Manufacturing Cluster
Semiconductors, Mechanical Systems, and Pump and Piping Systems
Course Number: 21.46400

Course Description:
By completing this course, students will be introduced to electronics theory, mechanical systems, and pump and piping systems. Topics include, but are not limited to, diodes and amplifiers, semiconductor fundamentals, mechanical drives, measurement processes and techniques, maintenance tools, manufacturing processes, bearing design and application, and pump and piping systems. Theory and practical application concepts are discussed and illustrated through labs.

Course Standard 1
MANF-SMSPPS-1
The following standard is included in all CTAE courses adopted for the Career Cluster/Pathways. Teachers should incorporate the elements of this standard into lesson plans during the course. The topics listed for each element of the standard may be addressed in differentiated instruction matching the content of each course. These elements may also be addressed with specific lessons from a variety of resources. This content is not to be treated as a unit or separate body of knowledge but rather integrated into class activities as applications of the concept.

Standard: Demonstrate employability skills required by business and industry.
The following elements should be integrated throughout the content of this course.
1.1 Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.

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<th>Telephone and Email Etiquette</th>
<th>Cell Phone and Internet Etiquette</th>
<th>Communicating At Work</th>
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<td>Using Blogs</td>
<td>Improving Communication Skills</td>
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<tr>
<td>Interacting with Subordinates</td>
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<td>Ways We Filter What We Hear</td>
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<td>Show You Are Listening</td>
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<td>Handling Unsolicited Calls</td>
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<td>Giving and Receiving Feedback</td>
<td>Asking Questions</td>
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Nonverbal Communication

<table>
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<th>Written Communication</th>
<th>Speaking</th>
<th>Applications and Effective Résumés</th>
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</thead>
<tbody>
<tr>
<td>Communicating Nonverbally</td>
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<tr>
<td>Matching Verbal and Nonverbal communication</td>
<td>Small Group Communication</td>
<td>Things to Include in a Résumé</td>
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<td>Improving Nonverbal</td>
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<td>Selling Yourself in a Résumé</td>
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## Indicators

<table>
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<th>Communication</th>
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</thead>
<tbody>
<tr>
<td>Showing Confidence</td>
<td>Making Speeches</td>
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<tr>
<td>Showing Assertiveness</td>
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<td>Answering Questions</td>
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<td>Terms to Use in a Résumé</td>
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<td></td>
<td>Describing Your Job Strengths</td>
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<td>Organizing Your Résumé</td>
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<td>Writing an Electronic Résumé</td>
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<td>Dressing Up Your Résumé</td>
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</table>

## 1.2 Demonstrate creativity by asking challenging questions and applying innovative procedures and methods.

<table>
<thead>
<tr>
<th>Teamwork and Problem Solving</th>
<th>Meeting Etiquette</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking Creatively</td>
<td>Preparation and Participation in Meetings</td>
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<tr>
<td>Taking Risks</td>
<td>Preparation and Participation in Meetings</td>
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<td>Building Team Communication</td>
<td>Conducting Two-Person or Large Group Meetings</td>
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<td>Inviting and Introducing Speakers</td>
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<td></td>
<td>Facilitating Discussions and Closing</td>
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<tr>
<td></td>
<td>Preparing Visual Aids</td>
</tr>
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<td></td>
<td>Virtual Meetings</td>
</tr>
</tbody>
</table>

## 1.3 Exhibit critical thinking and problem solving skills to locate, analyze and apply information in career planning and employment situations.

<table>
<thead>
<tr>
<th>Problem Solving</th>
<th>Customer Service</th>
<th>The Application Process</th>
<th>Interviewing Skills</th>
<th>Finding the Right Job</th>
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</thead>
<tbody>
<tr>
<td>Transferable Job Skills</td>
<td>Gaining Trust and Interacting with Customers</td>
<td>Providing Information, Accuracy and Double Checking</td>
<td>Preparing for an Interview</td>
<td>Locating Jobs and Networking</td>
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<tr>
<td>Becoming a Problem Solver</td>
<td>Learning and Giving Customers What They Want</td>
<td>Online Application Process</td>
<td>Questions to Ask in an Interview</td>
<td>Job Shopping Online</td>
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<tr>
<td>Identifying a Problem</td>
<td>Keeping Customers Coming Back</td>
<td>Following Up After Submitting an Application</td>
<td>Things to Include in a Career Portfolio</td>
<td>Job Search Websites</td>
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<tr>
<td>Becoming a Critical Thinker</td>
<td>Seeing the Customer’s Point</td>
<td>Effective Résumés:</td>
<td>Traits Employers are Seeking</td>
<td>Participation in Job Fairs</td>
</tr>
<tr>
<td>Managing</td>
<td>Selling Yourself and the Company</td>
<td>Matching Your Talents to a Job</td>
<td>Considerations Before Taking a Job</td>
<td>Searching the Classified Ads</td>
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<tr>
<td>Handling Customer Complaints</td>
<td>When a Résumé Should be Used</td>
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<td></td>
<td>Using Employment Agencies</td>
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<tr>
<td>Strategies for Customer Service</td>
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<td>Landing an Internship</td>
</tr>
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<td></td>
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<td></td>
<td>Staying Motivated to Search</td>
</tr>
</tbody>
</table>

## 1.4 Model work readiness traits required for success in the workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity.

