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Part 158: Mississippi Secondary Curriculum Frameworks in Career and Technical Education,
Manufacturing, Industrial Maintenance



2021 Industrial Maintenance

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

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Standards

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

National Center for Construction Education and Research (NCCER) Learning Series

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nccer.org/index.asp

International Society for Technology in Education Standards (ISTE)

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Permission does not constitute an endorsement by ISTE.
iste.org

College- and Career-Ready Standards

College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College and Career Ready Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/oae/college-and-career-readiness-standards

Framework for 21st Century Learning

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

Preface

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

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

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning

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

Learning Management System: An Online Resource

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

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

Executive Summary

Pathway Description

Industrial maintenance is an instructional program that prepares students for employment or continued education in the occupations of installation, maintenance, and repair work. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the NCCER.

Grade Level and Class Size Recommendations

It is recommended that students enter this program as a 10th grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and student maturity. A maximum of 25 students is recommended for classroom-based courses, while a maximum of 15 students is recommended for lab-based courses.

Student Prerequisites

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

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

Assessment

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

Applied Academic Credit

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

Teacher Licensure

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

Professional Learning

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

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

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

- 1. Fundamentals of Industrial Maintenance—Course Code: 993002**
- 2. Application of Industrial Maintenance—Course Code: 993003**
- 3. Theory of Industrial Maintenance—Course Code: 993012**
- 4. Advanced Skills of Industrial Maintenance—Course Code: 993013**

Course Description: Fundamentals of Industrial Maintenance

This course includes an introduction to the field as well as fundamentals of safety, math, and hand and power tools.

Course Description: Application of Industrial Maintenance

This course provides an introduction to blueprints, materials handling, orientation to the trade, tools of the trade, fasteners and anchors, oxy-fuel cutting, and craft-related mathematics. This course gives students real-world, hands-on practice in these areas.

Course Description: Theory of Industrial Maintenance

This course includes an in-depth study of the industrial maintenance profession, test equipment, gaskets and packing, pumps and pump drivers, types of valves, and machine lubrication. This course also reinforces safety related to the industrial maintenance industry.

Course Description: Advanced Skills of Industrial Maintenance

This course includes an in-depth study of material handling and rigging, mobile and support equipment, electrical theory, conductor terminations and splices, and hydraulic and pneumatic systems.

Fundamentals of Industrial Maintenance—Course Code: 993002

Unit	Title	Hours
1	Orientation	3
2	Employability Skills	7.5
3	Fundamentals of Student Organizations	4.5
4	Communication Skills	7.5
5	Basic Safety	35
6	Introduction to Construction Math	15
7	Hand Tools	22.5
8	Power Tools	22.5
Total		117.5

Application of Industrial Maintenance—Course Code: 993003

Unit	Title	Hours
9	Introduction to Construction Drawings	15
10	Introduction to Materials Handling	7.5
11	Tools of the Trade	15
12	Fasteners and Anchors	15
13	Oxy-Fuel Cutting	22.5
14	Basic Electrical (Industrial Maintenance)	15
15	Soldering and Brazing Copper and Plastic Piping	22.5
Total		112.5

Theory of Industrial Maintenance—Course Code: 993012

Unit	Title	Hours
16	Safety Review and Orientation to the Trade	22.5
17	Craft – related Mathematics	15
18	Gaskets and Packing	22.5
19	Pumps and Drivers	15
20	Introduction to Valves	15
21	Lubrication	15
22	Construction Drawings	15
23	Test Equipment	15
Total		135

Advanced Skills of Industrial Maintenance—Course Code: 993013

Unit	Title	Hours
24	Material Handling and Rigging	20
25	Mobile and Support Equipment	15
26	Hydraulic Systems	15
27	Pneumatic Systems	15
28	Electrical Theory and Conductor Terminations and Splices	25
29	SMAW-Groove Welds with Backing	47.5
Total		137.5

Option 2—Two 2-Carnegie Unit Courses

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

1. **Industrial Maintenance I—Course Code: 993001**
2. **Industrial Maintenance II—Course Code: 993011**

Course Description: Industrial Maintenance I

This course introduces students to fundamentals of safety, tools, math, blueprint reading, materials handling, fasteners and anchors, and oxy-fuel cutting.

