Title 7: Education K-12

Part 126: Manufacturing

2014 Welding

Mississippi Department of Education

Program CIP: 48.0508 – Welding Technology/Welder

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Office of Career and Technical Education
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 the 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

The Welding curriculum was presented to the Mississippi Board of Education on November 14-15, 2013. The following persons were serving on the state board at the time:

Dr. Lynn House, Interim State Superintendent of Education
Dr. O. Wayne Gann, Chair
Mr. Howell "Hal" N. Gage, Vice Chair
Ms. Kami Bumgarner
Mr. William Harold Jones
Dr. John R. Kelly
Mr. Charles McClelland
Mr. Richard Morrison
Ms. Martha "Jackie" Murphy
Mr. Simon F. Weir II

Jean Massey, Associate Superintendent of Education for the Office of Career and Technical Education at the Mississippi Department of Education, assembled a taskforce committee to provide input throughout the development of the Welding *Curriculum Framework and Supporting Materials.*

Brad Skelton, Instructional Design Specialist for the Research and Curriculum Unit at Mississippi State University researched and authored this framework. bradley.skelton@rcu.msstate.edu

Also, special thanks are extended to the teachers who contributed teaching and assessment materials that are included in the framework and supporting materials:

Dale Box, Greene County Vo-Tech, Leakesville, MS
Lamonn Brashier, Wayne County Career and Technical Center, Waynesboro, MS
Jason Frey, George County High School, Lucedale, MS
Paul Heffner, Jackson County Technical Center, Vancleave, MS
Chevis Necaise, Hancock County Career and Technical Center, Kiln, MS

Appreciation is expressed to the following professional, who provided guidance and insight throughout the development process:

Mike Barkett, Program Coordinator, Mississippi Construction Education Foundation President, mike@mcef.net

Standards

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

NCCER Learning Series
NCCER Learning Series from the National Center for Construction Education and Research
Reprinted with permission from NCCER Learning Series, Copyright © 2008, National Center for Construction Education and Research, 352.334.0920, http://www.nccer.org/index.asp

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
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 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

Welding is an instructional program that prepares students for employment or continued education in the occupations of the welding field. 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:

Use the approved curriculum.

1. All instructors must be NCCER certified.

2. 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.
3. Follow NCCER guidelines on test security and performance profiles.
4. Have an active advisory committee with at least two commercial contractors involved.
5. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
6. Involve commercial contractors in class presentations or field trips.
7. All construction programs must be included in the accreditation process.
8. Show active involvement in student leadership development (e.g., VICA and SkillsUSA).
9. 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 Welding program, the following student prerequisites are suggested:

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

or

1. TABE Reading Score (eighth grade or higher)
2. Instructor Approval

or

1. 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:

1. **Orientation and Cutting—Course Code: 993302**
2. **Shielded Metal Arc Welding (SMAW)—Course Code: 993303**
3. **Advanced Welding I—Course Code: 993304**
4. **Advanced Welding II—Course Code: 993306**

Course Description: Orientation and Cutting

This course focuses on the NCCER Learning Series Core. Students will leave the class with a firm foundation of knowledge in the areas of employability skills, safety, and basic tool knowledge. Additionally, students will learn Oxyfuel Cutting fundamentals.

Course Description: Shielded Metal Arc Welding (SMAW)

This course introduces students to Shielded Metal Arc Welding (SMAW). Students will focus on proper equipment setup, safety measures, and proper welding techniques.

Course Description: Advanced Welding I

This course focuses on specialized welding symbols used in blueprints and drawings. Additionally, students will learn about Plasma Arc Cutting (PAC), Carbon Arc Cutting (CAC), and advanced techniques used in SMAW.

Course Description: Advanced Welding II

This course will offer students the opportunity to examine Gas Metal Arc Welding (GMAW) and Flux-Cored Arc Welding (FCAW). Additionally, students will learn about Gas Tungsten Arc

Welding (GTAW). Students will learn safety measures, setup procedures, and welding techniques for each type of welding.

Orientation and Cutting—Course Code: 993302

Unit	Unit Name	Hours
1	Introduction and Orientation	15
2	Basic Safety	15
3	Introduction to Construction Math	15
4	Hand and Power Tools	15
5	Introduction to Blueprints and Basic Rigging	15
6	Introduction to Materials Handling	8
7	Base Metal Preparation, Weld Quality, Joint Fit-up, Alignment, and Oxyfuel Cutting	62
Total		145

Shielded Metal Arc Welding [SMAW]—Course Code: 993303

Unit	Unit Name	Hours
8	Shielded Metal Arc Welding (SMAW)	135
Total		135

Advanced Welding I—Course Code: 993304

Unit	Unit Name	Hours
9	Orientation and Welding Safety Review	8
10	Welding Symbols and Reading Welding Detail Drawings	15
11	Plasma Arc Cutting (PAC) and Carbon Arc Cutting and Gouging (CAC-A)	15
12	Advanced Shielded Metal Arc Welding (SMAW)	102
Total		140

Advanced Welding II—Course Code: 993306

Unit	Unit Name	Hours
13	Gas Metal Arc Welding (GMAW) & Flux-Core Arc Welding (FCAW)	80
14	Gas Tungsten Arc Welding (GTAW)	60
Total		140

Option 2—Two Two-Carnegie-Unit Courses

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

1. **Introduction to Welding—Course Code: 993300**
2. **Advanced Welding—Course Code: 993301**

Course Description: Introduction to Welding

This course focuses on the NCCER Learning Series Core and SMAW. Students will leave the class with a firm foundation of knowledge in the areas of employability skills, safety, and basic tool knowledge. Additionally, students will learn Oxyfuel Cutting fundamentals. Students will cover proper equipment setup, safety measures, and correct welding techniques.

Course Description: Advanced Welding

This course focuses on specialized welding symbols used in blueprints and drawings as well as PAC, CAC, and advanced techniques used in SMAW. Additionally, this course will offer students the opportunity to examine GMAW and FCAW. Additionally, students will learn about GTAW. Students will learn safety measures, setup procedures, and welding techniques for each type of welding.

Introduction to Welding—Course Code: 993300

1	Introduction and Orientation	15
2	Basic Safety	15
3	Introduction to Construction Math	15
4	Hand and Power Tools	15
5	Introduction to Blueprints and Basic Rigging	15
6	Introduction to Materials Handling	8
7	Base Metal Preparation and Weld Quality, Joint Fit-up and Alignment, and Oxyfuel Cutting	62
8	Shielded Metal Arc Welding (SMAW)	135
Total		280

Advanced Welding—Course Code: 993301

9	Orientation and Welding Safety Review	8
10	Welding Symbols and Reading Welding Detail Drawings	15
11	Plasma Arc Cutting and Carbon Arc Cutting and Gouging	15
12	Advanced Shielded Metal Arc Welding (SMAW)	102
13	Gas Metal Arc Welding (GMAW) & Flux-Core Arc Welding (FCAW)	80
14	Gas Tungsten Arc Welding (GTAW)	60
Total		280

Research Synopsis

Introduction

The Welding curriculum is designed to prepare the students for entry level employment in the field of welding and fabrication. Students in Welding I complete study in occupational orientation and safety, basic math, introduction to blueprints (welding symbols), hand and power tools, Oxy/Fuel operations, and shielded metal arc welding (SMAW). Students in Welding II complete study in occupational orientation and safety, advanced shielded metal arc welding (SMAW), semi-automatic arc welding [gas metal arc welding and flux-cored arc welding (GMAW/FCAW)], gas tungsten arc welding (GTAW), carbon arc cutting principles and practices (CAC-A), plasma arc cutting (PAC), and employability skills.

Needs of the Future Workforce

The outlook for the state shows an increase in employment projected through 2018 for all welding occupations (MDES, 2013). There are jobs predicted to open in all areas due to attrition and retirement (Table 1.1). According to the American Welding Society (AWS), "With demand for skilled welders rising and the technology of welding becoming more advanced, especially where automation is concerned, students have a unique opportunity to learn a career that can be shaped around their interests" (AWS, 2013). Students in this field will have opportunities open to them across the state and the nation.

Table 1.1: Current and Projected Occupation Report

Description	**Jobs, 2008**	**Projected Jobs, 2018**	**Change (Number)**	**Change (Percent)**	**Average Hourly Earning**
Boilermakers	370	460	90	24.3	$20.54
Plumbers, Pipefitters, and Steamfitters	8,000	8,870	870	10.9	$17.97
Sheet Metal Workers	1,860	1,060	200	10.8	$17.66
Structural Iron and Steel Workers	1,260	1,450	190	15.1	$17.54
Helpers – Pipelayers,	1,120	1,400	280	25.0	$12.96

Plumbers, Pipefitters, and Steamfitters					
Welders, Cutters, Solderers, and Brazers	7,750	8,500	750	9.7	$18.30
Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	260	280	20	7.7	$16.16

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed March 19, 2013).

Perkins IV Requirements

The Welding 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 Welding curriculum is integrated with academic common core standards. Lastly, the Welding 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 Welding 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

Applied Math content from the curriculum aligns to the 2007 Mississippi Math

Framework Revised Academic Benchmarks.

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 Welding 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 Welding 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

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 Welding curriculum. SkillsUSA is the student's organization for Welding. SkillsUSA provides students with growth opportunities and competitive events. It also opens the doors to the world of manufacturing, welding and construction as well as scholarships opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Welding 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 Welding curriculum provides opportunities for students to work together and help each other to complete complex tasks.

Conclusions

The Welding Curriculum is one of Mississippi's most comprehensive trade and industrial curriculums. Students that complete these programs are well-equipped for a variety of endeavors. Instructors are urged to encourage Welding students to pursue educational opportunities at community colleges and universities in Mississippi.

Professional Organizations

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

Mississippi Construction Education Foundation (MCEF).
290 Commerce Park Drive, Suite B
Ridgeland, MS 39157
Phone: 601.605.2989 or Toll-free: 800.358.3788
Fax: 601.605.2987
http://www.mcef.net/

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Fax: 386.518.6303
http://www.nccer.org/

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Jackson, MS 39205-0771
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Fax: 601.354.7788
http://www.mde.k12.ms.us/vocational/SkillsUSA/index.htm

SkillsUSA-National
14001 SkillsUSA Way
Leesburg, Virginia 20176
Phone: 703.777.8810
Fax: 703.777.8999
http://www.skillsusa.org/index.shtml

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 or lab rules and regulations, and transportation regulations. b. Give a brief overview of the course. Explain to students what Welding 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 construction 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 Welding Technology 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.
** NCCER Module Alignment can be found in Appendix G.

Scenario

The Perfect Peanut Butter and Jelly Sandwich

Unit 1

You are the superintendent of the construction crew who needs to provide instructions for preparing peanut butter and jelly sandwiches for the crew. The superintendent will prepare written instructions and pass them on to the foreman, who will then verbally assign the job to the helper. The helper will correctly prepare the sandwiches according to the instructions. You will be judged using a communication or presentation rubric.

