



## 2024 Instrumentation

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

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# Standards

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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 Instrumentation curriculum is aligned to the following standards:

## **NCCER Learning Series Instrumentation Standards**

The NCCER Learning Series is the set of industry standards that should be taught nationwide by contractors, associations, and secondary and postsecondary schools. To develop the NCCER Learning Series, the organization assembled a team of subject-matter experts representing construction companies and schools nationwide. Each committee met several times, combining experts' knowledge and experience to finalize the benchmarks and requirements included in the standards.

[nccer.org/craft-catalog/instrumentation](http://nccer.org/craft-catalog/instrumentation)

As a part of the certification process, all Mississippi Instrumentation pathway instructors will be required to complete the Instructor Certification Training Program successfully. Doing so ensures instructors possess the necessary comprehensive knowledge and understanding of the standards.

## **International Society for Technology in Education Standards (ISTE)**

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[iste.org](http://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 required 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 so teachers and parents know what they need to do to help them.

[mdek12.org/oae/college-and-career-readiness-standards](http://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, technology skills; and life and career skills. *21 Framework Definitions* (2019).

[battelleforkids.org/networks/p21/frameworks-resources](http://battelleforkids.org/networks/p21/frameworks-resources)

## Preface

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Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly 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

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The following are resources for Mississippi teachers:

Curriculum, Assessment, and Professional Learning

Program resources can be found at the RCU's website, [rcu.msstate.edu](http://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](mailto:helpdesk@rcu.msstate.edu).

# Executive Summary

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## **Pathway Description**

The Instrumentation pathway provides a foundation of knowledge to prepare students for employment or continued education in several occupations related to the instrumentation industry. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the National Center for Construction Education and Research (NCCER).

When developing this curriculum, the authors recognized the importance of incorporating differentiated instruction and the needs of 21<sup>st</sup>-century learners. Therefore, teaching strategies include online and face-to-face instruction aligned with NCCER Connect e-books, online lectures, video presentations, online quizzes, active figures, and Spanish content. Students can access this information to learn new content and review, reinforce, or revise their work.

## **College, Career, and Certifications**

NCCER Learning Series

## **Grade Level and Class Size Recommendations**

It is recommended that students enter this program as sophomores. Exceptions to this are district-level decisions 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 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](http://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](http://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](http://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 or [helpdesk@rcu.msstate.edu](mailto:helpdesk@rcu.msstate.edu).

# Course Outlines

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## 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 Instrumentation—Course Code: 235060**
2. **Application of Instrumentation—Course Code: 235061**
3. **Theory of Instrumentation—Course Code: 235062**
4. **Advanced Skills of Instrumentation—Course Code: 235063**

### Course Description: Fundamentals of Instrumentation

Fundamentals of Instrumentation includes an introduction to the field and fundamentals of employability and communication skills, safety, math, and hand and power tools. This is a 1-Carnegie-unit course.

### Course Description: Application of Instrumentation

Application of Instrumentation provides an introduction to hand and power tools, blueprints, materials handling, introduction to instrumentation materials, lubricants, sealants, cleaners, fasteners, and tubing. This course gives students real-world, hands-on practice in these areas. This 1-Carnegie-unit course should only be taken after students successfully complete Fundamentals of Instrumentation.

### Course Description: Theory of Instrumentation

Theory of Instrumentation includes a study of instrumentation safety, hand and power tools, instrumentation math, and drawings and documents. This 1-Carnegie-unit course should only be taken after students successfully complete Application of Instrumentation.

### Course Description: Advanced Skills of Instrumentation

Advanced Skills of Instrumentation includes an in-depth study of electrical systems, gaskets, O-rings, packing, steel piping, and hoses. This 1-Carnegie-unit course should only be taken after students successfully complete Theory of Instrumentation.

### Fundamentals of Instrumentation—Course Code: 235060

Unit	Unit Title	Hours
1	Orientation	10
2	Employability Skills	45
3	Fundamentals of Student Organizations	10
4	Communication Skills	20
5	Basic Safety	20
6	Introduction to Construction Math	35
<b>Total</b>		<b>140</b>

**Application of Instrumentation—Course Code: 235061**

<b>Unit</b>	<b>Unit Title</b>	<b>Hours</b>
7	Hand Tools	23
8	Power Tools	20
9	Introduction to Construction Drawings	20
10	Introduction to Materials Handling	15
11	Inspect, Handle, and Store Instrumentation Materials	13
12	Lubricants, Sealants, and Cleaners	14
13	Fasteners	15
14	Tubing	20
<b>Total</b>		<b>140</b>