Course Description: Industrial Maintenance II

This course is a continuation of Industrial Maintenance I, with the emphasis on employability skills, safety, gaskets, packing, pumps, drivers, valves, lubrication, construction drawings, test equipment, material handling and rigging, mobile and support equipment, electrical theory, conductor termination and splices, hydraulic and pneumatic systems, and welding.

Industrial Maintenance I—Course Code: 993001

Unit	Title	Hours
1	Orientation	3
2	Employability Skills	7.5
3	Fundamentals of Student Organizations	4.5
4	Communication Skills	7.5
5	Basic Safety	35
6	Introduction to Construction Math	15
7	Hand Tools	22.5
8	Power Tools	22.5
9	Introduction to Construction Drawings	15
10	Introduction to Materials Handling	7.5
11	Tools of the Trade	15
12	Fasteners and Anchors	15
13	Oxy-Fuel Cutting	22.5
14	Basic Electrical (Industrial Maintenance)	15
15	Soldering and Brazing Copper and Plastic Piping	22.5
Total		230

Industrial Maintenance II—Course Code: 993011

Unit	Title	Hours
16	Safety Review and Orientation to the Trade	22.5
17	Craft – related Mathematics	15
18	Gaskets and Packing	22.5
19	Pumps and Drivers	15
20	Introduction to Valves	15
21	Lubrication	15
22	Construction Drawings	15
23	Test Equipment	15
24	Material Handling and Rigging	20
25	Mobile and Support Equipment	15
26	Hydraulic Systems	15
27	Pneumatic Systems	15
28	Electrical Theory and Conductor Terminations and Splices	25
29	SMAW-Groove Welds with Backing	47.5
Total		272.5

Career Pathway Outlook

Overview

Industrial machinery mechanics and machinery maintenance workers install, maintain, and repair manufacturing equipment and other industrial machineries such as conveying systems, production machinery, and packaging equipment. Millwrights install, dismantle, repair, reassemble, and move machinery in factories, power plants, and construction sites. Workers in this occupation must follow safety precautions and use protective equipment such as hardhats, safety glasses, and hearing protectors. Most work full time in manufacturing facilities; however, they may be on call and work night or weekend shifts. Overtime is common.

Industrial machinery mechanics, machinery maintenance workers, and millwrights typically need a high school diploma. Industrial machinery mechanics and machinery maintenance workers also usually need at least a year of on-the-job training. Most millwrights go through an apprenticeship program that may last up to four years.

Needs of the Future Workforce

In Mississippi, employment of industrial machinery mechanics, machinery maintenance workers, and millwrights is projected to grow faster than average for all occupations. The need to keep increasingly sophisticated machinery functioning and efficient will continue to create demand for these workers. Data for this synopsis were compiled from employment projections prepared by the U.S. Census Bureau, the U.S. Bureau of Labor Statistics (2020), and the Mississippi Department of Employment Security (2020).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2016	Projected Jobs, 2026	Change (Number)	Change (Percent)	Average Hourly Earnings, 2019
Industrial Machinery Mechanics	4,350	4,880	530	12.2	\$23.86
Maintenance Workers, Machinery	1,480	1,660	180	12.2	\$20.99
Millwrights	1,270	1,390	120	9.5	\$20.83
Installation, Maintenance, and Repair Workers—All Other	730	760	30	4.1	\$20.88
Helpers—Installation, Maintenance, and Repair Workers	1,400	1,510	110	7.9	\$15.80

Source: Mississippi Department of Employment Security; mdes.ms.gov (2019).

Perkins V Requirements and Academic Infusion

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

Transition to Postsecondary Education

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

Best Practices

Innovative Instructional Technologies

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

Differentiated Instruction

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

CTE Student Organizations

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

Cooperative Learning

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

Work-Based Learning

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

Professional Organizations

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

SkillsUSA
skillsusa.org

Using This Document

Suggested Time on Task

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

Competencies and Suggested Objectives

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

Teacher Resources

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

Perkins V Quality Indicators and Enrichment Material

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

Unit 1: Orientation

Competencies and Suggested Objectives	
1. Describe local program and center expectations, policies, and procedures. ^{DOK 1}	
a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations.	
b. Give a brief overview of the course. Explain to students what industrial maintenance is, why it is important, and how it will be delivered.	
c. Compare and contrast local program and school policies to the expectations of employers.	
d. Preview course objectives, program policy, and industry standards.	
2. Discuss work-based learning (WBL) opportunities related to program areas. ^{DOK 1}	
a. Define WBL.	
b. Explore the opportunities available through program areas such as WBL, job shadowing, apprenticeship programs, on-the-job training, and so forth.	

