/V Technology and Communications	5
6	The 16 National Career Clusters: Business Management and Administration	5
7	The 16 National Career Clusters: Education and Training	5
8	The 16 National Career Clusters: Finance	5
9	The 16 National Career Clusters: Government and Public Administration	5
10	The 16 National Career Clusters: Health Science	5
11	The 16 National Career Clusters: Hospitality and Tourism	5
12	The 16 National Career Clusters: Human Services	5
13	The 16 National Career Clusters: Information Technology	5
14	The 16 National Career Clusters: Law, Public Safety, Corrections and	5
15	The 16 National Career Clusters: Manufacturing	5
16	The 16 National Career Clusters: Marketing	5
17	The 16 National Career Clusters: Science, Technology, Engineering and Math	5
18	The 16 National Career Clusters: Transportation, Distribution and Logistics	5
19	Financial Literacy/Reality Fair	20
20	College and Career Focus	20
Total		140

Career Pathway Outlook

Overview
The Keystone course provides an overview of the 16 Career Clusters in the National Career Clusters Framework. The overview will consist of various jobs, earnings, and requirements for students to explore throughout the course.

Needs of the Future Workforce
Data for this synopsis were compiled from employment projections prepared by the U.S. Census Bureau, the U.S. Bureau of Labor Statistics (2019), and the Mississippi Department of Employment Security (2019).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2016	Projected Jobs, 2026	Change (Number)	Change (Percent)	Average Hourly Earnings, 2019
Management Occupations	63,150	68,070	4,920	7.8	$39.19
Business and Financial Operations Occupations	32,730	34,440	1,710	5.2	$29.23
Computer and Mathematical Occupations	12,210	13,030	820	6.7	$33.62
Architecture and Engineering Occupations	15,320	16,410	1,090	7.1	$36.01
Life, Physical, and Social Science Occupations	7,260	7,660	400	5.5	$29.84
Community and Social Service Occupations	15,120	16,490	1,370	9.1	$18.99
Legal Occupations	6,040	6,300	260	4.3	$35.75
Education, Training, and Library Occupations	77,340	84,310	6,970	9.0	$21.24
Arts, Design, Entertainment, Sports, and Media Occupations	8,660	8,880	220	2.5	$22.35
Healthcare Practitioners and Technical Occupations	78,060	84,220	6,160	7.9	$30.86
Healthcare Support Occupations	31,400	34,830	3,430	10.9	$12.37
Protective Service Occupations	32,540	33,690	1,150	3.5	$15.90
Food Preparation and Serving Related Occupations	97,530	109,540	12,010	12.3	$10.16
Building and Grounds Cleaning and Maintenance Occupations	39,020	42,480	3,460	8.9	$11.34
Personal Care and Service Occupations	34,890	38,320	3,430	9.8	$11.22
Sales and Related Occupations	122,620	127,230	4,610	3.8	$14.61

Office and Administrative Support Occupations	171,440	168,460	(2,980)	(1.7)	$15.61
Farming, Fishing, and Forestry Occupations	13,980	13,700	(280)	(2.0)	$17.64
Construction and Extraction Occupations	44,980	47,290	2,310	5.1	$19.24
Installation, Maintenance, and Repair Occupations	54,030	57,420	3,390	6.3	$20.82
Production Occupations	103,140	103,960	820	0.8	$16.92
Transportation and Material Moving Occupations	92,550	97,530	4,980	5.4	$16.01

Source: Mississippi Department of Employment Security; mdes.ms.gov (2019).

Perkins V Requirements and Academic Infusion

The Keystone curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for fitness and nutrition careers. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, the curriculum focuses on ongoing and meaningful professional development for teachers, as well as relationships with industry.

Transition to Postsecondary Education

The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The instructor's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the Keystone curriculum. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to careers and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Keystone curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The Keystone curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the Keystone curriculum that will allow and encourage collaboration with professionals in a variety of fields.

Project-Based Learning

The Keystone curriculum is intended to be taught in a student-led, inquiry-based, flipped classroom environment. It is important that the career cluster units in particular be taught in the flipped classroom environment. Students should develop projects based on what they want to research and learn about each cluster. The flipped classroom model suggests that much of this research and information-gathering is done *outside* of the classroom, while project work takes place during class time. For more information, please visit jonbergmann.com.

Work-Based Learning

Work-based learning is an extension of understanding competencies taught in the Keystone classroom. This curriculum is designed in a way that necessitates active involvement by the students in the community around them and the global environment. These real-world connections and applications link all types of students to knowledge, skills, and professional dispositions. Work-based learning should encompass ongoing and increasingly more complex involvement with local companies and professionals. Thus, supervised collaboration and immersion into the industry around students are keys to students' success, knowledge, and skills development.

Professional Organizations

Association of Career and Technical Education
acteonline.org

Distributive Education Clubs of America
deca.org

Family, Career, and Community Leaders of America
fcclainc.org

Future Business Leaders of America
fbla-pbl.org

Future Educators of America
futureeducators.org

Future Farmers of America
ffa.org

Health Occupational Students of America
hosa.org

Mississippi Association of Career and Technical Education
mississippiacte.com

SkillsUSA
skillsusa.org

Technology Student Association
tsaweb.org

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80%of the time in the course. The remaining percentage of class time will include instruction in non-tested material, review for end-of-course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Teacher Resources
Teacher resources for this curriculum may be found in multiple places. Many program areas have teacher resource documents that accompany the curriculum and can be downloaded from the same site as the curriculum. The teacher resource document contains references, lesson ideas, websites, teaching and assessment strategies, scenarios, skills to master, and other resources divided by unit. This document could be updated periodically by RCU staff. Please check the entire document, including the entries for each unit, regularly for new information. If you have something you would like to add or have a question about the document, call or email the RCU's instructional design specialist for your program. The teacher resource document can be downloaded at rcu.msstate.edu/curriculum/curriculumdownload.aspx. All teachers should request to be added to the Canvas Resource Guide for their course. This is where all resources will be housed in the future if they are not already. To be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Many of the units include an enrichment section at the end. If the Keystone program is currently using the Mississippi Career Planning and Assessment System (MS-CPAS) as a measure of accountability, the enrichment section of material will not be tested. If this is the case, it is suggested to use the enrichment material when needed or desired by the teacher and if time allows in the class. This material will greatly enhance the learning experiences for students. If, however, the Keystone program is using a national certification or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be tested. It is the responsibility of the teacher to ensure all competencies for the selected assessment are covered throughout the year.

Unit 1: Orientation, Course Introduction, and Ethics

Competencies and Suggested Objectives
1. Describe course expectations, school policies, and safety procedures. DOK1 a. Identify student expectations and policies for the course. b. Describe the operating procedures for the equipment utilized in the class.
2. Understand the importance of employability skills to be successful in the workplace. DOK1 a. Demonstrate effective written and verbal communication skills. b. Identify proper attire and appearance required for the workplace. c. Understand interpersonal skills and the ability to work well with others. d. Identify ethical behavior and the proper use of technology in the workplace.
3. Explore student organizations related to the sixteen national career clusters. DOK1 a. Discuss leadership and personal development in accordance with student organizations. b. Describe parliamentary procedure. c. Discuss officer roles and responsibilities.