Attachments for Scenario

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

Unit 2: Basic Safety

Competencies and Suggested Objectives
1. Describe, define, and illustrate general safety rules for working in a shop or lab and how they relate to the construction 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 or 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 job site 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.
** NCCER Module Alignment can be found in Appendix G.

Scenario

Safety Hazard Inspection

Unit 2

You are a safety inspector, and your job is to inspect the job site for safety hazards. You will identify and list all hazards and complete the inspection report. You will report the results of the inspection to the superintendent of the job site and discuss the corrections that must be completed before the job site will be declared safe. You will be evaluated using the Case-Study Rubric.

Attachments for Scenario

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

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 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 tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.
** NCCER Module Alignment can be found in Appendix G.

Scenario

<u>Job Estimation</u>

Unit 3

You are the subcontractor who is bidding on a job using specifications provided by the contractor. Estimate the amount of materials, cost, and labor for the bid. The completed bid will be submitted to the contractor for consideration. All bids will be evaluated using an answer key.

Attachments for Scenario

None

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.
** NCCER Module Alignment can be found in Appendix G.

Scenario

Making the Cut

Unit 4

You are an apprentice on a job, and you must demonstrate to your supervisor the safe use of hand and power tools. You will begin by measuring a specified length, choosing the correct tool, and then correctly and safely demonstrating the procedure. The supervisor will evaluate you using the Performance Rubric.

Attachments for Scenario

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

Unit 5: Introduction to Blueprints and Basic Rigging

Competencies and Suggested Objectives
1. Read, analyze, and understand basic components of a basic 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.
2. Identify and use basic rigging tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. DOK3, RIG a. While identifying rigging equipment, describe how to perform safety inspections and use slings and common rigging hardware. b. Describe basic load-handling practices and basic hitch configurations and their proper connections. c. Identify basic rigging procedures, and demonstrate proper use of American National Standards Institute (ANSI) hand signals.
** NCCER Module Alignment can be found in Appendix G.

Scenario

Sketching for Fire-Safety Plan

Unit 5

You are a student and need to design a fire safety plan for your home. Measure each room in your house and sketch it to scale. Include escape routes, the direction of doors, north reference, and any exterior features such as sidewalks and trees. Present the sketch to the class. You will be evaluated with the Presentation Rubric.

Attachments for Scenario

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

Unit 6: Introduction to Materials Handling

Competencies and Suggested Objectives
1. Safely handle and store materials. DOK 1, 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.
** NCCER Module Alignment can be found in Appendix G.

Scenario

Moving Day

Unit 6

You are a helper who has been assigned the job of material placement. Follow the instructions of the supervisor to properly move and store the materials on the job site. The supervisor will inspect the job when completed. You will be evaluated using the Performance Rubric.

Attachments for Scenario

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

Unit 7: Base Metal Preparation and Weld Quality, Joint Fit-up and Alignment, and Oxyfuel Cutting

Competencies and Suggested Scenarios
1. Explore regulations and job code specifications for welding, base metal cleaning, joint designs and their purpose. DOK2, BMP, WQT, JFA, WSS a. Discuss codes governing welding, the causes of weld imperfections, welder qualification tests, and the importance of quality of skill. b. Select and use a nondestructive examination practice and a destructive test method to test a student-made weld. c. Explain joint fit-up.
2. Identify fit-up gauges and measuring devices to check joint fit-up. DOK2, JFA a. Discuss the use of Straightedges. b. Discuss the use of Squares. c. Discuss the use of Levels. d. Discuss the use of Hi-Lo Gauges.
3. Demonstrate the use of fit-up gauges and measuring devices to check joint fit-up. DOK2, JFA a. Demonstrate the proper use of Straightedges. b. Demonstrate the proper use of Squares. c. Demonstrate the proper use of Levels. d. Demonstrate the proper use of Hi-Lo Gauges.
4. Discuss the various fit-up tools. DOK2, JFA a. Describe the use of Hydraulic Jacks in joint fit-up. b. Describe the use of Chain Hoists in joint fit-up. c. Describe the use of Come-Alongs in joint fit-up.
5. Demonstrate the proper way to fit-up joints using the various fit-up tools. DOK2, JFA
6. Explain distortion. DOK2, PPM, HTM, WOC a. Discuss the causes of distortion. b. Discuss distortion in relation to metals being utilized. c. Discuss how to control distortion.
7. Identify joint misalignment and poor fit-up before and after welding. DOK2, JFA
8. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxyfuel cutting. DOK2, WOC, WSS a. Identify and explain the use of oxyfuel cutting equipment. b. Demonstrate how to use an oxyfuel torch. c. Perform oxyfuel cutting: • Straight line and square shapes • Piercing and slot cutting • Bevels • Washing • Gouging d. Set up and operate a motorized, portable oxyfuel gas cutting machine.
** NCCER Module Alignment can be found in Appendix G.

Scenario

Joint Fit-up

Unit 7

You are a helper who has been assigned the job of joint fit-up. Perform designated joint fit-up using appropriate tools. Also check the joint for proper fit-up and alignment using gauges and measurement devices. Follow the directions of your supervisor (instructor) to ensure a proper fit. You will be evaluated using the Performance Rubric.

Attachments for Scenario

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

Unit 8: Shielded Metal Arc Welding (SMAW)

Competencies and Suggested Scenarios
1. Explain safety hazards, protective devices used, and how to avoid accidents that commonly occur in the welding trade. DOK1, WWS a. Recite safety hazards in the shielded metal arc welding shop environment. b. Perform safety inspection of SMAW welding equipment. c. Properly handle welding materials.
2. Identify types of shielded metal arc welding machines and their accessories. DOK2, SWS a. Explain the differences in electrical current used in welding shielded metal arc welding applications and the type of machines needed to perform the welding project. b. Demonstrate setting up arc welding equipment and how to use tools associated with weld cleaning.
3. Select shielded metal arc electrodes for welding applications. DOK2, SES a. Explain factors that affect electrode selection, types of filler material, the ASME filler metal classification system, and how to store the filler electrodes. b. Properly select and weld metal using filler electrodes.
4. Setup and make beads and fillet welds. DOK2, SBF a. Describe the process for striking and extinguishing an arc, arc blow, and wander while properly exhibiting the process using a SMAW machine b. Perform stringer, weave, and overlapping beads. c. Perform fillet welds in the 2F, 3F and 4F positions with carbon steel filler electrodes.
** NCCER Module Alignment can be found in Appendix G.

Scenario

Do It Right the First Time!

Unit 8

Have each student demonstrate the proper setup of a SMAW welding machine. Students will have to perform required safety inspection of machine and work area, select correct current, proper electrode selection, and perform a weld of the instructor's choice. Students will be evaluated using the Welding Performance Rubric.

Attachments for Scenario

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

Unit 9: Orientation and Welding Safety Review

Competencies and Suggested Scenarios
1. Describe local program and vocational or career–technical center policies and procedures. DOK1, COM, EMP a. Describe local program and vocational or career–technical center policies and procedures.
2. Describe employment opportunities and responsibilities of the welder. DOK2, EMP a. Describe employer expectations in the workplace.
3. Explore leadership skills and personal development opportunities. DOK2, COM, EMP a. Demonstrate team-building and leadership skills. b. Demonstrate through practice appropriate work ethics.
4. Describe general safety rules for working in a welding shop/lab and industry. DOK1, BSM, WSS a. Discuss safety issues and prevention associated with the installation and welding shop or lab area. b. Demonstrate fire safety and prevention techniques in the workplace.
** NCCER Module Alignment can be found in Appendix G.

Scenario

Safety Hazard Inspection

Unit 9

You are a safety inspector, and your job is to inspect the job site for safety hazards. You will identify and list all hazards and complete the inspection report. You will report the results of the inspection to the superintendent of the job site and discuss the corrections that must be completed before the job site will be declared safe. You will be evaluated using the Performance Rubric.

Attachments for Scenario

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

Unit 10: Welding Symbols and Reading Welding Detail Drawings

Competencies and Suggested Scenarios
1. Examine the various parts of a welding symbol.[DOK2, WWS] a. Discuss the standard welding symbols. b. Discuss the welding symbol base. c. Discuss symbols and location of symbols for welds. d. Discuss supplemental and other symbols.
2. Discuss fillet and groove weld symbols.[DOK2, WWS]
3. Identify the various welding symbols on drawings, specifications, and welding procedure specifications.[DOK2, WWS, WDD] a. Identify the standard welding symbols. b. Identify the welding symbol base. c. Identify symbols and location of symbols for welds. d. Identify supplemental and other symbols.
4. Interpret welding symbols from a blueprint.[DOK3, WWS, WDD]
5. Examine a welding detail drawing.[DOK3, WWS, WDD] a. Identify and explain lines, materials fills, and sections. b. Identify and explain object views. c. Identify and explain dimensioning.
6. Discuss notes and bill of materials.[DOK3, WWS, WDD]
7. Interpret basic elements of a welding detail drawing.[DOK3, WWS, WDD]
8. Demonstrate how to sketch or draw basic welding drawings.[DOK3, WWS, WDD]
** NCCER Module Alignment can be found in Appendix G.

Scenario

Win, Lose or Draw

Unit 10

Give each student a different welding scenario of your choosing. Then have each student draw a basic welding drawing using as many of the welding symbols as defined by the instructor. The drawing should include symbols, symbol base, any supplemental weld symbols, lines, fills and proper dimensions. You will be evaluated using the Performance Rubric.

Attachments for Scenario

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

Unit 11: Plasma Arc Cutting (PAC) and Carbon Arc Cutting and Gouging (CAC-A)

Competencies and Suggested Scenarios
1. Explain the plasma arc cutting (PAC) process.[DOK2, WSS, PAC] a. Discuss safety procedures and protective devices used in plasma arc cutting. b. Discuss transferred and non-transferred arc processes.
2. Identify PAC equipment and accessories.[DOK2, WSS, PAC] a. Identify the PAC equipment power source control unit. b. Identify the various PAC equipment torches and nozzles. c. Demonstrate proper setup of PAC equipment for safe operation.
3. Set up and perform various types of cuts using PAC equipment.[DOK2, PAC]
4. Properly store equipment and clean the work area after use.[DOK1, PAC]
5. Explain the air carbon arc cutting (CAC-A) process.[DOK2, WSS, CAC] a. Discuss safety procedures and protective devices used in plasma arc cutting. b. Describe cutting, gouging, washing, and beveling.
6. Identify the various CAC-A electrodes.[DOK2, WSS, CAC] a. Identify plain, copper-coated for direct current, and copper-coated for alternating current. b. Identify various electrode styles such as round, round-jointed, and special shapes. c. Demonstrate proper setup of CAC-A equipment for safe operation.
7. Perform washing and gouging activities using CAC-A equipment.[DOK3, CAC]
8. Properly store equipment and clean the work area after use.[DOK3, CAC]
** NCCER Module Alignment can be found in Appendix G.

Scenario

To PAC or Not to PAC

Unit 11

Have each student demonstrate the proper setup of a PAC or CAC-A welding machine. Students will have to explain and perform required safety inspection of machine and work area; select correct current, torch and tip ; and perform a cut of the instructor's choice. Students will be evaluated using the Cutting Performance Rubric.