**Theory of Instrumentation—Course Code: 235062**

<b>Unit</b>	<b>Unit Title</b>	<b>Hours</b>
15	Orientation Review and Reinforcement	15
16	Instrumentation Safety	35
17	Hand and Power Tools for Instrumentation	30
18	Instrumentation Math	30
19	Instrument Drawings	30
<b>Total</b>		<b>140</b>

**Advanced Skills of Instrumentation—Course Code: 235063**

<b>Unit</b>	<b>Unit Title</b>	<b>Hours</b>
20	Electrical Systems	40
21	Gaskets, O-Rings, and Packing	30
22	Steel Piping	50
23	Hoses	20
<b>Total</b>		<b>140</b>

## Option 2—Two 2-Carnegie-Unit Courses

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

1. **Instrumentation I—Course Code: 235050**
2. **Instrumentation II—Course Code: 235051**

### Course Description: Instrumentation I

Instrumentation I emphasizes basic safety, employability and communication skills, math, hand and power tools, drawings, materials handling, instrumentation materials, lubricants, sealants, cleaners, fasteners, and tubing.

### Course Description: Instrumentation II

Instrumentation II is an in-depth study of instrumentation safety, tools, instrumentation math, drawings and documents, electrical systems, gaskets, O-rings, packing, steel piping, and hoses. The course should be taken after the student has successfully completed Instrumentation I.

### Instrumentation I—Course Code: 235050

Unit	Unit Title	Hours
1	Orientation	10
2	Employability Skills	45
3	Fundamentals of Student Organizations	10
4	Communication Skills	20
5	Basic Safety	20
6	Introduction to Construction Math	35
7	Hand Tools	23
8	Power Tools	20
9	Introduction to Construction Drawings	20
10	Introduction to Materials Handling	15
11	Inspect, Handle, and Store Instrumentation Materials	13
12	Lubricants, Sealants, and Cleaners	14
13	Fasteners	15
14	Tubing	20
<b>Total</b>		<b>280</b>

### Instrumentation II—Course Code: 235051

Unit	Unit Title	Hours
15	Orientation Review and Reinforcement	15
16	Instrumentation Safety	35
17	Hand and Power Tools for Instrumentation	30
18	Instrumentation Math	30
19	Instrument Drawings	30
20	Electrical Systems	40
21	Gaskets, O-Rings, and Packing	30

22	Steel Piping	50
20	Hoses	20
<b>Total</b>		<b>280</b>

# Career Pathway Outlook

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## Overview

The Instrumentation curriculum is designed to prepare students for entry-level employment. This pathway focuses on the discipline of measurement and control. Students will examine, analyze, restore, and finely tune instruments that identify, quantify, and denote changes in equipment found within the industrial workplace. Some workplace environments that relate to various careers within instrumentation are petrochemical plants, refineries, power generation facilities, pharmaceutical plants, and food & beverage industries. Instrumentation technicians who would like to move into the global job market may be interested in the petroleum industry, which provides employment opportunities in various foreign countries. A shortlist of skills relevant to this pathway are safety, process instrumentation, industrial automatic control, programmable logic control systems, instrument calibration, and instrumentation system troubleshooting.

Most careers in instrumentation require at least an associate degree, although careers with the highest earning potential—Scientific Instrument Maker and Engineering fields such as Mechanical, Electrical, Electronics, Controls, Quality, and Instrumentation, for example—usually require advanced degrees.

## Needs of the Future Workforce

There are over 33,627 instrumentation technicians currently employed in the United States, and the manufacturing industry is the highest paying overall for these careers. An encouraging detail is that women represent one out of every six instrument technicians job market employees. The employment of industrial engineering technologists and mechanical engineering technicians is projected to grow 3% through 2028, according to the U.S. Bureau of Labor Statistics. Medical equipment repairers have an even better job outlook at 4% by the same year. In Mississippi, the average employment growth total from 2020 to 2030 is projected to increase by 9.5% for all general occupations combined. The data in Table 1.1 below was compiled from the Mississippi Department of Employment Security in 2022.

Table 1.1: Current and Projected Occupation Report

<b>Description</b>	<b>Jobs, 2020</b>	<b>Projected Jobs, 2030</b>	<b>Change (Number)</b>	<b>Change (Percent)</b>	<b>Average Hourly Earnings, 2022</b>
Control and Valve Installers and Repairers	480	500	20	4.2%	\$22.90
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	290	300	10	3.4%	\$35.08
Electrical and Electronics Repairers, Commercial and Industrial Equipment	530	530	0	0%	\$29.90
Electricians	5,780	6,280	500	8.7%	\$26.08
Machinist	2,880	3,040	160	5.6%	\$19.88

Mechanical Engineering Technologists and Technicians	100	110	10	10%	\$24.88
Mechanical Engineers	1,590	1,710	120	7.5%	\$40.66
Precision Instrument and Equipment Repairers	120	120	0	0%	\$25.88

*Source:* Mississippi Department of Employment Security; mdes.ms.gov (2022).