Unit 2: Learning and Personality Styles

Competencies and Suggested Objectives
1. Discover learning and personality styles. DOK1 a. Complete learning and personality style inventories. b. Identify elements that shape personality development. • Character traits • Heredity • Environment c. Identify conflicts between personality, management styles, and work techniques to manage in the workplace and life.
2. Develop characteristics of highly effective people. DOK2 a. Participate in activities that strengthen self-motivation. b. Recognize the importance of time management and personal responsibility.

Unit 3: Agriculture, Food and Natural Resources

Competencies and Suggested Objectives
1. Understand career opportunities in the agriculture, food and natural resources career cluster. DOK2 a. Research the occupational outlook for jobs in the agriculture, food and natural resources career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the agriculture, food and natural resources career cluster in society. DOK3 a. Research the relationship of careers in agriculture, food and natural resources to society and other careers. b. Participate in a real-world job scenario associated with the agriculture, food and natural resources career cluster.

Unit 4: Architecture and Construction

Competencies and Suggested Objectives
1. Understand career opportunities in the architecture and construction career cluster. DOK2 a. Research the occupational outlook for jobs in the architecture and construction career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the architecture and construction career cluster in society. DOK2 a. Research the relationship of careers in architecture and construction to society and other careers. b. Participate in a real-world job scenario associated with the architecture and construction career cluster.

Unit 5: Arts, A/V Technology and Communications

Competencies and Suggested Objectives
1. Understand career opportunities in the arts, audio/video technology and communications career cluster. DOK2 a. Research the occupational outlook for jobs in the arts, audio/video technology and communications career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the arts, audio/video technology and communications career cluster in society. DOK2 a. Research the relationship of careers in arts, audio/video technology and communications to society and other careers. b. Participate in a real-world job scenario associated with the arts, audio/video technology and communications career cluster.

Unit 6: Business Management and Administration

Competencies and Suggested Objectives
1. Understand career opportunities in the business management and administration career cluster. DOK2 a. Research the occupational outlook for jobs in the business management and administration career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the business management and administration career cluster in society. DOK2 a. Research the relationship of careers in business management and administration to society and other careers. b. Participate in a real-world job scenario associated with the business management and administration career cluster.

Unit 7: Education and Training

Competencies and Suggested Objectives
1. Understand career opportunities in the education and training career cluster. DOK2 a. Research the occupational outlook for jobs in the education and training career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the education and training career cluster in society. DOK2 a. Research the relationship of careers in education and training to society and other careers. b. Participate in a real-world job scenario associated with the education and training career cluster.

Unit 8: Finance

Competencies and Suggested Objectives
1. Understand career opportunities in the finance career cluster. DOK2 a. Research the occupational outlook for jobs in the finance career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the finance career cluster in society. DOK2 a. Research the relationship of careers in finance to society and other careers. b. Participate in a real-world job scenario associated with the finance career cluster.

Unit 9: Government and Public Administration

Competencies and Suggested Objectives
1. Understand career opportunities in the government and public administration career cluster. DOK2 a. Research the occupational outlook for jobs in the government and public administration career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the government and public administration career cluster in society. DOK2 a. Research the relationship of careers in government and public administration to society and other careers. b. Participate in a real-world job scenario associated with the government and public administration career cluster.

Unit 10: Health Science

Competencies and Suggested Objectives
1. Understand career opportunities in the health science career cluster. DOK2 a. Research the occupational outlook for jobs in the health science career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the health science career cluster in society. DOK2 a. Research the relationship of careers in health science to society and other careers. b. Participate in a real-world job scenario associated with the health science career cluster.

Unit 11: Hospitality and Tourism

Competencies and Suggested Objectives
1. Understand career opportunities in the hospitality and tourism career cluster. DOK2 a. Research the occupational outlook for jobs in the hospitality and tourism career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the hospitality and tourism career cluster in society. DOK2 a. Research the relationship of careers in hospitality and tourism to society and other careers. b. Participate in a real-world job scenario associated with the hospitality and tourism career cluster.

Unit 12: Human Services

Competencies and Suggested Objectives
1. Understand career opportunities in the human services career cluster. DOK2 a. Research the occupational outlook for jobs in the human services career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the human services career cluster in society. DOK2 a. Research the relationship of careers in human services to society and other careers. b. Participate in a real-world job scenario associated with the human services career cluster.

Unit 13: Information Technology

Competencies and Suggested Objectives
1. Understand career opportunities in the information technology career cluster. DOK2 a. Research the occupational outlook for jobs in the information technology career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the information technology career cluster in society. DOK2 a. Research the relationship of careers in information technology to society and other careers. b. Participate in a real-world job scenario associated with the information technology career cluster.

Unit 14: Law, Public Safety, Corrections, and Security

Competencies and Suggested Objectives
1. Understand career opportunities in the law, public safety, corrections, and security career cluster. DOK2 a. Research the occupational outlook for jobs in the law, public safety, corrections, and security career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the law, public safety, corrections, and security career cluster in society. DOK2 a. Research the relationship of careers in law, public safety, corrections, and security to society and other careers. b. Participate in a real-world job scenario associated with the law, public safety, corrections, and security career cluster.

Unit 15: Manufacturing

Competencies and Suggested Objectives
1. Understand career opportunities in the manufacturing career cluster. DOK2 a. Research the occupational outlook for jobs in the manufacturing career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the manufacturing career cluster in society. DOK2 a. Research the relationship of careers in manufacturing to society and other careers. b. Participate in a real-world job scenario associated with the manufacturing career cluster.

Unit 16: Marketing

Competencies and Suggested Objectives
1. Understand career opportunities in the marketing career cluster. DOK2 a. Research the occupational outlook for jobs in the marketing career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the marketing career cluster in society. DOK2 a. Research the relationship of careers in marketing to society and other careers. b. Participate in a real-world job scenario associated with the marketing career cluster.

Unit 17: Science, Technology, Engineering and Math

Competencies and Suggested Objectives
1. Understand career opportunities in the science, technology, engineering and math career cluster. DOK2 a. Research the occupational outlook for jobs in the science, technology, engineering and math career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the science, technology, engineering and math career cluster in society. DOK2 a. Research the relationship of careers in science, technology, engineering and math to society and other careers. b. Participate in a real-world job scenario associated with the science, technology, engineering and math career cluster.

Unit 18: Transportation, Distribution and Logistics

Competencies and Suggested Objectives
1. Understand career opportunities in the transportation, distribution and logistics career cluster. DOK2 a. Research the occupational outlook for jobs in the transportation, distribution and logistics career cluster. • Career pathways • Education and training • Salaries • Aptitudes
2. Identify the significance of the transportation, distribution and logistics career cluster in society. DOK2 a. Research the relationship of careers in transportation, distribution and logistics to society and other careers. b. Participate in a real-world job scenario associated with the transportation, distribution and logistics career cluster.