Attachments for Scenario

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

Unit 12: Advanced Shielded Metal Arc Welding (SMAW)

Competencies and Suggested Scenarios
1. Review safety hazards, protective devices used, and basic operation of SMAW equipment. DOK1, WSS, SWS
2. Discuss the various groove welds with and without backing. DOK3, GWB, OGW a. Discuss proper Square groove welds. b. Discuss proper Bevel groove welds. c. Discuss proper V-groove welds. d. Discuss proper U-groove welds. e. Discuss proper J-groove welds. f. Discuss proper Flare V-groove welds. g. Discuss proper Flare bevel groove welds.
3. Discuss and demonstrate proper SMAW equipment setup for making V-groove welds. DOK3, SWS
4. Prepare materials to perform SMAW V-groove welds with and without backing. DOK3, GWB, OGW
5. Setup and perform SMAW V-groove welds with and without backing in the 1G, 2G, 3G and 4G positions. DOK3, GWB, OGW
6. Properly store equipment and clean the work area after use. DOK3, SWS
** NCCER Module Alignment can be found in Appendix G.

Scenario

Shipyard Repairs

Unit 12

You are welder in a shipyard. Your foreman (instructor) asks you to perform a SWAW weld to replace a metal plate on the interior of a ship. Demonstrate the proper setup of a SMAW welding machine. Verbally explain and perform required safety inspection of machine and work area; select correct current and electrode; and perform a weld of the foreman's (instructor's) choice. You will be evaluated using the Welding Performance Rubric.

Attachments for Scenario

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

Unit 13: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)

Competencies and Suggested Scenarios
1. Explain the GMAW and FCAW welding processes.[DOK3, GFE, GFP, WSS] a. Explain the characteristics of welding current and power sources. b. Explain the use of GMAW and FCAW shielding gases and filler metals. c. Discuss the safety precautions to observe when operating GMAW and FCAW equipment.
2. Explain the use of GMAW and FCAW equipment parts and modes.[DOK3, GFE, GFP, WSS] a. Discuss Spray Transfer mode. b. Discuss Globular mode. c. Discuss Short circuiting mode. d. Discuss Pulse mode.
3. Demonstrate proper setup of GMAW and FCAW equipment.[DOK3, GFE, GFP, WSS]
4. Setup and perform GMAW-S (short-circuit) multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas.[DOK3, GFE, GFP, WSS]
5. Setup and perform GMAW-S (short-circuit) multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire and shielding gas.[DOK3, GFE, GFP, WSS]
6. Setup and perform FCAW multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux-cored wire and, if required, shielding gas.[DOK3, GFE, GFP, WSS]
7. Setup and perform FCAW multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing) using flux-cored wire and, if required, shielding gas.[DOK3, GFE, GFP, WSS]
8. Properly store equipment and clean the work area after use.[DOK3, GFE, GFP, WSS]
** NCCER Module Alignment can be found in Appendix G.

Scenario

This is How We Do It-GMAW

Unit 13

You are a welder in a sheet metal facility. Weld two pieces of sheet metal together using the GMAW techniques discussed in class. Demonstrate the proper setup of a GMAW welding machine. Perform required safety inspection of machine and work area; select correct current and electrode; and perform a weld of the instructor's choice. You will be evaluated using the Welding Performance Rubric.

Attachments for Scenario

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

Unit 14: Gas Tungsten Arc Welding (GTAW)

Competencies and Suggested Scenarios
1. Explain the GTAW welding process including safety procedures. DOK3, WSS, GTE, GTP
2. Identify the various parts and function of GTAW equipment. DOK3, WSS, GTE, GTP a. Identify and describe the function of the various GTAW torches. b. Identify and describe the function of the gas nozzles used in GTAW. c. Identify and describe the function of tungsten electrodes used in GTAW. d. Identify and describe the function of the shielding gas used in GTAW.
3. Identify the various types and appropriate uses of GTAW filler metals. DOK3, WSS, GTE, GTP a. Discuss Carbon Steel and Low-Alloy Steel. b. Discuss Stainless Steel, Aluminum and Aluminum alloy. c. Discuss Copper, Copper alloy, Nickel and Nickel alloy. d. Discuss Magnesium alloy, Titanium and Titanium alloy. e. Discuss Stainless Steel flux-cored electrodes and rods.
4. Demonstrate the proper setup of GTAW Equipment. DOK3, WSS, GTE, GTP
5. Setup and perform multiple-pass GTAW fillet welds on carbon steel plate coupons in 1F, 2F, 3F and 4F positions using carbon steel filler metal. DOK3, WSS, GTE, GTP
6. Setup and perform multiple-pass GTAW open V-groove welds on carbon steel plate coupons in 1G, 2G, 3G and 4G positions using carbon steel filler metal. DOK3, WSS, GTE, GTP
7. Properly store equipment and clean the work area after use. DOK3, WSS, GTE, GTP
** NCCER Module Alignment can be found in Appendix G.

Scenario

Bicycle Maker

Unit 14

You (the instructor) are the supervisor for a bicycle factor assembly line. Your job is to lead a group of GTAW welders as they assemble bicycle frames. Have students demonstrate the proper setup of a GTAW welding machine. Each student will have to perform required safety inspection of machine and work area; select correct current and electrode, and filler material; and perform a weld of the instructor's choice. Students will be evaluated using the Welding Performance Rubric.

Attachments for Scenario

See the 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: 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 Welding Technology 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 or 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 job site 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.
		Student Passed Safety Quiz with 100%
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 Blueprints and Basic Rigging		
	1.	Read, analyze, and understand basic components of a basic blueprint.
	2.	Identify and use basic rigging tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools.

Unit 6: Introduction to Materials Handling		
	1.	Safely handle and store materials.
Unit 7: Base Metal Preparation and Weld Quality, Joint Fit-up and Alignment, and Oxyfuel Cutting		
	1.	Explore regulations and job code specifications for welding, base metal cleaning, joint designs and their purpose.
	2.	Identify fit-up gauges and measuring devices to check joint fit-up.
	3.	Demonstrate the use of fit-up gauges and measuring devices to check joint fit-up.
	4.	Discuss the various fit-up tools.
	5.	Demonstrate the proper way to fit-up joints using the various fit-up tools.
	6.	Explain distortion.
	7.	Identify joint misalignment and poor fit-up before and after welding.
	8.	Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxyfuel cutting.
Unit 8: Shielded Metal Arc Welding (SMAW)		
	1.	Explain safety hazards, protective devices used, and how to avoid accidents that commonly occur in the welding trade.
	2.	Identify types of shielded metal arc welding machines and their accessories.
	3.	Select shielded metal arc electrodes for welding applications.
	4.	Setup and make beads and fillet welds.
Unit 9: Orientation and Welding Safety Review		
	1.	Describe local program and vocational or career–technical center policies and procedures.
	2.	Describe employment opportunities and responsibilities of the welder.
	3.	Explore leadership skills and personal development opportunities.
	4.	Describe general safety rules for working in a welding shop/lab and industry.
Unit 10: Welding Symbols and Reading Welding Detail Drawings		
	1.	Examine the various parts of a welding symbol.
	2.	Discuss fillet and groove weld symbols.
	3.	Identify the various welding symbols on drawings, specifications, and welding procedure specifications.
	4.	Interpret welding symbols from a blueprint.
	5.	Examine a welding detail drawing.
	6.	Discuss notes and bill of materials.
	7.	Interpret basic elements of a welding detail drawing.
	8.	Demonstrate how to sketch or draw basic welding drawings.

Unit 11: Plasma Arc Cutting (PAC) and Carbon Arc Cutting and Gouging (CAC-A)		
	1.	Explain the plasma arc cutting (PAC) process.
	2.	Identify PAC equipment and accessories.
	3.	Set up and perform various types of cuts using PAC equipment.
	4.	Properly store equipment and clean the work area after use.
	5.	Explain the air carbon arc cutting (CAC-A) process.
	6.	Identify the various CAC-A electrodes.
	7.	Perform washing and gouging activities using CAC-A equipment.
	8.	Properly store equipment and clean the work area after use.
Unit 12: Advanced Shielded Metal Arc Welding (SMAW)		
	1.	Review safety hazards, protective devices used, and basic operation of SMAW equipment.
	2.	Discuss the various groove welds with and without backing.
	3.	Discuss and demonstrate proper SMAW equipment setup for making V-groove welds.
	4.	Prepare materials to perform SMAW V-groove welds with and without backing.
	5.	Setup and perform SMAW V-groove welds with and without backing in the 1G, 2G, 3G and 4G positions.
	6.	Properly store equipment and clean the work area after use.
Unit 13: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)		
	1.	Explain the GMAW and FCAW welding processes.
	2.	Explain the use of GMAW and FCAW equipment parts and modes:
	3.	Demonstrate proper setup of GMAW and FCAW equipment.
	4.	Setup and perform GMAW-S (short-circuit) multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas.
	5.	Setup and perform GMAW-S (short-circuit) multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire and shielding gas.
	6.	Setup and perform FCAW multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux-cored wire and, if required, shielding gas.
	7.	Setup and perform FCAW multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing) using flux-cored wire and, if required, shielding gas.
	8.	Properly store equipment and clean the work area after use.
Unit 14: Gas Tungsten Arc Welding (GTAW)		
	1.	Explain the GTAW welding process including safety procedures.
	2.	Identify the various parts and function of GTAW equipment.
	3.	Identify the various types and appropriate uses of GTAW filler metals.

	4.	Demonstrate the proper setup of GTAW Equipment.
	5.	Setup and perform multiple-pass GTAW fillet welds on carbon steel plate coupons in 1F, 2F, 3F, and 4F positions using carbon steel filler metal.
	6.	Setup and perform multiple-pass GTAW open V-groove welds on carbon steel plate coupons in 1G, 2G, 3G, and 4G positions using carbon steel filler metal.
	7.	Properly store equipment and clean the work area after use.

Appendix A: Unit References

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.

General Books and Trade Publications

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For additional references, activities, and Web resources, please refer to the Manufacturing Technology Learning Management System(available only to registered users).