<table>
<thead>
<tr>
<th>Workplace Ethics</th>
<th>Personal Characteristics</th>
<th>Employer Expectations</th>
<th>Business Etiquette</th>
<th>Communicating at Work</th>
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</thead>
<tbody>
<tr>
<td>Demonstrating Good Work Ethic</td>
<td>Demonstrating a Good Attitude</td>
<td>Behaviors Employers Expect</td>
<td>Language and Behavior</td>
<td>Handling Anger</td>
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<tr>
<td>Behaving Appropriately</td>
<td>Gaining and Showing Respect</td>
<td>Objectionable Behaviors</td>
<td>Keeping Information Confidential</td>
<td>Dealing with Difficult Coworkers</td>
</tr>
<tr>
<td>Maintaining Honesty</td>
<td>Demonstrating Responsibility</td>
<td>Establishing Credibility</td>
<td>Avoiding Gossip</td>
<td>Dealing with a Difficult Boss</td>
</tr>
</tbody>
</table>
Playing Fair | Showing Dependability | Demonstrating Your Skills | Appropriate Work Email | Dealing with Difficult Customers
---|---|---|---|---
Using Ethical Language | Being Courteous | Building Work Relationships | Cell Phone Etiquette | Dealing with Conflict
Showing Responsibility | Gaining Coworkers’ Trust | | Appropriate Work Texting | |
Reducing Harassment | Persevering | | Understanding Copyright | |
Respecting Diversity | Handling Criticism | | Social Networking | |
Making Truthfulness a Habit | Showing Professionalism | | |
Leaving a Job Ethically | | | |

1.5 Apply the appropriate skill sets to be productive in a changing, technological, diverse workplace to be able to work independently and apply team work skills.

<table>
<thead>
<tr>
<th>Expected Work Traits</th>
<th>Teamwork</th>
<th>Time Management</th>
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<tbody>
<tr>
<td>Demonstrating Responsibility</td>
<td>Teamwork Skills</td>
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<tr>
<td>Dealing with Information Overload</td>
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<td>Transferable Job Skills</td>
<td>Decisions Teams Make</td>
<td>Juggling Many Priorities</td>
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<td>Managing Change</td>
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<td>Adopting a New Technology</td>
<td>Problems That Affect Teams</td>
<td>Organizing Workspace and Tasks</td>
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<td>Expressing Yourself on a Team</td>
<td>Staying Organized</td>
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<td></td>
<td>Giving and Receiving Constructive Criticism</td>
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<td>Managing Projects</td>
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<td></td>
<td></td>
<td>Prioritizing Personal and Work Life</td>
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</table>

1.6 Present a professional image through appearance, behavior and language.

<table>
<thead>
<tr>
<th>On-the-Job Etiquette</th>
<th>Person-to-Person Etiquette</th>
<th>Communication Etiquette</th>
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<tbody>
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<td>Appropriate Dress</td>
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<td>Proper Use of Work Email</td>
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<td>Business Meal Functions</td>
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<td>Proper Use of Cell Phone</td>
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<td>Proper Use in Texting</td>
<td>Presenting Yourself to Associates</td>
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<td>Behavior at Conventions</td>
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<td>Cross-Cultural Etiquette</td>
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<td>Working in a Cubicle</td>
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</table>

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards
L9-10RST 1-10 and L9-10WHST 1-10:
Common Core ELA/Literacy standards have been written specifically for technical subjects and have been adopted as part of the official standards for all CTAE courses. Additional Common Core ELA/Literacy standards for Speaking and Listening are listed in the foundational course standards below.
Course Standard 2

**MANF-SMSPPS-2**

Demonstrate appropriate industrial safety procedures in the manufacturing lab.