Unit 2: Employability Skills

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

Unit 3: Fundamentals of Student Organizations

Competencies and Suggested Objectives	
1. Discuss the history, mission, and purpose of career and technical student organizations (CTSOs) for industrial maintenance, including SkillsUSA. ^{DOK 1}	- Trace the history of the CTSO for industrial maintenance. - Identify the mission, purpose, and/or goals of the CTSO for industrial maintenance.
2. Explore the advantages of membership in a CTSO. ^{DOK 1}	- Discuss the membership process for the CTSO for industrial maintenance. - Explain the activities related to the local chapter and the state and national organizations.
3. Discuss the organization's brand resources. ^{DOK 1}	- Identify the motto, creed, and/or pledge and discuss their meanings. - Recognize related brand resources, such as: - Emblem - Colors - Official attire - Logos - Graphic standards
4. Describe the importance of effective communication skills. ^{DOK 1}	- Demonstrate verbal and nonverbal communication skills. - Apply appropriate speaking and listening skills to class- and work-related situations.
5. Apply leadership skills to class- and work-related situations and 21st century skills. ^{DOK 2}	- Define leadership. - Discuss the attributes of a leader. - Identify the roles a leader can assume.
6. Utilize team-building skills in class- and work-related situations. ^{DOK 2}	- Define team-building. - Discuss the attributes of a team. - Identify the roles included in a team.
7. Discuss various competitions offered through the CTSO for industrial maintenance. ^{DOK1}	- Describe each of the competitions and the skills needed to accomplish the tasks. - Perform the tasks needed to complete an assigned requirement for a competition.

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

Unit 4: Communication Skills

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

Unit 5: Basic Safety

Competencies and Suggested Objectives	
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry. ^{DOK 2}	- Describe how to avoid on-site accidents. - Explain the relationship between housekeeping and safety. - Explain the importance of following all safety rules and company safety policies according to OSHA standards. - Explain the importance of reporting all on-the-job injuries, accidents, and near misses. - Explain the need for evacuation policies and the importance of following them. - Explain the causes of accidents and the impact of accident costs. - Compare and contrast shop/lab safety rules to industry safety rules.
2. Identify and apply safety around welding operations. ^{DOK 1}	- Use proper safety practices when welding or working around welding operations. - Use proper safety practices when welding in or near trenches and excavations. - Explain the term “proximity work.”
3. Display appropriate safety precautions to take around common jobsite hazards. ^{DOK1}	- Explain the safety requirements for working in confined areas. - Explain the different barriers and barricades and how they are used.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). ^{DOK1}	- Identify commonly used PPE. - Understand proper use of PPE. - Demonstrate appropriate care for PPE.
5. Explain fall protection and ladder, stair, and scaffold procedures and requirements. ^{DOK1}	- Explain the use of proper fall protection. - Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the safety data sheet (SDS). ^{DOK1}	- Explain the function of the SDS. - Interpret the requirements of the SDS. - Discuss hazardous material exposures.
7. Display appropriate safety procedures related to fires. ^{DOK 1}	- Explain the process by which fires start. - Explain fire prevention of various flammable liquids. - Explain the classes of fire and the types of extinguishers. - Illustrate the proper steps to follow when using a fire extinguisher. - Demonstrate the proper techniques for putting out a fire.

8. Explain safety in and around electrical situations. ^{DOK 1}
 - a. Explain the injuries that can result when electrical contact occurs.
 - b. Explain safety around electrical hazards.
 - c. Explain actions to take when an electrical shock occurs.

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

Unit 6: Introduction to Construction Math

Competencies and Suggested Objectives
1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. ^{DOK 2} a. Define basic geometric shapes used in the construction industry. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions and convert fractions to whole numbers. d. Convert decimals to percentages and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and a tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 7: Hand Tools

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

Unit 8: Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of power tools. ^{DOK 2} a. Identify, visually inspect, and discuss the safe use of common power tools. b. Discuss safety rules. c. Select and demonstrate the use of power tools. d. Explain the procedures for maintenance.

Unit 9: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand the basic components of a drawing.^{DOK 3} a. Recognize and identify terms, components, and symbols commonly used on drawings. b. Relate information on construction drawings to actual locations on the drawings. c. Recognize different types of drawings. d. Interpret and use drawing dimensions.