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Appendix B: Industry Standards

NCCER Learning Series Standards for the Construction Core Technology Program[1] (taken from the National Center for Construction Education and Research)

Crosswalk for NCCER Core and Welding Level One and Two

	Units	1	2	3	4	5	6				
CORE											
BSM			X								
ICM				X							
IHT					X						
IPT					X						
BLU						X					
RIG						X					
COM		X									
EMP		X									
IMH							X				
	Units	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**		
Welding											
BSM				X							
ICM											
IHT											
IPT											
BLU											
RIG											
COM				X							
EMP				X							
IMH											
WSS		X	X	X	X	X	X	X	X		
WOC		X									
PAC						X					
CAC						X					
BMP		X									
WQT		X									
SWS			X								
SES			X								
SBF			X								
JFA		X									
GWB							X				
OGW							X				
WWS					X						
WDD					X						
PPM		X				X					
HTM		X									
GFE								X			
GFP								X			
GTE									X		
GTP									X		

[1] *NCCER learning series.* Retrieved October 12, 2011, from http://www.nccer.org/

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)
RIG – BASIC RIGGING (00106-09)
COM – BASIC COMMUNICATION SKILLS (00107-09)
EMP – BASIC EMPLOYABILITY SKILLS (00108-09)
IMH – INTRODUCTION TO MATERIALS HANDLING (00109-09)

NCCER WELDING (CWD)

LEVEL ONE

WSS – Welding Safety
WOC – Oxy-Fuel Cutting
PAC – Plasma Arc Cutting
CAC – Air Carbon Arc Cutting and Gouging
BMP – Base Metal Prep
WQT – Weld Quality
SWS – SMAW – Equipment and Setup
SES – Shielded Metal Arc Electrodes
SBF – SMAW – Beads and Fillet Welds
JFA – Joint Fit-up and Alignment
GWB – SMAW – Groove Welds with Backing
OGW – SMAW – Open V-Groove Welds

LEVEL TWO

WWS – Welding Symbols
WDD – Reading Welding Detail Drawings
PPM – Physical Characteristics and Mechanical Properties of Metals
HTM – Preheating and Post-weld Heat Treatment of Metal
GFE – GMAW AND FCAW: Equipment and Filler Metals
GFP – GMAW AND FCAW: Plate
GTE – GTAW: Equipment and Filler Metals
GTP – GTAW – Plate

The NCCER Content Standards and Performance Elements are adapted from *NCCER Learning Series from the National Center for Construction Education and Research*
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NCCER CORE (CCR)

SAF – Basic Safety (MODULE 00101-09)

- Explain the idea of a safety culture and its importance in the construction crafts.
- Identify causes of accidents and the impact of accident costs.
- Explain the role of OSHA in jobsite safety.
- Explain OSHA's General Duty Clause and 1926 CFR Subpart C.
- Recognize hazard recognition and risk assessment techniques.
- Explain fall protection, ladder, stair, and scaffold procedures and requirements.
- Identify struck-by hazards, and demonstrate safe working procedures and requirements.
- Identify caught-in-between hazards, and demonstrate safe working procedures and requirements.
- Define safe work procedures to use around electrical hazards.
- Demonstrate the use and care of appropriate personal protective equipment (PPE).
- Explain the importance of hazard communications (HazCom) and material safety data sheets (MSDSs).
- Identify other construction hazards on your jobsite, including hazardous material exposures, environmental elements, welding and cutting hazards, confined spaces, and fires.

MAT – Introduction to Construction Math (MODULE 00102-09)

- Add, subtract, multiply, and divide whole numbers with and without a calculator.
- Use a standard ruler, a metric ruler, and a measuring tape to measure.
- Add, subtract, multiply, and divide fractions.
- Add, subtract, multiply, and divide decimals with and without a calculator.
- Convert decimals to percentages and percentages to decimals.
- Convert fractions to decimals and decimals to fractions.
- Explain what the metric system is and how it is important in the construction trade.
- Recognize and use metric units of length, weight, volume, and temperature.
- Recognize some of the basic shapes used in the construction industry, and apply basic geometry to measure them.

HTO – Introduction to Hand Tools (MODULE 00103-09)

- Recognize and identify some of the basic hand tools and their proper uses in the construction trade.
- Visually inspect hand tools to determine if they are safe to use.
- Safely use hand tools.

PTO – Introduction to Power Tools (MODULE 00104-09)

- Identify power tools commonly used in the construction trades.
- Use power tools safely.
- Explain how to maintain power tools properly.

BLU – Introduction to Blueprints (MODULE 00105-09)

- Recognize and identify basic blueprint terms, components, and symbols.

- Relate information on blueprints to actual locations on the print.
- Recognize different classifications of drawings.
- Interpret and use drawing dimensions.

RIG – Basic Rigging (MODULE 00106-09)

- Identify and describe the use of slings and common rigging hardware.
- Describe basic inspection techniques and rejection criteria used for slings and hardware.
- Describe basic hitch configurations and their proper connections.
- Describe basic load-handling safety practices.
- Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

COM – Basic Communication Skills (MODULE 00107-09)

- Interpret information and instructions presented in both verbal and written form.
- Communicate effectively in on-the-job situations using verbal and written skills.
- Communicate effectively on the job using electronic communication devices.

EMP – Basic Employability Skills (MODULE 00108-09)

- Explain the role of an employee in the construction industry.
- Demonstrate critical thinking skills and the ability to solve problems using those skills.
- Demonstrate knowledge of computer systems, and explain common uses for computers in the construction industry.
- Define effective relationship skills.
- Recognize workplace issues such as sexual harassment, stress, and substance abuse.

IMH – Introduction to Materials Handling (MODULE 00109-09)

- Define a load.
- Establish a pre-task plan prior to moving a load.
- Use proper materials-handling techniques.
- Choose appropriate materials-handling equipment for the task.
- Recognize hazards and follow safety procedures required for materials handling.

NCCER WELDING (CWD)

LEVEL ONE

WSS – WELDING SAFETY (MODULE 29101-09)

- Identify some common hazards in welding.
- Explain and identify proper personal protection used in welding.
- Describe how to avoid welding fumes.
- Explain some of the causes of accidents.
- Identify and explain uses for material safety data sheets.
- Explain safety techniques for storing and handling cylinders.
- Explain how to avoid electric shock when welding.
- Describe proper material handling methods.

WOC – OXY-FUEL CUTTING (MODULE 29102-09)

- Identify and explain the use of oxyfuel cutting equipment.
- Set up oxyfuel equipment.
- Light and adjust an oxyfuel torch.
- Shut down oxyfuel cutting equipment.
- Disassemble oxyfuel equipment.
- Change cylinders.
- Perform oxyfuel cutting:
    - Straight line and square shapes
    - Piercing and slot cutting
    - Bevels
    - Washing
    - Gouging
- Operate a motorized, portable oxy-fuel gas cutting machine.

PAC – PLASMA ARC CUTTING (MODULE 29103-03)

- Explain the plasma arc cutting processes.
- Identify plasma arc cutting equipment.
- Prepare and set up plasma arc cutting equipment.
- Use plasma arc cutting equipment to make various types of cuts.
- Properly store equipment, and clean the work area after use.

CAC – AIR CARBON ARC CUTTING AND GOUGING (MODULE 29104-09)

- Identify and explain the air carbon arc cutting (CAC-A) process and equipment.
- Select and install CAC-A electrodes.
- Prepare the work area and CAC-A equipment for safe operation.
- Use CAC-A equipment for washing and gouging activities.
- Perform storage and housekeeping activities for CAC-A equipment.
- Make minor repairs to CAC-A equipment.

BMP – BASE METAL PREP (MODULE 29105-09)

- Clean base metal for welding or cutting.
- Identify and explain joint design.
- Explain joint design considerations.
- Mechanically bevel the edge of a mild steel plate.
- Thermally bevel the end of a mild steel plate.
- Select the proper joint design based on a welding procedure specification (WPS) or instructor direction.

WQT – WELD QUALITY (MODULE 29106-09)

- Identify and explain codes governing welding.
- Identify and explain weld imperfections and their causes.
- Identify and explain nondestructive examination practices.
- Identify and explain welder qualification tests.
- Explain the importance of quality artisanship.

- Identify common destructive testing methods.
- Perform a visual inspection of fillet welds.

SWS – SMAW – EQUIPMENT AND SETUP (MODULE 29107-09)

- Identify and explain shielded metal arc welding (SMAW) safety.
- Explain welding electrical current.
- Identify welding power supplies and their characteristics.
- Explain how to set up welding power supplies.
- Set up a machine for welding.
- Identify tools used for weld cleaning.

SES – SHIELDED METAL ARC ELECTRODES (MODULE 29108-09)

- Identify factors that affect electrode selection.
- Explain the American Welding Society (AWS) and the American Society of Mechanical Engineers (ASME) filler metal classification system.
- Identify different types of filler metals.
- Explain the storage and control of filler metals.
- Explain filler metal traceability requirements and how to use applicable code requirements.
- Identify and select the proper electrode for an identified welding task.

SBF – SMAW – BEADS AND FILLET WELDS (MODULE 29109-09)

- Set up shielded metal arc welding (SMAW) equipment.
- Describe methods of striking an arc.
- Properly strike and extinguish an arc.
- Describe causes of arc blow and wander.
- Make stringer, weave, and overlapping beads.
- Make fillet welds in the following positions:
    - Horizontal (2F)
    - Vertical (3F)
    - Overhead (4F)

JFA – JOINT FIT-UP AND ALIGNMENT (MODULE 29110-09)

- Identify and explain job code specifications.
- Use fit-up gauges and measuring devices to check joint fit-up.
- Identify and explain distortion and how it is controlled.
- Fit-up joint using plate and pipe fit-up tools.
- Check for joint misalignment and poor fit-up before and after welding.

GWB – SMAW – GROOVE WELDS WITH BACKING (MODULE 29111-09)

- Identify and explain groove welds.
- Identify and explain groove welds with backing.
- Set up shielded metal arc welding (SMAW) equipment for making V-groove welds.
- Perform SMAW for V-groove welds with backing in the following positions:
    - Flat (1G)

- Horizontal (2G)
- Vertical (3G)
- Overhead (4G)

OGW – SMAW – OPEN V-GROOVE WELDS (MODULE 29112-09)

- Prepare shielded metal arc welding (SMAW) equipment for open-root V-groove welds.
- Perform open-root V-groove welds in the following positions:
    - Flat (1G)
    - Horizontal (2G)
    - Vertical (3G)
    - Overhead (4G)

LEVEL TWO

WWS – WELDING SYMBOLS (MODULE 29201-09)

- Identify and explain the various parts of a welding symbol.
- Identify and explain fillet and groove weld symbols.
- Read welding symbols on drawings, specifications, and welding procedure specifications.
- Interpret welding symbols from a print.

WDD – READING WELDING DETAIL DRAWINGS (MODULE 29202-09)

- Identify and explain a welding detail drawing.
- Identify and explain lines, material fills, and sections.
- Identify and explain object views.
- Identify and explain dimensioning.
- Identify and explain notes and bill of materials.
- Interpret basic elements of a welding detail drawing.
- Sketch or draw a basic welding drawing.

PPM – PHYSICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF METALS (MODULE 29203-09)

- Identify and explain the composition and classification of base metals.
- Explain and demonstrate field identification methods for base metals.
- Identify and explain the physical characteristics and mechanical properties of metals.
- Identify and explain forms and shapes of structural metals.
- Explain metallurgical considerations for welding metals.

HTM – PREHEATING AND POSTWELD HEAT TREATMENT OF METAL (MODULE 29204-09)

- Explain and demonstrate how to preheat metals.
- Describe maintaining interpass temperature.
- Explain postweld heat treatment of metals.
- Explain the effects of welding on metal:
    - Heat-affected zone (HAZ)
    - Cracking

GFE – GMAW AND FCAW: EQUIPMENT AND FILLER METALS (MODULE 29205-09)

- Explain gas metal arc welding (GMAW) and flux cored arc welding (FCAW) safety.
- Explain the characteristics of welding current and power sources.
- Identify and explain the use of GMAW and FCAW equipment:
    - Spray transfer
    - Globular
    - Short circuiting
    - Pulse
- Identify and explain the use of GMAW and FCAW shielding gases and filler metals.
- Set up GMAW and FCAW equipment, and identify tools for weld cleaning.

