



2025 Welding

Program CIP: 48.0508 – Welding Technology/Welder

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The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances 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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Standards

Standards and alignment crosswalks are referenced in the appendices. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE welding curriculum is aligned to the following standards:

National Center for Construction Education and Research (NCCER) Learning Series – Core, Welding I, and Welding 2 Standards

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.

nccer.org

American Welding Society (AWS) S.E.N.S.E. EG2.0 Guidelines

The American Welding Society (AWS), aws.org, sets industry standards for quality and welding qualifications. Their standards cover a variety of welding processes, materials, and applications. According to the NCCER website, these standards also correlate to the American Welding Society (AWS) S.E.N.S.E. (Schools Excelling through National Skills Education) program standards and guidelines for entry-level welders.

nccer.org/media/2023/03/aws_sense-nccer_welding-alignment.pdf

College- and Career-Readiness Standards

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

mdek12.org/oea/college-and-career-readiness-standards

Framework for 21st Century Learning

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills.

battelleforkids.org/networks/p21/frameworks-resources

Preface

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

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

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning

Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource

Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, contact the RCU at 662.325.2510 or helpdesk@rcu.msstate.edu.

Executive Summary

Pathway Description

Welding is a pathway in the Advanced Manufacturing career cluster. This instructional program prepares students for continued education or employment in welding occupations. The curriculum framework for this program was developed in partnership with Build Mississippi. Build Mississippi is the accredited sponsor for the National Center for Construction Education and Research (NCCER). This program begins with a welding industry introduction. It explores policies for local programs and student organizations such as SkillsUSA. Welding operations safe practices, skills in construction math, hand and power tool usage, and reading construction drawings are developed. The program also surveys employability skills, communication skills, materials handling, oxyfuel cutting, SMAW welding electrodes and welding equipment, and quality of welds.

College, Career, and Certifications

Year 1: NCCER Core Curriculum and Year 2: NCCER Welding Level 1

Grade Level and Class Size Recommendations

It is recommended that students enter this program as freshmen, sophomores, juniors, or seniors. Exceptions to this are a district-level decision based on class size, enrollment numbers, student maturity, and CTE delivery method. This is a hands-on, lab- or shop-based course. Therefore, a maximum of 15 students is recommended per class with only one class with the teacher at a time.

Student Prerequisites

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

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

Assessment

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

Applied Academic Credit

The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure

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

Professional Learning

If you have specific questions about the content of any training sessions provided, please contact the RCU at 662.325.2510 or helpdesk@rcu.msstate.edu.

Course Outlines

Option 1 – Four-1 Carnegie Unit Courses

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

1. **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 – Course Code: 993302

This course focuses on the NCCER Learning Series Core. It addresses work-based learning opportunities, student organizations, and leadership skills. Students will demonstrate basic safety practices within the classroom shop area and within the industrial welding setting. They will apply construction math, use and maintain hand and power tools, read blueprints and interpret welding symbols all the while developing communication and employability skills. Students will follow safe materials handling procedures and perform multiple cutting techniques while operating oxyfuel torch equipment.

Course Description: Shielded Metal Arc Welding (SMAW) – Course Code: 993303

This course introduces students to Shielded Metal Arc Welding (SMAW). Students will understand and demonstrate safe welding practices. They will identify and properly configure equipment such as SMAW cables, connectors, and tools. Critical course topics include exploring the use of SMAW electrodes, studying the classification system, and then selecting and properly handling the electrodes for distinctive tasks. Technical mastery of skills that include preparing the work area, striking an arc, producing a variety of weld bead types, and completing fillet welds in multiple positions. This 1-Carnegie-unit course should only be taken after students have successfully completed “Orientation and Cutting.”

Course Description: Advanced Welding I – Course Code: 993304

This course focuses on specialized welding symbols used in blueprints and drawings. Students will learn about Plasma Arc Cutting (PAC), Air Carbon Arc Cutting (A-CAC), and advanced techniques used in SMAW. It explores welding safety when preparing base metals, joint fit-up and alignment, weld quality, cutting processes, and SMAW groove welds with backing. Students prepare and fit up joints, interpret welding symbols concerning welding drawings, and perform non-destructive and destructive weld testing practices. This 1-Carnegie-unit course should only be taken after students have successfully completed “Shielded Metal Arc Welding (SMAW).”

Course Description: Advanced Welding II – Course Code: 993306

This course focuses on a variety of SMAW open-root groove welds, Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW). Students will demonstrate safe equipment handling as well as setup and cleanup procedures as they enhance their welding techniques. They will incorporate filler metals, multiple pass GTAW fillet and groove welds executed on carbon steel coupons in multiple positions. This course trains

students regarding welding processes producing quality bead and fillet welds, and V-groove welds on alloys and carbon steel. This 1-Carnegie-unit course should only be taken after students successfully complete “Advanced Welding I.”

Orientation and Cutting – Course Code: 993302

Unit	Unit Title	Hours
1	Build Your Future in Construction	15
2	Basic Safety	15
3	Introduction to Construction Math	12
4	Hand Tools	8
5	Power Tools	8
6	Introduction to Construction Drawings	8
7	Communication Skills	8
8	Employability Skills	8
9	Introduction to Materials Handling	15
10	Oxyfuel Cutting	43
Total		140

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

Unit	Unit Title	Hours
11	SMAW - Equipment and Setup	15
12	SMAW - Electrodes	15
13	SMAW - Beads and Fillet Welds	110
Total		140

Advanced Welding I – Course Code: 993304

Unit	Unit Title	Hours
14	Orientation and Welding Safety Review	10
15	Base Metal Preparation	15
16	Joint Fit-up and Alignment	8
17	Weld Quality	15
18	Plasma Arc Cutting	10
19	Air-Carbon Arc Cutting and Gouging	10
20	SMAW - Groove Welds with Backing	72
Total		140

Advanced Welding II – Course Code: 993306

Unit	Unit Title	Hours
21	SMAW - Open Root Groove Welds-Plate	60
22	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	40
23	Gas Tungsten Arc Welding (GTAW)	40
Total		140

Option 2 – Two-2-Carnegie Unit Courses

This curriculum consists of two 2-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 – Course Code: 993300

This course focuses on the NCCER Learning Series Core. It addresses work-based learning opportunities, student organizations, and leadership skills. Students will demonstrate basic safety practices within the classroom shop area and within the industrial welding setting. They will apply construction math, use and maintain hand and power tools, read blueprints, and interpret welding symbols, all the while developing communication and employability skills. Students will follow safe materials handling procedures and perform multiple cutting techniques while operating oxyfuel torch equipment. This course also introduces students to Shielded Metal Arc Welding (SMAW). Students will understand and demonstrate safe welding practices. They will identify and properly configure equipment such as SMAW cables, connectors, and tools. Critical course topics include exploring the use of SMAW electrodes, studying the classification system, and then selecting and properly handling the electrodes for distinctive tasks. Technical mastery of skills is developed such as preparing the work area, striking an arc, producing a variety of weld bead types, and completing fillet welds in multiple positions.