### **Perkins V Requirements and Academic Infusion**

The instrumentation curriculum meets Perkins V's requirements of introducing students to and preparing them for high-skill, high-wage occupations in instrumentation technology fields. It also offers students a program of study, including secondary and postsecondary education, and institutions of higher learning courses that will further prepare them for instrumentation technology careers. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, it focuses on ongoing and meaningful professional development for teachers and 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](http://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 instrumentation educator's goal should include teaching strategies incorporating 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 various 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 instrumentation curriculum. SkillsUSA is an example of a student organization with many outlets for instrumentation. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to the world of instrumentation technology 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 instrumentation curriculum for group work. Students need to be able to work collaboratively with others and solve problems without excessive conflict to function in today's workforce. The instrumentation curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the instrumentation curriculum that will allow and encourage collaboration with professionals currently in the instrumentation field.

### *Work-Based Learning*

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



# Professional Organizations

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Association for Career and Technical Education (ACTE)

[acteonline.org](http://acteonline.org)

National Center for Construction Education and Research (NCCER)

[nccer.org](http://nccer.org)

Skills USA – Mississippi

[mdek12.org/CTE/SO/SkillsUSA](http://mdek12.org/CTE/SO/SkillsUSA)

SkillsUSA-National

[skillsusa.org](http://skillsusa.org)

# Using This Document

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## **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 added to the guide send a help desk ticket to the RCU by emailing [helpdesk@rcu.msstate.edu](mailto: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 for students. If the instrumentation program is using a national certification, work-based learning, or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be assessed on that quality indicator. It is the responsibility of the teacher to ensure all competencies for the selected quality indicator are covered throughout the year.

# Unit 1: Orientation

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<b>Competencies and Suggested Objectives</b>
1. Describe local program and center expectations, policies, and procedures. <sup>DOK1</sup> <ol style="list-style-type: none"><li>Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations.</li><li>Give a brief overview of the course. Explain to students what construction technology is, why it is important, and how it will be delivered.</li><li>Compare and contrast local program and school policies to the expectations of employers.</li><li>Preview course objectives, program policy, and industry standards.</li></ol>
2. Work-based learning opportunities related to program areas. <sup>DOK1</sup> <ol style="list-style-type: none"><li>Define work-based learning.</li><li>Explore the opportunities available through the program areas:<ul style="list-style-type: none"><li>• CPE</li><li>• Job shadowing</li><li>• Apprenticeship programs</li><li>• On-the-job training</li><li>• Etc.</li></ul></li></ol>

## Unit 2: Employability Skills

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<b>Competencies and Suggested Objectives</b>	
1. Describe employment opportunities in the construction industry. <sup>DOK1</sup>	
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. <sup>DOK1</sup>	
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. <sup>DOK1</sup>	
a. Identify interview skills, such as speaking, dress, professionalism, and punctuality.	
b. Simulate a job interview.	
4. Describe basic employee responsibilities and appropriate work ethics. <sup>DOK1</sup>	
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.	

## Unit 3: Fundamentals of Student Organizations

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<b>Competencies and Suggested Objectives</b>	
1. 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's student organization.
2. Explore the advantages of membership in a student organization. DOK1	a. Discuss the membership process for the program area's student organization. b. Explain the activities related to the local chapter and the state and national organizations.
3. Discuss the organization's brand resources. DOK1	a. Identify the motto, creed, and/or pledge and discuss their meanings. b. Recognize related brand resources, such as: <ul style="list-style-type: none"><li>• Emblem</li><li>• Colors</li><li>• Official attire</li><li>• Logos</li><li>• Graphic standards</li></ul>
4. Describe the importance of effective communication skills. DOK1	a. Demonstrate verbal and nonverbal communication skills. b. Apply appropriate speaking and listening skills to class- and work-related situations.
5. Apply leadership skills to class- and work-related situations and 21st Century Skills. DOK2	a. Define leadership. b. Discuss the attributes of a leader. c. Identify the roles a leader can assume.
6. 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.
7. Discuss the various competitions offered through the program area's student organization. DOK1	a. Describe each of the competitions and the skills needed to accomplish the tasks. b. Perform the tasks needed to complete an assigned requirement for a competition.