Unit 10: Introduction to Materials Handling

Competencies and Suggested Objectives
1. Safely handle and store materials. ^{DOK 1} a. Define a load. b. Establish a pre-task plan prior to moving a load. c. Demonstrate proper materials-handling techniques. d. Choose the appropriate materials-handling equipment for a task. e. Recognize hazards and follow safety procedures required for materials handling. f. Identify and demonstrate commonly used knots.

Unit 11: Tools of the Trade

Competencies and Suggested Objectives
1. Identify and use tools found in the industrial maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools. ^{DOK2} a. Illustrate the use of tools used in the industrial maintenance profession. b. Identify and use common hand and power tools used in the industrial maintenance profession.

Unit 12: Fasteners and Anchors

Competencies and Suggested Objectives
1. Identify various fasteners and anchors found in the industrial maintenance trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application. ^{DOK2} a. Identify and install threaded fasteners, non-threaded fasteners, and anchors. b. Identify various grades of bolt hardness.

Unit 13: Oxy-Fuel Cutting

Competencies and Suggested Objectives
1. Identify and describe the basic equipment, setup, and safety rules for proper use of oxy-fuel equipment. ^{DOK2} a. Identify and explain the use of oxy-fuel equipment. b. Demonstrate how to use an oxy-fuel torch. c. Perform the following types of oxy-fuel cutting. • Straight line and square shapes • Piercing and slot cutting • Bevels • Washing

Unit 14: Basic Electrical (Industrial Maintenance)

Competencies and Suggested Objectives	
1.	Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits. ^{DOK2} - Describe how voltage, current, resistance, and power are mathematically related. - Describe the difference between series and parallel circuits and calculate loads in each. - Describe the purpose and operation of the various electrical components used in equipment.
2.	Explore the various electrical codes and standards such as National Electrical Code (NEC) and Underwriters Laboratories (UL). ^{DOK2}

Unit 15: Soldering, Brazing, and Copper and Plastic Piping

Competencies and Suggested Objectives	
1.	Identify and discuss the tools used in the piping trade, discuss the materials and methods used in connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance environment. ^{DOK2} a. Discuss and demonstrate how to use copper tubing in industrial maintenance. b. Discuss and demonstrate how to use plastic tubing in industrial maintenance.
2.	Prepare and solder copper piping systems in various industrial maintenance applications and properly clean, install fittings, and braze piping (silver solder). ^{DOK2} a. Solder copper pipe in industrial maintenance. b. Braze copper pipe in industrial maintenance.

Unit 16: Safety Review and Orientation to the Trade

Competencies and Suggested Objectives	
1.	Describe local program and career technical center policies and procedures. ^{DOK2} a. Describe local program and career technical center policies and procedures.
2.	Explore leadership skills and personal development opportunities provided for students by student organizations, including SkillsUSA. ^{DOK2} a. Demonstrate effective team-building and leadership skills. b. Practice appropriate work ethics.
3.	Discuss orientation to the trade. ^{DOK2} a. Describe the types of work performed by industrial maintenance craftworkers. b. Identify career opportunities available to industrial maintenance craftworkers. c. Explain the purpose and objectives of an apprentice training program. d. Explain the responsibilities and characteristics of good industrial maintenance craftworkers. e. Explain the importance of safety in relation to industrial maintenance craftworkers. f. Explain the role of NCCER in the training process.
4.	Describe general safety rules for working in a shop/lab and industry. ^{DOK2} a. Discuss safety issues and prevention associated with the industrial maintenance shop area. b. Explain fire safety and prevention in the workplace.

Unit 17: Craft-Related Mathematics

Competencies and Suggested Objectives
1. Identify and explain measuring devices, solve geometric mathematical problems, and use weight and measurement standards. ^{DOK2} a. Discuss mathematics used in the industrial maintenance industry.

Unit 18: Gaskets and Packing

Competencies and Suggested Objectives
1. Identify different types of gaskets and packing materials, list their applications, and install gaskets and packing. ^{DOK2} a. Identify the various types and materials of gaskets. b. Describe the use of O-rings in the industrial maintenance trade. c. Describe the uses and methods of packing in the industrial maintenance trade.