Course Description: Advanced Welding – Course Code: 993301

This course focuses on specialized welding symbols used in blueprints and drawings. Students will learn about Plasma Arc Cutting (PAC), Air Carbon Arc Cutting (A-CAC), and advanced techniques used in SMAW. It explores welding safety when preparing base metals, joint fit-up and alignment, weld quality, cutting processes, and SMAW groove welds with backing. Students prepare and fit up joints, interpret welding symbols concerning welding drawings, and perform non-destructive and destructive weld testing practices. This course also focuses on a variety of SMAW open-root groove welds, Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW). Students will demonstrate safe equipment handling as well as setup and cleanup procedures as they enhance their welding techniques. They will incorporate filler metals, multiple pass GTAW fillet, and groove welds executed on carbon steel coupons in multiple positions. This course trains students regarding welding processes producing quality bead and fillet welds, and V-groove welds on alloys and carbon steel. This 2-Carnegie-unit course should only be taken after students successfully complete “Introduction to Welding.”

Introduction to Welding – Course Code: 993300

Unit	Unit Title	Hours
1	Build Your Future in Construction	15
2	Basic Safety	15
3	Introduction to Construction Math	12
4	Hand Tools	8
5	Power Tools	8

6	Introduction to Construction Drawings	8
7	Communication Skills	8
8	Employability Skills	8
9	Introduction to Materials Handling	15
10	Oxyfuel Cutting	43
11	SMAW - Equipment and Setup	15
12	SMAW - Electrodes	15
13	SMAW - Beads and Fillet Welds	110
Total		280

Advanced Welding – Course Code: 993301

Unit	Unit Name	Hours
14	Orientation and Welding Safety Review	10
15	Base Metal Preparation	15
16	Joint Fit-up and Alignment	8
17	Weld Quality	15
18	Plasma Arc Cutting	10
19	Air-Carbon Arc Cutting and Gouging	10
20	SMAW - Groove Welds with Backing	72
21	SMAW - Open Root Groove Welds-Plate	60
22	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	40
23	Gas Tungsten Arc Welding (GTAW)	40
Total		280

Career Pathway Outlook

Overview

The Welding program prepares students for entry-level welding and fabrication employment. Students enrolled in this course will develop employability skills and understand the importance of occupational safety. They will hone their skills in basic math as they read blueprints, interpret welding symbols, operate hand and power tools, and examine weld quality. They will prepare proper mechanical and thermal joints of varying base metals and explain joint fit-up techniques when controlling weldment distortion. Students will study oxyfuel cutting operations, basic and advanced shielded metal arc welding (SMAW), semi-automatic arc welding involving gas metal arc welding (GMAW) and flux cored arc welding (FCAW), gas tungsten arc welding (GTAW), air-carbon arc cutting principles and practices (A-CAC), and plasma arc cutting (PAC). Students will also demonstrate multiple positions of groove and open-root groove welds. Emphasis is given to properly setting up, cleaning, and storing welding equipment when the work begins and ends each day. Detail oriented welders need to maintain steady hand-eye coordination, exhibit strength and stamina, and maintain a safe work environment awareness. A welding professional's work environment may include either indoor industrial manufacturing facilities, or they may work in all types of weather outdoors at construction sites, bridges, roads, railways, pipelines, and oil rigs. At times, they may work in a confined area designed to contain sparks and glare. They may work on a scaffold or platform high off the ground. A welder could choose underwater work environments, including lakes, rivers, offshore, or even deep sea. They could maintain, construct, or repair equipment on military bases or even cruise or passenger ships at shipyards.

Most careers related to welders, cutters, solderers, and brazers require at least a high school diploma, and some states and localities may require a license, although careers with the highest earning potential—welding inspector, welding engineer, welding research scientist, and postsecondary teachers, for example—require advanced degrees. Students can utilize their acquired welding-related skills and knowledge within educational pathways related to engineering, technology, vocational education, business management, agriculture, and military applications. They can accomplish this by attending some of the two-year and four-year welding-related postsecondary degree programs available within Mississippi and across the nation.

Needs of the Future Workforce

In relation to welding, construction laborers are on the list of the top twenty-fastest growing occupations nationally, and this career is projected to grow 4% through 2032, according to the U.S. Bureau of Labor and Statistics. The nation's aging infrastructure will require their expertise to help rebuild bridges, highways, and buildings. In 2022, welders, cutters, solderers, and brazers held about 431,800 jobs nationally. A categorized employment list for these professionals includes manufacturing, 65%, specialty trade contractors, 7%, repair and maintenance, 4%, and self-employed workers, 4%. Through 2032, 42,600 new openings for these careers are expected each year. These occupations in the Gulfport-Biloxi-Pascagoula, MS area have a higher share of employment than the national average, which accounts for nearly 15 out of every 1,000 jobs overall. The patterns of job growth shown in Table 1.1 relate to a range of welding occupations.

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2020	Projected Jobs, 2030	Change (Number)	Change (Percent)	Average Hourly Earnings, 2024
Agricultural Equipment Operators	440	500	60	13.6%	\$14.62
Aircraft Mechanics and Service Technicians	1,130	1,180	50	4.4%	\$32.97
Bicycle Repairers	30	40	10	33.3%	\$13.89
Boilermakers	190	190	0	0%	\$30.14
Construction Laborers	12,210	12,530	320	2.6%	\$17.72
Control and Valve Installers and Repairers, Except Mechanical Door	480	500	20	4.2%	\$27.61
Electric Motor, Power Tool, and Related Repairers	220	220	0	0%	\$22.03
Electricians	5,780	6,280	500	8.7%	\$27.39
Excavating and Loading Machine and Dragline Operators, Surface Mining	420	430	10	2.4%	\$21.67
Farm Equipment Mechanics and Service Technicians	670	700	30	4.5%	\$21.34
Farmers, Ranchers, and Other Agricultural Managers	6,580	7,160	580	8.8%	\$25.53
Farming, Fishing, and Forestry Occupations	10,510	11,040	530	5%	\$19.79
Farmworkers and Laborers, Crop, Nursery, and Greenhouse	3,230	3,380	150	4.6%	\$17.30
First-Line Supervisors of Construction Trades and Extraction Workers	6,380	6,620	240	3.8%	\$33.74
First-Line Supervisors of Mechanics, Installers, and Repairers	4,550	4,800	250	5.5%	\$33.16
General and Operations Managers	19,310	20,980	1,670	8.6%	\$48.63
Helpers--Installation, Maintenance, and Repair Workers	710	750	40	5.6%	\$15.69

Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	350	390	40	11.4%	\$16.30
Industrial Machinery Mechanics	5,110	5,450	340	6.7%	\$27.69
Installation, Maintenance, and Repair Workers, All Other	1,140	1,200	60	5.3%	\$26.34
Machinists	2,880	3,040	160	5.6%	\$23.31
Maintenance and Repair Workers, General	13,760	15,160	1,400	10.2%	\$19.52
Millwrights	540	570	30	5.6%	\$25.78
Miscellaneous Assemblers and Fabricators	16,410	17,170	760	4.6%	\$18.81
Mobile Heavy Equipment Mechanics, Except Engines	1,400	1,420	20	1.4%	\$24.49
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	520	530	10	1.9%	\$18.75
Operating Engineers and Other Construction Equipment Operators	3,430	3,590	160	4.7%	\$21.78
Pipelayers	390	410	20	5.1%	\$20.95
Plumbers, Pipefitters, and Steamfitters	3,050	3,300	250	8.2%	\$25.61
Production Occupations	101,130	103,540	2,410	2.4%	\$20.51
Rail Car Repairers	350	380	30	8.6%	\$23.09
Riggers	430	470	40	9.3%	\$29.64
Security and Fire Alarm Systems Installers	360	490	130	36.1%	\$20.20
Service Unit Operators, Oil, Gas, and Mining	140	190	50	35.7%	\$28.98
Sheet Metal Workers	1,510	1,570	60	4%	\$23.02
Structural Iron and Steel Workers	640	650	10	1.6%	\$22.00
Welders, Cutters, Solderers, and Brazers	6,370	6,830	460	7.2%	\$24.61

Source: Mississippi Department of Employment Security; mdes.ms.gov (2024).

Perkins V Requirements and Academic Infusion

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

Transition to Postsecondary Education

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

Best Practices

Innovative Instructional Technologies

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

Differentiated Instruction

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

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the welding curriculum. SkillsUSA is an example of a student organization with several outlets for welding. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to the world of welding careers and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the 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 complete complex tasks. There are many field experiences within the welding curriculum that will allow and encourage collaboration with professionals currently in the welding field.

Work-Based Learning

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

Professional Organizations

American Institute of Steel Construction (AISC)

aisc.org

American Welding Society (AWS)

aws.org

Association for Iron & Steel Technology (AIST)

aist.org

Build Mississippi

buildmississippi.com

Fabricators & Manufacturers Association International (FMA)

fmanet.org

Industrial Fasteners Institute (IFI)

indfast.org

National Center for Construction Education and Research (NCCER)

nccer.org

National Steel Heating, Cooling Contractors of America (NSHCCA)

nshccaonline.com

Society of Manufacturing Engineers (SME)

sme.org

Using This Document

Competencies and Suggested Objectives

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

Teacher Resources

All teachers should request to be added to the Canvas Resource Guide for their course. For questions or to be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material

Some of the units may include an enrichment section at the end. This material will greatly enhance the learning experiences of students. If the welding program is using a national certification, work-based learning, or another measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be assessed on that quality indicator. The teacher is responsible for ensuring all competencies for the selected quality indicator are covered throughout the year.

Unit 1: Build Your Future in Construction

Competencies and Suggested Objectives	
1.	Describe local program and center expectations, policies, and procedures. ^{DOK1} a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. b. Give a brief overview of the course and the welding industry. c. Explain the Advanced Manufacturing/Welding Pathway, why it is important, and how it will be delivered. d. Compare and contrast local program and school policies to expectations of employers. e. Preview course objectives, program policy, and the industry standards.
2.	Investigate work-based learning opportunities related to program areas. ^{DOK1} a. Define work-based learning. b. Identify ways to pursue a career in the welding industry. c. Explore the opportunities available through the program areas, including: • Job shadowing • Apprenticeship programs • On-the-job training
3.	Discuss the history, mission, and purpose of student organizations, including SkillsUSA. ^{DOK1} a. Trace the history of the program area student organization. b. Identify the mission, purpose, and/or goals of the program area student organization.
4.	Explore the advantages of membership in a student organization. ^{DOK1} a. Discuss the membership process for the program area student organization. b. Explain the activities related to the local chapter and the state and national organization.
5.	Discuss the organization's brand resources. ^{DOK2} a. Identify the motto, creed, and/or pledge and discuss their meanings. b. Recognize related brand resources such as: • Emblem • Colors • Official Attire • Logos • Graphic Standards
6.	Apply leadership skills to class and work-related situations and 21st Century Skills. ^{DOK2} a. Define leadership. b. Discuss the attributes of a leader. c. Identify the roles a leader can assume.
7.	Utilize teambuilding skills in class and work-related situations. ^{DOK2} a. Define teambuilding. b. Discuss the attributes of a team. c. Identify the roles included in a team.
8.	Discuss the various competitions offered through the program area student organization. ^{DOK2}

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| <ul style="list-style-type: none">a. Describe each of the competitions and the skills needed to accomplish the tasks.b. Perform the tasks needed to complete an assigned requirement for a competition. |
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Unit 2: Basic Safety

Competencies and Suggested Objectives	
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to welding and the manufacturing industry. ^{DOK2}	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 Occupational Safety and Health Administration (OSHA) standards. d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain causes of accidents and the impact of accident costs. g. Compare and contrast shop/lab safety rules to industry safety rules.
2. Identify and apply safety around welding operations. ^{DOK2}	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. ^{DOK2}	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). ^{DOK2}	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. ^{DOK2}	a. Explain the use of proper fall protection. b. Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the safety data sheet (SDS). ^{DOK2}	a. Explain the function of the SDS. b. Interpret the requirements of the SDS. c. Discuss hazardous material exposures.
7. Display appropriate safety procedures related to fires. ^{DOK2}	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. ^{DOK2}	a. Explain injuries that can result when electrical contact occurs. b. Explain safety around electrical hazards. c. Explain actions to take when an electrical shock occurs.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student’s file.

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

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. ^{DOK3} a. Define basic angles and geometric shapes used in the manufacturing industry. • Explain angle types. • Explain geometric shapes and give an overview of their characteristics. • Discuss area and volume. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions and convert fractions to whole numbers. d. Convert decimals to percentages and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 4: Hand Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of hand tools. ^{DOK2} a. Identify, visually inspect, and discuss the safe use of common hand tools used on job sites. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance.
2. Explore measurement and layout tools. ^{DOK2}

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

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 5: Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of power tools. ^{DOK2} a. Identify, visually inspect, and discuss the safe use of common power tools including electric, pneumatic, and hydraulic. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance.
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 6: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand basic components of a blueprint. ^{DOK3} a. Recognize and identify terms, components, and symbols commonly used on blueprints. b. Relate information on drawings to actual locations on the print. c. Recognize different types of drawings. d. Interpret and use drawing dimensions and scale types.
2. Interpret symbols from a blueprint. ^{DOK3}
3. Examine various detail drawings. ^{DOK3}

Enrichment
1. Interpret welding symbols from a blueprint.
2. Examine a welding detail drawing.
3. Interpret basic elements of a welding detail drawing.
4. Demonstrate how to sketch or draw basic welding drawings.