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

## Unit 4: Communication Skills

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<b>Competencies and Suggested Objectives</b>	
1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. <sup>DOK2</sup> <ol style="list-style-type: none"><li>Follow basic written and verbal instructions.</li><li>Effectively communicate in on-the-job situations using verbal, written, or electronic communication.</li><li>Demonstrate reading and writing requirements in on-the-job situations.</li></ol>
2.	Discuss the importance of good listening skills in on-the-job situations. <sup>DOK2</sup> <ol style="list-style-type: none"><li>Apply the tips for developing good listening skills.</li></ol>

## Unit 5: Basic Safety

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<b>Competencies and Suggested Objectives</b>	
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry. <sup>DOK2</sup>	<ol style="list-style-type: none"><li>Describe how to avoid on-site accidents.</li><li>Explain the relationship between housekeeping and safety.</li><li>Explain the importance of following all safety rules and company safety policies according to OSHA standards.</li><li>Explain the importance of reporting all on-the-job injuries, accidents, and near misses.</li><li>Explain the need for evacuation policies and the importance of following them.</li><li>Explain the causes of accidents and the impact of accident costs.</li><li>Compare and contrast shop/lab safety rules to industry safety rules.</li></ol>
2. Identify and apply safety around welding operations. <sup>DOK1</sup>	<ol style="list-style-type: none"><li>Use proper safety practices when welding or working around welding operations.</li><li>Use proper safety practices when welding in or near trenches and excavations.</li><li>Explain the term “proximity work.”</li></ol>
3. Display appropriate safety precautions to take around common job site hazards. <sup>DOK1</sup>	<ol style="list-style-type: none"><li>Explain the safety requirements for working in confined areas.</li><li>Explain the different barriers and barricades and how they are used.</li></ol>
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). <sup>DOK1</sup>	<ol style="list-style-type: none"><li>Identify commonly used PPE items.</li><li>Understand the proper use of PPE.</li><li>Demonstrate appropriate care for PPE.</li></ol>
5. Explain fall protection, ladder, stair, and scaffold procedures and requirements. <sup>DOK1</sup>	<ol style="list-style-type: none"><li>Explain the use of proper fall protection.</li><li>Inspect and safely work with various ladders, stairs, and scaffolds.</li></ol>
6. Explain the safety data sheet (SDS). <sup>DOK1</sup>	<ol style="list-style-type: none"><li>Explain the function of the SDS.</li><li>Interpret the requirements of the SDS.</li><li>Discuss hazardous material exposures.</li></ol>
7. Display appropriate safety procedures related to fires. <sup>DOK1</sup>	<ol style="list-style-type: none"><li>Explain the process by which fires start.</li><li>Explain fire prevention of various flammable liquids.</li><li>Explain the classes of fire and the types of extinguishers.</li><li>Illustrate the proper steps to follow when using a fire extinguisher.</li><li>Demonstrate the proper techniques for putting out a fire.</li></ol>
8. Explain safety in and around electrical situations. <sup>DOK1</sup>	<ol style="list-style-type: none"><li>Explain injuries that can result when electrical contact occurs.</li><li>Explain safety around electrical hazards.</li><li>Explain action to take when an electrical shock occurs.</li></ol>

**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 Math

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### Competencies and Suggested Objectives

1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. <sup>DOK2</sup>
  - a. Define basic geometric shapes used in the construction industry.
  - b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator.
  - c. Convert whole numbers to fractions and convert fractions to whole numbers.
  - d. Convert decimals to percentages and convert percentages to decimals.
  - e. Convert fractions to decimals.
  - f. Convert fractions to percentages.
  - g. Demonstrate reading a standard and metric ruler and tape measure.
  - h. Recognize and use metric units of length, weight, volume, and temperature.

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

## Unit 7: Hand Tools

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### Competencies and Suggested Objectives

1. Demonstrate the use and maintenance of hand tools. <sup>DOK2</sup>
  - a. Identify, visually inspect, and discuss the safe use of common hand tools including:
    - Hammers
    - Demolition tools
    - Chisels and punches
    - Screwdrivers
    - Adjustable wrenches
    - Non-adjustable wrenches
    - Sockets
    - Pliers
    - Tape measures
    - Levels
    - Squares
    - Handsaws
    - Clamps
    - Files
    - Utility knives
    - Shovels
  - b. Discuss safety rules.
  - c. Select and demonstrate the use of hand tools.
  - d. Explain the procedures for maintenance.

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

## Unit 8: Power Tools

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### Competencies and Suggested Objectives

1. Demonstrate the use and maintenance of power tools. <sup>DOK2</sup>
  - a. Identify, visually inspect, and discuss the safe use of common power tools including:
    - Electric drill (corded or cordless)
    - Hammer drill
    - Impact driver
    - Circular saw
    - Jigsaw
    - Reciprocating saw
    - Portable band saw
    - Miter or cutoff saw
    - Table saw
    - Portable or bench grinder
    - Oscillating multi-tool
    - Power nailer
  - b. Discuss safety rules.
  - c. Select and demonstrate the use of power tools.
  - d. Explain the procedures for maintenance.