Unit 19: Pumps and Drivers

Competencies and Suggested Objectives
1. Identify types of pumps and prime movers and explain pressure differential between the inlet and outlet of pumps. ^{DOK2} a. Identify and explain centrifugal, rotary, reciprocating, metering, and vacuum pumps. b. Explain net positive suction head and cavitation. c. Identify types of drivers.

Unit 20: Introduction to Valves

Competencies and Suggested Objectives
1. Identify types of valves and explain how to store and properly install valves.^{DOK2} a. Identify types of valves that start, stop, regulate, relieve pressure, and regulate direction of flow. b. Explain how to properly store, handle, and mount valves in various locations and positions.

Unit 21: Lubrication

Competencies and Suggested Objectives
1. Describe and explain lubricant classification, additives, uses, and environmental regulations regarding the disposal of oils and greases. ^{DOK2} a. Explain regulatory laws regarding industrial lubricants. b. Explain how lubricants protect mechanical machinery. c. Explain the properties and handling of lubricants and grease.

Unit 22: Construction Drawings

Competencies and Suggested Objectives
1. Identify components of blueprints and scales and perform projects from blueprints. ^{DOK2} a. Read and draw a basic blueprint found in industrial maintenance.

Unit 23: Test Equipment

Competencies and Suggested Objectives
1. Identify and explain the use of various test equipment used in the trade, differentiate between analog and digital meter readouts, and properly test circuits and mechanisms using available school metering devices.^{DOK2} a. Explain the operation of the following pieces of test equipment: • Tachometer • Pyrometers • Multimeters • Automated diagnostics tools • Wiggy voltage tester • Stroboscope • Frequency meter b. Explain how to read and convert from one scale to another using the test equipment above.

- Tachometer
- Pyrometers
- Multimeters
- Automated diagnostics tools
- Wiggy voltage tester
- Stroboscope
- Frequency meter

b. Explain how to read and convert from one scale to another using the test equipment above.

Unit 24: Material Handling and Rigging

Competencies and Suggested Objectives
1. Identify and explain safe rigging practices, load distribution, hand signals, and rigging equipment. ^{DOK2} a. Identify, describe the uses of, inspect, and maintain common rigging hardware and equipment, including the following: • Jacks • Block and tackle • Chain hoists • Come-alongs b. Tie knots used in rigging. c. Identify basic rigging and crane safety procedures and use the correct hand signals to guide a crane operator.

Unit 25: Mobile and Support Equipment

Competencies and Suggested Objectives
1. Recognize types of mobile and support equipment found in the trade, explain the application for each device, and demonstrate the safe use of the equipment. ^{DOK2} a. State and explain the safety precautions, operation, and application associated with the use of motor-driven equipment commonly used in industrial plants, including the following: • Portable generators • Air compressors • Aerial lifts • Forklifts • Mobile cranes b. Operate and perform preventive maintenance on the following equipment: • Portable generators • Air compressors • Aerial lifts

Unit 26: Hydraulic Systems

Competencies and Suggested Objectives
1. Explain the principles of hydraulic systems. ^{DOK2} a. Discuss safety procedures as applied to hydraulic systems. b. Explore the principles of industrial hydraulics.

Unit 27: Pneumatic Systems

Competencies and Suggested Objectives
1. Explain the principles of pneumatic systems. ^{DOK2} a. Discuss safety procedures as applied to pneumatic systems. b. Discuss the principles of industrial pneumatics.

Unit 28: Electrical Theory and Conductor Terminations and Splices

Competencies and Suggested Objectives	
1.	Describe the units of measurement of electricity and the types of circuits, define Ohm's and Kirchhoff's laws, and troubleshoot a simple circuit. ^{DOK2} a. Discuss the properties and physical laws of electricity. b. Identify the meters used to measure voltage, current, and resistance. c. Discuss the properties of a series and a parallel circuit. d. Discuss the properties of alternating currents. e. Discuss basic conduit-bending procedures.
2.	Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices. ^{DOK2} a. Describe how to make a conductor termination. b. Prepare cable ends for terminations and splices and connect the ends using lugs or connectors. c. Train cable at termination points. d. Describe the NEC requirements for making cable terminations and splices.

Unit 29: SMAW – Groove Welds with Backing

Competencies and Suggested Objectives
1. Perform basic Shielded Metal Arc Welding (SMAW) welding operations. ^{DOK2} a. Practice safety procedures for SMAW welding operations. b. Prepare base metal for SMAW welding. c. Demonstrate basic elements and techniques used in SMAW welding. d. Fabricate a welding project to specifications.