GFP – GMAW AND FCAW: PLATE (MODULE 29206-09)

- Perform GMAW-S (short-circuit) multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas.
- Perform GMAW-S (short-circuit) multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire.
- Perform GMAW spray fillet and V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire and shielding gas.
- Perform FCAW multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux cored wire and, if required, shielding gas.
- Perform FCAW multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using flux cored wire and, if required, shielding gas.

GTE – GTAW: EQUIPMENT AND FILLER METALS (MODULE 29207-09)

- Explain gas tungsten arc welding (GTAW) safety.
- Identify and explain the function of GTAW equipment.
- Identify and explain the function of GTAW filler metals.
- Identify and explain the function of GTAW shielding gases.
- Set up GTAW equipment.

GTP – GTAW – PLATE (MODULE 29208-09)

- Weld a pad in the flat position with stringer beads using GTAW and carbon steel filler metal.
- Make multiple-pass GTAW fillet welds on carbon steel plate coupons in the following positions, using carbon steel filler metal:
    - 1F
    - 2F
    - 3F
    - 4F
- Make multiple-pass GTAW V-groove welds on carbon steel plate coupons in the following positions, using carbon steel filler metal:
    - 1G
    - 2G

    - 3G
    - 4G
- Explain GTAW and set up equipment to weld aluminum plate.
- Explain and practice GTAW techniques for plate, including padding in the flat position with stringer beads, using aluminum filler metal.
- Make fillet welds on aluminum plate in the following positions:
    - 1F (flat)
    - 2F (horizontal)
    - 3F (vertical)
    - 4F (overhead)
- Make multiple-pass V-groove welds with backing on aluminum plate in the following positions:
    - 1G (flat)
    - 2G (horizontal)
    - 3G (vertical)
    - 4G (overhead)

Appendix C: 21st Century Skills[2]

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

[2] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

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 Welding Technology

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
Common Core Standards											
CCR1		X	X	X	X		X	X	X	X	X
CCR2		X	X	X	X		X	X	X	X	X
CCR3		X	X		X		X	X	X	X	X
CCR4		X	X		X	X	X	X	X	X	X
CCR5		X	X		X	X	X	X	X	X	X
CCR6		X			X						
CCR7		X	X		X	X	X	X	X	X	X
CCR8		X			X	X	X	X	X	X	X
CCR9		X			X	X	X	X	X	X	X
CCR10			X		X	X	X	X	X	X	X
CCW1											
CCW2		X				X					
CCW3			X		X	X	X				X
CCW4		X	X		X	X	X				X
CCW5		X	X		X	X	X				X
CCW6					X						X
CCW7		X									
CCW8		X	X		X	X	X	X	X	X	X
CCW9											
CCW10						X					
CCSL1		X	X	X	X	X	X	X	X	X	X
CCSL2		X	X	X	X	X	X	X	X	X	X
CCSL3		X	X				X				
CCSL4		X	X	X	X	X	X				
CCSL5		X									
CCSL6		X									
CCL1			X		X	X	X	X	X	X	X
CCL2			X					X	X	X	X
CCL3			X					X	X	X	X
CCL4		X	X		X	X	X	X	X	X	X
CCL5											
CCL6		X	X	X	X	X	X	X	X	X	X
CCM1				X							
CCM2				X							
CCM3				X							
CCM4				X							
CCM5				X							
CCM6				X							
CCM7				X		X					
CCM8				X		X					
CCM9				X		X					
CCM10				X							
CCM11				X							
CCM12				X							
CCM13				X							
CCM14				X							
CCM15											
CCM16				X							
CCM17				X							
CCM18				X							
CCM19				X							
CCM20				X							
CCM21				X							
CCM22				X							
CCM23											

CCM24											
CCM25											
CCM26				X							
CCM27				X							
CCM28				X							
CCM29				X							
CCM30				X		X					
CCM31				X		X					
CCM32				X		X					
CCM33				X		X					
CCM34											
CCM35											
CCM36											
CCM37											
CCM38											
CCM39											
CCM40				X		X					
CCM41				X		X					
CCM42				X		X					
CCM43				X		X					
CCM44				X		X					
CCM45											
CCM46											
CCM47											
CCM48											
CCM49											
CCM50											
CCM51											
CCM52											
CCM53											

Common Core Crosswalk for Welding Technology

	Units	Unit 11	Unit 12	Unit 13	Unit 14						
Common Core Standards											
CCR1		X	X	X	X						
CCR2		X	X	X	X						
CCR3		X	X	X	X						
CCR4		X	X	X	X						
CCR5		X	X	X	X						
CCR6											
CCR7		X	X	X	X						
CCR8		X	X	X	X						
CCR9		X	X	X	X						
CCR10		X	X	X	X						
CCW1											
CCW2											
CCW3					X						
CCW4					X						
CCW5					X						
CCW6					X						
CCW7											
CCW8		X	X	X	X						
CCW9											
CCW10											
CCSL1		X	X	X	X						
CCSL2		X	X	X	X						
CCSL3											
CCSL4											
CCSL5											
CCSL6											

CCL1		X	X	X	X						
CCL2		X	X	X	X						
CCL3		X	X	X	X						
CCL4		X	X	X	X						
CCL5											
CCL6		X	X	X	X						
CCM1											
CCM2											
CCM3											
CCM4											
CCM5											
CCM6											
CCM7											
CCM8											
CCM9											
CCM10											
CCM11											
CCM12											
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CCM14											
CCM15											
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CCM47											
CCM48											
CCM49											
CCM50											
CCM51											
CCM52											
CCM53											

English Language Arts (6-12)

College and Career Readiness Anchor Standards for Reading

Key Ideas and Details

CCR1: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCR2: Determine central ideas or themes of a text, and analyze their development; summarize the key supporting details and ideas.

CCR3: Analyze how and why individuals, events, and ideas develop and interact over the course of a text.

Craft and Structure

CCR4: Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

CCR5: Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

CCR6: Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas

CCR7: Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

CCR8: Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

CCR9: Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity

CCR10: Read and comprehend complex literary and informational texts independently and proficiently. Mathematics (High School)

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

CCW1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

CCW2: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

CCW3: Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

Production and Distribution of Writing

CCW4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCW5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

CCW6: Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Research to Build and Present Knowledge

CCW7: Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

CCW8: Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

CCW9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

Range of Writing

CCW10: 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

CCSL1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCSL2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

CCSL3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

Presentation of Knowledge and Ideas

CCSL4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

CCSL5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

CCSL6: Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

CCL1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

CCL2: Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Knowledge of Language

CCL3: 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.

Vocabulary Acquisition and Use

CCL4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

CCL5: Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

CCL6: Acquire and use accurately a range of 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.

Mathematics (High School)

Number and Quantity

The Real Number System

CCM1: Extend the properties of exponents to rational exponents.

CCM2: Use properties of rational and irrational numbers.

Quantities

CCM3: Reason quantitatively and use units to solve problems.

The Complex Number System

CCM4: Perform arithmetic operations with complex numbers.

CCM5: Represent complex numbers and their operations on the complex plane.

CCM6: Use complex numbers in polynomial identities and equations.

Vector and Matrix Quantities

CCM7: Represent and model with vector quantities.

CCM8: Perform operations on vectors.

CCM9: Perform operations on matrices and use matrices in applications.

Algebra

Interpret the structure of expressions

CCM10: Write expressions in equivalent forms to solve problems.

Arithmetic with Polynomials and Rational Expressions

CCM11: Perform arithmetic operations on polynomials.

CCM12: Understand the relationship between zeros and factors of polynomials.

CCM13: Use polynomial identities to solve problems.

CCM14: Rewrite rational expressions.

Creating Equations

CCM15: Create equations that describe numbers or relationships.

Reasoning with Equations and Inequalities

CCM16: Understand solving equations as a process of reasoning, and explain the reasoning.

CCM17: Solve equations and inequalities in one variable.

CCM18: Solve systems of equations.

CCM19: Represent and solve equations and inequalities graphically.

Functions

CCM20: Understand the concept of a function and use function notation.

CCM21: Interpret functions that arise in applications in terms of the context.

CCM22: Analyze functions using different representations.

Building Functions

CCM23: Build a function that models a relationship between two quantities.

CCM24: Build new functions from existing functions.

Linear, Quadratic, and Exponential Models

CCM25: Construct and compare linear, quadratic, and exponential models, and solve problems.

CCM26: Interpret expressions for functions in terms of the situation they model.

Trigonometric Functions

CCM27: Extend the domain of trigonometric functions using the unit circle.

CCM28: Model periodic phenomena with trigonometric functions.

CCM29: Prove and apply trigonometric identities.

Geometry

CCM30: Experiment with transformations in the plane.

CCM31: Understand congruence in terms of rigid motions.

CCM32: Prove geometric theorems.

CCM33: Make geometric constructions.

Similarity, Right Triangles, and Trigonometry

CCM34: Understand similarity in terms of similarity transformations.

CCM35: Prove theorems involving similarity.

CCM36: Define trigonometric ratios, and solve problems involving right triangles.

CCM37: Apply trigonometry to general triangles.

Circles

CCM38: Understand and apply theorems about circles.

CCM39: Find arc lengths and areas of sectors of circles.

Expressing Geometric Properties with Equations

CCM40: Translate between the geometric description and the equation for a conic section.

CCM41: Use coordinates to prove simple geometric theorems algebraically.

Geometric Measurement and Dimension

CCM42: Explain volume formulas, and use them to solve problems.

CCM43: Visualize relationships between two-dimensional and three-dimensional objects.

Modeling with Geometry

CCM44: Apply geometric concepts in modeling situations.

Statistics and Probability

CCM45: Summarize, represent, and interpret data on a single count or measurement variable.

CCM46: Summarize, represent, and interpret data on two categorical and quantitative variables.

CCM47: Interpret linear models.

Making Inferences and Justifying Conclusions

CCM48: Understand and evaluate random processes underlying statistical experiments.

CCM49: Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

Conditional Probability and the Rules of Probability

CCM50: Understand independence and conditional probability and use them to interpret data.

CCM51: Use the rules of probability to compute probabilities of compound events in a uniform probability model.

Using Probability to Make Decisions

CCM52: Calculate expected values, and use them to solve problems.

CCM53: Use probability to evaluate outcomes of decisions.