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

## Unit 9: Introduction to Construction Drawings

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<b>Competencies and Suggested Objectives</b>
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| <ol style="list-style-type: none"><li>1. Read, analyze, and understand the basic components of a blueprint. <sup>DOK3</sup><ol style="list-style-type: none"><li>a. Recognize and identify terms, components, and symbols commonly used on blueprints.</li><li>b. Relate information on construction drawings to actual locations on the print.</li><li>c. Demonstrate the use of an engineer's and architect's scales.</li><li>d. Recognize different types of drawings.</li><li>e. Interpret and use drawing dimensions.</li></ol></li></ol> |
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# Unit 10: Introduction to Materials Handling

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<b>Competencies and Suggested Objectives</b>
<ol style="list-style-type: none"><li>1. Safely handle and store materials. <sup>DOK1</sup><ol style="list-style-type: none"><li>a. Define a load.</li><li>b. Establish a pre-task plan prior to moving a load.</li><li>c. Demonstrate proper materials handling techniques.</li><li>d. Choose appropriate materials handling equipment for the task.</li><li>e. Recognize hazards and follow safety procedures required for materials handling.</li><li>f. Identify and demonstrate commonly used knots.</li></ol></li></ol>

## Unit 11: Inspect, Handle, and Store Instrumentation Materials

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<b>Competencies and Suggested Objectives</b>	
1. Discuss how to properly receive instrumentation materials. <sup>DOK1, SIM</sup>	
a. Inspect and handle materials.	
b. Identify and verify materials.	
2. Discuss the proper storage of materials. <sup>DOK1, SIM</sup>	
a. Identify various storage categories.	
b. Classify environmental conditions for storage.	

## Unit 12: Lubricants, Sealants, and Cleaners

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<b>Competencies and Suggested Objectives</b>	
1. Identify lubricants used in instrumentation work and state their applications. <sup>DOK1, LSC</sup>	
a. Identify various lubricants and fluids and explain how they are used.	
b. Describe the safe handling and storage requirements for lubricants.	
2. Identify sealants and adhesives used in instrumentation work and state their applications. <sup>DOK1, LSC</sup>	
a. Identify and describe various pipe and hardware sealants and adhesives.	
b. Identify and describe various other sealants and adhesives.	
c. Describe the safe handling and storage requirements for sealants and adhesives.	
3. Identify cleaning materials and products used in instrumentation work and describe their applications. <sup>DOK1, LSC</sup>	
a. Identify cleaning tools and materials used in instrumentation work and describe their use.	
b. Identify and describe various cleaning liquids used in and around instrumentation work.	
c. Describe the safe handling and storage requirements for cleaners and solvents.	

## Unit 13: Fasteners

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<b>Competencies and Suggested Objectives</b>
1. Identify threaded fasteners and their use. <sup>DOK2, FAS</sup> <ol style="list-style-type: none"><li>Install and torque threaded fasteners.</li><li>Identify and simulate the installation of various anchors.</li></ol>
2. Identify non-threaded fasteners and their use. <sup>DOK1, FAS</sup> <ol style="list-style-type: none"><li>Identify various retainers and pins and their uses.</li><li>Identify and describe the installation of blind rivets.</li><li>Discuss the use of various devices used to secure tubing and hoses.</li></ol>



## Unit 14: Tubing

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<b>Competencies and Suggested Objectives</b>	
1. Identify and describe the types of tubing and their uses. <sup>DOK1, TUB</sup>	
a. Describe the general sizing of tubing.	
b. Identify the various materials used in tubing and state their applications.	
c. Describe various standards that apply to tubing products.	
d. Describe the methods for properly handling and storing tubing.	
2. Describe the tools and methods used to cut and bend tubing. <sup>DOK1, TUB</sup>	
a. Identify various tube-cutting tools and explain how they are used.	
b. Identify various bend types and the flaws that must be avoided during bending.	
c. Identify various bending devices and explain how they are used.	
3. Identify and describe the various methods for joining tubing and related fittings. <sup>DOK1, TUB</sup>	
a. Identify various types of compression fittings and describe how to assemble a compression fitting.	
b. Identify fittings used for welding, brazing, and flare fittings.	
c. Describe the method used to join PVC tubing.	