Student Competency Profile

Student's Name: _____

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

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

Unit 1: Orientation		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Discuss work-based learning (WBL) opportunities related to program areas.
Unit 2: Employability Skills		
	1.	Describe employment opportunities in the construction industry.
	2.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	3.	Demonstrate appropriate interviewing skills.
	4.	Describe basic employee responsibilities and appropriate work ethics.
Unit 3: Fundamentals of Student Organizations		
	1.	Discuss the history, mission, and purpose of career and technical student organizations (CTSOs), including SkillsUSA.
	2.	Explore the advantages of membership in a CTSO.
	3.	Discuss the organization's brand resources.
	4.	Describe the importance of effective communication skills.
	5.	Apply leadership skills to class- and work-related situations and 21st century skills.
	6.	Utilize team-building skills in class- and work-related situations.
	7.	Discuss the various competitions offered through the program area's CTSO.
Unit 4: Communication Skills		
	1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	2.	Discuss the importance of good listening skills in on-the-job situations.

Unit 5: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry.
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.
	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection and ladder, stair, and scaffold procedures and requirements.
	6.	Explain the safety data sheet (SDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 6: Introduction to Construction Math		
	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
Unit 7: Hand Tools		
	1.	Demonstrate the use and maintenance of hand tools.
Unit 8: Power Tools		
	1.	Demonstrate the use and maintenance of power tools.
Unit 9: Introduction to Construction Drawings		
	1.	Read, analyze, and understand the basic components of a drawing.
Unit 10: Introduction to Materials Handling		
	1.	Safely handle and store materials.
Unit 11: Tools of the Trade		
	1.	Identify and use tools found in the industrial maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools.
Unit 12: Fasteners and Anchors		
	1.	Identify various fasteners and anchors found in the industrial maintenance trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application.
Unit 13: Oxy-Fuel Cutting		
	1.	Identify and describe the basic equipment, setup, and safety rules for proper use of oxy-fuel equipment.
Unit 14: Basic Electrical (Industrial Maintenance)		
	1.	Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits.
	2.	Explore the various electrical codes and standards such as National Electrical Code (NEC) and Underwriters Laboratories (UL).

Unit 15: Soldering, Brazing, and Copper and Plastic Piping		
	1.	Identify and discuss the tools used in the piping trade, discuss the materials and methods used in connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance environment.
	2.	Prepare and solder copper piping systems in various industrial maintenance applications and properly clean, install fittings, and braze piping (silver solder).
Unit 16: Safety Review and Orientation to the Trade		
	1.	Describe local program and career technical center policies and procedures.
	2.	Explore leadership skills and personal development opportunities provided for students by student organizations, including SkillsUSA.
	3.	Discuss orientation to the trade.
	4.	Describe general safety rules for working in a shop/lab and industry.
Unit 17: Craft-Related Mathematics		
	1.	Identify and explain measuring devices, solve geometric mathematical problems, and use weight and measurement standards.
Unit 18: Gaskets and Packing		
	1.	Identify different types of gaskets and packing materials, list their applications, and install gaskets and packing.
Unit 19: Pumps and Drivers		
	1.	Identify types of pumps and prime movers and explain pressure differential between the inlet and outlet of pumps.
Unit 20: Introduction to Valves		
	1.	Identify types of valves and explain how to store and properly install valves.
Unit 21: Lubrication		
	1.	Describe and explain lubricant classification, additives, uses, and environmental regulations regarding the disposal of oils and greases.
Unit 22: Construction Drawing		
	1.	Identify components of blueprints and scales and perform projects from blueprints.
Unit 23: Test Equipment		
	1.	Identify and explain the use of various test equipment used in the trade, differentiate between analog and digital meter readouts, and properly test circuits and mechanisms using available school metering devices.
Unit 24: Material Handling and Rigging		
	1.	Identify and explain safe rigging practices, load distribution, hand signals, and rigging equipment.