Appendix E: National Educational Technology Standards for Students (NETS-S)

	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
NETS Standards										
T1		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	X	X
T5		X								
T6		X	X	X	X	X	X	X	X	X
	Course	**Unit 10**	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**				
NETS Standards										
T1		X	X	X	X	X				
T2		X	X	X	X	X				
T3		X	X	X	X	X				
T4		X	X	X	X	X				
T5										
T6		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 MATHEMATICS FRAMEWORK COMPETENCIES

	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
MS Math Standards										
PRE-A1				X				X	X	
PRE-A2										
PRE-A3				X				X	X	
PRE-A4				X				X	X	
PRE-A5										
TRAN1										
TRAN2										
TRAN3				X				X	X	
TRAN4				X				X	X	
TRAN5				X				X	X	
ALG1										
ALG2										
ALG3				X						
ALG4				X						
ALG5										
GEO1										
GEO2										
GEO3										
GEO4				X				X	X	
GEO5										
ALGII1										
ALGII2										
ALGII3										
ALGII4				X						
ALGII5										
ADVALG1										
ADVALG2										
ADVALG3										
ADVALG4										
TRIG1										
TRIG2										
TRIG3										
TRIG4										
TRIG5										
PRECAL1										
PRECAL2										
PRECAL3										
PRECAL4										
PRECAL5										
CAL1										
CAL2										
CAL3										
CAL4										
CAL5										
CAL6										
CAL7										
CAL8										
CAL9										
ITE1										
ITE2										
ITE3										
ITE4										
ITE5										

	Course	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14				
MS Math Standards										
PRE-A1		X	X	X	X	X				
PRE-A2										
PRE-A3		X	X	X	X	X				
PRE-A4		X	X	X	X	X				
PRE-A5										
TRAN1										
TRAN2										
TRAN3			X	X	X	X				
TRAN4			X	X	X	X				
TRAN5			X	X	X	X				
ALG1										
ALG2										
ALG3										
ALG4										
ALG5										
GEO1										
GEO2										
GEO3										
GEO4			X	X	X	X				
GEO5										
ALGII1										
ALGII2										
ALGII3										
ALGII4										
ALGII5										
ADVALG1										
ADVALG2										
ADVALG3										
ADVALG4										
TRIG1										
TRIG2										
TRIG3										
TRIG4										
TRIG5										
PRECAL1										
PRECAL2										
PRECAL3										
PRECAL4										
PRECAL5										
CAL1										
CAL2										
CAL3										
CAL4										
CAL5										
CAL6										
CAL7										
CAL8										
CAL9										
ITE1										
ITE2										
ITE3										
ITE4										
ITE5										

PRE-A1 Apply concepts and perform basic operations using real numbers in real-world contexts.
PRE-A2 Apply properties to simplify algebraic expressions, solve linear equations and inequalities, and apply principles of graphing.
PRE-A3 Identify and apply geometric principles to polygons, angles, and two- and three-dimensional figures.
PRE-A4 Understand measurable attributes of objects and apply various formulas in problem solving situations.
PRE-A5 Interpret, organize, and make predictions about a variety of data using concepts of probability.

1. Apply concepts and perform basic operations using real numbers in real-world contexts.

a. Define, classify, and order rational and irrational numbers and their subsets. (DOK 1)
b. Formulate and solve standard and real-life problems involving addition, subtraction, multiplication, and division of rational numbers. (DOK 2)
c. Apply the concepts of Greatest Common Factor (GCF) and Least Common Multiple (LCM) to monomials with variables. (DOK 2)
d. Simplify and evaluate expressions using order of operations and use real number properties to justify solutions. (DOK 2)
e. Explain the rules of exponents related to multiplication and division of terms with exponents. (DOK 2)
f. Recognize and appropriately use exponential and scientific notation. (DOK 1)
g. Explain and use the inverse relationship between square roots and squares. (DOK 2)

2. Apply properties to simplify algebraic expressions, solve linear equations and inequalities, and apply principles of graphing.

a. Simplify and evaluate numerical and algebraic expressions. (DOK 1)
b. Apply properties of real numbers with an emphasis on the distributive properties of multiplication over addition and subtraction. (DOK 1)
c. Solve and check equations and inequalities using one variable. (DOK 2)
d. Model inequalities (and their solutions) on a number line. (DOK 1)
e. Graph linear equations and non-linear equations ($y = x^2$) using multiple methods including t-tables and slope-intercept. (DOK 2)
f. Given a linear graph, identify its slope as positive, negative, undefined, or zero, and interpret slope as rate of change. (DOK 2)
g. Determine slope, x-intercept, and y-intercept from a graph and/or equation in slope-intercept or standard form. (DOK 1)
h. Add, subtract, and multiply monomials and binomials. (DOK 1)
i. Predict characteristics of a graph given an equation or t-table. (DOK 2)

3. Identify and apply geometric principles to polygons, angles, and two- and three-dimensional figures.

a. Locate and identify angles formed by parallel lines cut by a transversal(s) (e.g., adjacent, vertical, complementary, supplementary, corresponding, alternate interior, and alternate exterior). (DOK 1)

b. Find missing angle measurements for parallel lines cut by a transversal(s) and for a vertex of a polygon. (DOK 1)

c. Explain the Pythagorean Theorem and apply it to solve routine and non-routine problems. (DOK 3)

d. Solve real-world and non-routine problems involving congruent and similar figures. (DOK 3)

e. Use two-dimensional representations (nets) of three-dimensional objects to describe objects from various perspectives. (DOK 2)

4. Understand measurable attributes of objects and apply various formulas in problem solving situations.

a. Solve real-world application problems that include length, area, perimeter, and circumference using standard measurements. (DOK 2)

b. Develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios. (DOK 3)

c. Use formulas and/or appropriate measuring tools to find length and angle measures (to appropriate levels of precision), perimeter, area, volume, and surface area of polygons, circles, spheres, cones, pyramids, and composite or irregular figures. (DOK 1)

5. Interpret, organize, and make predictions about a variety of data using concepts of probability.

a. Use a given mean, mode, median, and range to summarize and compare data sets including investigation of the different effects that change in data values have on these measures. (DOK 2)

b. Select the appropriate measures of central tendency for a particular purpose. (DOK 2)

c. Make and list conjectures by calculating probability for experimental or simulated contexts. (DOK 3)

d. Construct and interpret scatter plots to generalize trends from given data sets. (DOK 3)

Transition to Algebra

TRAN1	Understand relationships between numbers and their properties and perform operations fluently.
TRAN2	Understand, represent, and analyze patterns, relations, and functions.
TRAN3	Understand geometric principles of polygons, angles, figures.
TRAN4	Demonstrate and apply various formulas in problem-solving situations.
TRAN5	Interpret data.

1. Understand relationships between numbers and their properties and perform operations fluently.

a. Compare and contrast the subsets of real numbers. (DOK 1)
b. Simplify and evaluate expressions using order of operations and use real number properties to justify solutions. (DOK 2)
c. Express, interpret, and compute numbers using scientific notation in meaningful contexts. (DOK 1)
d. Apply the concept of Greatest Common Factor (GCF) and Least Common Multiple (LCM) to monomials with variables. (DOK 2)
e. Use the inverse relationship to develop the concept of roots and perfect squares. (DOK 2)

2. Understand, represent, and analyze patterns, relations, and functions.

a. Given a literal equation, solve for a specified variable of degree one. (DOK 1)
b. Explain and illustrate how changes in one variable may result in a change in another variable. (DOK 2)
c. Solve and check multi-step equations and inequalities, including distributive property, variables on both sides, and rational coefficients. (DOK 2)
d. Use real-world data to express slope as a rate of change. (DOK 2)
e. Graph solutions to linear inequalities. (DOK 2)
f. Write linear equations given slope and y-intercept or two points. (DOK 2)
g. Identify domain, range, slope, and intercepts of functions. (DOK 1)
h. Develop generalizations to characterize the behaviors of graphs (linear, quadratic, and absolute value). (DOK 2)
i. Classify and determine degree of a polynomial and arrange polynomials in ascending or descending order of a variable. (DOK 1)
j. Apply ratios and use proportional reasoning to solve real-world algebraic problems. (DOK 2)
k. Add, subtract, multiply, and divide polynomial expressions. (DOK 1)
l. Analyze the relationship between x and y values, and determine whether a relation is a function. (DOK 2)

3. Understand geometric principles of polygons, angles, figures.

a. Apply the Pythagorean Theorem to solve problems. (DOK 2)
b. Apply proportional reasoning to determine similar figures and find unknown measures. (DOK 2)

4. Demonstrate and apply various formulas in problem-solving situations.

a. Solve real-world problems involving measurements (i.e., circumference, perimeter, area, volume, distance, temperature, etc.). (DOK 2)
b. Explain and apply the appropriate formula to determine length, midpoint, and slope of a segment in a coordinate plane (i.e., distance formula, Pythagorean Theorem). (DOK 2)

5. Interpret data.

a. Construct graphs, make predictions, and draw conclusions from tables, line graphs, and scatter plots. (DOK 3)

b. Use a given mean, mode, median, and range to summarize and compare data sets including investigation of the different effects that change in data have on these measures of central tendency, and select the appropriate measures of central tendency for a given purpose. (DOK 2)
c. Calculate basic probability of experiments and simulations to make and test conjectures about results. (DOK 3)

Algebra I

ALG1	Represent, analyze and make inferences based on data with and without the use of technology.
ALG2	Demonstrate and apply various formulas in problem-solving situations.
ALG3	Understand how algebra and geometric representations interconnect and build on one another
ALG4	Understand, represent, and analyze patterns, relations, and functions.
ALG5	Understand relationships between numbers and their properties and perform operations fluently

1. Understand relationships between numbers and their properties and perform operations fluently.

a. Apply properties of real numbers to simplify algebraic expressions, including polynomials. (DOK 1)
b. Use matrices to solve mathematical situations and contextual problems. (DOK 2)

2. Understand, represent, and analyze patterns, relations, and functions.

a. Solve, check, and graph multi-step linear equations and inequalities in one variable, including rational coefficients in mathematical and real-world situations. (DOK 2)
b. Solve and graph absolute value equations and inequalities in one variable. (DOK 2)
c. Analyze the relationship between *x* and *y* values, determine whether a relation is a function, and identify domain and range. (DOK 2)
d. Explain and illustrate how a change in one variable may result in a change in another variable and apply to the relationships between independent and dependent variables. (DOK 2)
e. Graph and analyze linear functions. (DOK 2)
f. Use algebraic and graphical methods to solve systems of linear equations and inequalities in mathematical and real-world situations. (DOK 2)
g. Add, subtract, multiply, and divide polynomial expressions. (DOK 1)
h. Factor polynomials by using Greatest Common Factor (GCF) and factor quadratics that have only rational roots. (DOK 1)
i. Determine the solutions to quadratic equations by using graphing, tables, completing the square, the Quadratic formula, and factoring. (DOK 1)
j. Justify why some polynomials are prime over the rational number system. (DOK 2)
k. Graph and analyze absolute value and quadratic functions. (DOK 2)
l. Write, graph, and analyze inequalities in two variables. (DOK 2)

3. Understand how algebra and geometric representations interconnect and build on one another.

a. Apply the concept of slope to determine if lines in a plane are parallel or perpendicular. (DOK 2)

a. Solve problems that involve interpreting slope as a rate of change. (DOK 2)

4. Demonstrate and apply various formulas in problem-solving situations.

a. Solve real-world problems involving formulas for perimeter, area, distance, and rate. (DOK 2)

b. Explain and apply the appropriate formula to determine length, midpoint, and slope of a segment in a coordinate plane. (i.e., distance formula, Pythagorean Theorem). (DOK 2)

c. Represent polynomial operations with area models. (DOK 2)

5. Represent, analyze and make inferences based on data with and without the use of technology.

a. Draw conclusions and make predictions from scatter plots. (DOK 3)

b. Use linear regression to find the line-of-best fit from a given set of data. (DOK 3)

Geometry

GEO1	Compute and determine the reasonableness of a result in mathematical and real-world situations with and without technology.
GEO2	Understand relations, functions, and patterns. Analyze change using various geometric properties.
GEO3	Investigate, apply, and prove properties and theorems from postulates and definitions related to angles, lines, circles, polygons, and two- and three-dimensional figures. Explore applications of patterns and transformational geometry.
GEO4	Select and apply various strategies, tools, and formulas to calculate length, surface area, volume, and angle measurements.
GEO5	Represent, analyze, and make inferences based on data with and without the use of technology.