## Unit 15: Orientation Review and Reinforcement

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<b>Competencies and Suggested Objectives</b>
<ol style="list-style-type: none"><li>1. Describe local program and career center expectations, policies, and procedures. <sup>DOK1</sup><ol style="list-style-type: none"><li>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.</li><li>b. Give a brief overview of the course. Explain to students what instrumentation technology is, why it is important, and how it will be delivered.</li><li>c. Compare and contrast local program and school policies to expectations of employers.</li><li>d. Preview course objectives, program policy, and industry standards.</li></ol></li><li>2. Research, design, and conduct a project that will apply the knowledge and skills in a real-world, unpredictable environment. <sup>DOK3</sup><ol style="list-style-type: none"><li>a. Demonstrate effective team building and leadership skills.</li><li>b. Explore leadership skills and personal development opportunities provided to students through student organizations such as SkillsUSA.</li><li>c. Work as a team to design a community service project for which the knowledge and skills learned in the course can be used to improve the lives of others.</li></ol></li></ol>

## Unit 16: Instrumentation Safety

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<b>Competencies and Suggested Objectives</b>	
1. Describe the electrical hazards that instrument fitters and technicians might encounter. DOK1, ISP	<ol style="list-style-type: none"><li>a. Describe the effects of electrical shock and how to reduce the risk.</li><li>b. Identify and describe common personal and general electrical protective equipment.</li><li>c. Identify specific requirements for electrical safety.</li><li>d. Describe the various approach boundaries related to electrical hazards.</li><li>e. Describe how to conduct a shock hazard analysis.</li></ol>
2. Describe how lockout/tag-out procedures are used to prevent energy-related injury. DOK1, ISP	<ol style="list-style-type: none"><li>a. Describe the lockout/tag-out procedure for electrical and non-electrical equipment.</li><li>b. Describe the voltage testing requirements to be applied before beginning work.</li></ol>
3. Identify safety practices related to potentially hazardous tools and materials. DOK1, ISP	<ol style="list-style-type: none"><li>a. Identify basic hand and power tool safety practices.</li><li>b. Identify the hazards associated with various process fluids and solvents.</li><li>c. Identify safety practices related to batteries.</li></ol>

## Unit 17: Hand and Power Tools for Instrumentation

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<b>Competencies and Suggested Objectives</b>	
1. Identify and describe special hand tools related to threaded fasteners. <sup>DOK1, HPT</sup>	
a. Identify and describe how to use taps and dies.	
b. Identify extractors.	
2. Identify and describe the hand tools used in working with metal. <sup>DOK1, HPT</sup>	
a. Identify and describe conduit benders, cutters, and reamers.	
b. Identify and describe miscellaneous hand tools used in instrumentation work.	
3. Identify and describe power tools used by instrument fitters and technicians. <sup>DOK1, HPT</sup>	
a. Identify and describe how to use hammer drills and rotary hammers.	
b. Identify and describe how to use soldering guns and irons.	
c. Identify hydraulic knockout punches.	
d. Describe the basic concepts of safety guidelines for propellant-actuated tools.	

## Unit 18: Instrumentation Math

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<b>Competencies and Suggested Objectives</b>	
1.	Convert units of measurement from the inch-pound system to the metric system and vice versa. <sup>DOK2, CRM</sup> <ol style="list-style-type: none"><li>Identify units of measure in the inch-pound and metric systems.</li><li>Describe how to convert length, area, and volume values.</li><li>Describe how to convert weight values.</li><li>Describe how to convert pressure and temperature values.</li></ol>
2.	Solve basic algebraic equations. <sup>DOK2, CRM</sup> <ol style="list-style-type: none"><li>Define algebraic terms.</li><li>Demonstrate an understanding of the sequence of operations.</li><li>Solve basic algebraic equations.</li></ol>
3.	Identify and describe geometric figures. <sup>DOK2, CRM</sup> <ol style="list-style-type: none"><li>Describe the characteristics of a circle.</li><li>Identify and describe types of angles.</li><li>Identify and describe types of polygons.</li><li>Calculate various values associated with triangles.</li></ol>

## Unit 19: Instrument Drawings

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<b>Competencies and Suggested Objectives</b>
1. Identify and describe the types of drawings used in instrumentation work. <sup>DOK1, IDD</sup> <ol style="list-style-type: none"><li>Describe the structure and use of an instrument index.</li><li>Explain the use and importance of instrument specifications.</li><li>Describe various types of drawings used in instrumentation projects.</li></ol>
2. Identify and interpret instrumentation-related symbols and markings used on drawings. <sup>DOK2, IDD</sup> <ol style="list-style-type: none"><li>Interpret general instrument symbols used on instrumentation drawings.</li><li>Interpret graphic/pictorial and line symbols used on instrumentation drawings.</li><li>Describe the methods used to assign instrument tag numbers and identification abbreviations.</li></ol>

