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GENERAL MAINTENANCE MECHATRONICS CURRICULUM CATALOG

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AMT 1011: Fluid Power and Electrohydraulics/Pneumatics – Fundamentals of Fluid Power and Electrohydraulics/Pneumatics (Module 1)

Lecture Contact Hours: 16
Lab Contact Hours: 0

Description:
This module explains the fundamental concepts of fluid power. It covers the principals of fluid power, calculations of physical properties of fluids and their ability to do work. It introduces the various fluid power components, symbols, circuits. It introduces troubleshooting of fluid power components and systems with an emphasis on safety.

Competencies:
1. Describe safety concerns specific to hydraulics and pneumatics.
2. Demonstrate an understanding of safety circuits and guarding.
3. List the safety rules regarding hydraulic and pneumatic systems.
4. Check for heated components before touching.
5. Describe OSHA requirements for lock out tag out, as well as blockout equipment for safety.
6. Describe the steps for removing lock out tag out and restoring service.
7. Explain housekeeping and preventing slips and falls.
8. Define the term "pinch points".
9. List ways hazardous waste is properly handled.
10. Describe the aspects of fluid power.
11. Describe the properties of fluid power systems.
12. Describe fluids.
13. Describe the units of measures used in fluid power systems.
14. Utilize Pascal's law.
15. Convert mechanical energy to hydraulic.
16. Describe the advantages and disadvantages of fluid power.
17. Describe components in a basic system.
18. Describe fluids and fluid properties.
19. Utilize Pascal's law.
20. Calculate force, pressure, flow, and area requirements using formulas as applied to fluid power systems.
21. Convert mechanical energy to hydraulic
22. Compare positive displacement vs. non positive displacement pumps.
23. Explain pump inlet location importance to calculating charge pressure.
24. Define the term "pressure head".
25. Explain series parallel rules in regard to fluid flow and velocity.
26. Describe pneumatics and air compression.
27. Describe air receivers and air preparation.
28. List the typical components of a basic pneumatic system.
29. Explain the relationships of compressed air in terms of pressure, volume, and temperature.
30. Explain how the terms flow rate and velocity of compressed air are different and measured.
31. Describe vacuum types used in a pneumatic system.

32. Define absolute and vacuum gauge pressure.
33. Describe the reference documents and data management software used in the repair, replacement, and troubleshooting of fluid power components.
34. Recognize fluid power components from schematics, pictorials, cutaways and pictures.
35. Read fluid power standards and ANSI symbols for fluid power components.
36. Interpret fluid power schematics, sequence of operations, and exploded views.

AMT 1012: Fluid Power and Electrohydraulics/Pneumatics – Flow, Directional, Pressure Control Valves (Module 2)

Lecture Contact Hours: 10
Lab Contact Hours: 18

Description:
This module explains hydraulic and pneumatic control valves: directional controls, which control the direction of fluid flow; pressure controls, which perform functions such as limiting maximum system pressure and regulating reduced pressure in certain portions of a circuit; and the use and types of flow controls in a hydraulic and pneumatic circuit.

Competencies:
1. Describe safety concerns specific to hydraulics and pneumatics.
2. Demonstrate an understanding of safety circuits and guarding.
3. List the safety rules regarding hydraulic and pneumatic systems.
4. Check for heated components before touching.
5. Describe OSHA requirements for lock out tag out, as well as blockout equipment for safety.
6. Describe the steps for removing lock out tag out and restoring service.
7. Explain housekeeping and preventing slips and falls.
8. Define the term "pinch points".
9. List ways hazardous waste is properly handled.
10. Review lock and tag out equipment as appropriate for the valve.
11. Verify style and type of directional control valves in terms of:
    - 11.1. Identification
    - 11.2. Port labeling
    - 11.3. Actuation methods
12. Explain selecting of appropriate type of valve for the application.
13. Describe valve mounting methods & standards.
14. Identify DVC problems.
15. Explain how to disconnect valve from manifold.
16. Demonstrate the replacement of a new valve, depending on type; confirming appropriate type.
17. Interpret valve specifications for accurate replacement.
18. List valve appropriate replacement practices.
19. Explain returning valve to service.
20. Identify style and type of pressure control valves.

21. Identify style and type of flow control valves.
22. Identify style and type of vacuum control valves.
23. Explain the types of LOTO devices used with valves.

AMT 1013: Fluid Power and Electrohydraulics/Pneumatics – Pumps, Actuators, & Accumulators
(Module 3)

Lecture Contact Hours: 8
Lab Contact Hours: 8

Description:
This module explains different types of pumps, actuators and accumulators used in fluid power systems, which create flow and change fluid power into mechanical power, and devices that store energy in the system.

Competencies:
1. Describe safety concerns specific to hydraulics and pneumatics.
2. Demonstrate an understanding of safety circuits and guarding.
3. List the safety rules regarding hydraulic and pneumatic systems.
4. Check for heated components before touching.
5. Describe OSHA requirements for lock out tag out, as well as blockout equipment for safety.
6. Describe the steps for removing lock out tag out and restoring service.
7. Explain housekeeping and preventing slips and falls.
8. Define the term "pinch points".
9. List ways hazardous waste is properly handled.
10. Verify style and type of pump.
11. Differentiate between pump flow and pressure.
12. Troubleshoot hydraulic pumps:
    - 12.1. Pressure and flow
    - 12.2. Visual inspection for leaks
    - 12.3. Inspection of coupling device to motor
    - 12.4. Abnormal heat, sound or vibration
    - 12.5. Checking operation of relief valve
13. Repair hydraulic pumps:
    - 13.1. Disassembling and replacement of bad components
    - 13.2. Flushing pump with chemicals as appropriate and cleaning with compressed air
14. Identify air compressor types and uses.
15. Describe key components of compressors.
16. Compare venturis and vacuum generators and their uses.
17. Verify style and type of actuators:
    - 17.1. Linear (cylinder)
    - 17.2. Rotary (motor)
18. Describe troubleshooting actuators in terms of:
    - 18.1. Inspection for leaks
    - 18.2. Verification of air or fluid to the actuator (pressure)
    - 18.3. Documenting maintenance and service
19. Explain motor efficiency.
20. Verify functions, style and type of accumulators:

20.1. Bladder-type
20.2. Diaphragm-type
20.3. Piston-type
20.4. Spring-loaded-type
21. Explain how accumulators work
22. Describe the maintenance of actuators in terms of:
22.1. Installing gas accumulators
22.2. Charging gas accumulators
22.3. Removing bladder-type and piston-type accumulators
22.4. Repairing piston-type accumulators

AMT 1014: Fluid Power and Electrohydraulics/Pneumatics – Reservoirs, Fluids, & Filters
(Module 4)

Lecture Contact Hours: 7
Lab Contact Hours: 5

Description:
This module covers functions of hydraulic/pneumatic reservoir and reservoir components. Students will learn properties and requirements for fluids as well as how filters are used to maintain cleanliness in fluid power systems.

Competencies:
1. Describe safety concerns specific to hydraulics and pneumatics.
2. Demonstrate an understanding of safety circuits and guarding.
3. List the safety rules regarding hydraulic and pneumatic systems.
4. Check for heated components before touching.
5. Describe OSHA requirements for lock out tag out, as well as blockout equipment for safety.
6. Describe the steps for removing lock out tag out and restoring service.
7. Explain housekeeping and preventing slips and falls.
8. Define the term "pinch points".
9. List ways hazardous waste is properly handled.
10. Identify reservoir types and components located on fluid power systems.
11. Describe proper way to add hydraulic fluid to a tank.
12. Identify types of hydraulic oil coolers.
13. Describe pneumatic reservoirs.
14. Describe types of pneumatic dryers and their functions.
15. List the functions of hydraulic fluids
16. Explain the physical/chemical properties of hydraulic fluids
17. Identify the types of hydraulic fluids
18. Describe filling the reservoir with fluid
19. List the sources of contamination in hydraulic systems
20. List the sources of contamination in pneumatic systems
21. Explain the effects of contamination:
21.1. Hydraulic fluid
21.2. Hydraulic components

21.3. Pneumatic components
22. Show ability to read ISO cleanliness codes.
23. List the types of hydraulic filters.
24. Describe the maintenance of filtration systems.
25. Explain the replacement of hydraulic filters.
26. Identify pneumatic filter elements.
27. Describe filter ratings.
28. Explain the draining of a pneumatic filter.
29. List steps to replace various hydraulic filters.

AMT 1015: Fluid Power and Electrohydraulics/Pneumatics – Hose, Piping, & Tubing
(Module 5)

Lecture Contact Hours: 3
Lab Contact Hours: 9

Description:
This module covers various types of conductors that carry fluid through a system. The focus will be on fittings, hose, and steel tubing used in fluid power systems. Participants will cover selection, proper assembly, installation, and troubleshooting of these components to achieve a leak-free system.

Competencies:
1. Describe safety concerns specific to hydraulics and pneumatics.
2. Demonstrate an understanding of safety circuits and guarding.
3. List the safety rules regarding hydraulic and pneumatic systems.
4. Check for heated components before touching.
5. Describe OSHA requirements for lock out tag out, as well as blockout equipment for safety.
6. Describe the steps for removing lock out tag out and restoring service.
7. Explain housekeeping and preventing slips and falls.
8. Define the term "pinch points".
9. List ways hazardous waste is properly handled.
10. Discuss safely working with piping, tubing and hoses and recognize potential hazards and the use of proper personal protective equipment.
11. Demonstrate ability to size hose based on flow and velocity (fps) of oil in the line.
12. Demonstrate ability to size tubing based on flow and velocity (fps) of oil in the line.
13. Explain how to properly inspect hoses.
14. List steps to repair a hose.
15. List the types of threaded fittings and connections used with hose and tubing.
16. Explain selection of fittings.
17. Describe possible failures of fittings.
18. Explain troubleshooting connectors.
19. Demonstrate tube flaring, compression fitting and hose crimping.
20. Show understanding of pneumatic system layout and design.

AMT 1016: Fluid Power and Electrohydraulics/Pneumatics – Electrohydraulics/Pneumatics (Module 6)

Lecture Contact Hours: 9
Lab Contact Hours: 10

Description:
This module introduces students to the fundamentals of electro-fluid power, including basic electrical principles, basic fluid power principles, electro-fluid power limit devices, common electro-fluid power troubleshooting principles and practices, as well as preventive & predictive maintenance of electro-fluid power systems.

Competencies:
1. Describe safety concerns specific to hydraulics and pneumatics.
2. Demonstrate an understanding of safety circuits and guarding.
3. List the safety rules regarding hydraulic and pneumatic systems.
4. Check for heated components before touching.
5. Describe OSHA requirements for lock out tag out, as well as blockout equipment for safety.
6. Describe the steps for removing lock out tag out and restoring service.
7. Explain housekeeping and preventing slips and falls.
8. Define the term "pinch points".
9. List ways hazardous waste is properly handled.
10. Locate and identify the pneumatic pressure regulator.
11. Demonstrate ability to adjust a pneumatic pressure regulator correctly.
12. Locate and identify the hydraulic motor flow control.
13. Demonstrate ability to adjust a hydraulic flow control valve correctly.
14. Locate and identify the hydraulic pressure relief valve.
15. Demonstrate ability to adjust a hydraulic pressure relief valve correctly.
16. Identify system limitations such as gpm and psi tolerances.
17. Identify impact of pressure and flow on mechanical equipment.
18. Verify accuracy of pressure and flow gauges using another gauge.
19. Demonstrate ability to adjust pressure and flow to equipment specifications.
20. Demonstrate understanding of Zero and Span.
21. Describe procedures for Zero and Span adjustment on the AMTEC Trainer.
22. Demonstrate understanding of Gain and Ramp.
23. Describe procedures for Gain and Ramp adjustment on the AMTEC Trainer.
24. Demonstrate ability to adjust pressure sensor (and counter-pressure if required).
25. Demonstrate ability to confirm the operation of a switch.
26. Describe making an adjustment to a switch.

AMT 1017: Fluid Power and Electrohydraulics/Pneumatics – Fluid Power Systems and System Troubleshooting (Module 7)

Lecture Contact Hours: 7
Lab Contact Hours: 12

Description:
This module explains troubleshooting of hydraulic and pneumatic systems. This includes tracing out systems, isolating the problem, safe testing and inspection techniques, combination circuits and combined electro-hydraulic/pneumatic systems.

Competencies:
1. Describe safety concerns specific to hydraulics and pneumatics.
2. Demonstrate an understanding of safety circuits and guarding.
3. List the safety rules regarding hydraulic and pneumatic systems.
4. Check for heated components before touching.
5. Describe OSHA requirements for lock out tag out, as well as blockout equipment for safety.
6. Describe the steps for removing lock out tag out and restoring service.
7. Explain housekeeping and preventing slips and falls.
8. Define the term "pinch points".
9. List ways hazardous waste is properly handled.
10. Explain the principle of the Troubleshooting Method
11. List the steps of the Troubleshooting Method and briefly explain each.
12. Explain the Assessment Stage of the Troubleshooting Method in terms of:
    - 12.1. Pre-assess
    - 12.2. Actual Assess
13. Explain the Planning Stage of the Troubleshooting Method.
14. Explain the Diagnosis Stage of the Troubleshooting Method.
15. Explain the Repair Stage of Troubleshooting Method.
16. Explain the Confirm Stage of the Troubleshooting Method.
17. Explain the Document Stage of the Troubleshooting Method.

AMT 1021: General PM and Predictive Maintenance – Basic PM (Module 8)

Lecture Contact Hours: 6
Lab Contact Hours: 4

Description:
Basic PM covers how routine work is done to keep equipment in good working order and to optimize its efficiency and accuracy. Activities in this module include regular routine cleaning, lubricating, testing, checking for wear and tear and eventually replacing components to avoid breakdown.

Competencies:
1. Identify, explain, and demonstrate safe practices when doing general preventive maintenance.
   1.1. Identify and explain common slip hazards.
   1.2. Identify and explain hydraulic system injection hazards.
   1.3. Identify and explain chemical hazards.
2. Perform general housekeeping.
   2.1. Sweep and mop floor, pick up trash around work area.
   2.2. Wipe down equipment.
   2.3. Empty trash and chip bins.
   2.4. Empty rag bins.
3. Monitor floor management development system.
   3.1. Maintain neat work area.
   3.2. Replace used tolls and equipment in designated areas.
   3.3. Establish minimum and maximum quantities acceptable for floor area.
   3.4. Maintain recycle and waste segregation.
   3.5. Maintain recycle and waste segregation.
   3.6. Identify principles of a 5S program.
4. Perform equipment checks.
   4.1. Perform visual Inspection of equipment.
   4.2. Check gauges.
   4.3. Check for abnormal readings and conditions.
   4.4. Verify current readings.
   4.5. Check valve positions, abnormal noises, leaks, temperatures.
   4.6. Perform oven quality checks to maintain oven temperature standards.
5. Change filters.
   5.1. Change oil filters.
   5.2. Change air filters.
   5.3. Dispose of used filters.
6. Maintain oil and grease levels.
   6.1. Check sight glass-hydraulic oils.
   6.2. Check grease canisters.
   6.3. Check air lubricators.
   6.4. Check gear box oils.

7. Collect oil samples for analysis.
   7.1. Secure sample collection kit from store room.
   7.2. Clean port before taking sample.
   7.3. Take sample from equipment.
   7.4. Label sample container.
   7.5. Prepare sample for shipment to send to lab for analysis.
8. Interpret oil analysis data and take action
   8.1. Read and interpret oil analysis data.
   8.2. Determine root cause of contamination.
   8.3. Initiate work orders as required.
   8.4. Locate and eliminate source of contamination.
   8.5. Schedule a repair if contaminated.
9. Troubleshoot automatic lubrication systems.
   9.1. Identify types of lubrication systems.
   9.2. Identify components of a series type, automatic lube system.
   9.3. Troubleshoot series type, automatic lube system.