Note: Enrichment is highly recommended when covering the welding aspect of drawings.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 7: Communication Skills

Competencies and Suggested Objectives	
1. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. ^{DOK2}	
a. Follow basic written and verbal instructions.	
b. Effectively communicate in on-the-job situations using verbal, written, or electronic communication.	
2. Discuss the importance of good listening skills in on-the-job situations. ^{DOK2}	
a. Apply the tips for developing good listening and speaking skills.	

Unit 8: Employability Skills

Competencies and Suggested Objectives	
1. Describe employment opportunities in the welding and construction industry. ^{DOK2}	
a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training.	
b. Discuss the guidelines for developing a proper résumé.	
c. Demonstrate completing job applications.	
2. Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities. ^{DOK2}	
a. Perform various searches through the MDES website such as:	
• Number of jobs available for a specific area of expertise	
• Hourly wage	
• Percent of jobs in the county	
• Percent of jobs in the state	
3. Demonstrate appropriate interview skills. ^{DOK2}	
a. Identify interview skills such as speaking, dress, professionalism, punctuality.	
b. Simulate a job interview.	
4. Describe basic employee responsibilities and appropriate work ethics. ^{DOK2}	
a. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations.	
b. Define effective relationship skills and workplace issues including, but not limited to, sexual harassment, stress, and substance abuse.	
c. Demonstrate critical thinking and effective leadership skills.	

Unit 9: Introduction to Materials Handling

Competencies and Suggested Objectives
1. Safely handle and store materials. ^{DOK2} a. Define a load. b. Establish a pre-task plan prior to moving a load. c. Use proper materials-handling techniques. d. Recognize hazards and follow safety procedures required for materials handling.
2. Choose appropriate materials-handling equipment for the task. ^{DOK2} a. Motorized b. Non-Motorized

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

Unit 10: Oxyfuel Cutting

Competencies and Suggested Objectives
1. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxyfuel cutting. ^{DOK4} - Identify and explain the use of oxyfuel-cutting equipment. - Demonstrate how to use an oxyfuel torch. - Perform and analyze oxyfuel cutting. - Straight line and square shapes - Piercing and slot cutting - Bevels - Washing - Gouging
2. Demonstrate the assembly and disassembly of oxyfuel equipment and associated consumables. ^{DOK4} - Set up and operate a manual handheld oxyfuel torch. - Set up and operate a motorized, portable oxyfuel gas cutting machine.

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

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 11: Shielded Metal Arc Welding (SMAW) - Equipment and Setup

Competencies and Suggested Objectives	
1.	Demonstrate shielded metal arc welding (SMAW)-related safety practices and recognize how electrical characteristics apply to SMAW. ^{DOK3}
2.	Identify and describe SMAW equipment to include welding cable, connectors, and common tools used to clean various welds. ^{DOK2}
3.	Explain and demonstrate how to set up and start SMAW equipment. ^{DOK2}
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	

Unit 12: SMAW - Electrodes

Competencies and Suggested Objectives
1. Explain the SMAW electrode classification system and how to select the proper electrode for the task. ^{DOK2} a. Recognize the American Welding Society (AWS) filler metal specification system and various electrode characteristics. b. Describe the characteristics of the four main electrode groups.
2. Explain how to select electrodes and describe their proper care and handling. ^{DOK2} a. Select the proper electrodes for any given welding task. b. Demonstrate the proper handling and storage of electrodes.

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 13: SMAW - Beads and Fillet Welds

Competencies and Suggested Objectives
1. Demonstrate and explain how to prepare for SMAW welding and how to strike an arc. ^{DOK3} a. Identify and describe safety practices related to SMAW. b. Arrange the area and equipment for welding. c. Master the skill of striking an arc. d. Investigate and draw conclusions on how to respond to arc blow.
2. Demonstrate and explain how to successfully complete various types of beads and fillet welds. ^{DOK3} a. Master the skill of properly restarting and terminating a weld pass. b. Develop the proper techniques required to produce stringer and weave beads. c. Develop the proper techniques required to produce fillet welds in various positions.
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 14: Orientation and Welding Safety Review

Competencies and Suggested Scenarios	
1. Describe local program and career and technical center policies and procedures. ^{DOK1}	a. Describe local program and career and technical center policies and procedures.
2. Describe employment opportunities and responsibilities of the welder. ^{DOK2}	a. Describe employer expectations in the workplace.
3. Explore leadership skills and personal development opportunities. ^{DOK2}	a. Demonstrate team building and leadership skills. b. Demonstrate appropriate work ethics through practice.
4. Describe general safety rules for working in a welding shop/lab and an industrial setting. ^{DOK1}	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.
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	

Unit 15: Base Metal Preparation

Competencies and Suggested Objectives	
1. Identify safe practices related to preparation of various types of base metals.	DOK1
2. Identify and describe basic weld joint design and types of welds.	DOK2
a. Identify and describe the loads that are routinely placed on weld joints.	
b. Describe a welding procedure specification (WPS) and the information it provides.	
3. Prepare joints for welding.	DOK3
a. Mechanically prepare joints for welding.	
b. Thermally prepare joints for welding.	
c. Demonstrate basic properties of and cleaning procedures for types of carbon and stainless steel.	
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.	

Unit 16: Joint Fit-up and Alignment

Competencies and Suggested Objectives	
1. Identify fit-up gauges and measuring devices to check joint fit-up. ^{DOK2}	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.
2. Demonstrate the use of fit-up gauges and measuring devices to check joint fit-up. ^{DOK2}	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.
3. Discuss the various fit-up tools. ^{DOK2}	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.
4. Demonstrate the proper way to fit-up joints using the various fit-up tools. ^{DOK2}	a. Explain techniques to control weldment distortion and thermal expansion. b. Explain the reasoning for various codes and specifications.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.	

Unit 17: Weld Quality

Competencies and Suggested Objectives
1. Explore regulations and job code specifications for welding, base metal cleaning, joint designs, and their purpose. ^{DOK2} a. Discuss code agencies and the major 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.

Enrichment
1. Interpret welding symbols from a blueprint. 2. Examine a welding detail drawing. 3. Interpret basic elements of a welding detail drawing. 4. Demonstrate how to sketch or draw basic welding drawings.