Unit 19: Financial Literacy/Reality Fair

Competencies and Suggested Objectives
1. Understand how employment relates to the needs and functions of society. DOK2 a. Describe how the U.S. economy operates as a free-enterprise system. • Consumers • Producers • Supply and demand • Competition b. Explain how the global economy affects individuals, communities, and our country. c. Examine how socio-economic factors and technology affect employment trends.
2. Create a personal budget. DOK3 a. Identify reasons to keep track of spending habits. b. Identify sources of income and expenses. c. Explain the concept of "paying yourself first." d. Identify goals of saving. e. Examine types of saving and investing.
3. Research the options for the best credit for personal financial use. DOK2 a. Examine the types and the cost of credit. • Student loans • Credit cards • Debit cards • Mortgage loans • Auto loans b. Compare the advantages and disadvantages of using credit. c. Discover credit history and what actions affect credit reports.
4. Understand the significance of debt. DOK1 a. Identify the different types and causes of debt. b. Identify ways to manage debt. • Budgeting • Monitoring credit score
5. Demonstrate the proper use of financial documents and transactions. DOK2 • Deposit slips • Checks • Debit card transaction • Credit card transactions • Bank statements • Check registers

Unit 20: College and Career Focus

Competencies and Suggested Objectives
1. Understand essential skills and techniques for employability. DOK2 a. Identify soft and transferable skills essential for employment. b. Demonstrate effective interview techniques and behavior. c. Identify proper job application techniques.
2. Explore local and national career opportunities. DOK1 a. Utilize various sources to research career information. • Career planning software • College planning tool • Government databases b. Discover essential career exploration information. • Job responsibilities • Job skills • Education and training • Salary • Projected growth c. Evaluate work sites and/or participate in virtual field trips.
3. Develop a five-year plan for high school, college and/or career. DOK3 a. Determine goals related to desired career/profession. b. Identify the program of study in necessary high school and college for desired career. • Courses • Electives • Extracurricular activities c. Explore financial opportunities that assist with college costs. • Financial aid programs • Scholarships

Student Competency Profile

Student Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation, Course Introduction, and Ethics		
	1.	Identify course expectations, district and school policies, and safety procedures related to the Keystone course.
	2.	Understand the importance of employability skills to be successful in the workplace.
	3.	Explore student organizations related to the sixteen national career clusters.
Unit 2: Learning and Personality Styles		
	1.	Discover learning and personality styles.
	2.	Develop characteristics of highly effective people.
Unit 3: Agriculture, Food and Natural Resources		
	1.	Understand career opportunities in the agriculture, food and natural resources career cluster.
	2.	Identify the significance of the agriculture, food and natural resources career cluster in society.
Unit 4: Architecture and Construction		
	1.	Understand career opportunities in the architecture and construction career cluster.
	2.	Identify the significance of the architecture and construction career cluster in society.
Unit 5: Arts, A/V Technology and Communications		
	1.	Understand career opportunities in the arts, audio/video technology and communications career cluster.
	2.	Identify the significance of the arts, audio/video technology and communications career cluster in society.
Unit 6: Business Management and Administration		
	1.	Understand career opportunities in the business management and administration career cluster.
	2.	Identify the significance of the business management and administration career cluster in society.

Unit 7: Education and Training		
	1.	Understand career opportunities in the education and training career cluster.
	2.	Identify the significance of the education and training career cluster in society.
Unit 8: Finance		
	1.	Understand career opportunities in the finance career cluster.
	2.	Identify the significance of the finance career cluster in society.
Unit 9: Government and Public Administration		
	1.	Understand career opportunities in the government and public administration career cluster.
	2.	Identify the significance of the government and public administration career cluster in society.
Unit 10: Health Science		
	1.	Understand career opportunities in the health science career cluster.
	2.	Identify the significance of the health science career cluster in society.
Unit 11: Hospitality and Tourism		
	1.	Understand career opportunities in the hospitality and tourism career cluster.
	2.	Identify the significance of the hospitality and tourism career cluster in society.
Unit 12: Human Services		
	1.	Understand career opportunities in the human services career cluster.
	2.	Identify the significance of the human services career cluster in society.
Unit 13: Information Technology		
	1.	Understand career opportunities in the information technology career cluster. DOK2
	2.	Identify the significance of the information technology career cluster in society.
Unit 14: Law, Public Safety, Corrections, and Security		
	1.	Understand career opportunities in the law, public safety, corrections, and security career cluster.
	2.	Identify the significance of the law, public safety, corrections, and security career cluster in society.
Unit 15: Manufacturing		
	1.	Understand career opportunities in the manufacturing career cluster
	2.	Identify the significance of the manufacturing career cluster in society
Unit 16: Marketing		
	1.	Understand career opportunities in the marketing career cluster.
	2.	Identify the significance of the marketing career cluster in society.

Unit 17: Science, Technology, Engineering and Math		
	1.	Understand career opportunities in the science, technology, engineering and math career cluster.
	2.	Identify the significance of the science, technology, engineering and math career cluster in society.
Unit 18: Transportation, Distribution and Logistics		
	1.	Understand career opportunities in the transportation, distribution and logistics career cluster.
	2.	Identify the significance of the transportation, distribution and logistics career cluster in society.
Unit 19: Financial Literacy/Reality Fair		
	1.	Understand how employment relates to the needs and functions of society.
	2.	Create a personal budget.
	3.	Research the options for the best credit for personal financial use.
	4.	Understand the significance of debt.
	5.	Demonstrate the proper use of financial documents and transactions.
Unit 20: College and Career Focus		
	1.	Understand essential skills and techniques for employability.
	2.	Explore local and national career opportunities.
	3.	Develop a five-year plan for high school, college and/or career.

Appendix A: 21st Century Skills[1]

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21st Century Standards																					
CS1		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS2							x		x								x				x
CS3		x	x							x			x		x						
CS4				x							x		x								
CS5		x		x	x											x		x	x		
CS6						x												x			
CS7			x																	x	
CS8		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS9				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS10				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS11				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS12		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS13			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS14		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS15		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS16		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

[1] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

2015 Keystone

Mississippi Department of Education

Program CIP: 37.0103 Personal Decision-Making Skills

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Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land-grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

Table of Contents

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Dr. Jason S. Dean, chair
Mr. Buddy Bailey, vice chair
Ms. Rosemary G. Aultman
Dr. Karen Elam
Dr. John R. Kelly
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Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the *Keystone Curriculum Framework and Supporting Materials* are based on the following:

Common Core State Standards Initiative

The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. Copyright 2010. National Governors Association Center for Best Practices and Council of Chief State School Officers. All rights reserved. States and territories of the United States as well as the District of Columbia that have adopted the Common Core State Standards in whole are exempt from this provision and no attribution to the National Governors Association Center for Best Practices and Council of Chief State School Officers is required. Reprinted from http://www.corestandards.org/.

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21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and Information and Communication Technology (ICT) literacy.

Preface

Secondary Career and Technical Education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

My PLC: An online registration for all professional development sessions

To register for any session, teachers will need an account in the registration system, MyPLC, https://myplc.rcu.msstate.edu. To create an account, click on the link and navigate to the "Request a Guest ID" link. The ID should be the teacher's first initial and last name and the last four (4) digits of the social security number. Teachers should complete the entire form, which will then be sent to a secure server. Upon activation of the teacher's account, he or she will receive an e-mail with login instructions. The teacher may then browse for the available sessions and register for the desired courses.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Course Description

Keystone is a course to be taught in either 7th, 8th, or 9th grade and is to be used as an introduction to career pathways and career decision-making. The course was developed particularly to meet the needs of those schools participating in career academies. This introductory course includes content in self-development, career clusters, pathways, and choices, as well as financial planning. The course is designed to be taught in a "flipped" classroom environment where students are introduced to the content outside of class and actually *experience* the content during class.

Industry Certification

None

Assessment

The latest assessment blueprint for the curriculum can be found at the following location: http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Student Prerequisites

Students should be enrolled in 7th, 8th, or 9th grade in order to take Keystone.

Teacher Licensure

The latest teacher licensure information can be found at http://www.mde.k12.ms.us/educator-licensure

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for a professional learning specialist.