AMT 1022: General PM and Predictive Maintenance – Advanced Technologies in Predictive Maintenance (Module 9)

Lecture Contact Hours: 14
Lab Contact Hours: 6

Description:
Maintenance departments in modern automotive production facilities have been significantly influenced by quality-improvement philosophies. Gradual, continuous improvement in all aspects of plant operation is the goal of production operation, these same principles all apply to facility maintenance as well. Maintenance personnel can apply these concepts to their maintenance, troubleshooting, and repair tasks in order to continuously improve plant operations and efficiency. This module will introduce the learner to the various types and styles of predictive and preventive maintenance components used in industrial applications.

Competencies:
1. Demonstrate appropriate predictive and preventive maintenance safety.
   1.1. Demonstrate safe practices.
   1.2. Identify safety equipment.
2. Demonstrate correct use of vibration analysis to diagnose condition of equipment.
   2.1. Describe vibration concepts.
   2.2. Explain acceleration.
   2.3. Explain velocity.
   2.4. Describe displacement.
   2.5. Explain data collection routes.
   2.6. Collect data measurements.
   2.7. Describe the record keeping process.
3. Demonstrate correct techniques for laser shaft alignment.

3.1. Describe laser equipment safety.
3.2. Mount laser system components.
3.3. Measure the misalignment.
3.4. Describe alignment results.
3.5. Reposition equipment to alignment results.

4. Demonstrate correct techniques for balancing equipment.
   4.1. Explain balancing concepts and theory.
   4.2. Intrepret balancing readings.
   4.3. Explain balancing problems.
5. Demonstrate correct techniques for online & offline motor current analysis of equipment.
   5.1. Describe motor current analysis concepts and theory.
   5.2. Describe the function of motor current analyzers.
   5.3. Describe an electrical test without power.
   5.4. Describe phase orientation.
   5.5. Explain the process for a system check.
6. Demonstrate correct techniques for performing infrared thermograph of equipment.
   6.1. Describe infrared thermography concepts and theory.
   6.2. Evaluate digital images.
   6.3. Interpret image results.
   6.4. Identify false readings.
7. Demonstrate correct techniques for performing ultrasonic maintenance of equipment.
   7.1. Describe ultrasonic concepts and theory.
   7.2. Identify data point readings.
   7.3. Interpret ultrasonic readings.
8. Interpret data available in a maintenance database.
   8.1. Describe work order generation.
   8.2. Explain PM maintenance requests.
   8.3. Identify spare part locations.
   8.4. Evaluate daily log reports.
   8.5. Describe communication between shifts.
   8.6. Describe equipment history importance.
   8.7. Explain PM completion tracking.
   8.8. Interpret PM and CM reports.
   8.9. Explain down time tracking and costs.
9. Demonstrate correct procedures for predictive maintenance troubleshooting.
   9.1. Describe the concepts of PM troubleshooting.
   9.2. Identify specific PM safety concerns.
   9.3. Describe troubleshooting requirements.
   9.4. Explain operational troubleshooting.
   9.5. Describe system troubleshooting.
   9.6. Identify troubleshooting resources.
   9.7. Describe troubleshooting problems.
   9.8. Analyze troubleshooting case studies.

AMT 1031s: PLC – Introduction to Siemens PLC's (Module 10)

Lecture Contact Hours: 10
Lab Contact Hours: 0

Description:
This module introduces the student to the various elements of basic Siemens PLCs including the identification of Siemens Programmable Logic Control Systems as well as Overview of Siemens PLC system architectures, networks and software options. Students will also learn basic numbering systems, computer terminology, PLC functions, program structures, language standards, point addressing basics.

Competencies:
1. Describe the basic history of the development of industrial programmable controllers.
   1.1. Describe how machinery was controlled prior to PLC's being introduced.
   1.2. Describe efforts made to make working with PLC's easier for electricians
2. Describe the components of a typical PLC system.
   2.1. Describe the role of the chassis in a PLC system.
   2.2. Describe the role of input and output modules within a PLC system.
   2.3. Describe how a PLC system's components are specified.
   2.4. Define terminology such as chassis, module, backplane, discrete and analog.
   2.5. Describe the modes of operation that can be selected using the key switch on the processor module.
   2.6. Describe the addressing scheme used in Step 7 programming and how it relates to the physical hardware.
3. Describe typical applications for the various processors included in the Siemens PLC system architectures.
   3.1. Describe the various types of Siemens PLC's.
4. Demonstrate basic numbering systems, computer terminology.
   4.1. Describe the attributes associated with the ASCII format.
   4.2. Interpret data stored in binary format.
   4.3. Interpret data stored in octal format.
   4.4. Interpret data stored in hexadecimal format.
5. Explain the basic PLC functions, program structures and language standards.
   5.1. Identify the programming languages supported within the Step 7 programming environment.
   5.2. Describe which industries / industrial applications use the various types of programming languages.
6. Construct a basic program.
   6.1. Differentiate between ladder diagram symbols usually associated with inputs from those usually associated with outputs.

AMT 1032s: PLC – Siemens Hardware and Software (I/O) (Module 11)

Lecture Contact Hours: 10
Lab Contact Hours: 20

Description:
This module introduces the student to the memory and project organization within a Siemens S7 PLC processor and the installation, wiring and configuration of I/O modules, as well as how to start a new project.

Competencies:
1. Install and configure a PLC system.
   1.1. Describe the steps involved in installing / configuring a system.
2. Describe the Step 7 software & project organization.
   2.1. Describe which types of processors can be programmed using the Step 7 Totally Integrated Automation Portal (TIA Portal) software.
   2.2. Describe the two views available from within the Step 7 Totally Integrated Automation Portal (TIA Portal) software.
   2.3. Explain the relationship between projects, organization blocks, functions and networks within the Step 7 Totally Integrated Automation Portal (TIA Portal) software.
3. Describe the various Data Types used within the Step 7 TIA Portal environment.
4. Describe the differences between analog and discrete digital signals.
5. Describe the commissioning process.
6. Describe the various types of Program Blocks.
7. Describe the process of using a Watch Table and a Force Table.
8. Describe the components associated with distributed I/O.
9. Describe the Processor Scan for a S7-1200.
10. Discuss major failure modes in an automated system and use available information to restore a system to automatic operation.
    10.1. Describe why understanding I/O modules and associated components is so important for an electrician or technician.
    10.2. Describe the main reasons for stoppage while in automatic.
    10.3. Systematically troubleshoot a common tooling fault.

AMT 1033s: PLC – Programming Siemens PLC's (Module 12)

Lecture Contact Hours: 10
Lab Contact Hours: 20

Description:
The purpose of this module is to help student develop an understanding of programming a Siemens PLC.

Competencies:

1. Navigate through the TIA Portal software.
   1.1. Describe the specific models of PLC's where TIA Portal software can be used.
   1.2. Describe the basic functions that can be performed using STEP 7 Professional V11.
   1.3. Assign an IP Address and Subnet Mask to a PLC.
   1.4. Describe the two views from within the TIA Portal.
2. Use Tags to reference memory & I/O from within the TIA Portal software.
   2.1. Describe Tags.
   2.2. Differentiate between PLC and HMI tags.
3. Create and edit programs using the TIA Portal Software.
4. Normalize and scale analog values within a program.

AMT 1034s: PLC – Siemens PLC Communication (Module 13)

Lecture Contact Hours: 10
Lab Contact Hours: 20

Description:
This module introduces various elements of industrial communications using PLCs. Addresses common types of control communications in an industrial environment. Includes discussion of PLC addressing used in communications.

Competencies:
1. Configure and connect communications networks for Siemens PLC's and HMI's.
   1.1. Properly connect ProfiNet cables.
   1.2. Establish communications with devices on a network.
   1.3. Establish network connections between two PLC's.
   1.4. Add an HMI to a project
   1.5. Create HMI Screens with inputs (pushbuttons), outputs (pilot lights), text and data displays.
2. Describe closed-loop controls systems and PID loops.
3. Troubleshoot and diagnose problems associated with PLC's.

AMT 1031ab: PLC – Introduction to Allen-Bradley PLC's (Module 14)

Lecture Contact Hours: 10
Lab Contact Hours: 0

Description:
This course introduces the student to the various elements of basic Allen-Bradley PLCs including the identification of Programmable Logic Control Systems as well as an overview of PLC system architectures. Students will also learn basic numbering systems, computer terminology, PLC functions, program structures, language standards, point addressing basics.

Competencies:
1. Describe the basic history of the development of industrial programmable controllers.
   1.1. Describe how machinery was controlled prior to PLC's being introduced.
   1.2. Describe efforts made to make working with PLC's easier for electricians.
2. Describe the components of a typical PLC System.
   2.1. Describe the role of the chassis in a PLC system.
   2.2. Describe the role of Input and Output modules within a PLC system.
   2.3. Describe the importance of battery back-up on a PLC system.
   2.4. Describe how a PLC system's components are specified.
   2.5. Define terminology such as chassis, module, backplane, removable terminal block, discrete and analog.
   2.6. Describe the modes of operation that can be selected using the key switch on the processor module.
3. Demonstrate knowledge of Rockwell PLC system architectures.
   3.1. Describe which types of Allen-Bradley PLC's are included in the Logix 5000 family.
   3.2. Describe typical applications for the various processors included in the Logix 5000 family.
4. Demonstrate knowledge of basic numbering systems, computer terminology.
   4.1. Describe the attributes associated with the ASCII format.
   4.2. Interpret data stored in binary format.
   4.3. Interpret data stored in octal format.
   4.4. Interpret data stored in hexadecimal format.
5. Explain the basic PLC functions, program structures and language standards.
   5.1. Identify the programming languages supported within the RSLogix 5000 programming environment.
   5.2. Describe which industries / industrial applications use the various types of programming languages.
6. Construct a basic program.
   6.1. Differentiate between ladder diagram symbols usually associated with inputs from those usually associated with inputs from those usually associated with outputs.

1032ab: PLC – Allen-Bradley Hardware and Software (I/O) (Module 15)

Lecture Contact Hours: 10
Lab Contact Hours: 20

Description:
This module introduces the student to the memory and project organization within a ControlLogix processor, the installation, wiring and configuration of I/O modules, as well as how to start a new project using RSLogix 5000 software.

Competencies:
1. Provide a brief overview of Rockwell's integrated architecture (hardware & software).
   1.1. Describe where different Rockwell software applications are used.
   1.2. Describe the different types of networked communications and I/O configurations that are supported within Rockwell's Integrated Architecture.
2. Describe the ControlLogix memory & project organization.
   2.1. Describe the ControlLogix project organization model.
   2.2. Explain the relationship between tasks, programs and routines.
   2.3. Identify RSLogix 5000 project files based upon their file extension.
   2.4. Describe the different types of task execution.
   2.5. Describe the order of execution for programs within a task and routines within a program.
3. Describe the various types of tags used within ControlLogix.
   3.1. Differentiate between Base, Alias, Produced and Consumed tags.
   3.2. Describe the difference between controller-scope tags and program-scope tags.
4. Describe the various data types associated with base tags.
   4.1. Differentiate between BOOL, SINT, INT, DINT and REAL data types.
   4.2. Differentiate between TIMER, COUNTER, and CONTROL data types.
   4.3. Describe the use of arrays within tag data types.
   4.4. Describe structure-type tags.
   4.5. Describe user-defined tags (UDT's), which are also referred to as user-defined structure-type tags.
5. Describe and interpret real-world I/O addresses.
   5.1. Describe how tags are created for local and networked I/O modules.
   5.2. Describe the various types of data associated with real-world tag addressing.
6. Choose the appropriate type of task execution and configure tasks.
   6.1. Determine the appropriate type of task execution.
   6.2. Configure task execution.
7. Connect a PC to a PLC.
   7.1. Determine which operations require a personal computer to be connected to the PLC.
   7.2. Describe the components required and the proper steps to follow in order to establish a communication link between a PC and a PLC.
8. Configure I/O in a project.
   8.1. Create a new project file.

8.2. Configure the I/O modules for a project file.
8.3. Inhibit an I/O module.
9. Monitor tags.
9.1. Select the style used to display the tag's value.
9.2. Manually enter data into the tag's value and toggle bit values.
10. Replace a processor module.
10.1. Perform the required steps to replace a processor module.
10.2. Update firmware.
11. Upload/download project files and create back-ups.
11.1. Differentiate between upload and download.
11.2. Create back-up files.
12. Replace and wire I/O modules.
12.1. Describe types of discrete (digital) and analog modules.
12.2. Describe the difference between "electronic keying" and "mechanical keying".
12.3. Describe the difference between sinking and sourcing inputs.
13. Discuss major failure modes in an automated system and use available information to restore a system to Automatic operation.
13.1. Describe why understanding I/O modules and associate d components is so important for an electrician or technician.
13.2. Describe the main reasons for stoppage while in Automatic.
13.3. Systematically troubleshoot a common tooling fault.
14. Reset fuses on an output module.
15. Describe the specific Rockwell hardware and software of the AMTEC Manufacturing System Simulator.
16. Identify and trace I/O wiring on the AMTEC Manufacturing System Simulator.

AMT 1033ab: PLC – Programming Allen-Bradley PLC's (Module 16)

Lecture Contact Hours: 10
Lab Contact Hours: 20

Description:

Competencies:
1. Work with project files, tasks, programs and routines.
1.1. Modify the main task.
1.2. Mofify the main program.
1.3. Modify the main routine.
1.4. Inhibit a task.
1.5. Inhibit a program.
2. Define terminology associated with ladder logic programming.
2.1. Rung
2.2. Contact
2.3. Coil
2.4. XIC
2.5. XIO
2.6. OTE

2.7. OUT
2.8. OTL
2.9. Explain the difference between normally open and normally closed contacts.

3. Write a basic ladder logic program.
   3.1. Insert a rung.
   3.2. Add XIC and XIO instructions to an existing rung.
   3.3. Add branches to an existing rung.
   3.4. Add OTE instruction(s) to a rung.
4. Control program flow in a ladder logic program.
   4.1. Use the SUBR instruction.
   4.2. Use the JSR instruction.
   4.3. Use the RET instruction.
5. Work with timers and counters within a ladder logic program.
   5.1. Describe the use of timers and counters.
   5.2. Describe timer and counter tags and their members
   5.3. Add a timer or counter to an existing rung in a ladder logic program.
6. Utilize math instructions within a ladder logic program.
   6.1. Describe the following types of math Instructions.
      6.1.1. ADD
      6.1.2. SUBT
      6.1.3. MUL
      6.1.4. DIV
      6.1.5. AVE
      6.1.6. EQU
      6.1.7. GEQ
      6.1.8. GRT
      6.1.9. LES
      6.1.10. LIM
      6.1.11. NEQ
      6.1.12. CMP
      6.1.13. AND
      6.1.14. OR
   6.2. Describe the differences between arithmetic,relational, logical trigonometric, and conversion instruction categories.
   6.3. Add math instructions to an existing rung within a ladder logic program.
7. Explain the special instructions within RSLogix 5000 and how they are typically used.
   7.1. File Instructions
      7.1.1. COP
      7.1.2. MOV
      7.1.3. MVM
      7.1.4. FLL
      7.1.5. FBC
   7.2. Proportional, Integral, Derivative (PID) Instructions
   7.3. Sequencers

7.4. Shift Instructions
7.5. FIFO Instructions
7.6. System Values (GSV and SSV)

8. Describe the components and RSLogix 5000 instructions associated with motion and velocity control.
   8.1. Describe the components associated with a single axis loop.
   8.2. Describe the difference between incremental and absolute positioning.
   8.3. Describe the concepts of linear and circular interpolation.
   8.4. Describe RSLogix 5000 instructions commonly used to accomplish motion control.
      8.4.1. MSO
      8.4.2. MSF
      8.4.3. MAS
      8.4.4. MAH
      8.4.5. MAJ
      8.4.6. MAM
9. Explain the basic concepts of structured text programming.
   9.1. Selecting structured text as the language type for a routine.
   9.2. Describe the use of assignment statements.
   9.3. Arithmetic operators and arithmetic functions
   9.4. Relational operators
   9.5. Logical operators
   9.6. Constructs
      9.6.1. If Then
      9.6.2. For Do
      9.6.3. While Do
      9.6.4. Repeat Until
      9.6.5. Case Of
10. Utilize structured text programming to develop routines.
   10.1. Create a new routine using structured text as the language type.
   10.2. Add comments to a structured text routine
   10.3. Use assignment statements within a structured text routine.
   10.4. Program a simple routine using structured text.
11. Describe how sequential function chart programming differs from ladder logic and structured text programming.
12. Describe which types of applications are good candidates for using sequential function chart programming.
13. Describe the basic elements of sequential function chart programming:
   13.1. Linear Sequence
   13.2. Concurrent Processing
   13.3. Branching
   13.4. Actions
   13.5. Transitions
14. Create a simple sequential function chart routine.
15. Explain how function block programming differs from the other types of programming.