Unit 25: Mobile and Support Equipment		
	1.	Recognize types of mobile and support equipment found in the trade, explain the application for each device, and demonstrate the safe use of the equipment.
Unit 26: Hydraulic Systems		
	1.	Explain the principles of hydraulic systems.
Unit 27: Pneumatic Systems		
	1.	Explain the principles of pneumatic systems.
Unit 28: Electrical Theory and Conductor Terminations and Splices		
	1.	Describe the units of measurement of electricity and the types of circuits, define Ohm's and Kirchhoff's laws, and troubleshoot a simple circuit.
	2.	Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices.
Unit 29: SMAW Groove Welds with Backing		
	1.	Perform basic Shielded Metal Arc Welding (SMAW) welding operations.

Appendix A: Industry Standards

INDUSTRIAL SERVICES PATHWAY

CONTENT STANDARDS AND PERFORMANCE ELEMENTS¹

Crosswalk for Industrial Maintenance (Units 1-10)											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
BSM						X					
ICM							X				
IHT								X			
IPT									X		
BLU										X	
COM					X						
EMP		X									
IMH											X
OTT											
TOT											
GAP											
FAA											
OXY											
CRM											
CDI											
PAD											
ITV											
ITE											
MHR											
MSE											
LUB											
IME & INSTRUMENTATION TECHNICIAN LEVEL 2											
NEC											
ETO											
CON											
HDC											
PNC											
Welding Level 1											
WES											
BMP											
GWB – SMAW											
HVAC LEVEL 1											
CPP											
SAB											

	Units	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19
BSM							X			
ICM										
IHT										
IPT										
BLU										
COM										
EMP										
IMH										
OTT							X			
TOT		X								

¹ NCCER learning series. Retrieved April 22, 2013, from <http://www.nccer.org/>

GAP									X	
FAA			X							
OXY				X						
CRM								X		
CDI										
PAD										X
ITV										
ITE										
MHR										
MHR										
MSE										
LUB										
IME & INSTRUMENTATION TECHNICIAN LEVEL 2										
NEC					X					
ETO					X					
CON										
HDC									X	
PNC									X	
Welding Level 1										
WES			X							
BMP			X							
GWB – SMAW										
HVAC LEVEL 1										
CPP						X				
SAB						X				

	Units	Unit 20	Unit 21	Unit 22	Unit 23	Unit 24	Unit 25	Unit 26	Unit 27	Unit 28	Unit 29
BSM											
ICM											
IHT											
IPT											
BLU											
COM											
EMP											
IMH											
OTT											
TOT											
GAP											
FAA											
OXY											
CRM											
CDI				X							
PAD											
ITV		X									
ITE					X						
MHR						X					
MSE							X				
LUB			X								
IME & INSTRUMENTATION TECHNICIAN LEVEL 2											
NEC										X	
ETO										X	
CON										X	
HDC								X			
PNC									X		
Welding Level 1											
WES											X
BMP											X
GWB – SMAW											X
HVAC LEVEL 1											
CPP											
SAB											

NCCER Core

BSM – BASIC SAFETY (00101-09)

ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-09)

IHT – INTRODUCTION TO HAND TOOLS (00103-09)

IPT – INTRODUCTION TO POWER TOOLS (00104-09)

BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-09)

COM – BASIC COMMUNICATION SKILLS (00107-09)

EMP – BASIC EMPLOYABILITY SKILLS (00108-09)

IMH – INTRODUCTION TO MATERIALS HANDLING (00109-09)

IM E&I Technician Level 1

OTT – ORIENTATION TO THE TRADE

TOT – TOOLS OF THE TRADE

GAP – GASKETS AND PACKING

FAA – FASTNERS AND ANCHORS

OXY – OXYFUEL CUTTING

CRM – CRAFT-RELATED MATHEMATICS

CDI – CONSTRUCTION DRAWINGS

PAD – PUMPS AND DRIVERS

ITV – INTRODUCTION TO VALVES

ITE – INTRODUCTION TO TEST EQUIPMENT

MHR – MATERIAL HANDLING AND HAND RIGGING

MSE – MOBILE AND SUPPORT EQUIPMENT

LUB – LUBRICATION

Industrial Maintenance E&I Technician Level 2

NEC – Introduction to the National Electrical Code

ETO – Electrical Theory

CON – Conductor Terminations and Splices

Industrial Maintenance E&I Technician Level 3

HDC – Hydraulic Controls

PNC – Pneumatic Controls

Welding Level 1

WES – Welding Safety

BMP – Base Metal Preparation

GWB – SMAW – Groove Welds with Backing

HVAC – LEVEL 1

CPP – COPPER AND PLASTIC PIPING

SAB – SOLDERING AND BRAZING