Course Outline

Keystone – Course Code: 990002

Unit	Unit Name	Hours
1	Orientation, Course Introduction, and Ethics	5
2	Learning and Personality Styles	5
3	The 16 National Career Clusters: Agriculture, Food & Natural Resources	5
4	The 16 National Career Clusters: Architecture & Construction	5
5	The 16 National Career Clusters: Arts, A/V Technology & Communications	5
6	The 16 National Career Clusters: Business Management & Administration	5
7	The 16 National Career Clusters: Education & Training	5
8	The 16 National Career Clusters: Finance	5
9	The 16 National Career Clusters: Government & Public Administration	5
10	The 16 National Career Clusters: Health Science	5
11	The 16 National Career Clusters: Hospitality & Tourism	5
12	The 16 National Career Clusters: Human Services	5
13	The 16 National Career Clusters: Information Technology	5
14	The 16 National Career Clusters: Law, Public Safety, Corrections & Security	5
15	The 16 National Career Clusters: Manufacturing	5
16	The 16 National Career Clusters: Marketing	5
17	The 16 National Career Clusters: Science, Technology, Engineering & Math	5
18	The 16 National Career Clusters: Transportation, Distribution & Logistics	5
19	Financial Literacy/Reality Fair	20
20	College and Career Focus/Development of a Six-Year Plan	15
21	Revisions, Goal-Setting, Professionalism, and Presentation	15
Total		140

Keystone Research Synopsis

Introduction

Keystone is a course to be taught in either 7th, 8th, or 9th grade and is to be used as an introduction to career pathways and career decision-making. The course was developed particularly to meet the needs of those schools participating in career academies. This introductory course includes content in self-development, career clusters, pathways, and choices, as well as financial planning. The course is designed to be taught in a "flipped" classroom environment where students are introduced to the content outside of class and actually *experience* the content during class.

Needs of the Future Workforce

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2014). Employment opportunities for each of the occupations listed below are

Table 1.1: Current and Projected Occupation Report

	Mississippi					National				
			Projected Growth					Projected Growth		
Occupation	2010 Employment	2020 Projected Employment	Number	Percent	Mean Hourly Wage	2012 Employment	2022 Projected Employment	Number	Percent	Mean Hourly Wage
Management Occupations	50,010	51,330	1,320	2.60	$39.82	8,861.50	9,498.00	636.6	7.2	$51.64
Business and Financial Operations Occupations	25,450	27,920	2,470	9.70	$26.52	7,167.60	8,065.70	898.1	12.5	$33.05
Computer and Mathematical Occupations	9,450	10,590	1,140	12.10	$29.09	3,814.70	4,500.50	685.8	18	$37.85
Architecture and Engineering Occupations	15,620	16,260	640	4.10	$31.50	2,474.50	2,654.00	179.6	7.3	$37.08
Life, Physical, and Social Science Occupations	7,270	7,790	520	7.20	$28.20	1,249.10	1,374.80	125.7	10.1	$32.44
Community and Social Service Occupations	16,420	18,390	1,970	12.00	$18.30	2,374.70	2,783.40	408.8	17.2	$21.07
Legal Occupations	4,940	4,830	-110	(2.20)	$34.20	1,247.00	1,379.90	132.9	10.7	$47.30
Education, Training, and Library Occupations	77,880	88,480	10,600	13.60	$19.10	9,115.90	10,131.70	1,015.80	11.1	$24.46
Arts, Design, Entertainment, Sports, and Media Occupations	9,310	10,040	730	7.80	$19.00	2,570.90	2,751.60	180.6	7	$25.89
Healthcare Practitioners and Technical Occupations	75,390	88,170	12,780	17.00	$29.50	8,049.70	9,782.60	1,732.90	21.5	$34.97
Healthcare Support Occupations	43,830	51,270	7,440	17.00	$11.00	4,110.20	5,266.00	1,155.80	28.1	$13.16
Protective Service Occupations	25,410	28,190	2,780	10.90	$14.00	3,325.30	3,588.30	263	7.9	$20.54
Food Preparation and Serving Related Occupations	93,870	95,870	2,000	2.10	$9.00	11,780.10	12,882.00	1,101.80	9.4	$10.30
Building and Grounds Cleaning and Maintenance Occupations	33,110	36,520	3,410	10.30	$10.20	5,522.30	6,213.30	691	12.5	$12.29
Personal Care and Service Occupations	24,010	27,370	3,360	14.00	$10.70	5,375.60	6,498.50	1,122.90	20.9	$11.84
Sales and Related Occupations	113,080	117,980	4,900	4.30	$13.70	15,105.00	16,200.50	1,095.50	7.3	$18.04
Office and Administrative Support Occupations	163,220	166,650	3,430	2.10	$14.30	22,470.10	24,004.10	1,534.00	6.8	$16.40
Farming, Fishing, and Forestry Occupations	4,440	4,580	140	3.20	$14.40	947.2	915	-32.2	-3.4	$11.68
Construction and Extraction Occupations	44,770	47,150	2,380	5.30	$17.00	6,092.20	7,394.10	1,301.90	21.4	$21.46
Installation, Maintenance, and Repair Occupations	47,450	49,930	2,480	5.20	$18.40	5,514.80	6,046.00	531.2	9.6	$20.86
Production Occupations	100,610	104,590	3,980	4.00	$15.10	8,941.90	9,017.50	75.6	0.8	$16.45
Transportation and Material Moving Occupations	85,290	90,200	4,910	5.80	$14.50	9,245.70	10,036.40	790.6	8.6	$15.96

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed April 29, 2014).

Perkins IV Requirements

The Keystone curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. It also offers students a program of study including secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the Keystone curriculum is integrated with the common core state standards (CCSS). Lastly, the curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

The following national standards were referenced in the curriculum:

- 21st Century Skills and Information and Communication Technologies Literacy Standards
- Common Core State Standards (CCSS)
- International Society for Technology in Education (ISTE) Standards for Students (ISTE-S)

Best Practices

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The Keystone curriculum includes opportunities for teaching strategies that incorporate current technology. Each classroom should incorporate one teacher desktop or laptop as well as student computers in a networked environment. It is suggested that each classroom be equipped with an interactive white board and projector, intensifying the interaction between students and teachers during class. Teachers are encouraged to make use of the latest online communication tools such as wikis, blogs, and podcasts. They are also encouraged to teach using a learning management system, which introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. To combat this, the Keystone curriculum is written to include many projects which could allow students to choose the type of product they will produce or to perform a certain task. By encouraging various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers are encouraged to investigate and charter one of the many student organizations available to students. All career and technical education student organizations are relevant to this curriculum because all career clusters are addressed.