16. Explain which types of applications are good candidates for using function block programming.
17. Describe the basic concepts of function blocks.
    17.1. Inputs
    17.2. Outputs
    17.3. Wiring
    17.4. Feedback
    17.5. Order Of Execution
18. Use various types of function blocks within a routine.
    18.1. Mathematical
    18.2. Timers
    18.3. Counters

AMT 1034ab: PLC – Allen-Bradley PLC Communication (Module 17)

Lecture Contact Hours: 10
Lab Contact Hours: 20

Description:
Introduces various elements of industrial communications using PLCs. Addresses common types of control communications in an industrial environment. Includes discussion of PLC addressing used in communications.

Competencies:
1. Describe the levels and types of communications used in a conventional industrial network.
2. Describe common types of data communications and their characteristics.
3. Describe the use of Producer/Consumer Tags to exchange data between ControlLogix processors.
4. Describe the difference between data communicated via Producer/Consumer Tags and the Message (MSG) Instruction.
5. Use a Message (MSG) Instruction to communicate data from one processor to another when the data does not need to be updated at specific intervals.
6. Analyze the types of communications used on the AMTEC Manufacturing Systems Simulator.
7. Use DeviceNet protocol.
   7.1. Add/commission node.
   7.2. Set parameters.
   7.3. Identify maximum length.
   7.4. Identify baud rate.
   7.5. Install EDS (electronic data sheet) files.
   7.6. Use appropriate cables (various).
   7.7. Set up DNI devices.
8. Use Data Highway protocol.
   8.1. Add/commission node.
   8.2. Set parameters.

8.3. Identify maximum length.
8.4. Identify baud rate.
8.5. Use appropriate cables (blue hose).

9. Use Ethernet TCP/IP protocol.
   9.1. Identify and set address.
   9.2. Identify and set subnet mask.
   9.3. Identify and set gateway.
   9.4. Install drivers for network card.
   9.5. Identify maximum cable lengths.
10. Troubleshoot communication systems in PLC.
   10.1. Interpret error code using manual.
   10.2. Determine if PLC or terminal problem using specialized diagnostic tests.
   10.3. Check wiring connections; replace connections and/or wiring.
   10.4. Locate bad remote modules by troubleshooting network.
   10.5. Diagnose intermittent problems.
11. Install communication components.
   11.1. Set parameters such as master, slave, number of stations.
   11.2. Determine amt. of information to be communicated such as bytes.
   11.3. Set dip switches and baud rates.
   11.4. Install proper cabling.
   11.5. Determine and install module types.
   11.6. Determine type of communication to be used.
   11.7. Install terminating resistors.

AMT 1041: Blueprint Reading/Schematics – Drafting Fundamentals (Module 18)

Lecture Contact Hours: 11
Lab Contact Hours: 4

Description:
This module provides the student with the fundamental information in drafting necessary to retrieve read, manipulate and understand a mechanical part print. In addition, he or she should be able to identify different types of prints as well as being able to analyze them.

Competencies:
1. State the definition of a print.
2. Identify different types of prints.
3. Name the uses of prints.
4. List and explain the six (6) steps in reading a print.
5. Identify and name the different types of lines that are typically found on prints.
6. Define the different types of lines found on prints.
7. Explain the purpose of each type of line.
8. Identify and define orientation and shape terminology
9. Recognize and name a variety of geometric shapes.
10. State the definition of a scale.
11. Explain the difference between a scale and a rule.
12. Identify the different types of scales.
13. Explain the use of scales.
14. Define and give examples of orthographic projection.
15. Explain the 3 principal planes of projection as they relate to the development of views.
16. Explain and demonstrate how multiviews are developed.
17. Demonstrate how multiviews are read.
18. Identify the different views.
19. Differentiate between 2D and 3D views.
20. Show the difference between 3rd angle projection and 1st angle projection.
21. Provide a definition of sketching.
22. Explain the importance of sketching.
23. Explain the different types of sketches.
24. Describe the procedure to sketch horizontal, vertical, and inclined lines.
25. Describe the procedure to sketch arcs, a radius, circles, and an ellipse.
26. Explain the importance of proportional sketching.
27. State the definition of an auxiliary view.
28. Explain how auxiliary views are developed.
29. Explain how auxiliary views are used on a print.
30. State the definition of a section view.
31. Identify and name the two types of lines used with section views.
32. Identify the seven kinds of section views.
33. Show the difference between each kind of section view.
34. Explain the purpose for each kind of section view.

35. Describe how an isometric drawing is developed.
36. Explain the difference between an oblique and a perspective drawing.
37. Explain the purpose of a pictorial view.
38. Identify and describe the elements of a dimension.
39. Define the use of a leader line.
40. State the four general rules for dimension placement
41. Define tolerance
42. Identify the different types of tolerance.
43. Explain the importance of tolerances
44. Identify and interpret dimensions and tolerances
45. Describe the system for standard tolerances and their application.
46. Explain the concept of a datum reference system
47. Describe the use of feature control frames
48. Identify and explain the use of the three material conditions.
49. Recognize the primary symbols used in geometric dimensioning and tolerancing.
50. Define the four types of notes normally found on a print.
51. Recognize and describe the information given in a bill of materials.
52. Explain the importance of a revision note section.
53. Describe the information found in a revision notes block.
54. Identify and explain general notes on a print.
55. Identify and explain local notes on a print.
56. Explain the purpose of the title block.
57. Identify each area of the title block.
58. Name the areas that are typically found in a title block.
59. Explain the information located in the identified areas of a title block.

AMT 1042: Blueprint Reading/Schematics – Symbols and Schematics (Module 19)

Lecture Contact Hours: 11
Lab Contact Hours: 4

Description:
This module helps the learner to recognize, identify, describe, and relate the components used in schematics, along with their symbols and connectors, to describe electrical, electronics, pneumatics, hydraulics, and piping circuits, as well as welding and joining symbols interpretation.

Competencies:
1. State the definition of a schematic.
2. List 4 characteristics of schematics.
3. Identify a schematic from various kinds of technical drawings.
4. Explain how flow is indicated on a schematic.
5. Identify types of lines on schematics.
6. Identify the following schematics by their symbols:
   6.1. Electrical

6.2. Electronic
6.3. Fluid-power
6.4. Piping

7. Give the purpose of legends.
8. Describe a set-by-step approach to troubleshooting using a schematic.
9. State the meaning of symbols and lines on an electrical schematic.
10. Explain how to trace an electrical circuit.
11. State the meaning of symbols and lines on an electronics diagram.
12. Explain how to trace an electronics circuit.
13. Explain the purpose of a wiring diagram.
14. Demonstrate how to read an electrical schematic.
15. Identify the objects represented by the symbols on an industrial schematic.
16. Explain the difference in current flow between a series circuit and a parallel circuit.
17. Name the ways of joining pipe.
18. Identify the symbols for various kinds of fittings
19. Describe the function of a given fitting.
20. Explain the function of various components in a piping system.
21. Read & explain flow in a simple piping schematic.
22. Explain the function of a valve in a piping system.
23. Identify the symbols for various types of valves.
24. Explain the difference between a check valve and a ball valve.
25. Demonstrate the ability to determine pipe size from a diagram.
26. Describe a fluid power system.
27. List and give the purpose of the main parts of a hydraulic system.
28. List and give the purpose of the main parts of a pneumatic system.
29. Explain the purpose of local areas shown on a hydraulic or pneumatic diagram.
30. Identify & name the various components in a hydraulic or pneumatic diagram.
31. Describe a composite symbol.
32. Explain the purpose of local areas on a hydraulic or pneumatic diagram.
33. Explain the process of fusion welding.
34. Name the main methods of fusion welding.
35. Name the 5 types of joints and 3 ways of welding each joint.
36. Demonstrate how to read and interpret a complete welding symbol.

AMT 1051: Robotics – Introduction to Robotics (Module 20)

Lecture Contact Hours: 8
Lab Contact Hours: 2

Description:
The purpose of this module is to introduce students to robotics in regards to safety, types of robots, applications, basic components, terms and definitions.

Competencies:
1. Define a robot.
2. Describe history of industrial robotics.
3. Explain importance of industrial robot safety.
   3.1. Describe lock out/tag out safeguards.
   3.2. Describe common controls for stopping robot in emergencies.
   3.3. Identify safety devices.
   3.4. Describe proper safety training.
4. Describe basic component.
5. Describe different parts of robot body.
6. Describe coordinate systems.
7. Describe different robot teaching methods.
8. Describe servo motors.
9. Describe encoders.
10. Describe robot's controller.
11. Describe teach pendant.
12. Define end of arm tooling (EOAT).
    12.1. Identify end effector types.
    12.2. Describe grippers.
    12.3. Describe factors for gripper selection.
    12.4. Describe compliance.
13. Describe the reasons manufacturers use robots.
    13.1. Describe advantages and disadvantages.
    13.2. Describe welding robots.
    13.3. Describe material handling robots.
    13.4. Describe machine tending robots.
    13.5. Describe spraying/painting robots.
    13.6. Describe assembly robots.
    13.7. Describe fabrication and processing robots.
    13.8. Describe inspection robots.
14. Describe robot axes.
15. Identify Cartesian axes.
16. Describe coordinate systems.
17. Describe rotary and linear motion.
18. Describe degrees of freedom.

19. Describe types of paths robots can be programmed to take.
    19.1. Describe robot programming.
    19.2. Describe walk-through programming.
    19.3. Describe lead through programming.
20. Describe robot simulator programs.
21. Describe robot sensors.
    21.1. Explain the role of the controller for robot sensors.
    21.2. Identify common types of sensors.
    21.3. Describe robot vision.
    21.4. Describe role of sensors in robot safety.

AMT 1052: Robotics – Programming/Editing Robots (Module 21)

Lecture Contact Hours: 15
Lab Contact Hours: 15

Description:
This module is an introduction to robotic programming and editing. This module will review and allow the student to demonstrate robotic motion control, fundamental programming commands and program editing. Through lectures and labs students will learn the fundamentals of robot control.

Competencies:
1. Perform robot start up; control coordinate systems and motion systems.
   1.1. Power up robotic system.
   1.2. Control robotic coordinate systems.
   1.3. Control robotic motion systems.
2. Create and write programs.
   2.1. Create a robot program.
   2.2. Create a point within a robot program.
   2.3. Create a position register.
   2.4. Describe step mode for verifying a robot program and how it differs from continuous mode.
   2.5. Move a robot forward and backwards through a robot program.
   2.6. Program a robot to avoid singularity.
3. Copy, delete and edit programs.
   3.1. Open a program on teach pendant.
   3.2. Copy a program on teach pendant.
   3.3. Delete a program on teach pendant.
   3.4. Edit program lines.
   3.5. Make program adjustments in a robot program for both online and offline conditions.
4. Program instructions.
   4.1. Compare conditional versus unconditional program branching.
   4.2. Describe “Register” and its use for programming.
   4.3. Change the user frame number in a program.

4.4. Change the tool frame number in a program.
4.5. Manipulate position register elements.
4.6. Use wait instructions.
4.7. Use digital input/output instructions.
4.8. Describe macros used on the robot.

5. Manipulate files.
   5.1. Back up robot programs to a portable storage device.
   5.2. Load robot programs from a portable storage device.

AMT 1053: Robotics – Robot Maintenance and PM (Module 22)

Lecture Contact Hours: 2
Lab Contact Hours: 2

Description:

This module is intended to instruct an operator, technician, engineer, programmer or student to master a robot and replace battery backups.

Competencies:

1. Master the robot backup system.
   1.1. Explain mastering concepts.
   1.2. Describe backup batteries and components.
2. Perform PM on robot components.
   2.1. Describe lubrication of robotic systems.
   2.2. Describe maintenance of EOAT and sensors.

AMT 1054: Robotics – Troubleshooting Robots Using Error Codes (Module 23)

Lecture Contact Hours: 10
Lab Contact Hours: 11

Description:

This module is intended to instruct an operator, technician, engineer, programmer or student on error codes and how to interpret them.

Competencies:

1. Read robot error codes.
   1.1. Locate correct error code(s).
   1.2. Interpret error code(s).
2. Use error codes to return robot to normal operations.
   2.1. Troubleshoot robot based on error code analysis.
   2.2. Repair robot.
3. Use correct robot recovery procedures.
   3.1. Back up robot.

3.2. Start up robot after recovery.

AMT 1055: Robotics – Integration of PLC with Robotics (Module 24)

Lecture Contact Hours: 3
Lab Contact Hours: 12

Description:
This module introduces the student to the concepts associated with integrating robotic applications in a PLC-controlled, automated system. The standard safety and interface signals associated with integrated systems are discussed. Various types of robotic applications are discussed along with the interface signals typically associated with each application. Programming concepts that support optimizing cycle time are also stressed.

Competencies:
1. Describe the processes involved in system integration.
2. Describe the basic elements associated with developing a controls architecture.
3. Describe items to be considered concerning safety circuits when developing a controls architecture.
   3.1. Describe the concept of Control Reliability.
   3.2. Describe the options available for handling Safety Signals.
4. Describe the levels of communications to be considered when developing a controls architecture.
5. Describe common approaches to integrating robotic applications within an automated system.
6. Describe Operator Shared Workspace and components associated with designing a safe Operator Shared Workspace.
7. Describe the process referred to as Mapping I/O.
8. Describe Scope of Control and typical signals shared between multiple PLC's controlling a manufacturing application.
9. Describe System Integration.
10. Describe the elements required when integrating robotic applications with PLC-controlled systems.
11. Describe the major concepts associated with vision applications within manufacturing.
12. Describe various types of FANUC I/O.
13. Describe various types of FANUC software.

AMT 1061: Controls & Instrumentation – Fundamentals (Module 25)

Lecture Contact Hours: 6
Lab Contact Hours: 4

Description:
The purpose of this course is to teach the student how to troubleshoot/replace/install circuit boards.

Competencies:
1. Identify and describe the various steps of the SIMPLER troubleshooting method techniques and other fault troubleshooting methods.
2. Define the following terms related to controls & instrumentation:
   2.1. Noise
   2.2. Black Box
   2.3. Opens
   2.4. Shorts
   2.5. Fuse Puller
   2.6. Intermittent Fault
   2.7. Oxidation
3. Describe the half-splitting method.
4. Perform troubleshooting procedures using voltmeters, ammeters, ohmmeters, and oscilloscopes.
5. Determine if a component is open or shorted using various types of test instruments.
6. Perform fundamental troubleshooting on the following components to determine if they are defective:
   6.1. Switches
   6.2. Fuses
   6.3. Inductors
   6.4. Capacitors
   6.5. Transformers
7. Describe how static electricity is formed and how it destroys instruments as a charged body discharges.
8. List and explain the factors that affect the amount of static charge that develops.
9. Explain shielding and how it prevents an object from being damaged during discharge.
10. List and describe ways in which ESD can be prevented or minimized in an industrial environment.
11. Define the following terms:
    11.1. Wetting
    11.2. Tinning
    11.3. Flux
    11.4. Solder sucker
    11.5. Wave soldering machine
12. Describe the visual appearance of a good and bad solder connection.

13. Explain the proper and improper steps of the soldering procedure.

AMT 1062: Controls & Instrumentation – Sensors and Photoeyes (Module 26)

Lecture Contact Hours: 8
Lab Contact Hours: 8

Description:
The purpose of this module is to introduce students to photoeyes, limit switches, proximity switches and other common input devices in regards to installation, maintenance and troubleshooting.