1. Compute and determine the reasonableness of a result in mathematical and real-world situations with and without technology.

a. Apply problem-solving skills to solve and verify the solutions for unknown measures in similar polygons. (DOK 2)

b. Given exact irrational solutions, determine the best rational estimation. (DOK 2)

c. Solve real-world or application problems that involve square roots and the Pythagorean Theorem. (DOK 3)

2. Understand relations, functions, and patterns. Analyze change using various geometric properties.

a. Represent data from geometric and real-world contexts with expressions, formulas, tables, charts, graphs, relations, and functions. (DOK 2)

b. Recognize and write the equation of a circle in standard form *(x-h)2 + (y-k)2 = r2* and identify the center and radius. (DOK 2)
c. Use slope to analyze and write equations for parallel and perpendicular lines. (DOK 2)
d. Apply the Midpoint and Distance Formulas to solve application problems involving the coordinate plane. (DOK 2)
e. Determine the effects of rigid (translations, rotations, and reflections) and nonrigid (dilations) motions and compositions when performed on objects on the coordinate plane. (DOK 2)

3. Investigate, apply, and prove properties and theorems from postulates and definitions related to angles, lines, circles, polygons, and two- and threedimensional figures. Explore applications of patterns and transformational geometry.

a. Use inductive reasoning to make conjectures and deductive reasoning to make valid conclusions. (DOK 3)
b. Develop and evaluate mathematical arguments and proofs to include paragraph, two-column, and flow chart forms. (DOK 3)
c. Identify, classify, and apply angle relationships formed by parallel lines cut by transversals. (DOK 2)
d. Use the properties of altitudes, medians, angle bisectors, and perpendicular bisectors of triangles to solve problems. (DOK 2)
e. Classify triangles and apply postulates and theorems to test for triangle inequality, congruence, and similarity. (DOK 2)
f. Determine and justify if a given shape could be tessellated. (DOK 2)
g. Describe and draw cross-sections of prisms, cylinders, pyramids, and cones. (DOK 1)
h. Graph a vector and determine the magnitude and direction of a given vector. (DOK 2)
i. Given the pre-image or image, find figures obtained by applying reflections, translations, rotations, and dilations; describe and justify the method used. (DOK 2)

4. Select and apply various strategies, tools, and formulas to calculate length, surface area, volume, and angle measurements.

a. Use the properties of circles using arc, angle, and segment relationships to find missing measures. (DOK 2)
b. Solve real-world applications and mathematical problems to find missing measurements in right triangles by applying special right triangle relationships, geometric means, or trigonometric functions. (DOK 2)
c. Solve real-world and mathematical problems involving the lateral area, surface area and volume of three-dimensional figures, including prisms, cylinders, cones, pyramids, and spheres. (DOK 2)
d. Explain and use the properties of 45-45-90 and 30-60-90 triangles. (DOK 2)
e. Apply the relationships of sine, cosine, and tangent to problems involving right triangles. (DOK 2)

5. Represent, analyze, and make inferences based on data with and without the use of technology.

a. Apply multiple strategies and representations, including area models, to solve probability problems. (DOK 2)

Algebra II

ALGII1	Understand relationships among numbers and compute fluently. Verify with technology.
ALGII2	Use algebraic concepts to identify patterns, use multiple representations of relations and functions, and apply operations to expressions, equations, and inequalities.
ALGII3	Use coordinate geometry to specify locations, describe relationships, and apply transformations to analyze algebraic relationships.
ALGII4	Understand measurable attributes of objects and apply appropriate techniques and formulas to determine measurements.
ALGII5	Use technology to represent, analyze, and make inferences based on data.

1. Understand relationships among numbers and compute fluently. Verify with technology.

a. Diagram the relationship among the subsets of the complex number system. (DOK 2)
b. Compute with rational and radical expressions and complex numbers, expressing in simplest form. (DOK 1)
c. Evaluate powers of the imaginary unit, *i*. (DOK 1)
d. Perform computations, including addition, scalar multiplication, multiplication, determinants, and inverses on matrices. (DOK 1)
e. Solve applications and problems in mathematical settings involving arithmetic and geometric sequences and series. (DOK 3)
f. Explain and use the inverse relationship between exponential and logarithmic expressions. (DOK 2)
g. Use the properties of logarithms to simplify logarithmic expressions and to find their approximate values. (DOK 1)
h. Solve application problems involving exponential functions related to growth and decay. (DOK 3)

2. Use algebraic concepts to identify patterns, use multiple representations of relations and functions, and apply operations to expressions, equations, and inequalities.

a. Solve compound and absolute value inequalities, graphing and writing solutions in interval notation. (DOK 2)
b. Solve systems of absolute value and quadratic equations using a variety of solution methods including graphing. (DOK 2)
c. Given constraints, find the maximum and minimum value(s) of a system of linear inequalities and explain your reasoning. (DOK 2)
d. Given the solution(s) to a quadratic equation, find a quadratic equation to fit the solution(s) and explain or justify the solution process. (DOK 2)

e. Use the discriminant to classify and predict the types of solutions of quadratic equations and justify the classification. (DOK 2)
f. Factor sums and differences of cubes and factor polynomials by grouping. (DOK 2)
g. Solve radical equations. (DOK 2)
h. Write equivalent forms of rational expressions using real and complex conjugates. (DOK 2)
i. Solve equations involving rational expressions and verify solutions. (DOK 2)
j. Explain the results of compositions of functions. (DOK 2)
k. Explain the Binomial Theorem and use it to expand binomial expressions raised to positive integral powers. (DOK 2)
l. Interpret the zeros and maximum or minimum value(s) of quadratic functions. (DOK 2)

3. Use coordinate geometry to specify locations, describe relationships, and apply transformations to analyze algebraic relationships.

a. Determine and justify whether the inverse of a relation or a function exists. (DOK 2)
b. Classify functions based on sketches of their graphs. (DOK 2)
c. Sketch and describe transformations of quadratic and absolute value functions. (DOK 2)
d. Represent complex numbers and the sum of complex numbers in a complex coordinate plane. (DOK 1)
e. Identify and sketch the essential graphs of the four conic sections: circle, parabola, ellipse, and hyperbola. (DOK 1)

4. Understand measurable attributes of objects and apply appropriate techniques and formulas to determine measurements.

a. Verify the appropriateness of the numerical value and the units of a variable in an equation. (DOK 2)
b. Describe the level of accuracy of measurements in real-world situations by using absolute value inequalities. (DOK 1)

5. Use technology to represent, analyze, and make inferences based on data.

a. Through the use of technology, use scatter plots and linear and quadratic regression analysis to determine an appropriate function to model real-life data. (DOK 3)
b. Solve simple combinations. (DOK 2)
c. Model a data set using the median-fit-method with a linear equation and make predictions based on the model and the equation. (DOK 3)
d. Identify the difference between permutations and combinations and use them to solve real-world problems. (DOK 2)

Advanced Algebra

ADVALG1 Understand and perform computations with different representations of numbers.
ADVALG2 Use algebraic concepts to identify patterns and use multiple representations of relations and functions. Apply operations to expressions and equations.
ADVALG3 Recognize, analyze, and graph conic sections.

ADVALG4 Apply simple probability and curve fitting to data.

1. Understand and perform computations with different representations of numbers.

a. Express a series using summation notation. (DOK 2)
b. Evaluate the sum of a series. (DOK 2)
c. Explain expansion by minors and find the determinant of a 3 x 3 matrix with that process. (DOK 2)
d. Use problem-solving strategies to solve non-routine problems. (DOK 3)
e. Solve application problems involving *e* and exponential functions related to growth and decay. (DOK 3)

2. Use algebraic concepts to identify patterns and use multiple representations of relations and functions. Apply operations to expressions and equations.

a. Find the sum, difference, product, and quotient of functions, noting any restrictions on the domain. (DOK 2)
b. Provide a convincing argument (or proof) regarding the inverse relationship of two functions. (DOK 3)
c. Describe patterns found in Pascal's Triangle and explain the relationship to the Binomial Theorem. (DOK 2)
d. Write and graph the equations of conic sections. (DOK 1)
e. Solve linear-quadratic and quadratic-quadratic systems of equations and inequalities. (DOK 2)

3. Recognize, analyze, and graph conic sections.

a. Describe and explain the conic sections resulting from cutting a cone. (DOK 1)
b. Explain and perform the geometric constructions of conic sections. (DOK 2)

4. Apply simple probability and curve fitting to data.

a. Use technology and regression analysis to determine appropriate quadratic and cubic functions modeling real-life data. (DOK 3)

Trigonometry

TRIG1	Represent and compare numbers in various forms and perform operations.
TRIG2	Investigate basic concepts of vectors and operations with vectors.
TRIG3	Compare and produce equivalent forms of trigonometric expressions and solve trigonometric equations.
TRIG4	Use geometric modeling to analyze trigonometric relationships.
TRIG5	Select and apply formulas to determine length and area.