~~Conclusions~~

~~Based on the previous information, the Keystone curriculum will be filled with opportunities to develop workforce skills. Widely used teaching strategies such as cooperative learning, project-based learning, and demonstration will also be included. These will help to prepare students for the hands-on environment they will likely experience upon entering the workforce. The curriculum document will be updated regularly to reflect the needs of the current workforce.~~

Professional Organizations

Distributive Education Clubs of America
1908 Association Drive
Reston, VA 20191
703.860.5000
http://www.deca.org/
info@deca.org

Family, Career, and Community Leaders of America
1910 Association Drive
Reston, VA 20191-1584
703.476.4900
http://www.fcclainc.org/content/fccla/

Future Business Leaders of America
1912 Association Drive
Reston, VA 20191-1591
800.325.2946
http://www.fbla-pbl.org/

Future Educators of America
1525 Wilson Blvd., Suite 705
Arlington, VA 22209
800.766.1156
http://www.futureeducators.org/

Future Farmers of America
P.O. Box 68960, 6060 FFA Drive
Indianapolis, IN 46268-0960
317.802.6060
https://www.ffa.org/Pages/default.aspx

Health Occupational Students of America
548 Silicon Drive, Suite 101
Southlake, TX 76092
(800) 321-HOSA
http://www.hosa.org/

Mississippi Association of Career and Technical Education
P.O. Box 85
Raymond, MS 39154
601.857.5763
http://www.mississippiacte.com/

SkillsUSA
14001 SkillsUSA Way
Leesburg, VA 20176
703.777.8810
http://www.skillsusa.org/

Technology Student Association
1914 Association Drive
Reston, VA 20191-1540
888.860.9010
http://www.tsaweb.org/

Using This Document

Suggested Time on Task

This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives

A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References

A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Important Information for Teachers of the Keystone Curriculum

The Keystone curriculum is intended to be taught in a student-led, inquiry-based, flipped classroom environment. It is important that the career cluster units in particular be taught in the flipped classroom environment. Students should develop projects based on what they want to research and learn about each cluster. The flipped classroom model suggests that much of this research and information-gathering is done *outside* of the classroom, while project work takes place during class time. For more information, please visit http://jonbergmann.com/, http://flippedclassroom.org, and http://teachinquiry.com.

Unit 1: Orientation, Course Introduction, and Ethics

Competencies and Suggested Objectives
1. Identify course expectations, district and school policies, and, safety procedures related to the Keystone Course. DOK1, CS3, CS8, CS12, CS15, CS16 a. Summarize course expectations and district and school policies. b. Describe the operating procedures for the equipment utilized in the class.
2. Investigate ethical, cultural, and societal issues of self and of others. DOK1, CS1, CS3, CS5, CS14, CS16 a. Discuss personal responsibility of being prepared for class and working in groups. b. Discuss proper behavior and attire required for off-campus visits. c. Discuss ethics related to computer and technology use. d. Discuss ethics in an educational environment. e. Discuss ethics in the occupational environment.
3. Identify the Sixteen National Career Clusters. DOK1, CS1, CS8 a. Investigate each cluster and the career pathways within each one.

Unit 2: Learning and Personality Styles

Competencies and Suggested Objectives
3. Discover learning and personality styles. DOK1, CS3, CS8, CS12, CS14 d. Complete learning style and personality style inventories. e. Identify forces that shape personality development including personality traits, heredity, and environment. f. Discuss how conflicting learning and personality styles are handled in the workplace and in life.
4. Develop characteristics of highly effective people. DOK2, CS3, CS7, CS8, CS12, CS13, CS14, CS15, CS16 a. Participate in activities that strengthen self-motivation. b. Recognize the importance of time management and personal responsibility.

Unit 3: Agriculture, Food & Natural Resources

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Agriculture, Food & Natural Resources career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS4, CS5
2. Assess the role of Agriculture, Food & Natural Resources careers in society. DOK3, CS1, CS4, CS5, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Agriculture, Food & Natural Resources career cluster play in society. b. Participate in a real-world job scenario associated with the Agriculture, Food & Natural Resources career cluster.

Unit 4: Architecture and Construction

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Architecture and Construction career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS5
2. Assess the role of Architecture and Construction careers in society. DOK3, CS1, CS5, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Architecture and Construction career cluster play in society. b. Participate in a real-world job scenario associated with the Architecture and Construction career cluster.

Unit 5: Arts, A/V Technology & Communications

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Arts, A/V Technology & Communications career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS6, CS9, CS10, CS11
2. Assess the role of Arts, A/V Technology & Communications careers in society. DOK3, CS1, CS6, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Arts, A/V Technology & Communications career cluster play in society. b. Participate in a real-world job scenario associated with the Arts, A/V Technology & Communications career cluster.

Unit 6: Business Management and Administration

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Business Management and Administration career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS2
2. Assess the role of Business Management and Administration careers in society. DOK3, CS1, CS2, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Business Management and Administration career cluster play in society. b. Participate in a real-world job scenario associated with the Business Management and Administration career cluster.

Unit 7: Education and Training

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Education and Training career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS8, CS12, CS13, CS16
2. Assess the role of Education and Training careers in society. DOK3, CS1, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Education and Training career cluster play in society. b. Participate in a real-world job scenario associated with the Education and Training career cluster.

Unit 8: Finance

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Finance career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS2
2. Assess the role of Finance careers in society. DOK3, CS1, CS2, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Finance career cluster play in society. b. Participate in a real-world job scenario associated with the Finance career cluster.

Unit 9: Government and Public Administration

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Government and Public Administration career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS3
2. Assess the role of Government and Public Administration careers in society. DOK3, CS1, CS3, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Government and Public Administration career cluster play in society. b. Participate in a real-world job scenario associated with the Government and Public Administration career cluster.

Unit 10: Health Science

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Health Science career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS4
2. Assess the role of Health Science careers in society. DOK3, CS1, CS4, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Health Science career cluster play in society. b. Participate in a real-world job scenario associated with the Health Science career cluster.

Unit 11: Hospitality and Tourism

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Hospitality and Tourism career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS8 CS12, CS14
2. Assess the role of Hospitality and Tourism careers in society. DOK3, CS1, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Hospitality and Tourism career cluster play in society. b. Participate in a real-world job scenario associated with the Hospitality and Tourism career cluster.

Unit 12: Human Services

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Human Services career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS3, CS4, CS14
2. Assess the role of Human Services careers in society. DOK3, CS1, CS3, CS4, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Human Services career cluster play in society. b. Participate in a real-world job scenario associated with the Human Services career cluster.

Unit 13: Information Technology

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Information Technology career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS9, CS10, CS11
2. Assess the role of Information Technology careers in society. DOK3, CS1, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Information Technology career cluster play in society. b. Participate in a real-world job scenario associated with the Information Technology career cluster.

Unit 14: Law, Public Safety, Corrections, & Security

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Law, Public Safety, Corrections, & Security career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS3, CS14
2. Assess the role of Law, Public Safety, Corrections, & Security careers in society. DOK3, CS1, CS3, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Law, Public Safety, Corrections, & Security career cluster play in society. b. Participate in a real-world job scenario associated with the Law, Public Safety, Corrections, & Security career cluster.

Unit 15: Manufacturing

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Manufacturing career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS5, CS15
2. Assess the role of Manufacturing careers in society. DOK3, CS1, CS5, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Manufacturing career cluster play in society. b. Participate in a real-world job scenario associated with the Manufacturing career cluster.

Unit 16: Marketing

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Marketing career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS2
2. Assess the role of Marketing careers in society. DOK3, CS1, CS2, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Marketing career cluster play in society. b. Participate in a real-world job scenario associated with the Marketing career cluster.

Unit 17: Science, Technology, Engineering & Math

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Science, Technology, Engineering & Math career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS5, CS6
2. Assess the role of Science, Technology, Engineering & Math careers in society. DOK3, CS1, CS5, CS6, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Science, Technology, Engineering & Math career cluster play in society. b. Participate in a real-world job scenario associated with the Science, Technology, Engineering & Math career cluster.