2.1 Wear approved PPE (shoes, eye wear, gloves, hard hats, etc.).
2.2 Understand the importance of lockout/tagout procedures to control various energy types (i.e. electrical, thermal (steam), hydraulic, pneumatic, or gravitational). Practice correct lockout/tagout procedures using a padlock and tag as described under OSHA’s 29 CFR 1910.147 standard, the Control of Hazardous Energy (Lockout/Tagout).
2.3 Discuss the Material Safety Data Sheets (MSDS) Right-to-Know Law.
2.4 Identify types of fires, types of fire extinguishers, and types of protective clothing.
2.5 Identify the appropriate action for reporting fires and appropriate firefighting procedures.
2.6 Demonstrate Use of Lab Emergency Power Disconnect (“Kill Switch”).
2.7 Demonstrate an understanding of safety precautions and procedures.
2.8 Demonstrate the safe use of test equipment.
2.9 Understand safety rules to follow when working with hydraulic and pneumatic systems.
2.10 Review general safety standards for working with pneumatic, hydraulic, and pumping systems in the laboratory.
2.11 Identify and discuss the potential safety hazards and precautions of working with such systems.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

**ELACC9-10SL1**: Initiate and participate effectively in a range of collaborative discussions(one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

Course Standard 3

**MANF-SMSPPS-3**

Apply the fundamentals of Diodes.

3.1 Explain the fundamentals of semiconductor theory in forming a PN junction.
3.2 Describe safety aspects pertaining to personal and equipment safety for working with power supplies.
3.3 Recognize the power supply schematics for simple half-wave, full-wave, and bridge rectifier circuits.
3.4 Describe the basic concept of passive filtering circuits within a power supply.
3.5 Describe the power supply input and output voltage signals for simple half-wave, full-wave, and bridge rectifier circuits.
3.6 Demonstrate basic semiconductor testing for shorts and opens.
3.7 Explain the electrical operation of a bipolar transistor when used as an electrical switch.
3.8 Describe the basic amplification characteristics of a common base, common emitter, and common collector configuration.
3.9 Demonstrate operational checks by measuring input and output to transistor when used in an amplifier.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

**ELACC9-10SL4**: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
SCSh2: Students will use standard safety practices for all classroom laboratory and field investigations.
   a. Follow correct procedures for use of scientific apparatus.
   b. Demonstrate appropriate technique in all laboratory situations.

ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

### Course Standard 4

**MANF-SMSPPS-4**

Demonstrate the fundamentals of Semiconductors.

4.1 Identify and list various diodes by symbols and physical characteristics.
4.2 Explain the differences between forward biasing a diode and reverse biasing a diode.
4.3 Test diodes using a diode tester.
4.4 Describe the basic operational principles of a silicon control rectifier (SCR), a junction field effect transistor (JFET), and a uni-junction transistor (UJT).
4.5 Identify the physical characteristics of an SCR, JFET, and a UJT.
4.6 Describe the basic operational principles of a DIAC and TRIAC.
4.7 Identify the physical characteristics of a DIAC and a TRIAC.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

### Course Standard 5

**MANF-SMSPPS-5**

Connect field devices to IO Cards.

5.1 Discuss the operation of Triacs and Diacs.
5.2 Discuss the difference between Sourcing and Sinking.
5.3 Discuss the difference between NPN and PNP.
5.4 Install switches and other control devices to input cards and address the terminals.
5.5 Install relays, indicator lights, solenoids and motor starters to output cards and address the terminals.
5.6 Write and execute a program using field connected devices.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

ELACC9-10SL1: Initiate and participate effectively in a range of collaborative discussions(one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

ELACC9-10SL5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
## Course Standard 6

**MANF-SMSPPS-6**

**Explain introductory concepts of mechanical systems.**

6.1 Recommend student to have already taken or be taking Physics and Physical Science.

6.2 Define the terminology applying to basic mechanics such as force, mass, weight, friction, work, horsepower, efficiency, inertia, velocity, torque, and energy.

6.3 Identify and discuss common maintenance terminology.

6.4 Describe a typical mechanical system and discuss the procedures for maintaining the system.

**Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards**

**ELACC9-10SL1:** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

**ELACC9-10SL4:** Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

## Course Standard 7

**MANF-SMSPPS-7**

**Compute applied mathematics and measurements.**

7.1 Compare and contrast standards and metric measuring systems.

7.2 Use formulas to determine areas and volumes.

7.3 Determine drive ratios for belt drives, chain drives, and gear drives.

7.4 Identify and use common tools of measurement.

7.5 Identify and use various precision measurement instruments.

**Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards**

**ELACC9-10SL1:** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

**ELACC9-10SL4:** Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

**MCC9-12.G.GMD.3:** Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

## Course Standard 8

**MANF-SMSPPS-8**

**Demonstrate proper use of maintenance tools and materials in industrial systems.**

8.1 Identify various mechanical tools used in industrial maintenance systems.

8.2 Demonstrate the use of the mechanical tools used in industrial systems.

8.3 Identify and discuss the types and characteristics of common metals used in maintenance and manufacturing.

8.4 Identify the types and characteristics of common non-metals used in maintenance and manufacturing.

8.5 Define the terminology applied to fasteners.

8.6 Identify common fasteners used in mechanical maintenance.
Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

ELACC9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

### Course Standard 9

**MANF-SMSPPS-9**

Describe various manufacturing processes.