1. Represent and compare numbers in various forms and perform operations.

a. Perform conversions across measurement systems including degree to radian measurements of angles, radian measurements to degree measurements of angles, polar to rectangular coordinates, rectangular to polar coordinates, rectangular to

trigonometric forms of complex numbers, and trigonometric to rectangular forms of complex numbers. (DOK 1)

b. Determine the product and quotient of complex numbers in trigonometric form. (DOK 1)
c. Apply De Moivre's theorem to determine the *n*th roots of a complex number given in polar form. (DOK 1)
d. Explain the addition formulas for sine and cosine and use them to prove (or simplify) other trigonometric functions. (DOK 2)

2. Investigate basic concepts of vectors and operations with vectors.

a. Recognize and draw different notations for vectors to represent a quantity. (DOK 1)
b. Analyze properties of vectors and the effects of these properties on operations with vectors. (DOK 2)
c. Apply the limit definition of *e*. (DOK 2)

3. Compare and produce equivalent forms of trigonometric expressions and solve trigonometric equations.

a. Determine the domain and range of trigonometric functions. (DOK 2)
b. Identify and apply trigonometric identities. (DOK 2)
c. Verify identities analytically and with technology. (DOK 2)
d. Solve trigonometric equations in real-world situations or mathematical settings. (DOK 2)

4. Use geometric modeling to analyze trigonometric relationships.

a. Use the unit circle to solve real-world applications and problems in mathematical settings. (DOK 3)
b. Apply the six trigonometric functions in relation to a right triangle to solve realworld applications and problems in mathematical settings. (DOK 3)
c. Find exact values of trigonometric functions of special angles in the unit circle. (DOK 1)
d. Recognize, sketch, and interpret graphs of the six trigonometric functions and include restrictions on their domain. (DOK 2)
e. Model and apply right triangle formulas, Law of Sines, and Law of Cosines to problem-solving situations. (DOK 2)
f. Use the graph of polar coordinates and associated equations to model real-world applications and mathematical situations. (DOK 2)

5. Select and apply formulas to determine length and area.

a. Find arc length and sector area of a circle. (DOK 2)
b. Using graphs of functions of the form $f(t) = A \sin (Bt + C)$ or $f(t) = A \cos (Bt + C)$, interpret A, B, C in terms of amplitude, frequency, period, and phase shift. (DOK 2)
c. Given one angle and the measures of two adjacent sides, determine the area of a triangle and explain the process used. (DOK 2)

PRECAL1 Explore and illustrate the characteristics and operations connecting sequences and series.
PRECAL2 Analyze, manipulate, and solve equations and inequalities.
PRECAL3 Recognize, sketch, and transform graphs of functions.
PRECAL4 Adapt curves to data.
PRECAL5 Explore and apply fundamental principles of probability.

1. Explore and illustrate the characteristics and operations connecting sequences and series.

a. Express sequences and series using recursive and explicit formulas. (DOK 2)
b. Evaluate and apply formulas for arithmetic and geometric sequences and series. (DOK 2)
c. Calculate limits based on convergent and divergent series. (DOK 2)
d. Evaluate and apply infinite geometric series. (DOK 2)

2. Analyze, manipulate, and solve equations and inequalities.

a. Determine characteristics of graphs of parent functions (domain/range, increasing/decreasing intervals, intercepts, symmetry, end behavior, and asymptotic behavior). (DOK 2)
b. Determine horizontal, vertical, and slant asymptotes and holes of rational functions and explain how each was found. (DOK 2)
c. Determine the domain and range of functions, including piece-wise functions. (DOK 2)
d. Determine the end behavior of polynomial functions. (DOK 2)
e. Decompose composite functions into component functions. (DOK 2)
f. Solve exponential and logarithmic equations to include real-world applications. (DOK 2)
g. Find the possible rational roots using the Rational Root Theorem. (DOK 1)
h. Find the zeros of polynomial functions by synthetic division and the Factor Theorem. (DOK 1)
i. Graph and solve quadratic inequalities. (DOK 2)
j. Decompose a rational function into partial fractions. (DOK 2)

3. Recognize, sketch, and transform graphs of functions.

a. Describe the attributes of graphs and the general equations of parent functions (linear, quadratic, cubic, absolute value, rational, exponential, logarithmic, square root, cube root, and greatest integer). (DOK 1)
b. Explain the effects of changing the parameters in transformations of functions. (DOK 2)
c. Predict the shapes of graphs of exponential, logarithmic, rational, and piece-wise functions, and verify the prediction with and without technology. (DOK 2)
d. Relate symmetry of the behavior of even and odd functions. (DOK 2)

4. Adapt curves to data.

a. Use regression methods available through technology to determine appropriate exponential and logarithmic functions that model real-life data. (DOK 3)
b. Use regression methods available through technology to determine appropriate cubic functions that model real-life data. (DOK 3)

5. Explore and apply fundamental principles of probability.

a. Analyze expressions in summation and factorial notation to solve problems. (DOK 2)
b. Expand and apply the Binomial Theorem to problem-solving situations. (DOK 2)

Calculus

CAL1	Compute and determine the reasonableness of results in mathematical and real world situations.
CAL2	Demonstrate basic knowledge of functions, including their behavior and characteristics.
CAL3	Evaluate limits and communicate an understanding of the limiting process.
CAL4	Use the definition and formal rules of differentiation to compute derivatives.
CAL5	Apply derivatives to find solutions in a variety of situations.
CAL6	Employ various integration properties and techniques to evaluate integrals.
CAL7	Use geometric concepts to gain insights into, answer questions about, and graph various implications of differentiation.
CAL8	Adapt integration methods to model situations to problems.
CAL9	Apply appropriate techniques, tools, and formulas to determine values for the definite integral.

1. Compute and determine the reasonableness of results in mathematical and real world situations.

a. Estimate limits from graphs or tables. (DOK 2)
b. Estimate numerical derivatives from graphs or tables of data. (DOK 2)
c. Prove statements using mathematical induction. (DOK 3)

2. Demonstrate basic knowledge of functions, including their behavior and characteristics.

a. Predict and explain the characteristics and behavior of functions and their graphs (domain, range, increasing/decreasing intervals, intercepts, symmetry, and end behavior). (DOK 2)
b. Investigate, describe, and determine asymptotic behavior using tables, graphs, and analytical methods. (DOK 2)
c. Determine and justify the continuity and discontinuity of functions. (DOK 2)

3. Evaluate limits and communicate an understanding of the limiting process.

a. Solve mathematical situations and application problems involving or using derivatives, including exponential, logarithmic, and trigonometric functions. (DOK 2)
b. Calculate limits using algebraic methods. (DOK 2)
c. Verify the behavior and direction of non-determinable limits. (DOK 2)

4. Use the definition and formal rules of differentiation to compute derivatives.

a. State and apply the formal definition of a derivative. (DOK 1)
b. Apply differentiation rules to sums, products, quotients, and powers of functions. (DOK 2)
c. Use the chain rule and implicit differentiation. (DOK 2)
d. Describe the relationship between differentiability and continuity. (DOK 2)

5. Apply derivatives to find solutions in a variety of situations.

a. Define a derivative and explain the purpose/utility of the derivative. (DOK 2)
b. Apply the derivative as a rate of change in varied contexts, including velocity, speed, and acceleration. (DOK 2)
c. Apply the derivative to find tangent lines and normal lines to given curves at given points. (DOK 2)
d. Predict and explain the relationships between functions and their derivatives. (DOK 2)
e. Model rates of change to solve related rate problems. (DOK 2)
f. Solve optimization problems. (DOK 2)

6. Employ various integration properties and techniques to evaluate integrals.

a. State and apply the First and Second Fundamental Theorem of Calculus. (DOK 2)
b. Apply the power rule and u-substitution to evaluate indefinite integrals. (DOK 2)

7. Use geometric concepts to gain insights into, answer questions about, and graph various implications of differentiation.

a. Demonstrate and explain the differences between average and instantaneous rates of change. (DOK 2)
b. Apply differentiation techniques to curve sketching. (DOK 2)
c. Apply Rolle's Theorem and the Mean Value Theorem and their geometric consequences. (DOK 2)
d. Identify and apply local linear approximations. (DOK 1)
e. Analyze curves with attention to non-decreasing functions (monotonicity) and concavity. (DOK 2)

8. Adapt integration methods to model situations to problems.

a. Apply integration to solve problems of area. (DOK 2)
b. Utilize integrals to model and find solutions to real-world problems such as calculating displacement and total distance traveled. (DOK 2)

9. Apply appropriate techniques, tools, and formulas to determine values for the definite integral.

a. Interpret the concept of definite integral as a limit of Riemann sums over equal subdivisions. (DOK 3)

ITE1 Compute unit conversions and illustrate graphical interpretations.
ITE2 Apply algebraic equations and functions to engineering situations.
ITE3 Apply geometric principles to engineering situations.
ITE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
ITE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

1. Compute unit conversions and illustrate graphical interpretations.

a. Convert units using a standardized method. (DOK 1)
b. Convert decimal to binary numbers and binary to decimal numbers. (DOK 1)
c. Interpret analytical data for graphical depiction. (DOK 2)
d. Determine the proper outputs from graphical configurations of numeric value. (DOK 2)
e. Determine and convert the values of molarity, weight percent, mass percent, volume percent, and ppm of chemical solutions by hand calculations and Excel spreadsheet calculations. (DOK 1)

2. Apply algebraic equations and functions to engineering situations.

a. Write mass and energy balance equations to solve for some unknown value. (DOK 2)
b. Find voltage, current, resistance, and solve power in series, parallel, and complex electric circuit theory problems using simultaneous equations generated from Ohm's Law, Kirchhoff's Voltage Law, and Kirchhoff's Current Law (i.e., 3 equations and 3 unknowns). (DOK 2)
c. Graph a "Line of Best Fit" from given lab data and determine the degree of linearity (R2 value), slope of the line, and equation of the line. (DOK 2)
d. Determine the BTU requirements and associated utility costs of an engineering operation. (DOK 2)

3. Apply geometric principles to engineering situations.

a. Solve general surveying problems. (DOK 2)
b. Compute dynamic moment calculations using numeric values as well as geometric/spatial positions. (DOK 2)
c. Calculate seepage under a dam and interpret a geological flownet diagram. (DOK 2)
d. Identify the five basic types of internal stresses in structural members. (DOK 1)
e. Select optimal geometric shapes for providing structural support. (DOK 2)
f. Calculate the maximum force a member can withstand before failure. (DOK 2)

4. Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
Note: This is a projects-based course. The teaching strategies to accompany the following three items are an integral part of the course.

a. Design and construct a chemical engineering system to meet specific criteria. (DOK 4)

b. Design and construct an electronic device to meet specific criteria. (DOK 4)
c. Design and construct a mechanical device to meet specific criteria. (DOK 4)

5. Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

a. Evaluate a failed engineering project. (DOK 4)

Appendix G: NCCER Module Alignment

NCCER Modules are listed for each Unit.

Unit 1: NCCER Modules: 00101-09, 00107-09 and 00108-09
Unit 2: NCCER Modules: 00102-09 and 00105-09
Unit 3: NCCER Modules: 00101-09, 00103-09, 00104-09, 00105-09, 00106-09, 29110-09 and 29202-09
Unit 4: NCCER Modules: 29102-09, 29103-09, 29104-09, 29105-09 ,26106-09 and 29110-09
Unit 5: NCCER Modules: 29101-09, 29107-09, 29108-09, 29109-09, 29111-09 and 29112-09
Unit 6: NCCER Modules: 00101-09, 00107-09, 00108-09, and 29101-09
Unit 7: NCCER Modules: 29102-09, 29105-09, 29106-06, and 29110-09
Unit 8: NCCER Modules: 29107-09, 29108-09, and 29109-09
Unit 9: NCCER Modules: 29101-09
Unit 10: NCCER Modules: 29201-09 and 29202-09
Unit 11: NCCER Modules: 29103-09 and 29107-09
Unit 12: NCCER Modules: 29111-09 and 29112-09
Unit 13: NCCER Modules: 2 9205-09 and 29206-09
Unit 14: NCCER Modules: 29207-09 and 29208-09