Unit 18: Transportation, Distribution & Logistics

Competencies and Suggested Objectives
1. Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Transportation, Distribution & Logistics career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions. DOK2, CS1, CS5, CS8
2. Assess the role of Transportation, Distribution & Logistics careers in society. DOK3, CS1, CS5, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Discover the roles that careers in the Transportation, Distribution & Logistics career cluster play in society. b. Participate in a real-world job scenario associated with the Transportation, Distribution & Logistics career cluster.

Unit 19: Financial Literacy/Reality Fair

Competencies and Suggested Objectives
1. Create a personal budget. DOK3, CS2, CS11, CS16 a. Identify reasons to keep track of spending habits. b. Identify sources of income and expenses. c. Explain the concept of "paying yourself first." d. Identify goals of saving. e. Examine types of saving and investing. f. Create a personal budget based on your findings.
2. Examine credit options, pros, and cons. DOK2, CS2, CS9, CS10, CS11, CS16 a. Examine the types and the cost of credit. b. Compare the advantages and disadvantages of using credit. c. Discover credit history and what actions affect credit reports.
5. Examine the effects of debt. DOK1, CS2, CS16 a. Define debt. b. Explore reasons people go into debt. c. Identify ways to stay out of debt. d. Determine consequences of debt on a household (i.e., person, family, business).
6. Recognize and demonstrate the use of forms used during financial planning, including deposit slips, checks, debit card transactions, credit card transactions, bank statements, and check registries. DOK2, CS2, CS9, CS16

Unit 20: College and Career Focus/Development of a Six-Year Plan

Competencies and Suggested Objectives
1. Develop an awareness of the workplace. DOK2, CS1, CS8, CS12, CS13, CS14, CS15, CS16 a. Describe how employment relates to the needs and functions of the economy, society, and personal fulfillment. b. Analyze why people work. c. Describe the U.S. economy as a free-enterprise system and explain how it works. d. Identify consumers, producers, supply and demand, and competition. e. Explain how the global economy affects individuals, communities, and our country. f. Examine the influences that society, economy, and technological advances have on employment trends and future employment training. g. Distinguish societal views on employment trends. h. Distinguish economic views on employment trends. i. Explore technological advances that affect employment trends in our country.
2. Identify workplace skills that affect careers. DOK1, CS1, CS12, CS13, CS14, CS15, CS16 a. Recognize and develop transferable skills. i. Discuss what transferable skills are and how the skills are important in the workplace. ii. Explain what skills are needed in all professions, regardless of level.
3. Explore local and national career opportunities. DOK1, CS1, CS9, CS10, CS11 a. Demonstrate the ability to locate, understand, and use career information. i. Research information on careers on the internet. b. Evaluate sources of career information. ii. Choices (or other career planning software) iii. Big Future (www.bigfuture.com) iv. Careers (www.careers.org) v. Occupational Outlook Handbook (www.bls.gov) c. Analyze the different types of career information for potential careers. vi. Explore the job responsibilities for this career/profession. vii. List and explain skills needed for this career/profession. viii. Identify education and training needed for this career/profession. ix. Explore the technology used in this career/profession. x. Identify salary possibilities. xi. Explain the projected growth/decline for this career/profession. g. Evaluate work sites and/or participate in virtual field trips. xii. Students can use the internet to see job conditions, work sites, and interviews with

people in this career/profession.
4. Identify and demonstrate the steps to make career decisions. DOK2, CS12, CS13, CS14, CS15, CS16 a. Determine how personality affects career decisions. b. Determine future goals for yourself in this career/profession.
5. Analyze the relationship between educational achievement and career success. DOK2, CS12, CS13, CS14, CS15, CS16 a. Determine what courses/activities matter in high school. b. Determine what electives are most important to meeting career goals.
6. Develop a six-year plan including four years of high school courses and activities plus two years of post-secondary study and activities. DOK3, CS7, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16 a. Investigate local, state, and national scholarship opportunities. b. Discover financial aid programs, i.e., FAFSA, MTAG, and so forth. c. Complete a six-year program of study to prepare for the future.
7. Demonstrate skills to complete a job application and a mock interview. DOK3, CS7, CS12, CS13, CS14, CS15, CS16

Unit 21: Revisions,Goal-Setting, Professionalism, and Presentation

Competencies and Suggested Objectives
1. Complete and review a career planning computer course. DOK2, CS1, CS12, CS13, CS14, CS15, CS16 a. Input personal information in the career planning computer course. b. Interpret data provided by the career planning computer course. c. Document the information and your conclusions regarding the information provided by the career planning computer course.
2. Set personal goals for a career and life plan. DOK3, CS1, CS12, CS13, CS14, CS15, CS16 a. Develop a functional personal goals list. b. Discuss list with instructor and parents. c. Refine goals based on input and further review. d. Present complete written set of personal goals.
3. Exhibit necessary professional behaviors to obtain and maintain desired employment. DOK2, CS12, CS13, CS14, CS15, CS16 a. Demonstrate characteristics desired by organization, such as punctuality, teamwork, positive work ethic, appropriate attire, positive personal attitudes and abilities. b. Demonstrate appropriate interview and employment behaviors (i.e., effective speech, good posture, proper etiquette, appropriate eye contact and gestures). c. Practice professional presentation techniques.

Student Competency Profile

Student Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation, Course Introduction, and Ethics		
	1.	Identify course expectations, district and school policies, and, safety procedures related to the Keystone Course.
	2.	Investigate ethical, cultural, and societal issues of self and of others.
	3.	Identify the Sixteen National Career Clusters.
Unit 2: Learning and Personality Styles		
	1.	Discover learning and personality styles.
	2.	Develop characteristics of highly effective people.
Unit 3: Agriculture, Food & Natural Resources		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Agriculture, Food & Natural Resources career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions
	2.	Assess the role of Agriculture, Food & Natural Resources careers in society.
Unit 4: Architecture and Construction		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Architecture and Construction career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Architecture and Construction careers in society.
Unit 5: Arts, A/V Technology & Communications		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Arts, A/V Technology & Communications career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Arts, A/V Technology & Communications careers in society.
Unit 6: Business Management and Administration		
	1.	Using videos, multimedia, guest speakers, or other interactive methods,

		investigate career opportunities in the Business Management and Administration career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Business Management and Administration careers in society.
Unit 7: Education and Training		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Education and Training career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Education and Training careers in society.
Unit 8: Finance		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Finance career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Finance careers in society.
Unit 9: Government and Public Administration		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Government and Public Administration career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Government and Public Administration careers in society.
Unit 10: Health Science		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Health Science career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Health Science careers in society.
Unit 11: Hospitality and Tourism		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Hospitality and Tourism career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Hospitality and Tourism careers in society.
Unit 12: Human Services		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Human Services career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Human Services careers in society.
Unit 13: Information Technology		

	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Information Technology career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Information Technology careers in society.
Unit 14: Law, Public Safety, Corrections, & Security		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Law, Public Safety, Corrections, & Security career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Law, Public Safety, Corrections, & Security careers in society.
Unit 15: Manufacturing		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Manufacturing career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Manufacturing careers in society.
Unit 16: Marketing		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Marketing career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Marketing careers in society.
Unit 17: Science, Technology, Engineering & Math		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Science, Technology, Engineering & Math career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Science, Technology, Engineering & Math careers in society.
Unit 18: Transportation, Distribution & Logistics		
	1.	Using videos, multimedia, guest speakers, or other interactive methods, investigate career opportunities in the Transportation, Distribution & Logistics career cluster, including available jobs, salaries, benefits, education, career advancements, and working conditions.
	2.	Assess the role of Transportation, Distribution & Logistics careers in society.
Unit 19: Financial Literacy/Reality Fair		
	1.	Create a personal budget.
	2.	Examine credit options, pros, and cons.
	3.	Examine the effects of debt.
	4.	Recognize and demonstrate the use of forms used during financial planning,