- 9.1 Describe the forming processes used in manufacturing.
- 9.2 Describe separating processes used in manufacturing.
- 9.3 Describe conditioning processes used in manufacturing.
- 9.4 Describe assembling processes used in manufacturing.
- 9.5 Describe finishing processes used in manufacturing.
- 9.6 Identify and select component materials and fasteners in accordance with manufacturer's specifications.
- 9.7 Demonstrate safe use of appropriate power shop equipment.
- 9.8 Demonstrate the ability to use layout and measurement tools to transfer print dimensions to a part.
- 9.9 Demonstrate the safe use of equipment to drill, cut, ream, and tap in accordance with print specifications.
- 9.10 Demonstrate safe and proper use of files, grinders, and other hand and power tools in accordance with good shop practices.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

ELACC9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

### Course Standard 10

**MANF-SMSPPS-10**

Demonstrate an understanding and identify components of power transmission systems.

- 10.1 Identify common belts and the belt codes used in industrial maintenance systems.
- 10.2 Define the common terms used in belt drive systems.
- 10.3 Align pulleys used in belt drive systems.
- 10.4 Install and tension a belt.
- 10.5 Define the common terms used in chain drive systems.
- 10.6 Identify common chains and chain codes used in chain drive systems.
- 10.7 Align a sprocket used in a chain drive system.
- 10.8 Install and tension a chain.
- 10.9 Define common terms used in gear drive systems.
- 10.10 Identify common gears used in gear drive systems.
- 10.11 Demonstrate the ability to properly use a gear gauge.
10.12 Remove and install gears used in a gear drive system.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

ELACC9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Course Standard 11

MANF-SMSPPS-11
Examine and explain basic system principles and components for mechanical systems.

11.1 Identify the different types of bearings.
11.2 Explain the use and applications of the different types of bearings.
11.3 Remove and install bearings in bore.
11.4 Remove and install bearings on a shaft.
11.5 Identify the causes of bearing failure.
11.6 Inspect a bearing used in mechanical systems.
11.7 Explain the function of packing and seals in industrial production equipment.
11.8 Remove and install packings and seals.
11.9 Identify commonly used couplings in mechanical systems.
11.10 Align couplings using a straight edge, feeler gauge and dial indicators.
11.11 Install and remove couplings in a mechanical system.
11.12 Define the common terms used in the lubrication process.
11.13 Identify the types of liquid and solid lubricants for various applications.
11.14 Diagnose symptoms of lubricant failure.
11.15 Properly and safely apply lubricants to drive components.
11.16 Identify and demonstrate the proper and safe use of lubricating equipment.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

ELACC9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Course Standard 12

MANF-SMSPPS-12
Examine and explain pumps and piping systems.

12.1 Identify the various pumps used in the industry.
12.2 Discuss gear, vane, and piston pump principles of operation.
12.3 Discuss the applications of various pumps used in the industry.
12.4 Discuss and identify various materials used in piping systems.
12.5 Identify various fittings used in piping systems.
12.6 Identify and discuss the types of valves used in piping systems.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards

ELACC9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
Performance Standards
ELACC9-10SL1: Initiate and participate effectively in a range of collaborative discussions(one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.
ELACC9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Course Standard 13
MANF-SMSPPS-13
Utilize Article 430 of the National Electrical Code (NEC) to calculate the installation requirements for motors and motor control systems.

13.1 Calculate the size for branch circuit conductors covered by NEC selection 430-22.
13.2 Calculate the size for feeder circuit protection covered by NEC section 430-22.
13.3 Calculate the size for ground fault/short circuit protection (fuses and circuit breakers) using locked motor current, Table 430-152, and Article 430-52 of the NEC.
13.4 Calculate the size of overload protection according to sections 430-74 and 430-34 of the NEC.
13.5 Size equipment grounds according to Table 250-95 of the NEC.
13.6 Size and locate the motor disconnects according to NEC Part H, Article 430.
13.7 Size controllers according the NEMA standards.
13.8 Calculate the size of control conductors according to Article 430-72 of the NEC.
13.9 Size raceways for motor circuits using Chapter 9: Table 3A, 3B, 3C, 4, and 5 of the NEC.

Support of CTAE Foundation Course Standards and Common Core GPS and Georgia Performance Standards
ELACC9-10SL1: Initiate and participate effectively in a range of collaborative discussions(one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

Recommended Workplace Learning Experience
1. Complete 2-3 day job shadow experience within the Mechatronics field.
2. Compete in local or regional competitions related to Mechatronics.
3. Tour additional local advanced manufacturing operations.