Competencies:
1. List the advantages and disadvantages of proximity sensors.
2. Explain the operation of a polarized optical sensor.
3. Describe the difference between visible and infrared LEDs.
4. Explain the operation of the following optical sensing methods, their physical layout, applications (i.e. types of targets), and if they are light-to-dark or dark-to-light devices.
   4.1. Opposed
   4.2. Reflective
   4.3. Diffuse
5. Describe the variables that affect the operating range of an optical sensor.
6. Define excess gain, and given the percentage of light produced by the emitter, determine the required excess gain to overcome any loss of light.
7. Describe how the size of the reflector affects the ability of a retro-reflective sensor to detect a target.
8. Explain how the different types of timing adjustments affect the operation of optical sensors.
9. Describe the difference between sinking and sourcing connections of an optical sensor.
10. Define the following terms related to discrete motion sensors:
    10.1. Lateral
    10.2. Axial
    10.3. Switching frequency
    10.4. Ferrous metal
    10.5. Non-ferrous metal
    10.6. Dielectric constant
    10.7. Load
    10.8. Concentrators
11. List the types and applications of limit switches and guidelines that should be followed when mounting them.
12. Describe the operation and applications of reed switches.
13. Describe the operation, characteristics, and applications of hall-effect sensors.
14. Identify the types of materials that an inductive proximity detector can sense.
15. Describe what happens to the oscillator of an inductive and capacitive proximity detector when it senses a target.

16. List the factors that affect the ability of an inductive sensor to detect a target and identify how these factors affect the sensing distance.
17. Describe how conductive and non-conductive targets affect the capacitance of a capacitive proximity detector.
18. List the factors that affect the ability of an inductive sensor to detect a target and and explain how the sensitivity adjustment setting can affect the sensor's ability to detect targets of different thicknesses.
19. Explain in detail the hysteresis (differential travel) properties of motion detection sensors.
20. Define the following terms related to pressure sensors:
    - 20.1. Pressure
    - 20.2. Head
    - 20.3. Hydrostatic Pressure
    - 20.4. Differential Pressure
    - 20.5. Inches of Water Column
21. Explain how a temperature change affects the boiling point of a liquid in an open container.
22. Identify three factors that affect force on a liquid.
23. Describe how a varying atmospheric pressure can affect the hydrostatic pressure of a liquid in an open container.
24. List the reference value for gage, absolute, and vacuum pressure.
25. Convert psia to psig, and psig to psia.
26. Identify the difference between direct, indirect, and inferred measurements.
27. Describe the operation of the following pressure measuring devices:
    - 27.1. Mechanical Gauges
    - 27.2. Semiconductor Strain Gauge
    - 27.3. Manometer
    - 27.4. Diaphragm
    - 27.5. Bourdon Tube
    - 27.6. Bellows
    - 27.7. Capacitive Sensors
28. Provide the different types of standard electronic and pneumatic transmission signals produced by a transmitter and their numerical ranges.
29. Define the following terms related to temperature instruments:
    - 29.1. Absolute Zero
    - 29.2. Condensation
    - 29.3. Ambient Temperature
    - 29.4. Temperature
    - 29.5. Black Body
    - 29.6. Positive Temperature Coefficient (PTC)
    - 29.7. Negative Temperature Coefficient (NTC)
30. Explain the Law of Thermodynamics.
31. List and describe the three category types of heat transfer.
32. Identify the Fahrenheit and Celsius temperature scales, list their freezing and boiling points, and convert specific values from one scale to the other.
33. Define BTU and calorie and explain how they relate to temperature.

34. Describe the principle of operation for the following temperature measurement instruments:
    - 34.1. Thermocouple
    - 34.2. Resistance Temperature Detector (RTD)
    - 34.3. Thermistor Radiation Thermometry Devices
35. Define the following terms related to process, flow, and analytical:
    - 35.1. Flow
    - 35.2. Inferred Measurements
    - 35.3. Custody Transfer
    - 35.4. Level
    - 35.5. Interface
    - 35.6. Non-Invasive
    - 35.7. Humidity
    - 35.8. Dew Point
    - 35.9. Reagent
    - 35.10. Buffer
    - 35.11. Neutral
36. Describe volumetric flow rate, flow velocity, and mass flow rate, and explain the difference between them.
37. Describe the operation of the following flow measurement instruments:
    - 37.1. Differential Pressure
    - 37.2. Lobed Impeller
    - 37.3. Corioles Meter
38. List the types of measuring devices typically used for point level measurements and continuous measurements.
39. Describe the operation of the following level measurement instruments.
    - 39.1. Bubbler (Purge)
    - 39.2. Capacitive Probe
    - 39.3. Hydrostatic Pressure Detector
    - 39.4. Ultrasonic Sensor
    - 39.5. Differential Pressure Detector
    - 39.6. Load Cell Detector
40. Identify acidic and alkaline solutions by definition, pH value, and molecular structure, and describe how to make them neutral.
41. Explain how water vapor forms when the dew point is reached.
42. Describe the operation of a pH analyzer and a chilled-mirror.

AMT 1063: Controls & Instrumentation – Calibration and Loop Tuning (Module 27)

Lecture Contact Hours: 4
Lab Contact Hours: 8

Description:
The purpose of this module is to introduce students to the modes of control: on-off, proportional, integral, and derivative; the affect each mode has on maintaining the process quality; how loop tuning will assure that the process will meet quality standards efficiently and maintain the standards.

Competencies:
1. Define the following common industrial control systems terms:
   1.1. Servomechanisms
   1.2. Motion Control
   1.3. Batch Process Control
   1.4. Continuous Process Control
   1.5. Feedback
   1.6. Sequential Process
2. Describe the function of the following elements in an open-loop and closed-loop industrial control system:
   2.1. Comparator
   2.2. Actuator
   2.3. Controller
   2.4. Measurement Device
   2.5. Manufacturing Process
   2.6. Input Device
3. List the following signals that are produced or affect the elements of open and closed-loop industrial control systems:
   3.1. Set Point
   3.2. Controlled Variable
   3.3. Command Signal
   3.4. Feedback Signal
   3.5. Disturbance
   3.6. Error Signal
4. List and explain three types of control modes performed by the controller in a closed loop system.
5. List and describe the differences between open-loop systems and closed-loop feedback systems.
6. Describe the operation of feed-forward control.
7. Provided with tables and charts which represents P&IDs (Piping and Instrumentation Diagrams), interpret this information to answer questions about:
   7.1. Symbols
   7.2. Letters
   7.3. Numbers

7.4. Lines
7.5. Loop functions
7.6. P&ID system diagrams

8. List the elements of a closed-loop system on a P&ID and describe the types of operational characteristics the system provides based on the drawing.
9. Identify the following elements in a closed-loop system:
   9.1. Primary element
   9.2. Control valve
   9.3. Controller
   9.4. Heat exchanger
   9.5. Sensor
   9.6. Feedback loop
   9.7. Actuator
   9.8. Transducer
   9.9. Transmitter
   9.10. Final control element
10. List and describe the information provided by an Information Block.
11. List the circumstances that require the calibration of instruments in a closed-loop system.
12. Properly select and assemble the instruments required to perform the calibration procedure.
13. Describe when calibration procedures should be performed.
14. Recognize zero and span errors so that they can be properly corrected.
15. List the common standard transmission signals produced by transmitters and how they pertain to zero and span.
16. Describe what the standard transmission signals represent, and interpret their numerical values.
17. List the different functions that are performed by a process calibrator, and when they should be used.
18. Define the following terms related to tuning a controller:
    18.1. PID
    18.2. Offset
    18.3. Steady state error
    18.4. Responsive
    18.5. Sluggish
    18.6. Reset
    18.7. Rate
19. Identify how the proportional, integral, and derivative modes are affected by certain conditions in a closed loop system, and they respond to them.
20. List the preliminary steps that should be taken before tuning a controller.
21. Define the following tuning terms and identify their abbreviation:
    21.1. Ultimate Proportional Gain Value (GU)
    21.2. Ultimate Period (PU)
    21.3. Process Identification
22. Describe the Ziegler-Nichols Continuous Cycling Method used for tuning a controller.

23. Given a process identification waveform on a graph, the ultimate proportional setting and the appropriate formulas, determine the following values using the Ziegler-Nichols Continuous Cycling Method for a proportional-integral-derivative controller:
    23.1. Ultimate Period
    23.2. Proportional Gain Setting
    23.3. Proportional Band Setting
    23.4. Integral Setting (Reset Rate or Reset Time)
    23.5. Derivative Setting
24. Describe how the ¼ decay ratio reaction curve is used to verify the controller settings and how controller adjustments are made if it is not properly tuned.
25. Identify the mode in which the controller is set (manual or automatic) when performing the process identification procedure and the ¼ decay ratio reaction curve verification method, and whether the controller is open or closed-loop.

AMT 1064: Controls & Instrumentation – Final Control Elements (Module 28)

Lecture Contact Hours: 24
Lab Contact Hours: 38

Description:
In this module, students will be introduced to final control elements including AC, DC, and servo motors, variable speed drives, motor control, relays and motor starters. Students will become proficient in troubleshooting motors and variable speed drives, adjusting speed and direction; interpreting relay logic and sizing of components for various applications.

Competencies:
1. Describe the differences between motion and process control manufacturing equipment.
2. List and describe the different types of motions that are controlled by servomechanisms.
3. Describe the types of linear signals produced by a tachometer to indicate velocity and direction.
4. Explain the various types of motion measurements that can be made by a potentiometer, and the types of signals it produces.
5. Provide information from the following list regarding the incremental encoder.
    5.1. Use of a counter
    5.2. Pattern of optical tracks
    5.3. Effects from power loss
    5.4. Position
    5.5. Velocity Measurements
    5.6. Resolution
6. Provide information from the following list regarding the absolute encoder.
    6.1. Effects from power loss
    6.2. Characteristics of the Gray code
    6.3. Converting Gray to binary on paper and by using logic gates
    6.4. Converting binary to Gray on paper and by using logic gates

6.5. Pattern of the optical tracks on a Gray code wheel
6.6. Types of measurements it makes
6.7. Resolution

7. Describe the operation of the resolver, what types of measurements they are capable of making, and in what situations they are used.
8. Analyze and explain the operation of a closed-loop velocity system.
9. Analyze and explain the operation of a closed-loop position system.
10. Describe the differences between conventional DC motors, servo motors, and stepper motors.
11. Define the following terms related to DC motors:
    11.1. Motor Action
    11.2. Commutator
    11.3. Commutation
    11.4. Compensating Windings
    11.5. Main Field
    11.6. Rotor
    11.7. Brushes
    11.8. Torque
    11.9. Armature
    11.10. Neutral Plane
    11.11. Armature Reaction
    11.12. Interpoles
    11.13. CEMF
    11.14. Speed Regulation
12. Given the direction of current flow through a wire and the polarity of the magnetic field it is placed within, identify which direction the conductor will move.
13. Explain the right-hand rule for motors.
14. Describe the operation of the following DC motors, their wiring configurations, and their operational characteristics.
    14.1. Series
    14.2. Shunt
    14.3. Compound
15. Explain how CEMF affects armature current, magnetic field strength, speed, and the torque of a DC motor as load conditions change.
16. Describe how CEMF has an effect on speed regulation, and why a motor draws a large amount of current when it is starting or stalled.
17. Label the leads of the various field and armature coils of a DC motor.
18. Explain how to change the direction of the DC motor.
19. List the characteristics, operation, and applications of the following types of servo motors:
    19.1. Moving Coil DC Motor
    19.2. Brushless DC Motor
20. Given the number of stepper pulses applied per second to a stepper motor and the step angle, determine RPMs.

21. Given the number of degrees between the salient poles, and the number of degrees between the rotor poles, determine the step angle of a VR stepper motor.
22. Given the sequence (direction) that the stator poles are energized, identify the direction the rotor of a VR motor turns.
23. List and explain the causes that make ac motors fail.
24. Define the following terms related to AC motors:
    - 24.1. Synchronous Speed
    - 24.2. Rotor
    - 24.3. Stator
    - 24.4. Slip
    - 24.5. Main Winding
    - 24.6. Run Winding
    - 24.7. Auxiliary Winding
    - 24.8. Start Winding
    - 24.9. Phase-Splitting
    - 24.10. Armature
    - 24.11. Field Coils
    - 24.12. Single-Phasing
25. Describe the operation of a squirrel cage induction motor.
26. Given the number of poles and the frequency applied to the stator windings, determine the synchronous speed of an AC motor.
27. Given the applied frequency and the rotor speed, determine the slip of an AC induction motor.
28. Describe what happens to the synchronous speed, slip, rotor current, rotor speed, and torque when the physical load to which an induction motor
29. Explain the operation and the physical components of the capacitor-start split-phase AC induction motor.
30. Describe the symptoms of a split-phase AC motor when the capacitor becomes defective. .
31. Given the AC waveforms and stator winding diagram of a three-phase motor, indicate the direction of current flow through the stator coils and the direction of the resultant field during various time periods.
32. Indicate how the rotational direction of 3-Phase AC motors are reversed.
33. Interpret information listed on a motor nameplate.
34. Describe how to change the speed of an AC motor.
35. Explain how to save energy consumption of an AC motor.
36. List the sections of an AC drive, and identify which circuits are used in each one.
37. Explain the operation and purpose of the following circuits:
    - 37.1. Converter
    - 37.2. Inverter
    - 37.3. Intermediate Circuit
    - 37.4. Control Circuit
    - 37.5. Operator Control Panel
38. List the function of the diodes placed across the switching transistors in the inverter.
39. Describe the self-speed regulating capabilities of an AC motor.

40. Identify where the simulated voltage of a drive is applied to an AC motor.
41. Explain the V/Hz operation and what occurs in the stator winding if this function is not provided when the frequency is changed to vary the speed of the motor.
42. List the conditions that cause a fault trip action to occur.
43. Describe how the width of the PWM voltage spikes cause voltage to be varied.
44. Define the following terms:
    - 44.1. Acceleration
    - 44.2. Deceleration
    - 44.3. IGBTs
    - 44.4. Overhauling
    - 44.5. Slip
    - 44.6. Overcurrent
45. Explain the difference between overload current and short circuit current, and what causes them to develop.
46. Describe the operation of fuses in a motor starter circuit and the conditions that cause them to blow.
47. Explain what the different contacts in a motor start are used for, and what causes them to open or close.
48. Describe the operation of the different types of overload heaters and the conditions that cause them to trip open.
49. Explain how arcing is created when power is removed, and how they are suppressed using arc chutes.
50. Describe the operation of the control circuit in a motor starter.
51. List the reasons for using motor starters.

AMT 1071: Basic Electricity and Electronics – Introduction to Basic Electricity (Module 29)

Lecture Contact Hours: 10
Lab Contact Hours: 12

Description:
This course introduces the student to the various elements of basic electricity including the identification of electrical symbols as well as interpretation of schematics, cross referencing prints, tracing circuits, interpreting sequential function charts, line drawings and time charts.

Competencies:
1. Describe the importance of observing electric safety.
2. Describe the fundamental concepts of electricity.
3. Describe why electrical safety hazards occur.
4. Describe grounding.
5. Describe how different current levels affect the human body.
6. Describe the ways in which electric shock can be received.
7. List the steps that should be followed when treating an individual who receives an electric shock.
8. Describe the causes and the danger of burns caused by electricity.
9. Describe the various practices that should be followed to prevent electrical hazards.
10. Describe how various types of electrical devices are engineered to prevent electrical hazardous conditions from occurring.
11. Describe the basic structure of the atom.
12. Explain the characteristics of insulators and conductors
13. Describe how an atom becomes an ion.
14. Explain the process of current flow.
15. List the six sources of electricity and explain how they produce electrical pressure.
16. List the requirements of an electrical circuit.
17. Define voltage and give the letter for its unit of measure.
18. Define current and give the letter for it unit of measure.
19. Define resistance and give the symbol and letter for its unit of measure.
20. Define conductance and give the letter for its unit of measure.
21. Define power and give the letter for its unit of measure.
22. Identify various types of fixed resistors and describe the characteristics of each one.
23. Interpret the resistor color code.
24. List the factors that determine the resistance of wires, their current carrying capacity, and be able to size them.
25. Define grounding and list practical applications in electrical circuitry.
26. Describe the construction of the different types of variable resistors and explain applications they are used for.
27. Explain how to connect various types of switches and pushbuttons for various types of applications.
28. Describe the operation of circuit protection devices.