		~~including deposit slips, checks, debit card transactions, credit card transactions, bank statements, and check registries.~~
~~Unit 20: College and Career Focus/Development of a Six-Year Plan~~		
	~~1.~~	~~Develop an awareness of the workplace.~~
	~~2.~~	~~Identify workplace skills that affect careers.~~
	~~3.~~	~~Explore local and national career opportunities.~~
	~~4.~~	~~Identify and demonstrate the steps to make career decisions.~~
	~~5.~~	~~Analyze the relationship between educational achievement and career success.~~
	~~6.~~	~~Develop a six-year plan including four years of high school courses and activities plus two years of post-secondary study and activities.~~
	~~7.~~	~~Demonstrate skills to complete a job application and a mock interview.~~
~~Unit 21: Revisions, Goal-Setting, Professionalism, and Presentation~~		
	~~1.~~	~~Complete and review a career planning computer course.~~
	~~2.~~	~~Set personal goals for a career and life plan.~~
	~~3.~~	~~Exhibit necessary professional behaviors to obtain and maintain desired employment.~~

Appendix A: Unit References

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Appendix B: 21st Century Skills[2]

21st Century Crosswalk for Keystone																						
	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
21st Century Standards																						
CS1		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
CS2							x		x								x				x	
CS3		x	x							x			x		x							
CS4				x							x		x									
CS5		x		x	x											x		x	x			
CS6						x												x				
CS7			x																	x		
CS8		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
CS9				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS10				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS11				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
CS12		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
CS13			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
CS14		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
CS15		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
CS16		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

CSS1-21st Century Themes

CS1 – Global Awareness

4. Using 21st century skills to understand and address global issues
5. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
6. Understanding other nations and cultures, including the use of non-English languages

CS2 – Financial, Economic, Business, and Entrepreneurial Literacy

4. Knowing how to make appropriate personal economic choices
5. Understanding the role of the economy in society
6. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 – Civic Literacy

4. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
5. Exercising the rights and obligations of citizenship at local, state, national, and global levels
6. Understanding the local and global implications of civic decisions

CS4 – Health Literacy

6. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
7. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction

[2] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

8. Using available information to make appropriate health-related decisions
9. Establishing and monitoring personal and family health goals
10. Understanding national and international public health and safety issues

CS5 Environmental Literacy

5. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
6. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
7. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
8. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2 Learning and Innovation Skills

CS6 Creativity and Innovation

4. Think Creatively
5. Work Creatively with Others
6. Implement Innovations

CS7 Critical Thinking and Problem Solving

5. Reason Effectively
6. Use Systems Thinking
7. Make Judgments and Decisions
8. Solve Problems

CS8 Communication and Collaboration

3. Communicate Clearly
4. Collaborate with Others

CSS3 Information, Media and Technology Skills

CS9 Information Literacy

3. Access and Evaluate Information
4. Use and Manage Information

CS10 Media Literacy

3. Analyze Media
4. Create Media Products

CS11 ICT Literacy

2. Apply Technology Effectively

CSS4 Life and Career Skills

CS12 Flexibility and Adaptability

3. Adapt to change
4. Be Flexible

CS13 Initiative and Self Direction

4. Manage Goals and Time

5. Work Independently
6. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

3. Interact Effectively with others
4. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

3. Manage Projects
4. Produce Results

CS16 Leadership and Responsibility

3. Guide and Lead Others
4. Be Responsible to Others

Appendix C: Common Core Standards

Common Core Crosswalk for English/Language Arts (11-12)																						
	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Common Core Standards																						
RST.11.1.																						
RST.11.2.																						
RST.11.3.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.4.																						
RST.11.5.																						
RST.11.6.																						
RST.11.7.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.8.																						
RST.11.9.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.10.																						
WHST.11.1.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.2.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.3.																						
WHST.11.4.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.5.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.6.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.7.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.8.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.9.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.10.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Reading Standards for Literature (11-12)

College and Career Readiness Anchor Standards for *Reading Literature*

Key Ideas and Details

RL.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RL.11.2. Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

RL.11.3. Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4. Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)

RL.11.5. Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.

RL.11.6. Analyze a case in which grasping point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7. Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)

RL.11.8. (Not applicable to literature)

RL.11.9. Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10. By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Informational Text (11-12)

College and Career Readiness Anchor Standards for *Informational Text*

Key Ideas and Details

RI.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RI.11.2. Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

RI.11.3. Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure

RI.11.4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RI.11.5. Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.

RI.11.6. Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness, or beauty of the text.

Integration of Knowledge and Ideas

RI.11.7. Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

RI.11.8. Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).

RI.11.9. Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including The Declaration of

Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity

RI.11.10. By the end of grade 11, read and comprehend literary nonfiction in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11–CCR text complexity band independently and proficiently.

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

W.11.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from and supports the argument presented.

W.11.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole;

include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

W.11.3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

a. Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.

b. Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters

c. Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).

d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

W.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12 on page 54.)

W.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

W.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

W.11.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

a. Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").

b. Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

College and Career Readiness Anchor Standards for *Speaking and Listening*

Comprehension and Collaboration

SL.11.1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SL.11.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11.3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4. Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

SL.11.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11.6. Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 on page 54 for specific expectations.)

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

L.11.1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

a. Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

b. Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

L.11.2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

a. Observe hyphenation conventions.

b. Spell correctly.

Knowledge of Language

L.11.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

a. Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.

a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

b. Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.

d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

L.11.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

a. Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.
b. Analyze nuances in the meaning of words with similar denotations.

L.11.6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Reading Standards for Literacy in History/Social Studies (11-12)

Key Ideas and Details

RH.11.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

RH.11.2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas

RH.11.3. Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain

Craft and Structure

RH.11.4. Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RH.11.5. Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

RH.11.6. Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.

Integration of Knowledge and Ideas

RH.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

RH.11.8. Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

RH.11.9. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Range of Reading and Level of Text Complexity

RH.11.10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Literacy in Science and Technical Subjects (11-12)

Key Ideas and Details

RST.11.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

RST.11.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

RST.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

RST.11.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (11-12)

Text Types and Purposes

WHST.11.1. Write arguments focused on discipline-specific content.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s)

and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST.11.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11.3. (Not applicable as a separate requirement)

Production and Distribution of Writing

WHST.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

WHST.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST.11.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

WHST.11.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Common Core Crosswalk for Mathematics (11-12)																						
	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Common Core Standards																						
S-IC.1.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
S-IC.2.																						
S-IC.3.																						
S-IC.4.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
S-IC.5.																						
S-IC.6.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
S-CP.1.																						
S-CP.2																						
S-CP.3.																						
S-CP.4.																						
S-CP.5.				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
S-CP.6.																						
S-CP.7.																						
S-CP.8.																						
S-CP.9.																						

Mathematics (High School)

Number and Quantity

The Real Number System

N-RN.1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.

N-RN.2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

N-RN.3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Quantities

N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.