Note: Enrichment is highly recommended when covering the welding aspect of drawings.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 18: Plasma Arc Cutting (PAC)

Competencies and Suggested Objectives	
1. Explain the plasma arc cutting (PAC) process. ^{DOK2}	
a. Discuss safety procedures and protective devices used in PAC.	
b. Discuss transferred and non-transferred arc processes.	
2. Identify PAC equipment and accessories. ^{DOK2}	
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. ^{DOK3}	
4. Properly store equipment and clean the work area after use. ^{DOK3}	
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	

Unit 19: Air-Carbon Arc Cutting (A-CAC) and Gouging

Competencies and Suggested Objectives	
1. Explain the air carbon arc cutting (A-CAC) process. ^{DOK2}	
a. Discuss safety procedures and protective devices used in A-CAC.	
b. Demonstrate proper setup of A-CAC equipment for safe operation.	
c. Describe cutting, gouging, washing, and beveling.	
2. Identify the various A-CAC electrodes. ^{DOK2}	
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.	
3. Perform washing and gouging activities using A-CAC equipment. ^{DOK3}	
4. Properly store equipment and clean the work area after use. ^{DOK3}	
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	

Unit 20: SMAW - Groove Welds with Backing

Competencies and Suggested Objectives	
1. Review safety hazards, protective devices used, and basic operation of SMAW equipment. DOK1	
2. Discuss the various groove welds with backing and their aspects and terminology. DOK3	
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 with backing. DOK3	
4. Prepare materials to perform SMAW V-groove welds with backing. DOK3	
5. Perform and analyze SMAW V-groove welds with backing in the 1G, 2G, 3G and 4G positions. DOK3	
6. Properly store equipment and clean the work area after use. DOK3	
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.	

Unit 21: SMAW - Open-Root Groove Welds-Plate

Competencies and Suggested Objectives	
1. Review safety hazards, protective devices used, and basic operation of SMAW equipment. DOK2	
2. Discuss the various open V-groove welds and their aspects and terminology. DOK3	
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	
4. Prepare materials to perform SMAW V-groove welds. DOK3	
5. Setup and perform SMAW V-groove welds in the 1G, 2G, 3G and 4G positions. DOK3	
6. Properly store equipment and clean the work area after use. DOK3	
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.	

Unit 22: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)

Competencies and Suggested Scenarios	
1. Explain the GMAW and FCAW welding processes. ^{DOK3}	a. Explain the characteristics of welding current and power sources. b. Explain the use of GMAW and FCAW shielding gases, filler metals, and consumables. 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}	a. Discuss spray transfer mode. b. Discuss globular mode. c. Discuss short-circuiting mode. d. Discuss pulse mode.
3. Demonstrate proper and safe setup of GMAW and FCAW equipment. ^{DOK3}	
4. Set up and perform GMAW-S (short-circuit) beads and multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas. ^{DOK3}	
5. Set up 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}	
6. Set up and perform FCAW beads and multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux-cored wire and, if required, shielding gas. ^{DOK3}	
7. Set up 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}	
8. Properly store equipment and clean the work area after use. ^{DOK3}	
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.	

Unit 23: Gas Tungsten Arc Welding (GTAW)

Competencies and Suggested Scenarios	
1. Explain the GTAW welding process including safety procedures.	DOK3
2. Identify the various parts, functions, and assembly of GTAW equipment.	DOK3
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
a. Discuss carbon steel and low-alloy steel.	
b. Discuss stainless steel, aluminum, and aluminum alloy.	
4. Demonstrate the proper setup of GTAW equipment.	DOK3
5. Setup and perform multiple-pass GTAW fillet and groove welds on carbon steel plate coupons in various positions using carbon steel filler metal.	DOK3
6. Properly store equipment and clean the work area after use.	DOK3
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.	
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.	
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.	

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: Build Your Future in Construction		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Investigate work-based learning opportunities related to program areas.
	3.	Discuss the history, mission, and purpose of student organizations, including SkillsUSA.
	4.	Explore the advantages of membership in a student organization.
	5.	Discuss the organization's brand resources.
	6.	Apply leadership skills to class and work-related situations and 21st Century Skills.
	7.	Utilize teambuilding skills in class and work-related situations.
	8.	Discuss the various competitions offered through the program area student organization.
Unit 2: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to welding and the manufacturing industry.
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.
	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection, ladder, stair, and scaffold procedures and requirements.
	6.	Explain the safety data sheet (SDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 3: Introduction to Construction Math		
	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
Unit 4: Hand Tools		
	1.	Demonstrate the use and maintenance of hand tools.
	2.	Explore measurement and layout tools.

Unit 5: Power Tools		
	1.	Demonstrate the use and maintenance of power tools.
Unit 6: Introduction to Construction Drawings		
	1.	Read, analyze, and understand basic components of a blueprint.
	2.	Interpret symbols from a blueprint.
	3.	Examine various detail drawings.
Unit 7: Communication Skills		
	1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	2.	Discuss the importance of good listening skills in on-the-job situations.
Unit 8: Employability Skills		
	1.	Describe employment opportunities in the welding and construction industry.
	2.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	3.	Demonstrate appropriate interview skills.
	4.	Describe basic employee responsibilities and appropriate work ethics.
Unit 9: Introduction to Materials Handling		
	1.	Safely handle and store materials.
	2.	Choose appropriate materials-handling equipment for the task.
Unit 10: Oxyfuel Cutting		
	1.	Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxyfuel cutting.
	2.	Demonstrate the assembly and disassembly of oxyfuel equipment and associated consumables.
Unit 11: Shielded Metal Arc Welding (SMAW) - Equipment and Setup		
	1.	Demonstrate shielded metal arc welding (SMAW)-related safety practices and recognize how electrical characteristics apply to SMAW.
	2.	Identify and describe SMAW equipment to include welding cable, connectors, and common tools used to clean various welds.
	3.	Explain and demonstrate how to set up and start SMAW equipment.
Unit 12: SMAW - Electrodes		
	1.	Explain the SMAW electrode classification system and how to select the proper electrode for the task.
	2.	Explain how to select electrodes and describe their proper care and handling.
Unit 13: SMAW - Beads and Fillet Welds		
	1.	Demonstrate and explain how to prepare for SMAW welding and how to strike an arc.
	2.	Demonstrate and explain how to successfully complete various types of beads and fillet welds.

Unit 14: Orientation and Welding Safety Review		
	1.	Describe local program and career and 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 an industrial setting.
Unit 15: Base Metal Preparation		
	1.	Identify safe practices related to preparation of various types of base metals.
	2.	Identify and describe basic weld joint design and types of welds.
	3.	Prepare joints for welding.
Unit 16: Joint Fit-up and Alignment		
	1.	Identify fit-up gauges and measuring devices to check joint fit-up.
	2.	Demonstrate the use of fit-up gauges and measuring devices to check joint fit-up.
	3.	Discuss the various fit-up tools.
	4.	Demonstrate the proper way to fit-up joints using the various fit-up tools.
Unit 17: Weld Quality		
	1.	Explore regulations and job code specifications for welding, base metal cleaning, joint designs, and their purpose.
Unit 18: Plasma Arc Cutting (PAC)		
	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.
Unit 19: Air-Carbon Arc Cutting (A-CAC) and Gouging		
	1.	Explain the air carbon arc cutting (A-CAC) process.
	2.	Identify the various A-CAC electrodes.
	3.	Perform washing and gouging activities using A-CAC equipment.
	4.	Properly store equipment and clean the work area after use.
Unit 20: SMAW - Groove Welds with Backing		
	1.	Review safety hazards, protective devices used, and basic operation of SMAW equipment.
	2.	Discuss the various groove welds with backing and their aspects and terminology.
	3.	Discuss and demonstrate proper SMAW equipment setup for making V-groove welds with backing.
	4.	Prepare materials to perform SMAW V-groove welds with backing.
	5.	Perform and analyze SMAW V-groove welds with backing in the 1G, 2G, 3G and 4G positions.