29. Identify standardized symbols used in schematic diagrams that represent various electronic components.
30. Following schematic diagrams, assemble electronic circuits using the Squiggly Line Method.
31. Describe how to setup, connect and operate a multimeter to measure voltages in a circuit.
32. Explain how to setup, connect and operate a multimeter to measure current in a circuit.
33. Describe how to setup, connect and operate a multimeter to measure the resistance of a component or a circuit.
34. Define an open condition and explain how to use a meter to identify an open circuit or component.
35. Define a shorted condition and explain how to use a meter to identify a shorted circuit or component.
36. Demonstrate how to use an ohmmeter to determine the operation of a component.
37. Describe the relationships of current, voltage and resistance.
38. Use Ohm's law equations to solve for electrical circuit values.
39. Perform numerical conversions using Metric Prefix method.
40. Explain the relationships between energy, work and power.
41. Use Watt's law equations to solve for electrical circuitry values
42. Using both Ohm's law and Watt's law, select the proper equation to determine either the voltage, current, resistance or power values in a circuit when any two of the other values are known.
43. Define the term series circuit with regard to physical and electrical description.
44. Solve series circuit problems by calculating the following parameters using Ohm's law and Watt's law.
    - 44.1. Total Resistance
    - 44.2. Total Current
    - 44.3. Total Voltage
    - 44.4. Total Power
45. Voltage drops, currents and power dissipated at individual resistors.
46. Explain the effects on the circuit parameters listed in objective 2 when an open develops.
47. Explain the effects on the circuit parameters listed in objective 2 when a shorted component develops.
48. Given the voltage value of the power sources used by a series circuit list the voltage that will be found across one of its resistor that is open, or that is shorted.
49. Describe how voltage and resistance values at individual resistors compare to the total voltage and total resistance values in a series circuit, based on ratios (or percentages).
50. Determine voltages in reference to ground in a series circuit
51. Indicate the voltage polarity across individual components in a DC series circuit.
52. Use a series circuit as a voltage divider.
53. Define a parallel circuit.
54. Solve parallel circuit problems by calculating the following parameters:
    - 54.1. Total Resistance
    - 54.2. Total Current
    - 54.3. Total Voltage
    - 54.4. Total Power

54.5. Total Conductance
55. Voltage drops, resistance, currents and power dissipated at individual resistors
56. Explain the effects on the circuit parameters listed in step 1 when an open component develops.
57. Explain the effects on the circuit parameters listed in step 1 when a shorted component develops.
58. Determine how the current supplied by batteries can be increased by connecting several in parallel.
59. Explain the effects on the circuit parameters listed in step 1 when the resistor value in one of the parallel branches is changed.
60. Use the three standard formulas for finding equivalent resistance for 2 or more resistors in parallel.
61. Describe the technique required to measure the value of a resistor in one branch.
62. Describe how resistance affects current in a parallel branch.
63. Explain how total current and total resistance is affected by adding parallel branches.
64. Give the voltage, resistance or wattage values of loads connected in parallel, determine the maximum number of branches that can be connected to a power supply before a fuse is blown.
65. Write the laws of attraction and repulsion.
66. Define the following terms:
    66.1. Magnetomotive force (mmf)
    66.2. Magnetic flux
    66.3. Reluctance
    66.4. Permeability
    66.5. Saturation
    66.6. Retentivity
    66.7. Residual magnetism
    66.8. Hysteresis
67. Explain the operation of an electromagnet.
68. List the five basic characteristics of magnetic flux lines.
69. List the four factors that determine the magnetic field strength emitted from an electromagnet.
70. Calculate the quantities of a magnetic circuit.
71. Explain the operation of the following electromagnetic applications and devices:
    71.1. Relay
    71.2. Solenoid
    71.3. Generator action
    71.4. Motor action
72. Define the following terms relating to an AC waveform.
    72.1. Cycle
    72.2. Alternation
    72.3. Period
    72.4. Peak Value (max.)
    72.5. Peak-to-Peak

72.6. Effective Value (RMS)
72.7. Instantaneous Value
72.8. Frequency
72.9. Hertz
72.10. Cycles per Second

73. State the difference between direct current and alternating current.
74. Describe the operation of an AC generator and identify when the voltage is minimum or maximum as the loop of wire rotates through the magnetic field.
75. Draw an AC sine wave and identify items A through G from the top objective.
76. Compute the effective (RMS), peak, peak-to-peak and average (Ave) values of voltages and currents for a sine wave.
77. Identify what type of AC voltage is listed on home appliances and what type of AC voltages are typically listed on schematic diagrams.
78. List the factors which determine the frequency produced by an AC generator.
79. Explain how AC current flows to and from the hot and neutral sockets of a home receptacle.
80. Given the number of AC cycles that occur during a given amount of time, calculate the period of one cycle.
81. Given a frequency, determine its time period in one second.
82. Perform Ohm's Law problems for a resistive circuit and AC volts applied.
83. Describe how RMS AC voltage values compare to DC voltage for heating and identify that it is used by Watt's Law formulas to calculate wattage values dissipated by resistors.

AMT 1072: Basic Electricity and Electronics – Instruments (Module 30)

Lecture Contact Hours: 2
Lab Contact Hours: 4

Description:
This module is an introduction to electrical measurement instruments. Main devices introduced include digital and analog multimeters, clamp-on ammeters, meggars, and the oscilloscope. Hands-on lab time is spent with each device type. Safe measuring techniques are emphasized. Additional devices covered are the pressure gauge, chart recorders, heat sensor and chain stretch monitor.

Competencies:
1. Operate a clamp-on current meter and describe what it is used for and the theory of its operation.
2. List the four major control sections of the oscilloscope.
3. Explain the electrical difference between a 1x and a 10x probe.
4. Identify the source of the signals that are applied to the vertical and horizontal plates of the scope.
5. Describe the significance of the AC-GND-DC switch, and identify which types of signals can be measured at each position.
6. Explain the purpose of triggering, and the function of the following trigger controls:

6.1. Slope
6.2. Level
6.3. Auto
6.4. Normal
7. Explain the function of the DC offset switch on a signal generator.
8. Describe the difference between an attenuator and compensation adjustment on the scope.
9. Explain how the vertical and horizontal controls affect the waveform position of one or both channels.
10. Explain how the SEC/DIV knob affects the waveforms of one or both channels.
11. Describe the difference between the intensity and focus controls on the scope.
12. Given a waveform displayed on a scope, a VOLTS/DIV and SEC/DIV setting, determine the time (Period), Frequency, and P-P Volts at a specified degree of the AC cycle.
13. Given the waveform of two sine waves displayed on a scope, determine the phase difference between them in degrees, and identify which one leads or lags the other one.
14. Explain how to connect chart recorders and describe what they are used for.
15. Describe applications of megohm meters and how to perform tests on wire installations and electric motors.

AMT 1073: Basic Electricity and Electronics – Components & Circuits (Module 31)

Lecture Contact Hours: 7
Lab Contact Hours: 15

Description:
This module concentrates on control logic components and circuit function. Combinational and sequential ladder logic design are thoroughly examined with great attention to reliability of function. Various circuits are constructed that demonstrate key component functionality concepts. Troubleshooting is practiced with analytical techniques utilizing multimeters, chart recorders, and oscilloscopes.

Competencies:
1. List the various names used for industrial control circuits that show its layout of components and wiring configurations.
2. Define the following terms:
   2.1. Energized
   2.2. De-energized
   2.3. Logic 0
   2.4. Logic 1
3. Give the terms use for the vertical and horizontal lines of a ladder diagram, and list abbreviations assigned to portions of the drawing when powered by 3-phase, single phase, and DC power sources.
4. Identify relay ladder diagram symbols that have been standardized by the NMTBA and the automobile industry, and describe how they operate in a circuit.
5. Identify the four fundamental elements of a ladder control circuit and describe the function of each one.

6. List the various types of common manual and automatic input devices used in ladder control circuits, and describe the function of each one.
7. List the various types of direct and indirect output devices used in a ladder logic circuits and describe their operation.
8. Identify ladder control circuits that perform various logic functions, and use truth tables that represent each type of logic circuit.
9. Interpret the ladder diagrams required to perform the following operations:
   9.1. Latching
   9.2. Forward/Reverse
   9.3. Start/Stop
10. Design relay ladder diagrams to perform various operations based on the circuit requirements described.
11. Identify components that are either input or output devices on the rung of a ladder circuit.
12. Identify the parts of a ladder diagram and follow the rules that apply to their labeling scheme.
13. Follow the rules that are permitted when designing and constructing a ladder diagram.
14. Describe the characteristics and uses of various types of manual and automatic switches.
15. Describe the operation and uses of various types of input devices, and identify their schematic symbols.
16. Compare the physical and electrical operations of relays, contactors, and solenoids.
17. Describe the difference between a timer and time-delay device.
18. Describe the characteristics of sequential circuits.
19. Create ladder logic diagrams to solve industrial applications.
20. Explain the difference between overload current and short circuit current, and what causes them to develop.
21. Describe the operation of different types of fuses, their applications, how they are rated, and how to size them.
22. Describe the operation of different types of circuit breakers, their applications, and how to size them.
23. Explain how arcing is created when power is removed, and how they are suppressed using arc chutes.
24. Define the terms selective coordination and describe the difference between the time current and series rated methods.
25. List and describe the factors that determine the ampacity of a wire conductor.
26. Describe how to size wire conductors, and how to derate them.
27. Explain the difference between insulation resistance and dielectric strength.
28. Identify what the different colors of insulation indicate.
29. Provide guidelines listed in the NFPA codes.
30. Define the following terms and abbreviations:
    30.1. Ampacity
    30.2. AWG
    30.3. NFPA
    30.4. NEC
    30.5. Derating

30.6. Overcurrents

AMT 1074: Basic Electricity and Electronics – Solid State Devices (Module 32)

Lecture Contact Hours: 4
Lab Contact Hours: 10

Description:
This module is an introduction to solid state devices and applications. Covers semiconductor theory and operational characteristics of devices such as the diode, bipolar junction transistor (BJT) and field effect transistor (FET). The basic DC power supply is examined in the lab. Concepts such as polarity, biasing, rectification and amplification are also addressed. Commonly used automotive manufacturing equipment serve as examples of solid state device application. Discussed are the camera-type vision system, barcode reader and laser etcher.

Competencies:
1. Define the following terms:
   1.1. Electron
   1.2. Proton
   1.3. Neutron
   1.4. Valance Shell
   1.5. Negative Ion
   1.6. Active Component
   1.7. Trivalent Material
   1.8. Pentavalent Material
   1.9. Semiconductor Crystal
   1.10. Impurities
   1.11. Doping
   1.12. Passive Component
   1.13. Covalent Bonding
2. Describe the properties of conductors, semiconductors, and insulators.
3. Describe the difference between electron flow and hole flow.
4. Explain how P-type and N-type materials are formed, and the difference between them.
5. Explain what is meant by barrier voltage, depletion region, and how it is formed.
6. Describe how forward, reverse, or no biasing, affects the PN junction of a semiconductor, and the resulting current that flows.
7. Identify the forward voltage drops across the PN junction of a silicon diode.
8. Describe how to forward and reverse bias semiconductor diodes, and what the applied voltages that are required at the anode and cathode for each of these conditions.
9. List the most common two ratings of a diode that should not be exceeded.
10. Describe the operation of a zener diode, and the voltage drops that form as the current changes when a series resistor or the supply voltage is varied.
11. Describe the operation of a light emitting diode, what is the purpose of its current limiting resistor, and how the LED should be connected in a circuit.

12. Identify if the condition of a diode is shorted, open, or good, by being given test results with an ohmmeter.
13. Given the applied voltage, indicate the voltage drops across each component of a series circuit that has a diode and resistor, when forward and reverse biased.
14. Describe the operation and identify the components of each section of a DC Power supply.
15. Given the input voltage of a power supply, determine the secondary of the transformer based on the turns ratio, the pulsating dc output voltage of the rectifier, and the dc output of the filter circuit.
16. For each section of a DC power supply, draw the waveforms of the input and outputs at each one.
17. Given the frequency of the applied AC supply voltage, list the frequency of the pulsating DC voltage at the outputs of a half-wave and full-wave rectifier.
18. Given the peak voltage of a pulsating DC voltage of half wave and full wave rectifiers, determine the average voltage.
19. Describe in detail when the diode is forward-biased and reverse-biased, and when the filter capacitor charges and discharges.
20. Describe how changing the values of the filter capacitor, load resistor, and voltage frequency affect the ripple of a dc power supply.
21. Describe the difference between voltage regulation and filtering, and explain in detail how the components for each circuit function to perform their operation.
22. Given the peak-to-peak value of an AC voltage applied to the rectifier, determine the required minimum PIV value of the rectifier diode in the circuit.
23. Describe what happens to the zener diode current and voltage when the load resistor value and the voltage changes.
24. Given various symptoms of a defective filtered rectifier circuit, determine the cause of the fault.
25. Describe the basic construction and operation of a bipolar junction transistor (BJT).
26. List the three terminals of the bipolar transistor, and how use resistors to properly bias the junctions.
27. Describe how a transistor operates as an amplifier, and a switching device as it is driven into saturation and cutoff.
28. Define the term thyristor.
29. Describe the operation of a UJT, SCR, diac and triac.
30. Identify the schematic symbols of a UJT, SCR, diac, and triac.
31. List the polarities required to properly bias and fire thyristor devices.
32. Define the term holding current as it pertains to thyristors.
33. List the factors that determine the type of function an Op Amp performs.
34. List the factors that determine the amplitude of the output produced by an Op Amp.
35. Given the input voltages applied to the inputs of an Op Amp comparator, list the voltages that will be produced at its output.
36. Describe the difference between analog and digital signals.
37. Given the logic states applied to the inputs of a digital AND gate, list the logic states that will be produced at its output.
38. Indicate how the power supply voltages are connected to the pins of an AND gate IC chip.

39. List advantages of fiber optic cable.
40. Describe common applications of fiber optic cable.
41. Differentiate between single mode and multimode fiber optic cable.
42. List the different types of fiber optic terminating connectors.
43. Identify the purpose and function of barcodes.
44. Describe barcode reader hardware.
45. Define vision systems.
46. Describe the linear array and matrix array.
47. Describe pixels.
48. Explain camera mounting considerations.
49. Identify the types of lighting configurations.
50. Describe the source of laser light.
51. Explain the behavior of laser light.
52. List safety hazards associated with laser equipment and precautionary measures that should be taken.

AMT 1081: Mechanical Systems/Mechanical Drives/Power Transmissions– Basic Mechanical Power Transmission (Module 33)

Description:
The purpose of this module is to introduce students to the basic concepts of Mechanical Power Transmission. It covers the principles of power transmission, calculations of speed and force and how they affect a power transmission systems ability to perform work. Understanding the basics of mechanical drawing, safe work practices for working around machinery, common hand tools associated with maintenance work and some of the more common terms and definitions.