N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

~~The Complex Number System~~

~~N-CN.1. Know there is a complex number i such that i2= −1, and every complex number has the form a + bi with a and b real.~~

~~N-CN.2. Use the relation i2= −1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.~~

~~N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.~~

~~N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.~~

~~N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, (−1 + √3 i)3= 8 because (−1 + √3 i) has modulus 2 and argument 120°.~~

~~N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.~~

~~N-CN.7. Solve quadratic equations with real coefficients that have complex solutions.~~

~~N-CN.8. (+) Extend polynomial identities to the complex numbers. For example, rewrite x2+ 4 as (x + 2i)(x − 2i).~~

~~N-CN.9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.~~

~~Vector and Matrix Quantities~~

~~N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|,||v||, v).~~

~~N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.~~

~~N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.~~

~~N-VM.4. (+) Add and subtract vectors~~

~~N-VM.4.a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.~~

~~N-VM.4.b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.~~

~~N-VM.4.c. Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.~~

~~N-VM.5. (+) Multiply a vector by a scalar.~~

~~N-VM.5.a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(vx, vy) = (cvx, cvy)$.~~

~~N-VM.5.b. Compute the magnitude of a scalar multiple cv using $||cv|| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).~~

~~N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.~~

~~N-VM.7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.~~

~~N-VM.8. (+) Add, subtract, and multiply matrices of appropriate dimensions.~~

~~N-VM.9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties~~

~~N-VM.10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.~~

~~N-VM.11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.~~

~~N-VM.12. (+) Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.~~

~~Algebra~~

~~Seeing Structure in Expressions~~

~~A-SSE.1. Interpret expressions that represent a quantity in terms of its context.~~

~~A-SSE.1.a. Interpret parts of an expression, such as terms, factors, and coefficients.~~

~~A-SSE.1.b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)nas the product of P and a factor not depending on P.~~

~~A-SSE.2. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.~~

~~A-SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.~~

~~A-SSE.3.a. Factor a quadratic expression to reveal the zeros of the function it defines.~~

~~A-SSE.3.b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.~~

~~A-SSE.3.c. Use the properties of exponents to transform expressions for exponential functions.~~

~~A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.~~

~~Arithmetic with Polynomials and Rational Expressions~~

~~A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials~~

~~A-APR.2. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x − a is p(a), so p(a) = 0 if and only if (x − a) is a factor of p(x).~~

~~A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.~~

~~A-APR.4. Prove polynomial identities and use them to describe numerical relationships.~~

A-APR.5. (+) Know and apply the Binomial Theorem for the expansion of (x+ y)n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x)in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Creating Equations

A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

A-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V =IR to highlight resistance R.

Reasoning with Equations and Inequalities

A-REI.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

A-REI.4. Solve quadratic equations in one variable.

A-REI.4.a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x − p)2= q that has the same solutions. Derive the quadratic formula from this form.

A-REI.4.b. Solve quadratic equations by inspection (e.g., for x2= 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

A-REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = −3x and the circle x2+y2= 3.

A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.

A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x)are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

A-REI.12.Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Interpreting Functions

F-IF.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

F-IF.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F-IF.7.a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.7.b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.7.c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

F-IF.7.d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

F-IF.7.e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

F-IF.8.a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.8.b. Use the properties of exponents to interpret expressions for exponential functions.

F-IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Building Functions

F-BF.1. Write a function that describes a relationship between two quantities.

F-BF.1.a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.1.b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.1.c. (+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

F-BF.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4. Find inverse functions.

F-BF.4.a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse.

F-BF.4.b. (+) Verify by composition that one function is the inverse of another.

F-BF.4.c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.

F-BF.4.d. (+) Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Linear, Quadratic, and Exponential Models

F-LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

F-LE.1.a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.

F-LE.1.b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

F-LE.1.c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another

F-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

F-LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

F-LE.4. For exponential models, express as a logarithm the solution to ab ct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

F-LE.5. Interpret the parameters in a linear or exponential function in terms of a context.

~~Trigonometric Functions~~

~~F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.~~

~~F-TF.2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.~~

~~F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi+x$, and $2\pi - x$ in terms of their values for x, where x is any real number.~~

~~F-TF.4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.~~

~~F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.~~

~~F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.~~

~~F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.~~

~~F-TF.8. Prove the Pythagorean identity $\sin2(\theta) + \cos 2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.~~

~~F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.~~

~~Geometry~~

~~Congruence~~

~~G-CO.1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.~~

~~G-CO.2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).~~

~~G-CO.3.Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.~~

~~G-CO.4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.~~

~~G-CO.5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.~~

~~G-CO.6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.~~

~~G-CO.7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.~~

~~G-CO.8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.~~

~~G-CO.9. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.~~

~~G-CO.10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.~~

~~G-CO.11. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.~~

~~G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.~~

~~G-CO.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.~~

~~Similarity, Right Triangles, and Trigonometry~~

~~G-SRT.1. Verify experimentally the properties of dilations given by a center and a scale factor:~~

~~G-SRT.1.a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.~~

~~G-SRT.1.b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.~~

~~G-SRT.2. Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.~~

~~G-SRT.3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.~~

~~G-SRT.4. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.~~

~~G-SRT.5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.~~

~~G-SRT.6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.~~

~~G-SRT.7. Explain and use the relationship between the sine and cosine of complementary angles.~~

~~G-SRT.8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.~~

~~G-SRT.9. (+) Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.~~

~~G-SRT.10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.~~

~~G-SRT.11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).~~

~~Circles~~

~~G-C.1. Prove that all circles are similar.~~

~~G-C.2. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.~~

~~G-C.3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.~~

~~G-C.4. (+) Construct a tangent line from a point outside a given circle to the circle.~~

~~G-C.5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.~~

~~Expressing Geometric Properties with Equations~~

~~G-GPE.1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.~~

~~G-GPE.2. Derive the equation of a parabola given a focus and directrix.~~

~~G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.~~

~~G-GPE.4. Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, $\sqrt{3}$) lies on the circle centered at the origin and containing the point (0, 2).~~

~~G-GPE.5. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).~~

~~G-GPE.6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.~~

~~G-GPE.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.~~

Geometric Measurement and Dimension

G-GMD.1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

G-GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

G-GMD.4. Identify the shapes of two-dimensional cross-sections of three dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Modeling with Geometry

G-MG.1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

G-MG.2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Statistics and Probability

Interpreting Categorical and Quantitative Data

S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots).

S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate.
Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

S-ID.5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

S-ID.6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

S-ID.6.a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

S-ID.6.b. Informally assess the fit of a function by plotting and analyzing residuals.

S-ID.6.c. Fit a linear function for a scatter plot that suggests a linear association.

S-ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S-ID.8. Compute (using technology) and interpret the correlation coefficient of a linear fit.

S-ID.9. Distinguish between correlation and causation.

Making Inferences and Justifying Conclusions

S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

S-IC.3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

S-IC.4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

S-IC.5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

S-IC.6. Evaluate reports based on data.

Conditional Probability and the Rules of Probability

S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").

S-CP.2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

S-CP.3. Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

S-CP.4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

S-CP.6. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.

S-CP.7. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.

S-CP.8. (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.

S-CP.9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Using Probability to Make Decisions

S-MD.1.(+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

~~S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.~~

~~S-MD.3.(+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.~~

~~S-MD.4.(+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?~~

~~S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.~~

> ~~S-MD.5.a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.~~
>
> ~~S-MD.5.b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.~~

~~S-MD.6.(+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).~~

~~S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).~~

Appendix D: International Society for Technology in Education (ISTE)

ISTE																						
	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ISTE Standards																						
T1		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T2		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T3		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T4		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T5		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T6		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.