	6.	Properly store equipment and clean the work area after use.
Unit 21: SMAW Open Root Groove Welds-Plate		
	1.	Review safety hazards, protective devices used, and basic operation of SMAW equipment.
	2.	Discuss the various open V-groove welds and their aspects and terminology.
	3.	Discuss and demonstrate proper SMAW equipment setup for making V-groove welds.
	4.	Prepare materials to perform SMAW V-groove welds.
	5.	Setup and perform SMAW V-groove welds in the 1G, 2G, 3G and 4G positions.
	6.	Properly store equipment and clean the work area after use.
Unit 22: 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 and safe setup of GMAW and FCAW equipment.
	4.	Set up and perform GMAW-S (short-circuit) beads and multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas.
	5.	Set up 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.	Set up and perform FCAW beads and multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux-cored wire and, if required, shielding gas.
	7.	Set up 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 23: Gas Tungsten Arc Welding (GTAW)		
	1.	Explain the GTAW welding process including safety procedures.
	2.	Identify the various parts, functions, and assembly 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 and groove welds on carbon steel plate coupons in various positions using carbon steel filler metal.
	6.	Properly store equipment and clean the work area after use.

Appendix A: National Center for Construction Education and Research (NCCER) - National Craft Assessment and Certification Program – Core, Welding I, and Welding II Standards

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Standards																								
Core																								
BFC		X							X						X									
BSM			X		X	X			X	X	X	X		X	X	X			X	X	X	X	X	X
ICM				X	X																			
IHT				X																				
IPT					X																			
BLU						X																		
COM								X																
EMP								X																
IMH									X															
Welding – Level 1																								
WSM			X		X	X										X								
OCM			X		X	X				X														
PAC			X		X	X			X										X					
A-CAC			X		X	X													X					
BMP			X		X	X										X								
WQM			X				X									X		X						
SES			X								X													
SEM			X									X												
SBF			X								X			X										
JFA			X													X	X							
SGW			X								X				X	X				X				
SOR			X								X				X	X					X			
Welding – Level 2																								
WWS							X									X								
WDD							X									X								
PPM			X													X								
HTM			X													X								
GFE			X		X	X																X		
GFP			X		X	X																X		
FFP			X		X	X																X		
GTE			X		X	X																	X	
GTP			X		X	X																	X	

National Center for Construction Education and Research (NCCER) - National Craft Assessment and Certification Program – Level Test Specifications

NCCER Core 6th Edition

1. BFC – Build Your Future in Construction (00100)
2. BSM - Basic Safety (00101)
3. ICM - Introduction to Construction Math (00102)
4. IHT - Introduction to Hand Tools (00103)
5. IPT - Introduction to Power Tools (00104)
6. BLU - Introduction to Construction Drawings (00105)
7. COM - Basic Communication Skills (00107)

8. EMP - Basic Employability Skills (00108)
9. IMH - Introduction to Materials Handling (00109)

Welding Level 1 5th Edition

1. WSM - Welding Safety (29101)
2. OCM - Oxyfuel Cutting (29102)
3. PAC - Plasma Arc Cutting (29103)
4. A-CAC - Air Carbon Arc Cutting and Gouging (29104)
5. BMP - Base Metal Preparation (29105)
6. WQM - Weld Quality (29106)
7. SES - SMAW - Equipment and Setup (29107)
8. SEM - SMAW Electrodes (29108)
9. SBF - SMAW - Beads and Fillet Welds (29109)
10. JFA - Joint Fit-Up and Alignment (29110)
11. SGW - SMAW - Groove Welds with Backing (29111)
12. SOR - SMAW - Open Root Groove Welds-Plate (29112)

Welding Level 2 5th Edition

1. WWS - Welding Symbols (29201)
2. WDD - Reading Welding Detail Drawings (29202)
3. PPM - Physical Characteristics and Mechanical Properties of Metals (29203)
4. HTM - Preheating and Post-weld Heat Treatment of Metal (29204)
5. GFE - GMAW AND FCAW: Equipment and Filler Metals (29205)
6. GFP - GMAW Plate (29209)
7. FFP -FCAW Plate (29210)
8. GTE - GTAW: Equipment and Filler Metals (29207)
9. GTP - GTAW - Plate (29208)

Appendix B: American Welding Society (AWS) S.E.N.S.E. EG2.0 Guidelines

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Standards																								
OO		X						X	X						X									
SHW			X		X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DWS							X				X	X	X	X	X	X	X	X	X	X	X	X	X	X
SMA																					X	X		
GMA																							X	
FCA																						X		
GTA																								X
TCP																	X							
MAO											X													
MEO											X													
MPA																			X					
MAC																				X				
WIT																		X	X	X	X	X	X	X

American Welding Society (AWS) S.E.N.S.E. EG2.0 Guidelines

AWS SENSE Guidelines

1. OO Occupational Orientation
2. SHW Safety and Health of Welders
3. DWS Drawing and Welding Symbol Interpretation
4. SMA Shielded Metal Arc Welding
5. GMA Gas Metal Arc Welding
6. FCA Flux Cored Arc Welding
7. GTA Gas Tungsten Arc Welding
8. TCP Thermal Cutting Process
9. MAO Unit 1 Manual Oxyfuel Gas Cutting (OFC)
10. MEO Unit 2 Mechanized Oxyfuel Gas Cutting (OFC)
11. MPA Unit 3 Manual Plasma Arc Cutting—PAC
12. MAC Unit 4 Manual Air Carbon Arc Cutting
13. WIT Welding Inspection and Testing

Appendix C: College and Career Ready Standards – Mathematics (8th Grade, Algebra I, Geometry, and Algebra II)