## Unit 20: Electrical Systems

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<b>Competencies and Suggested Objectives</b>	
1. Describe the fundamentals of electricity. <sup>DOK1, ESI</sup>	
a. State how electrical power is created and distributed.	
b. State the safety practices associated with electricity.	
c. Describe the difference between alternating current and direct current.	
2. Explain basic electronic theory. <sup>DOK2, ESI</sup>	
a. Define voltage, current, resistance, and power and describe how they are related.	
b. Use Ohm's law to calculate a circuit's current, voltage, and resistance.	
c. Use the power formula to calculate how much power a circuit consumes.	
d. Describe the differences between series and parallel circuits and calculate circuit loads for each type.	
3. Identify the electronic measuring instruments used in instrumentation work and describe their uses. <sup>DOK1, ESI</sup>	
a. Describe how voltage is measured.	
b. Describe how current is measured.	
c. Describe how resistance is measured.	
4. Identify wiring related to instrumentation systems and describe their functions. <sup>DOK1, ESI</sup>	
a. Identify various types and ratings of wiring by size, jacket, and rating.	
b. Describe the purpose of electrical system grounding.	

## Unit 21: Gaskets, O-Rings, and Packing

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<b>Competencies and Suggested Objectives</b>	
1. Identify the types and applications of gaskets and gasket materials. <sup>DOK2, GOP</sup>	
a. Describe the types of flange facings.	
b. Describe the use and compatibility of gaskets.	
c. Properly install gaskets.	
2. Discuss O-rings and packings, including types, uses, and construction. <sup>DOK2, GOP</sup>	
a. Install O-rings.	
b. Describe the installation of packings.	



## Unit 22: Steel Piping

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<b>Competencies and Suggested Objectives</b>
1. Discuss the types of steel pipe and fittings. <sup>DOK2, SPP</sup> <ol style="list-style-type: none"><li>Describe the characteristics and uses of steel pipe.</li><li>Explain how pipe threads are classified and measured.</li><li>Identify the types and use of fittings.</li><li>Demonstrate how to measure steel pipe properly.</li></ol>
2. Identify and demonstrate the tools and procedures used to cut, ream, and thread steel pipe. <sup>DOK2, SPP</sup>
3. Describe and demonstrate the tools and methods of installing and mechanically joining steel pipe. <sup>DOK2, SPP</sup> <ol style="list-style-type: none"><li>Assemble flanged steel pipe.</li><li>Describe the welding procedures used to join steel pipe.</li></ol>

## Unit 23: Hoses

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<b>Competencies and Suggested Objectives</b>	
1. Identify and describe the types of hoses used in instrumentation systems. <sup>DOK2, HOS</sup>	
a. Identify relevant hose standards and common sizing/pressure-rating conventions.	
b. Discuss storing and handling of hoses.	
2. Identify and describe various hose construction and relevant hose fittings. <sup>DOK2, HOS</sup>	
a. Install standard, reusable hose fittings.	

# Student Competency Profile

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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.

<b>Unit 1: Orientation</b>		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Work-based Learning opportunities related to program areas.
<b>Unit 2: Employability Skills</b>		
	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 interview skills.
	4.	Describe basic employee responsibilities and appropriate work ethics.
<b>Unit 3: Fundamentals of Student Organizations</b>		
	1.	Discuss the history, mission, and purpose of student organizations, including SkillsUSA.
	2.	Explore the advantages of membership in a student organization.
	3.	Discuss the organization's brand resources.
	4.	Describe the importance of effective communication skills.
	5.	Apply leadership skills to class and work-related situations and 21st Century Skills.
	6.	Utilize teambuilding skills in class and work-related situations.
	7.	Discuss the various competitions offered through the program area's student organization.
<b>Unit 4: Communication Skills</b>		
	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.
<b>Unit 5: Basic Safety</b>		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry.
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.