Competencies:
1. Describe safety precautions for performing maintenance on mechanical systems
   1.1. Describe how mechanical safety relates to maintenance work.
   1.2. Explain the lockout/tagout procedure.
   1.3. List ways to minimize safety risks before machine maintenance.
   1.4. Identify different types of PPE for eyes and ears.
   1.5. Identify different types of PPE for hands and feet.
   1.6. List procedures for properly handling and storing maintenance equipment.
   1.7. Describe safety practices for ladders and scaffolding.
   1.8. Describe safe practices for lifting and transporting heavy objects.
2. Describe lockout/tagout requirements and proper procedures
   2.1. Define lockout/tagout.
   2.2. Match the forms of energy with their descriptions.
   2.3. Describe the purpose of a lockout device.
   2.4. Describe the purpose of a tagout device.
   2.5. Identify examples of blockout.
   2.6. Identify requirements for lockout/tagout devices.
3. Identify proper uses and requirements for personal protective equipment and explain common hazards
   3.1. Describe the purpose of PPE.
   3.2. Identify the characteristics of proper head protection equipment.
   3.3. Identify characteristics of common types of foot and leg protection.
4. Describe the function of maintenance.
   4.1. Describe the function of maintenance as it is related to the type of industry, process requirements, and business.
   4.2. Describe the condition of machinery by performance, downtime, service life, efficiency, safety, and environmental impact.
   4.3. Describe the maintenance function by the prevention of breakdowns and by the repair of breakdowns.
   4.4. Explain the maintenance function for urgent breakdown repair, routine work, and planned work.
5. Describe definitions for the terms relating to basic mechanics.
   5.1. Describe force is an influence capable of producing a change in motion or shape of a body.

5.2. Describe Newton's three laws of motion.
5.2.1. Explain Newton's first law-inertia.
5.2.2. Explain Newton's second law-acceleration.
5.2.3. Explain Newton's third law-for action there is an opposite and equal reaction.
5.3. Explain the concept of friction.
5.4. Describe the concept of doing work.
5.5. Describe the calculation formula of power.
5.6. Describe the principle of efficiency
5.7. Define torque as it is related to fasteners.
6. Identify basic machines and concepts used to transmit power.
7. Describe the basic concepts of the three classes of levers.
7.1. Explain the first class lever.
7.2. Explain the second class lever.
7.3. Explain the third class lever.
8. Describe the function of the pulley.
8.1. Explain a single fixed pulley.
8.2. Explain a single movable pulley.
8.3. Explain movable pulleys.
9. Describe the concept of the inclined plane.
10. Describe the operation of the wheel and axle.
11. Describe the purpose and operation of the screw.
12. Describe process of mechanical power transmission and components used to transmit mechanical energy.
13. Identify systems used to transmit power.
14. Describe the two categories of driving machines.
14.1. Describe the use of engines as driving machines.
14.1.1. Describe steam engines used to transmit power.
14.1.2. Describe gasoline engines used to transmit power.
14.1.3. Describe air motors used to transmit power.
14.2. Identify the types of prime movers used to transmit power.
15. Identify the use of electrical motors used to transmit power.
15.1. Describe the basic use of AC motors.
15.2. Describe the basic use of DC motors.
16. Describe the function of a transmission to change the output torque and/or speed (RPM) of a motor or prime mover.
17. Describe the two basic types of transmissions.
17.1. Identify the function of a gearbox.
17.2. Identify the function of a variable speed drive.
18. Identify the different types of driven machines.
18.1. Describe the function of pumps.
18.2. Describe the function of compressors.
18.3. Describe the function of fans.
18.4. Describe the function of generators.
18.5. Describe the function of blenders.

18.6. Describe the function of machine tools.

19. Explain the criticality of understanding operating principles as it relates to satisfactory maintenance of rotating machinery.
    19.1. Describe machinery performance.
    19.2. Describe machinery downtime.
    19.3. Describe satisfactory service life.
    19.4. Describe the acceptable level of efficiency.
    19.5. Describe the operational principles to keep personnel safe.
    19.6. Describe the manner of operation that is not detrimental to the environment.
    19.7. Explain maintenance cost as a percent of Replacement Asset Value (RAV) as the universal benchmark measure of operating asset performance success.
20. Describe the "satisfactory" seven criteria.
    20.1. Define correct mounting of rotating machinery.
    20.2. Define mechanism as a function of machine operation.
    20.3. Define balancing.
    20.4. Define lubrication.
    20.5. Define the use of bearings.
    20.6. Define the function of a transmission.
    20.7. Define the basic concept of alignment.
    20.8. Define the use of seals.
    20.9. Define the function of guards.
21. Identify the machines whose purpose it is to drive other machines.
    21.1. Describe electric motors.
        21.1.1. Define AC motors.
        21.1.2. Define DC motors.
    21.2. Define steam turbines.
    21.3. Describe internal combustion engines.
        21.3.1. Define diesel engines.
        21.3.2. Define gasoline & gas engines.
    21.4. Explain the operation of air motors.
22. Describe process of mechanical power transmission and components used to transmit mechanical energy.
23. Identify the three types of machines whose purpose it is to transmit mechanical energy to a driven machine.
    23.1. Describe the function of gearboxes.
    23.2. Describe the function of differentials.
    23.3. Describe the function of variable speed drives.
24. List the advantages and disadvantages of gearboxes.
    24.1. Describe the operation and advantages and disadvantages of a bevel gearbox.
    24.2. Describe the operation and advantages and disadvantages of a herringbone gearbox.
    24.3. Describe the operation and advantages and disadvantages of a helical gearbox.
    24.4. Describe the operation and advantages and disadvantages of a spur gearbox.
    24.5. Describe the operation and advantages and disadvantages of a worm gearbox.

24.6. Describe the operation and advantages and disadvantages of a planetary gearbox.

25. Identify types of gears used with nonintersecting shafts.
26. Identify the terms associated with gear anatomy.
    - 26.1. Describe a pinion gear.
    - 26.2. Describe the term for the larger gear.
    - 26.3. Describe gear mesh.
    - 26.4. Describe gear backlash.
    - 26.5. Describe gear speed.
    - 26.6. Describe an idler gear.
    - 26.7. Describe a spline shaft.
27. Describe the operation of differentials.
28. Describe the characteristics of variable speed drives.
    - 28.1. Identify the two types of mechanical variable speed drives.
        - 28.1.1. Describe variable pitch drives.
        - 28.1.2. Describe traction drives.
    - 28.2. Identify the three types of hydraulic variable speed drives.
        - 28.2.1. Describe hydrostatic drives
        - 28.2.2. Describe hydroviscous drives.
        - 28.2.3. Describe hydrodynamic drives.
    - 28.3. Identify DC electrical variable speed drives.
29. Describe process of mechanical power transmission and components used to transmit mechanical energy.
30. List the three driven machines needed to be coupled to driving machines.
    - 30.1. Describe different types of pumps and compressors.
    - 30.2. Describe the two types of industrial fans.
    - 30.3. Describe the different generators, blenders, and machine tools used in manufacturing.
31. Describe the operation of pumps.
32. Identify the different types of pumps used to move materials.
    - 32.1. Describe the use of positive displacement pumps.
    - 32.2. Describe the use of rotary gear pumps.
    - 32.3. Describe the use of rotary vane pumps.
    - 32.4. Describe the use of regenerative pumps.
    - 32.5. Describe the use of peristaltic pumps.
    - 32.6. Describe the use of piston pumps.
    - 32.7. Describe the use of screw pumps.
    - 32.8. Describe the use of progressive cavity pumps.
    - 32.9. Describe the use of roots-type pumps.
    - 32.10. Describe the use of plunger pumps.
    - 32.11. Describe the use of flexible impeller pumps.
    - 32.12. Describe the use of velocity pumps.
    - 32.13. Describe the use of educator-jet pumps.
    - 32.14. Describe the use of axial-flow pumps.

32.15. Describe the use of steam pumps.
32.16. Describe the use of valveless pumps.
33. Identify the operation of compressors.
33.1. Describe the use of diagonal or mixed-flow compressors.
33.2. Describe the use of axial-flow compressors.
33.3. Describe the use of reciprocating compressors.
33.4. Describe the use of rotary screw compressors.
33.5. Describe the use of rotary vane compressors.
33.6. Describe the use of diaphragm compressors.
34. Describe the use of industrial fans.
34.1. Describe the use of centrifugal fans.
34.2. Describe the use of axial fans.
35. Describe the use of electrical generators.
35.1. Describe the use and advantages and disadvantages of electromagnetic generators.
35.2. Describe the use and advantages and disadvantages of electrostatic generators.
36. Identify the use of blenders and mixers in industrial operations.
36.1. Describe the use and advantages and disadvantages of dispersion mixers.
36.2. Describe the use and advantages and disadvantages of high shear mixers.
36.3. Describe the use and advantages and disadvantages of kneaders.
36.4. Describe the use and advantages and disadvantages of multi-shaft mixers.
36.5. Describe the use and advantages and disadvantages of planetary mixers.
36.6. Describe the use and advantages and disadvantages of paddle mixers.
36.7. Describe the use and advantages and disadvantages of V-shell blenders.
36.8. Describe the use and advantages and disadvantages of double-cone blenders.
36.9. Describe the use and advantages and disadvantages of high viscosity mixers.
36.10. Describe the use and advantages and disadvantages of counter-rotation mixers.
36.11. Describe the use and advantages and disadvantages of drum mixers.
37. Identify the operation of various machine tools.
37.1. Explain the use of drill presses.
37.2. Describe the use of a radial arm drill press.
37.3. Describe the use of geared head drill press.
37.4. Describe the use of a mill drill press.
38. Explain the use of grinding machines.
38.1. Describe the use of a belt grinder.
38.2. Describe the use of a bench grinder.
38.3. Describe the use of a cylindrical grinder.
39. Describe the operation and components of a lathe.
40. Identify the operation of a milling machine.
40.1. Describe the use of a horizontal mill.
40.2. Describe the use of a vertical mill.
41. Identify the operation of a broaching machine.
41.1. Describe the use of a linear broach.
41.2. Describe the use of a rotary broach.

42. Describe process of mechanical power transmission and components used to transmit mechanical energy.
    - 42.1. Identify types of gears used with nonintersecting shafts.
    - 42.2. Describe the characteristics of belt drive systems.
    - 42.3. Identify common types of belts used to transmit motion in belt drive systems.
    - 42.4. Describe the characteristics of chain drive systems.
    - 42.5. Identify common types of chains used to transmit motion in chain drive systems.
    - 42.6. Describe how a clutch is used to transmit motion.
    - 42.7. Identify types of couplings.
    - 42.8. Identify types of bearings.
43. Select correct tool for a job or activity.
    - 43.1. Describe proper applications for hammers.
    - 43.2. Describe proper applications for screwdrivers.
    - 43.3. Describe proper applications for wrenches.
    - 43.4. Describe proper applications for chisels.
    - 43.5. Describe proper applications for punches.
    - 43.6. Describe proper applications for files.
    - 43.7. Describe proper applications for pliers.
    - 43.8. Describe proper applications for taps and dies.
    - 43.9. Describe proper applications for hacksaws.
44. Describe proper applications for measuring devices.
    - 44.1. Describe proper use of steel rules.
    - 44.2. Describe proper use of micrometers.
    - 44.3. Describe proper use of feeler gauges.
    - 44.4. Describe proper use of calipers.
    - 44.5. Describe proper use of dial indicators.
    - 44.6. Describe proper use of vernier calipers.
    - 44.7. Describe proper use of a height gauge.
    - 44.8. Describe proper use of a surface plate.
    - 44.9. Describe proper use of the different types of squares.
45. Describe the use of layout tools.
    - 45.1. Describe proper use of scribes.
    - 45.2. Describe proper use of compasses.
46. Describe proper use of easy outs.
47. Describe proper use of reamers.
48. Describe proper use of rivet guns.
49. Describe proper use of snips.
50. Describe proper use of knives.
51. Identify various power tools.
    - 51.1. Describe proper use of electric power tools.
    - 51.2. Describe proper use of pneumatic power tools.
52. Identify the various types of power saws.
    - 52.1. Describe proper use of circular saws.
    - 52.2. Describe proper use of band saws.

52.3. Describe proper use of saber saws.
53. Identify the types of grinders.
53.1. Describe proper use of vertical grinders.
53.2. Describe proper use of horizontal (pedestal) grinders.
53.3. Describe proper use of pencil grinders.
54. Identify the various types of sanders.
54.1. Describe proper use of hand-held belt sander.
54.2. Describe proper use of disc sander.
54.3. Describe proper use of finish sander.
55. Identify the various types of impact wrenches.
55.1. Describe proper use of uni-directional impact wrenches.
55.2. Describe proper use of bi-directional impact wrenches.
56. Identify the various types of pneumatic hammers.
56.1. Describe proper use of air hammer (or air chisel).
56.2. Describe proper use of air chipping hammer.
56.3. Describe proper use of impact palm nailer.
57. Interpret information on a blueprint.
57.1. Describe the purpose of a blueprint.
57.2. Identify the three basic elements of a blueprint.
57.2.1. Identify the drawing.
57.2.2. Identify the dimensions.
57.2.3. Identify the notes.
57.3. Identify the six areas of a blueprint.
57.3.1. Identify the title block.
57.3.2. Identify the bill of materials.
57.3.3. Identify the revision block.
57.3.4. Identify the general notes.
57.3.5. Identify the local notes.
57.3.6. Identify the drawing area.
57.4. Define orthographic view.
57.4.1. Identify the front view.
57.4.2. Identify the top view.
57.4.3. Identify the right side view.
57.5. Define auxiliary view.
57.6. Define section view.
57.7. Describe how to show part edges and surfaces.
57.8. Identify how to indicate dimensions.
57.9. Describe the appearance and use of object lines.
57.10. Describe the appearance and use of hidden lines.
57.11. Describe the appearance and use of center lines.
57.12. Describe the appearance and use for break lines.
57.13. Describe the appearance and use of dimension lines.
57.14. Describe the appearance and use of extension lines.
57.15. Explain the tolerance information on a print.

57.15.1. Describe bi-lateral tolerances.
57.15.2. Describe uni-lateral tolerances.
57.15.3. Describe limits.
57.16. Explain how to use scale information on a print.

AMT 1082: Mechanical Systems/Mechanical Drives/Power Transmissions – Flexible Drives (Module 34)

Lecture Contact Hours: 2
Lab Contact Hours: 4

Description:
A mechanical drive system is a combination of mechanical components that transfer power from one location to another. Mechanical drive systems may also change the size, direction, and speed of the applied force. This includes chains, sprockets, and components. This module will introduce the learner to the various types and styles of flexible chain drives.

Competencies:

1. Describe safety precautions for performing maintenance on mechanical systems
   1.1. Describe how mechanical safety relates to maintenance work.
   1.2. Explain the lockout/tagout procedure.
   1.3. List ways to minimize safety risks before machine maintenance.
   1.4. Identify different types of PPE for eyes and ears.
   1.5. Identify different types of PPE for hands and feet.
   1.6. List procedures for properly handling and storing maintenance equipment.
   1.7. Describe safety practices for ladders and scaffolding.
   1.8. Describe safe practices for lifting and transporting heavy objects.
2. Describe lockout/tagout requirements and proper procedures
   2.1. Define lockout/tagout.
   2.2. Match the forms of energy with their descriptions.
   2.3. Describe the purpose of a lockout device.
   2.4. Describe the purpose of a tagout device.
   2.5. Identify examples of blockout.
   2.6. Identify requirements for lockout/tagout devices.
3. Identify proper uses and requirements for personal protective equipment and explain common hazards
   3.1. Describe the purpose of PPE.
   3.2. Identify the characteristics of proper head protection equipment.
   3.3. Identify characteristics of common types of foot and leg protection.
4. Identify common types and styles of flexible belt drive systems.
   4.1. Identify the four common types of belts used for flexible belt drives.
   4.2. Identify V-belts and double V-belts.
   4.3. Identify timing and cog belts.
   4.4. Identify adjustable (variable speed) belts

4.5. Identify flat belts.

5. Describe characteristics of flexible drive systems.
   5.1. List and describe the characteristics of V-belts.
   5.2. Describe the construction of V-belts.
   5.3. Explain the identification of V-belt letter/number combinations.
   5.4. Compute the correct belt length required when the belt is missing.
   5.5. Identify the correct matching number application.
6. Explain the proper V-belt alignment and tensioning procedures.
   6.1. Identify considerations for proper V-belt alignment and tension.
   6.2. Explain the result of misalignment and improper tension.
   6.3. Identify the three misalignment conditions of pulley-to-pulley alignment.
   6.4. Describe two methods used for tensioning a V-belt drive system.
7. Describe characteristics of double V-belts and timing belts.
   7.1. List the characteristics of double V-belts.
   7.2. Describe the characteristics of timing belts.
   7.3. Describe the construction of double V-belts.
   7.4. Describe the construction of timing belts.
   7.5. List the uses of double V-belts.
   7.6. List the applications of timing belts.
8. Explain the function of variable-speed belt drives.
   8.1. Describe the function of variable-speed belt drives.
   8.2. Describe the operation of a variable-speed belt drive.
   8.3. Compute the change in the driven pulley speed.
   8.4. Compute the change in the driver pulley speed.
9. Demonstrate satisfactory chain drive and component safety knowledge.
   9.1. Identify common chain drive safety guidelines.
   9.2. Identify the potential hazard of pinch points.
   9.3. Explain the proper procedure for lock-out, tag-out, and block-out.
   9.4. Identify the PPE required and/or not appropriate for chain drive maintenance.
   9.5. Identify the potential for burn hazards.
   9.6. Explain the proper use of using a hydraulic puller to remove sprockets.
10. Identify common types and styles of chain drive systems.
    10.1. Identify the three common types of chains used for chain drives.
    10.2. Identify various styles of roller chain.
    10.3. Identify various styles of silent chain.
    10.4. Identify various styles of engineering chain.
11. Describe characteristics of roller chain drive systems.
    11.1. List and describe the characteristics of standard roller chain.
    11.2. Describe the construction of heavy series chain.
    11.3. Describe the construction of double pitch roller chain.
    11.4. Describe the construction of hollow pin, side bow, and leaf chain.
12. Explain the proper chain drive alignment and tensioning procedures.
    12.1. Identify considerations for proper chain alignment and tension.
    12.2. Explain the result of misalignment and improper tension.