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Mathematics Standards																								
8th Grade																								
8.NS.1				X							X								X	X				
8.NS.2				X							X								X	X				
8.EE.1				X								X	X	X							X	X	X	X
8.EE.2				X								X	X	X							X	X	X	X
8.EE.3				X								X	X	X							X	X	X	X
8.EE.4				X								X	X	X							X	X	X	X
8.EE.5							X										X							X
8.EE.6							X										X							X
8.EE.7												X	X	X							X	X	X	X
8.EE.8												X	X	X							X	X	X	X
8.F.1																							X	X
8.F.2																							X	X
8.F.3																							X	X
8.F.4																							X	X
8.F.5																							X	X
8.G.1																	X							X
8.G.2																	X							X
8.G.3																	X							X
8.G.4																	X							X
8.G.5																	X							X
8.G.6																	X							X
8.G.7																	X							X
8.G.8																	X							X
8.G.9																							X	X
8.SP.1																							X	X
8.SP.2																							X	X
8.SP.3																							X	X
8.SP.4				X							X								X	X				
Algebra I																								
N-RN.3				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
N-Q.1				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
N-Q.2				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
N-Q.3				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
A-SSE.1				X			X																	
A-SSE.2																								
A-SSE.3																								
A-APR.1																								
A-APR.3																								
A-CED.1				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
A-CED.2				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
A-CED.3				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	
A-CED.4					X		X																	X
A-REI.1																								
A-REI.3																								
A-REI.4																					X	X		
A-REI.5																								
A-REI.6																								
A-REI.10																							X	X
A-REI.11																							X	X
A-REI.12																								
F-IF.1							X																	
F-IF.2							X																	

F-IF.3						X												
F-IF.4						X												
F-IF.5						X												
F-IF.6						X												
F-IF.7						X											X	X
F-IF.8						X												
F-IF.9						X												
F-BF.1																		
F-BF.3																		
F-LE.1																		
F-LE.2				X													X	X
F-LE.5						X		X										
S-ID.1						X		X										
S-ID.2						X		X									X	X
S-ID.3						X		X										
S-ID.5						X		X										
S-ID.6						X		X									X	X
S-ID.7						X		X										
S-ID.8						X		X										
S-ID.9						X		X									X	X
Geometry																		
G-CO.1						X			X	X	X	X	X	X	X	X	X	X
G-CO.2						X			X	X	X	X	X	X	X	X	X	X
G-CO.3						X			X	X	X	X	X	X	X	X	X	X
G-CO.4						X						X						
G-CO.5																		
G-CO.6																		
G-CO.7																		
G-CO.8																		
G-CO.9																		
G-CO.10																		
G-CO.11																		
G-CO.12																		
G-CO.13																		
G-SRT.1						X			X	X	X	X	X	X	X	X	X	X
G-SRT.2						X			X	X	X	X	X	X	X	X	X	X
G-SRT.3						X			X	X	X	X	X	X	X	X	X	X
G-SRT.4						X			X	X	X	X	X	X	X	X	X	X
G-SRT.5						X			X	X	X	X	X	X	X	X	X	X
G-SRT.6						X			X	X	X	X	X	X	X	X	X	X
G-SRT.7						X												
G-SRT.8																		
G-C.1																		
G-C.2																		
G-C.3																		
G-C.5																		
G-GPE.1						X						X						
G-GPE.4						X						X						
G-GPE.5						X						X						
G-GPE.6						X						X						
G-GPE.7																		
G-GMD.1																		
G-GMD.3																		
G-GMD.4																		
G-MG.1						X						X						
G-MG.2																		
G-MG.3						X						X						
Algebra II																		
N-RN.1																		
N-RN.2				X														
N-Q.2				X		X												
N-CN.1																		
N-CN.2																		
N-CN.7																		
A-SSE.2																		

decimal expansion of $\sqrt{2}$, show that $\sqrt{2}$ is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.

EE Expressions and Equations

Work with radicals and integer exponents.

1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.
2. Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.
3. Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3×10^8 and the population of the world as 7×10^9 , and determine that the world population is more than 20 times larger.
4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Understand the connections between proportional relationships, lines, and linear equations.

5. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.
6. Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation $y = mx$ for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b .

Analyze and solve linear equations and pairs of simultaneous linear equations.

7. Solve linear equations in one variable.
 - a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).
 - b. Solve linear equations and inequalities with rational number coefficients, including those whose solutions require expanding expressions using the distributive property and collecting like terms.
8. Analyze and solve pairs of simultaneous linear equations.
 - a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.
 - b. Solve systems of two linear equations in two variables algebraically and

estimate solutions by graphing the equations. Solve simple cases by inspection. For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.

- c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

F Functions

Define, evaluate, and compare functions.

1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.
2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.
3. Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

Use functions to model relationships between quantities.

4. Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

G Geometry

Understand congruence and similarity using physical models, transparencies, or geometry software.

1. Verify experimentally the properties of rotations, reflections, and translations
 - a. Lines are taken to lines, and line segments to line segments of the same length.
 - b. Angles are taken to angles of the same measure.
 - c. Parallel lines are taken to parallel lines.
2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.
3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
5. Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.

Understand and apply the Pythagorean Theorem

6. Explain a proof of the Pythagorean Theorem and its converse.
7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.
8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.

9. Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

SP Statistics and Probability

Investigate patterns of association in bivariate data

1. Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.
2. Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.
3. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.
4. Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

RN The Real Number System

Use properties of rational and irrational numbers

3. Explain why:
 - a. the sum or product of two rational numbers is rational.
 - b. the sum of a rational number and an irrational number is irrational; and
 - c. the product of a nonzero rational number and an irrational number is irrational.

Q Quantities

Reason quantitatively and use units to solve problems.

1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
2. Define appropriate quantities for the purpose of descriptive modeling. [Refer to the Quantities section of the High School Number and Quantity Conceptual Category in the previous pages of this document.]
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Algebra**SSE Seeing Structure in Expressions**

Interpret the structure of expressions

1. Interpret expressions that represent a quantity in terms of its context.
 - a. Interpret parts of an expression, such as terms, factors, and coefficients.
 - b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P .
2. Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$ thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.

Write expressions in equivalent forms to solve problems.

3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
 - a. Factor a quadratic expression to reveal the zeros of the function it defines.
 - b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
 - c. Use the properties of exponents to transform expressions for exponential functions.

APR Arithmetic with Polynomials and Rational Expressions

Perform arithmetic operations on polynomials

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

Understand the relationship between zeros and factors of polynomials

3. Identify zeros of polynomials when suitable factorizations are available and use the zeros to construct a rough graph of the function defined by the polynomial (limit to 1st- and 2nd- degree polynomials).

CED Creating Equations

Create equations that describe numbers or relationships

1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
2. Create equations in two variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. [Note this standard appears in future courses with a slight variation in the standard language.]
3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R .

REI Reasoning with Equations and Inequalities

Understand solving equations as a process of reasoning and explain the reasoning

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

Solve equations and inequalities in one variable

3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
4. Solve quadratic equations in one variable.
 - a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.
 - b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions.

Solve systems of equations

5. Given a system of two equations in two variables, show and explain why the sum of equivalent forms of the equations produces the same solution as the original system.
6. Solve systems of linear equations algebraically, exactly, and graphically while focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
11. Explain why the x -coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, quadratic, absolute value, and exponential functions.