	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection, ladder, stair, and scaffold procedures and requirements.
	6.	Explain the safety data sheet (SDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
<b>Unit 6: Introduction to Construction Math</b>		
	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
<b>Unit 7: Hand Tools</b>		
	1.	Demonstrate the use and maintenance of hand tools.
<b>Unit 8: Power Tools</b>		
	1.	Demonstrate the use and maintenance of power tools.
<b>Unit 9: Introduction to Construction Drawings</b>		
	1.	Read, analyze, and understand basic components of a blueprint.
<b>Unit 10: Introduction to Materials Handling</b>		
	1.	Safely handle and store materials.
<b>Unit 11: Inspect, Handle, and Store Instrumentation Materials</b>		
	1.	Discuss how to properly receive instrumentation materials.
	2.	Discuss the proper storage of materials.
<b>Unit 12: Lubricants, Sealants, and Cleaners</b>		
	1.	Identify lubricants used in instrumentation work and state their applications.
	2.	Identify sealants and adhesives used in instrumentation work and state their applications.
	3.	Identify cleaning materials and products used in instrumentation work and describe their applications.
<b>Unit 13: Fasteners</b>		
	1.	Identify threaded fasteners and their use.
	2.	Identify non-threaded fasteners and their use.
<b>Unit 14: Tubing</b>		
	1.	Identify and describe the types of tubing and their uses.
	2.	Describe the tools and methods used to cut and bend tubing.
	3.	Identify and describe the various methods for joining tubing and related fittings.
<b>Unit 15: Orientation Review and Reinforcement</b>		
	1.	Describe local program and career center expectations, policies, and procedures.
	2.	Research, design, and conduct a project that will apply the knowledge and skills in a real-world, unpredictable environment.

<b>Unit 16: Instrumentation Safety</b>		
	1.	Describe the electrical hazards that instrument fitters and technicians might encounter.
	2.	Describe how lockout/tag-out procedures are used to prevent energy-related injury.
	3.	Identify safety practices related to potentially hazardous tools and materials.
<b>Unit 17: Hand and Power Tools for Instrumentation</b>		
	1.	Identify and describe special hand tools related to threaded fasteners.
	2.	Identify and describe the hand tools used in working with metal.
	3.	Identify and describe power tools used by instrument fitters and technicians.
<b>Unit 18: Instrumentation Math</b>		
	1.	Convert units of measurement from the inch-pound system to the metric system, and vice versa.
	2.	Solve basic algebraic equations.
	3.	Identify and describe geometric figures.
<b>Unit 19: Instrument Drawings</b>		
	1.	Identify and describe the types of drawings used in instrumentation work.
	2.	Identify and interpret instrumentation-related symbols and markings used on drawings.
<b>Unit 20: Electrical Systems</b>		
	1.	Describe the fundamentals of electricity.
	2.	Explain basic electronic theory
	3.	Identify the electronic measuring instruments used in instrumentation work and describe their uses.
	4.	Identify wiring related to instrumentation systems and describe their functions.
<b>Unit 21: Gaskets, O-Rings, and Packing</b>		
	1.	Identify the types and applications of gaskets and gasket materials.
	2.	Discuss O-rings and packings to include types, uses, and construction.
<b>Unit 22: Steel Piping</b>		
	1.	Discuss the types of steel pipe and fittings.
	2.	Identify and demonstrate the tools and procedures used to cut, ream, and thread steel pipe.
	3.	Describe and demonstrate the tools and methods of installing and mechanically joining steel pipe.
<b>Unit 23: Hoses</b>		
	1.	Identify and describe the types of hoses used in instrumentation systems.
	2.	Identify and describe various hose construction and relevant hose fittings.

# Appendix A: Industry 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
<b>Standards</b>																								
<b>Core</b>																								
BSM						X									X									
ICM							X																	
IHT								X																
IPT									X															
BLU										X														
COM					X																			
EMP			X																					
IMH											X													
<b>Instrumentation</b>																								
ISP												X					X							
HPT																		X						
CRM																			X					
IDD																				X				
SIM																								
ESI																					X			
FAS														X										
GOP																						X		
LSC													X											
TUB															X									
SPP																							X	
HOS																								X

National Center for Construction Education and Research (NCCER)-Learning Series Standards for the Construction Core Technology Program

## NCCER Core

1. BSM - Basic Safety (00101-15)
2. ICM - Introduction to Construction Math (00102-15)
3. IHT - Introduction to Hand Tools (00103-15)
4. IPT - Introduction to Power Tools (00104-15)
5. BLU - Introduction to Construction Drawings (00105-15)
6. COM - Basic Communication Skills (00107-15)
7. EMP - Basic Employability Skills (00108-15)
8. IMH - Introduction to Materials Handling (00109-15)

## Instrumentation-Level 1

9. ISP – Instrumentation Safety Practices
10. HPT – Hand and Power Tools for Instrumentation
11. CRM – Craft-Related Mathematics
12. IDD – Instrumentation Drawings and Documents
13. SIM – Inspect, Handle, and Store Instrumentation Materials
14. ESI – Electrical Systems for Instrumentation
15. FAS – Fasteners
16. GOP – Gaskets, O-Rings, and Packing
17. LSC – Lubricants, Sealants, and Cleaners
18. TUB – Tubing
19. SPP – Steel Piping Practices
20. HOS – Hoses