12.3. Identify the three misalignment conditions of sprocket-to-sprocket alignment.
12.4. Describe two methods used for tensioning a roller chain drive system.
13. Describe characteristics of silent chain drives.
13.1. List the characteristics of silent chain drives.
13.2. Describe the advantages of silent chain drives.
13.3. Describe the construction of silent chains.
13.4. List the two ways used to keep silent chain from sliding off the sprockets.
13.5. Explain the conveying application of silent chain drives.
14. Describe characteristics of engineering chain.
14.1. Describe cast engineering chain construction and their application.
14.2. Describe double-flex, drop forged, engineered steel polymeric and weld steel chain and their applications.
14.3. Describe corrosion resistant chain and tabletop chain.
14.4. Compute the change in the driven sprocket speed.
14.5. Compute the change in the driver sprocket speed.
15. Describe engineered and drive chain sprockets.
15.1. Describe sprocket types and styles.
15.2. Describe segmental sprockets and traction wheels.
15.3. Describe the selection and specifications, including number of teeth, height of teeth, bore and hub sizes, and gapped sprockets.
16. Describe lubrication and chain guards.
16.1. Describe the three styles of chain lubrication.
16.2. Describe the application of chain guards.

AMT 1083: Mechanical Systems/Mechanical Drives/Power Transmissions – Couplings and Alignment (Module 35)

Lecture Contact Hours: 10
Lab Contact Hours: 30

Description:
This module examines the types and functions of couplings used in industrial power transmissions. Students will learn how to install, align, and maintain shaft couplings.

Competencies:
1. Describe safety precautions for performing maintenance on mechanical systems
1.1. Describe how mechanical safety relates to maintenance work.
1.2. Explain the lockout/tagout procedure.
1.3. List ways to minimize safety risks before machine maintenance.
1.4. Identify different types of PPE for eyes and ears.
1.5. Identify different types of PPE for hands and feet.
1.6. List procedures for properly handling and storing maintenance equipment.
1.7. Describe safety practices for ladders and scaffolding.
1.8. Describe safe practices for lifting and transporting heavy objects.

2. Describe lockout/tagout requirements and proper procedures
   2.1. Define lockout/tagout.
   2.2. Match the forms of energy with their descriptions.
   2.3. Describe the purpose of a lockout device.
   2.4. Describe the purpose of a tagout device.
   2.5. Identify examples of blockout.
   2.6. Identify requirements for lockout/tagout devices.
3. Identify proper uses and requirements for personal protective equipment and explain common hazards
   3.1. Describe the purpose of PPE.
   3.2. Identify the characteristics of proper head protection equipment.
   3.3. Identify characteristics of common types of foot and leg protection.
4. Name the types and functions of couplings.
   4.1. Describe the main and secondary functions of couplings.
   4.2. Describe coupling types.
   4.3. Select the proper coupling per application.
5. Install and replace various coupling systems.
   5.1. Name mounting method of couplings.
   5.2. Replace various couplings.
   5.3. Set stationary and movable machine.
   5.4. Maintain and troubleshoot various coupling systems.
   5.5. Perform visual inspection.
   5.6. Lubricate a coupling.
   5.7. Describe three preventive maintenance steps for couplings.
6. Align various types of couplings using a straight edge and a feeler gage.
   6.1. Name the types of misalignment.
   6.2. Identify steps to determine misalignment.
   6.3. Recognize tools used to determine misalignment.
7. Align various types of couplings using dial indicators.
   7.1. Demonstrate the use of a dial indicator.
   7.2. Identify shaft alignment tolerances.
8. Align various types of couplings using a straight edge and a feeler gage.
   8.1. Determine soft-foot.
   8.2. Align a motor to a pump using a straight edge and a feeler gage.
9. Align various types of couplings using dial indicators.
   9.1. Identify steps to align a motor to a pump using dial indicators –- Rim and Face.
   9.2. Align a motor to a pump using dial indicators.
   9.3. Demonstrate reverse dial indicator method.
10. Align rotating shafts using precision alignment tools.
    10.1. Demonstrate knowledge of laser safety.
    10.2. Demonstrate knowledge of laser terminology.
    10.3. Name types of laser shaft alignment systems.
    10.4. Recognize major components of a laser shaft alignment system.
11. Maintain and troubleshoot various coupling systems.
    11.1. Perform visual inspection.
    11.2. Troubleshoot a coupling system.

AMT 1084: Mechanical Systems/Mechanical Drives/Power Transmissions – Bearings, Shafts, and Seals (Module 36)

Lecture Contact Hours: 8
Lab Contact Hours: 12

Description:
A mechanical system consists of a combination of components that function together to perform work and motion. Bearings, shafts and seals are fundamental components that help comprise a power transmission system. This module will introduce the student to the basic types and functions of these components.

Competencies:
1. Describe safety precautions for performing maintenance on mechanical systems.
   1.1. Describe how mechanical safety relates to maintenance work.
   1.2. Explain the lockout/tagout procedure.
   1.3. List ways to minimize safety risks before machine maintenance.
   1.4. Identify different types of PPE for eyes and ears.
   1.5. Identify different types of PPE for hands and feet.
   1.6. List procedures for properly handling and storing maintenance equipment.
   1.7. Describe safety practices for ladders and scaffolding.
   1.8. Describe safe practices for lifting and transporting heavy objects.
2. Describe lockout/tagout requirements and proper procedures.
   2.1. Define lockout/tagout.
   2.2. Match the forms of energy with their descriptions.
   2.3. Describe the purpose of a lockout device.
   2.4. Describe the purpose of a tagout device.
   2.5. Identify examples of blockout.
   2.6. Identify requirements for lockout/tagout devices.
3. Identify proper uses and requirements for personal protective equipment and explain common hazards.
   3.1. Describe the purpose of PPE.
   3.2. Identify the characteristics of proper head protection equipment.
   3.3. Identify characteristics of common types of foot and leg protection.
4. Install and troubleshoot plain bearings.
   4.1. Describe the main functions and application of plain bearings.
5. Install and troubleshoot ball bearings.
   5.1. Describe the function, construction, and operation of ball bearings.
6. Install and troubleshoot roller bearings.
   6.1. Describe the operation and function of roller bearings.
7. Install and troubleshoot plain bearings.
   7.1. Install and adjust a solid bearing.
   7.2. Select a lubrication system for a plain bearing system.
   7.3. Install and adjust a type 1 bearing using an arbor press.

7.4. Identify the size and type of plain bearing given a specific application.
7.5. Select a plain bearing for a given application.
7.6. Troubleshoot a plain bearing installation.

8. Install and troubleshoot ball bearings.
   8.1. Identify a ball bearing given a part number.
   8.2. Describe two methods of mechanically mounting a ball bearing.
   8.3. Install a temperature bearing using a thermal mounting process.
   8.4. Handle and clean an antifriction bearing.
   8.5. Identify a ball bearing given a sample.
   8.6. Install and remove a ball bearing on a shaft using an arbor press.
   8.7. Install a ball bearing on a shaft using a bearing heater.
   8.8. Remove a ball bearing on a shaft using a bearing puller.
9. Install and troubleshoot roller bearings.
   9.1. Describe how to install and remove roller bearings.
   9.2. Identify type and size of a tapered roller bearing given a sample.
   9.3. Install a tapered roller bearing on a shaft and housing using a sleeve and hammer.
   9.4. Install a roller bearing using an arbor press.
   9.5. Pack a tapered roller bearing with grease.
   9.6. Install and align a direct mount tapered roller bearing system using a cup follower retainer.
   9.7. Measure a change in shaft end play due to operation heat.
10. Install and troubleshoot angular contact bearings.
   10.1. Mount and remove an angular contact bearing.
   10.2. Select a lubricant for an antifriction bearing for a given application.
11. Troubleshoot bearings, shafts and seals.
   11.1. Identify conditions that lead to premature failure of bearings and seals.
   11.2. Identify common symptoms of bearing fatigue.
12. Name the types of seals and their functions.
   12.1. Describe the function, operation and installation of O-rings.
   12.2. Install, remove, and inspect an O-ring seal.
   12.3. Install, remove, and inspect a lip seal.
   12.4. Install, remove, and inspect a mechanical seal system.
   12.5. Describe the function and use of mechanical seals.
   12.6. Select a seal for a given application.
   12.7. Maintain a seal.
   12.8. Troubleshoot a given seal installation.
13. Troubleshoot bearings, shafts, and seals.
   13.1. Identify conditions that lead to premature failure of bearings and seals.
14. Name the function of shafts.
   14.1. Describe the purpose of a shaft.
   14.2. Describe the different materials used for shafts.
   14.3. List types of shaft materials and their applications.
   14.4. Describe how shafts are specified.

AMT 1085: Mechanical Systems/Mechanical Drives/Power Transmissions – Brakes & Clutches (Module 37)

Lecture Contact Hours: 2
Lab Contact Hours: 4

Description:
A mechanical drive system is a combination of mechanical components that transfer power from one location to another. Mechanical drive systems may also change the size, direction, and speed of the applied force. This includes the application of brake systems and clutch components. This module will introduce the learner to the various types and styles of braking systems and clutches used in industrial applications.

Competencies:
1. Describe safety precautions for performing maintenance on mechanical systems.
   1.1. Describe how mechanical safety relates to maintenance work.
   1.2. Explain the lockout/tagout procedure.
   1.3. List ways to minimize safety risks before machine maintenance.
   1.4. Identify different types of PPE for eyes and ears.
   1.5. Identify different types of PPE for hands and feet.
   1.6. List procedures for properly handling and storing maintenance equipment.
   1.7. Describe safety practices for ladders and scaffolding.
   1.8. Describe safe practices for lifting and transporting heavy objects.
2. Describe lockout/tagout requirements and proper procedures.
   2.1. Define lockout/tagout.
   2.2. Match the forms of energy with their descriptions.
   2.3. Describe the purpose of a lockout device.
   2.4. Describe the purpose of a tagout device.
   2.5. Identify examples of blockout.
   2.6. Identify requirements for lockout/tagout devices.
3. Identify proper uses and requirements for personal protective equipment and explain common hazards.
   3.1. Describe the purpose of PPE.
   3.2. Identify the characteristics of proper head protection equipment.
   3.3. Identify characteristics of common types of foot and leg protection.
4. Describe types of brakes and clutches.
   4.1. Define a brake as it is used in a manufacturing application.
   4.2. Describe how brakes function.
   4.3. List three types of brakes used on equipment in a production application
   4.4. Define clutch as it is used in a manufacturing application.
   4.5. Describe how clutches function.
   4.6. List two types of clutches used on equipment in a production application.
5. Describe styles of brakes used to control movement in industrial equipment.
   5.1. Describe the operation of an electromechanical brake.

5.2. Match the types of electromechanical brakes with their descriptions.
5.3. Describe the operation of a hydraulic brake system.
5.4. Describe the operation of a mechanical brake system.
5.5. Describe the operation of an air brake system.
5.6. Identify examples of a drum brake.
5.7. Identify examples of a disc brake.
5.8. Identify examples of a power off brake.

6. Describe styles of clutches used to control movement in industrial equipment.
   6.1. Describe the importance of shaft rotation in clutch applications.
   6.2. Describe positive engagement.
   6.3. Describe the three types of clutches.
   6.4. Describe the operation of a dog tooth clutch.
   6.5. Describe the operation of a single and multiple plate clutches.
   6.6. Describe the operation of a cone clutch.
   6.7. Describe the operation of a centrifugal clutch.
   6.8. Describe the operation of a dry fluid clutch.
   6.9. Describe the operation of a fluid coupling clutch.
   6.10. Match the types of electromechanical clutches with their descriptions.
   6.11. Describe the operation of a hydraulic clutch.
   6.12. Describe the operation of an air clutch.
7. Describe maintenance practices used in the inspection, disassembly, and assembly of clutch units.
   7.1. Identify symptoms of failure patterns found in clutch/brake systems.
   7.2. Identify the damage found in worn and/or failed clutch/brakes.

AMT 1086: Mechanical Systems/Mechanical Drives/Power Transmissions – Gears & Cams (Module 38)

Lecture Contact Hours: 8
Lab Contact Hours: 6

Description:
A mechanical system is a combination of mechanical components that transfer power from one location to another. Mechanical drive systems may also change size, direction, and speed of the applied force. This includes the application of the various forms of gears and cam follower components. This module will introduce the learner to the various types and styles of gears and cam follower components used in industrial applications

Competencies:
1. Describe safety precautions for performing maintenance on mechanical systems.
   1.1. Describe how mechanical safety relates to maintenance work.
   1.2. Explain the lockout/tagout procedure.
   1.3. List ways to minimize safety risks before machine maintenance.
   1.4. Identify different types of PPE for eyes and ears.
   1.5. Identify different types of PPE for hands and feet.

1.6. List procedures for properly handling and storing maintenance equipment.
1.7. Describe safety practices for ladders and scaffolding.
1.8. Describe safe practices for lifting and transporting heavy objects.

2. Describe lockout/tagout requirements and proper procedures.
   2.1. Define lockout/tagout.
   2.2. Match the forms of energy with their descriptions.
   2.3. Describe the purpose of a lockout device.
   2.4. Describe the purpose of a tagout device.
   2.5. Identify examples of blockout.
   2.6. Identify requirements for lockout/tagout devices.
3. Identify proper uses and requirements for personal protective equipment and explain common hazards.
   3.1. Describe the purpose of PPE.
   3.2. Identify the characteristics of proper head protection equipment.
   3.3. Identify characteristics of common types of foot and leg protection.
4. Describe the purpose and function of gears and gear drives.
   4.1. Describe the basic function of a gear drive system.
   4.2. Explain the basic operation of gears.
   4.3. Describe the various styles and types of gear drive assemblies.
   4.4. Define the most common gear terms.
5. Describe open gears.
   5.1. Identify the five basic gear types.
   5.2. Describe gear types with parallel shafts.
   5.3. Describe gear types with angled shafts.
   5.4. Explain backlash.
   5.5. List and describe the different materials used to manufacture gears.
   5.6. Describe the specifications needed when ordering replacement gears.
   5.7. Identify the numerous ways gear will fail.
6. Describe enclosed gears.
   6.1. Describe the functions and uses of enclosed gear drives.
   6.2. Identify the three basic types of speed reducers.
   6.3. Describe the three styles of gearbox mounting.
7. Describe seals, breathers, and lubrication.
   7.1. Identify the two basic styles of seals.
   7.2. Describe the use of seals
   7.3. Describe the use of a breather.
   7.4. Describe the common types of oil used in gearbox lubrication.
8. Describe gear ratings and application and selection.
   8.1. Describe the rating criteria for gearbox application.
   8.2. Describe the criteria for application and selection of replacement gearboxes.
9. Describe industrial cam follower functions, uses, and terms.
   9.1. Describe the basic function of an industrial cam follower.
   9.2. Explain the basic operation of cam followers and rod ends.
   9.3. Describe the various styles and types of cam followers and rod ends.