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

Functions

IF Interpreting Functions

Understand the concept of a function and use function notation

1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x . The graph of f is the graph of the equation $y = f(x)$.
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
3. Recognize that sequences are functions whose domain is a subset of the integers.

Interpret functions that arise in applications in terms of the context

4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.
5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.
6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Analyze functions using different representations

7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
 - a. Graph functions (linear and quadratic) and show intercepts, maxima, and minima.
 - b. Graph square root and piecewise-defined functions, including absolute value functions.
8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
 - a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

BF Building Functions

Build a function that models a relationship between two quantities

1. Write a function that describes a relationship between two quantities.
 - a. Determine an explicit expression or steps for calculation from a context.

Build new functions from existing functions

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

LE Linear, Quadratic, and Exponential Models

Construct and compare linear, quadratic, and exponential models and solve problems

1. Distinguish between situations that can be modeled with linear functions and with exponential functions.
 - a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.
 - b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
 - c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

Interpret expressions for functions in terms of the situation they model

5. Interpret the parameters in a linear or exponential function in terms of a context.

Statistics and Probability

ID Interpreting Categorical and Quantitative Data

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

1. Represent and analyze data with plots on the real number line (dot plots, histograms, and box plots).
2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

Summarize, represent, and interpret data on two categorical and quantitative variables

5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
6. Represent data on two quantitative variables on a scatter plot and describe how the variables are related.
 - a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
 - b. Informally assess the fit of a function by plotting and analyzing residuals.
 - c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
8. Compute (using technology) and interpret the correlation coefficient of a linear fit.
9. Distinguish between correlation and causation.

2016 Mississippi College- and Career- Readiness Standards for Mathematics: High School - Geometry

Geometry

CO Congruence

Experiment with transformations in the plane

1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

9. Prove theorems about lines and angles. Theorems include vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.
10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180° ; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

11. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Make geometric constructions

12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.
13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

SRT Similarity, Right Triangles, and Trigonometry

Understand similarity in terms of similarity transformations

1. Verify experimentally the properties of dilations given by a center and a scale factor:
 - a. A dilation takes a line not passing through the center of the dilation to a parallel line and leaves a line passing through the center unchanged.
 - b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
2. Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.
3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems involving similarity

4. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.
5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
7. Explain and use the relationship between the sine and cosine of complementary angles.
8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

C Circles

Understand and apply theorems about circles

1. Prove that all circles are similar.

2. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.
3. Construct the inscribed and circumscribed circles of a triangle and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

GPE Expressing Geometric Properties with Equations

Translate between the geometric description and the equation for a conic section

1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

Use coordinates to prove simple geometric theorems algebraically

4. Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.
5. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).
6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

GMD Geometric Measurement and Dimension

Explain volume formulas and use them to solve problems

1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.
3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

Visualize relationships between two-dimensional and three-dimensional objects

4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

MG Modeling with Geometry

Apply geometric concepts in modeling situations

1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

2016 Mississippi College- and Career- Readiness Standards for Mathematics: High School - Algebra II

Number and Quantity

RN The Real Number System

Extend the properties of exponents to rational exponents

1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define $5^{1/3}$ to be the cube root of 5 because we want $[5^{1/3}]^3 = 5^{(1/3) \cdot 3}$ to hold, so $[5^{1/3}]^3$ must equal 5.
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Q Quantities

Reason quantitatively and use units to solve problems

2. Define appropriate quantities for the purpose of descriptive modeling.

CN The Complex Number System

Perform arithmetic operations with complex numbers

1. Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.
 2. Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
- Use complex numbers in polynomial identities and equations
7. Solve quadratic equations with real coefficients that have complex solutions.

Algebra

SSE Seeing Structure in Expressions

Interpret the structure of expressions

2. Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.

Write expressions in equivalent forms to solve problems

3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
 - a. Use the properties of exponents to transform expressions for exponential functions.
4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1) and use the formula to solve problems. For example, calculate mortgage payments.

APR Arithmetic with Polynomials and Rational Expressions

Understand the relationship between zeros and factors of polynomials

2. Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a , the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.
3. Identify zeros of polynomials when suitable factorizations are available and use the zeros to construct a rough graph of the function defined by the polynomial (limit to 1st- and 2nd- degree polynomials).

Use polynomial identities to solve problems

4. Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.

Rewrite rational expressions

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

CED Creating Equations

Create equations that describe numbers or relationships

1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
2. Create equations in two or more variables to represent relationships between quantities, graph equations on coordinate axes with labels, and scales. [Note this standard appears in previous courses with a slight variation in the standard language.]
3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context.

REI Reasoning with Equations and Inequalities

Understand solving equations as a process of reasoning and explain the reasoning

1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
2. Solve simple rational and radical equations in one variable and give examples showing how extraneous solutions may arise.

Solve equations and inequalities in one variable

4. Solve quadratic equations in one variable.
 - a. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions.

Solve systems of equations

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

7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.

Represent and solve equations and inequalities graphically

11. Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations.

Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

Functions

IF Interpreting Functions

Understand the concept of a function and use function notation

3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. Interpret functions that arise in applications in terms of the context
4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.
6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Analyze functions using different representations

7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
 - a. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
 - b. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
 - a. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth and decay.
9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

BF Building Functions

Build a function that models a relationship between two quantities

1. Write a function that describes a relationship between two quantities.

- a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
 - b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.
2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

Build new functions from existing functions

3. Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
4. Find inverse functions.
 - a. Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.

LE Linear, Quadratic, and Exponential Models

Construct and compare linear, quadratic, and exponential models and solve problems

2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
4. For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a , c , and d are numbers and the base b is 2, 10, or e ; evaluate the logarithm using technology.

Interpret expressions for functions in terms of the situation they model

5. Interpret the parameters in a linear or exponential function in terms of a context.

TF Trigonometric Functions

Extend the domain of trigonometric functions using the unit circle

1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.
2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Geometry

GPE Expressing Geometric Properties with Equations

Translate between the geometric description and the equation for a conic section

2. Derive the equation of a parabola given a focus and directrix.

Statistics and Probability

ID Interpreting Categorical and Quantitative Data

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

4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

Summarize, represent, and interpret data on two categorical and quantitative variables

6. Represent data on two quantitative variables on a scatter plot and describe how the variables are related.
 - a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context.

Emphasize linear, quadratic, and exponential models.

IC Making Inferences and Justifying Conclusions

Understand and evaluate random processes underlying statistical experiments

1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

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

3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
6. Evaluate reports based on data.

CP Conditional Probability and the Rules of Probability

Understand independence and conditional probability and use them to interpret data

1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).
2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities and use this characterization to determine if they are independent.
3. Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the

probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

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

6. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A and interpret the answer in terms of the model.
7. Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.