

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.

Person-to-Person Etiquette	Telephone and Email Etiquette	Cell Phone and Internet Etiquette	Communicating At Work	Listening
Interacting with Your Boss	Telephone Conversations	Using Blogs	Improving Communication Skills	Reasons, Benefits, and Barriers
Interacting with Subordinates	Barriers to Phone conversations	Using Social Media	Effective Oral Communication	Listening Strategies
Interacting with Co-workers	Making and Returning Calls		Effective Written Communication	Ways We Filter What We Hear
Interacting with Suppliers	Making Cold Calls		Effective Nonverbal Skills	Developing a Listening Attitude
	Handling Conference Calls		Effective Word Use	Show You Are Listening
	Handling Unsolicited Calls		Giving and Receiving Feedback	Asking Questions
				Obtaining Feedback
				Getting Others to Listen

Nonverbal Communication	Written Communication	Speaking	Applications and Effective Résumés
Communicating Nonverbally	Writing Documents	Using Language Carefully	Completing a Job Application
Reading Body Language and mixed Messages	Constructive Criticism in Writing	One-on-One Conversations	Writing a Cover Letter
Matching Verbal and Nonverbal communication		Small Group Communication	Things to Include in a Résumé
Improving Nonverbal		Large Group	Selling Yourself in a Résumé

Indicators		Communication	
Nonverbal Feedback		Making Speeches	Terms to Use in a Résumé
Showing Confidence Nonverbally		Involving the Audience	Describing Your Job Strengths
Showing Assertiveness		Answering Questions	Organizing Your Résumé
		Visual and Media Aids	Writing an Electronic Résumé
		Errors in Presentation	Dressing Up Your Résumé

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

Teamwork and Problem Solving	Meeting Etiquette
Thinking Creatively	Preparation and Participation in Meetings
Taking Risks	Preparation and Participation in Meetings
Building Team Communication	Conducting Two-Person or Large Group Meetings
	Inviting and Introducing Speakers
	Facilitating Discussions and Closing
	Preparing Visual Aids
	Virtual Meetings

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

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

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

Workplace Ethics	Personal Characteristics	Employer Expectations	Business Etiquette	Communicating at Work
Demonstrating Good Work Ethic	Demonstrating a Good Attitude	Behaviors Employers Expect	Language and Behavior	Handling Anger
Behaving Appropriately	Gaining and Showing Respect	Objectionable Behaviors	Keeping Information Confidential	Dealing with Difficult Coworkers
Maintaining Honesty	Demonstrating Responsibility	Establishing Credibility	Avoiding Gossip	Dealing with a Difficult Boss

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.

Expected Work Traits	Teamwork	Time Management
Demonstrating Responsibility	Teamwork Skills	Managing Time
Dealing with Information Overload	Reasons Companies Use Teams	Putting First Things First
Transferable Job Skills	Decisions Teams Make	Juggling Many Priorities
Managing Change	Team Responsibilities	Overcoming Procrastination
Adopting a New Technology	Problems That Affect Teams	Organizing Workspace and Tasks
	Expressing Yourself on a Team	Staying Organized
	Giving and Receiving Constructive Criticism	Finding More Time
		Managing Projects
		Prioritizing Personal and Work Life

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

On-the-Job Etiquette	Person-to-Person Etiquette	Communication Etiquette	Presenting Yourself
Using Professional Manners	Meeting Business Acquaintances	Creating a Good Impression	Looking Professional
Introducing People	Meeting People for the First Time	Keeping Phone Calls Professional	Dressing for Success
Appropriate Dress	Showing Politeness	Proper Use of Work Email	Showing a Professional Attitude
Business Meal Functions		Proper Use of Cell Phone	Using Good Posture
Behavior at Work Parties		Proper Use in Texting	Presenting Yourself to Associates
Behavior at Conventions			Accepting Criticism
International Etiquette			Demonstrating Leadership
Cross-Cultural Etiquette			
Working in a Cubicle			

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.

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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.

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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

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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.

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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.

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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.

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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.

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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

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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.

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.

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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.