10. Describe industrial cam follower bushing types and operating clearances.
    - 10.1. Describe the basic function of an industrial cam follower bushing.
    - 10.2. Explain the basic types of bushing applicable to cam follower usage.
    - 10.3. Describe the procedure to determine proper operating clearances.

AMT 1091: Safety – Basic OSHA Safety (Module 39)

Lecture Contact Hours: 9
Lab Contact Hours: 1

Description:
Basic OSHA Safety introduces students to OSHA and the OSHA regulations that apply to the auto manufacturing industry.

Competencies:
1. Describe OSHA and proper hazard recognition and reporting.
   1.1. Explain the purpose, history, and importance of OSHA.
   1.2. Explain the employer's responsibilities under the OSH Act.
   1.3. Explain the employee's responsibilities under the OSH Act.
   1.4. Look up OSHA standards.
   1.5. Explain the General Duty Clause.
   1.6. Identify steps to an OSHA inspection.
   1.7. Identify basic OSHA documentation.
   1.8. Recognize and report hazards.
2. Describe proper use of personal protective equipment.
   2.1. Describe the purpose of PPE.
   2.2. Identify common forms of PPE and when each should be used.
   2.3. Explain the importance of wearing PPE.
   2.4. Inspect PPE.
   2.5. Care for and store PPE.
3. Describe proper fire safety in the workplace.
   3.1. Explain the importance of fire safety.
   3.2. Identify the different types of fires.
   3.3. Identify the different types of fires extinguishers.
   3.4. Explain how to use a fire extiguisher.
   3.5. Identify emergency exit routes.
4. Describe proper electrical safety in the workplace.
   4.1. Explain the importance of electrical safety.
   4.2. Identify the difference between a qualified and an affected worker.
   4.3. Define basic electrical terminology
   4.4. Explain the hazards associated with arc flash and how to avoid them.
5. Use a ladder and walking an walkway safety
   5.1. Define walking and working surface.
   5.2. Identify hazards in walking and working surfaces.
   5.3. Identify OSHA standards for the following topics:
      5.3.1. Ladders
      5.3.2. Scaffolds
      5.3.3. Ramps
      5.3.4. Stairs

5.3.5. Floor Openings
5.3.6. Wall Openings
5.3.7. Working Platforms

6. Identify proper machine guarding.
   6.1. Explain the importance of machine guarding.
   6.2. Identify different hazard areas created by machines.
   6.3. Identify different forms of safeguards.
   6.4. Identify forms of machine guards
   6.5. Explain ways to safeguard machines
   6.6. Explain the importance of lockout/tagout when guards must be bypassed.

AMT 1092: Safety – Hoists and Cranes (Module 40)

Lecture Contact Hours: 6
Lab Contact Hours: 0

Description:
Introduces the basic concepts and safety rules and issues related to the use of overhead cranes and hoists.

Competencies:
1. Describe hoist and crane safety.
   1.1. Describe operation safety.
   1.2. Describe equipment safety.
2. Idenfity basic types of hoists and cranes.
   2.1. Describe lifting medium.
   2.2. Describe operation.
   2.3. Describe suspension.
3. Explain hoist, trolley and bridge motions.
   3.1. Define one axis of motion.
   3.2. Define two axes of motion.
   3.3. Define three axes of motion.
4. Describe communication when using hoists and cranes.
   4.1. Describe verbal communications.
   4.2. Describe hand signals.
5. Explain lifting weights, calculating or verifying listed weights.
   5.1. Explain volumes.
   5.2. Describe weight tables.
6. Describe inspection.
   6.1. Describe daily or pre-start.
   6.2. Describe maintenance inspection.

AMT 1093: Safety – Rigging Awareness and Fundamentals (Module 41)

Lecture Contact Hours: 10
Lab Contact Hours: 6

Description:
Introduces the basic concepts and safety rules and issues related to the use of rigging equipment, attachment components, calculating sling angle stresses, and safe lifting and turning loads.

Competencies:
1. Rigging Safety
   1.1. Rigging safety knowledge
   1.2. Organizations related to rigging safety
   1.3. Inspection methods for rope, sling, and chain
   1.4. Strap and/or sling selection for safe lifting
   1.5. Rigging attachment selection for safe rigging
   1.6. Consequences of overloading rigging equipment and/or underestimating load weight
2. Center of Gravity and Proper Balancing of a Load
   2.1. Definition of rigging
   2.2. Concept of changes in movement and positioning
   2.3. Difference between rigging and lifting
   2.4. Developing a plan of movement
   2.5. Weakest component of rigging
   2.6. Conditions of proper rigging
3. Calculating Load Weights
   3.1. Shape of the load in standard geometric shapes
   3.2. Using a stock material weight table
   3.3. Correct lifting weight considering the size and shape of the load
4. Functions and Types of Slings
   4.1. Fiber rope
   4.2. Synthetic
   4.3. Wire
   4.4. Chain
5. Types of Hitches
   5.1. Vertical
   5.2. Bridle
   5.3. Basket
   5.4. Choker
6. Rigging Attachments
   6.1. Shackles
   6.2. Master links
   6.3. Hooks
7. Rigging Equipment Maintenance
   7.1. Inspection
   7.2. Storage
   7.3. Record keeping

AMT 1094: Safety – First Aid, CPR, and AED (Module 42)

Lecture Contact Hours: 3.5
Lab Contact Hours: 2.5

Description:
The purpose of the American Red Cross Blended Learning First Aid/CPR/AED program for the lay responder is to provide participants with the knowledge and skills necessary to help sustain life and minimize the consequences of injury or sudden illness until advanced medical help arrives. This module is designed to meet the various training needs of those in workplace, school or community settings.

Competencies:
1. Recognize an emergency situation.
   1.1. Recognize an emergency situation.
   1.2. Identify how to respond correctly to an emergency.
2. Describe protection for self.
   2.1. Identify the purpose of Good Samaritan Laws.
   2.2. Identify the difference between consent and implied convent.
   2.3. Identify standard precautions to reduce the risk of disease transmission during and after care.
3. Describe prioritizing care.
   3.1. Identify how to prioritize care for life-threatening injuries or sudden illnesses.
   3.2. Identify how to check a conscious person for life-threatening and non-life-threatening conditions.
   3.3. Identify how to check an unconscious person.
   3.4. Recognize signals of shock and how to care for shock.
   3.5. Identify how to clear the airway of a conscious choking adult.
4. Identify cardiac emergencies and unconscious choking.
   4.1. Recognize the signals of a heart attack in an adult.
   4.2. Identify what care to give to a person who is having a cardiac emergency.
   4.3. Identify the steps for giving adult CPR.
   4.4. Identify the steps for clearing the airway of an unconscious choking adult.
5. Describe appropriate uses of an Automated External Defibrillator (AED).
   5.1. Identify what defibrillation is and how it works.
   5.2. Identify the need for early defibrillation and the role of CPR in cardiac arrest.
   5.3. Identify the operational differences between current models of AEDs.
   5.4. Identify the general steps and safety precautions to follow when using an AED on an adult.
   5.5. Identify the general steps and safety precautions to follow when using an AED on a child.
   5.6. Recognize and care for a victim of Sudden Illnesses.
6. Recognize and care for a victim of sudden illness
   6.1. Recognize and care for a victim of sudden illness.

7. Recognize soft tissue injuries.
   7.1. Recognize and care for soft tissue injuries, including controlling bleeding.
   7.2. Recognize and care for different types of burns.
8. Recognize injuries to muscles, bones, and joints.
   8.1. Recognize and care for injuries to the muscles, bones and joints.
   8.2. Identify how to splint a bone or joint injury.
   8.3. Recognize and care for injuries to the head, neck and back.
9. Recognize heat and cold-related injuries.
   9.1. Recognize and care for a victim of a heat-related emergency.
   9.2. Recognize and care for a victim of a cold-related emergency.

AMT 1001: Computer Literacy – Orientation to Computer Systems (Module 43)

Lecture Contact Hours: 3
Lab Contact Hours: 5

Description:
Orientation to Computer Systems introduces participants to the typical computer systems and associated components in the automotive manufacturing industry.

Competencies:
1. Describe common computer hardware components.
   1.1. Describe and identify parts of a personal/laptop computer.
   1.2. Explain basics of boot (cold/warm) sequences, methods, and start-up utilities.
   1.3. Explain the functions and common components of the computer's CPU/motherboard.
2. Install, configure, and operate common peripherals devices.
   2.1. Describe components, installation, and operation of common input (mouse/keyboard)/output (printers) peripherals.
   2.2. Describe installation of device drivers.
3. Identify and describe operation of common data storage devices
   3.1. Demonstrate knowledge of saving data to common storage devices.
   3.2. Identify types, sizes, and function of storage drives (CD, DVD, RW, Blu-Ray, floppy disk drives, flash drives, USB, Firewire, tape drives, hot swap, etc.).
4. Explain the purpose of security, protection, maintenance, and backup tools.
   4.1. Use software for disk maintenance, such as defrag, scandisk, check disk.
   4.2. Describe appropriate cleaning materials (compressed air, lint-free cloth, vacuum, etc.).
   4.3. Identify different types of backup.
   4.4. Explain the purpose of a firewall.
5. Demonstrate knowledge of computer ergonomics.
   5.1. Define proper posture when operating a computer and proper placement of computer components.
   5.2. Describe consequences of poor ergonomics (carpal tunnel, RSI, etc.).

AMT 1002: Computer Literacy – Operating Systems (Module 44)

Lecture Contact Hours: 2
Lab Contact Hours: 6

Description:
This module introduces participants to the basics of using computer operating systems in the automotive manufacturing industry.

Competencies:
1. Describe the purpose of an operating system.
   1.1. Identify types of operating system software.
   1.2. Explain the responsibilities of operating system software.

2. Identify steps in installing software onto a computer.
   2.1. Describe the purpose of formatting a drive.
   2.2. Explain DOS commands.
3. Perform file management techniques using operating system software.
   3.1. Download, upload, move, copy, and manipulate files.
4. Compare input and output devices.
   4.1. Set up a printer.
   4.2. Recognize various peripheral devices.

AMT 1003: Computer Literacy – Computer Applications (Module 45)

Lecture Contact Hours: 2
Lab Contact Hours: 6

Description:
This module introduces use of computer application program software such as Microsoft Office Word, Access and Excel.

Competencies:
1. Differentiate between software types.
   1.1. Describe types of utility software.
   1.2. Describe types of operating systems and application software.
2. Create basic word processing and presentation documents.
   2.1. Create a basic document and presentation.
   2.2. Use formatting features to enhance documents and presentations.
3. Create basic worksheets with formulas and a chart.
   3.1. Create a basic worksheet.
   3.2. Use formulas and functions to calculate totals, averages, minimums, maximums, and counts.
   3.3. Create a chart.
4. Create basic databases.
   4.1. Create a database.
   4.2. Use filtering features to query specific information in a database.
5. Use an email management system to produce and send correspondence including attachments.
   5.1. Use a basic email package to respond to email.
   5.2. Create an email with attachments.
6. Use communication software to collaborate and share information.
   6.1. Participate in an instant message chat or collaborative online meeting.
   6.2. Describe common uses of communication/collaborative software to work on a common document.

AMT 1004: Computer Literacy – Internet/Intranet (Module 46)

Lecture Contact Hours: 2
Lab Contact Hours: 6

Description:
This module provides students with basic skills in using the Internet and Intranet environments including searching for industry manuals and parts, downloading software and drivers, and other related tasks.

Competencies:
1. Use internet tools to search and find specific information.
   1.1. Search and identify websites that contain manufacturer's manuals and parts.
   1.2. Use basic evaluation techniques to validate Web site information.
2. Use internet tools to search and find specific manufacturer's manual and parts.
   2.1. Search and identify websites that contain manufacturer's manuals and parts.
   2.2. Use basic evaluation techniques to validate Web site information.
3. Use an intranet to search for company related documents.
   3.1. Describe an intranet and its uses.
   3.2. Explain the advantages and disadvantages of intranets.
4. Search and identify information on Electronic Data Sheets (EDS).
   4.1. Describe information on electronic data sheets.
   4.2. Search and use an EDS.

AMT 1101: Welding & Fabrication – Introduction to Welding (Module 47)

Lecture Contact Hours: 8
Lab Contact Hours: 0

Description:
This is an introductory course to arc welding. This course will introduce the power sources used in SMAW and GMAW welding, along with equipment and filler metals used to produce a welded joint. Welding principles will be introduced along with the metallurgy of steel and welding.

Competencies:
1. Identify Personal Protective Equipment (PPE) required for welding and fabrication.
    1.1. Identify eye protection.
        1.1.1. Safety Glasses
        1.1.2. Welding Shields
    1.2. Identify welding gloves.
    1.3. Identify safety clothing.
    1.4. Identify proper foot wear.
2. Identify and explain hazards associated with welding.
    2.1. Identify and explain hazards associated with ultraviolet rays.
    2.2. Identify and explain hazards associated with welding fumes.
    2.3. Identify and explain welding burn hazards.
    2.4. Identify and explain electrocution hazards.
3. Identify and explain SMAW power sources.
    3.1. Identify and explain AC power sources.
    3.2. Identify and explain DC power sources.
    3.3. Identify and explain engine-driven power sources.
4. Identify and explain SMAW welding equipment.
    4.1. Identify and explain a welding cable.
    4.2. Identify and explain an electrode holder.
    4.3. Identify and explain a ground clamp.
5. Identify and explain SMAW electrodes and filler metals.
    5.1. Identify and explain the uses of various weld rods.
    5.2. Explain tensile strength.
    5.3. Explain weld position.
    5.4. Explain characteristics of SMAW welding.
6. Explain SMAW welding principles.
    6.1. Explain arc striking.
    6.2. Explain polarity.
    6.3. Explain arc gap.
    6.4. Explain Ohm's Law.
    6.5. Explain welding beads.
7. Explain GMAW welding principles.
    7.1. Explain amp/volt relationship.
    7.2. Explain wire speed.

7.3. Explain transfer methods.
7.3.1. Explain short circuiting transfer method.
7.3.2. Explain spray transfer method.
7.3.3. Explain pulsed transfer method.
8. Identify and explain GMAW shielding gases.
9. Identify and explain GMAW power sources.
9.1. Identify and explain AC power sources.
9.2. Identify and explain DC power sources.
9.3. Identify and explain engine-driven power sources.
10. Demonstrate knowledge of GMAW welding equipment.
10.1. Identify and explain drive wheels.
10.2. Identify and explain a GMAW gun.
11. Identify and explain GMAW filler metals.
11.1. Identify and explain uses of various filler metals.
11.2. Explain tensile strength.
11.3. Explain characteristics of GMAW welding.
12. Explain basic weld metallurgy.
12.1. Explain different steels.
12.2. Explain carbon content.
12.3. Explain heat affected zone.
12.4. Explain pre-heating and post-heating.
12.5. Explain stress relieving.

AMT 1102: Welding & Fabrication – SMAW (Module 48)

Lecture Contact Hours: 3
Lab Contact Hours: 47

Description:
The Shielded Metal Arc Welding course is designed to teach welders about arc welding safety and the Shielded Metal Arc Welding process including flat, horizontal, vertical, and overhead welding techniques.

Competencies:
1. Identify personal protection equipment.
1.1. Identify and use welding shield.
1.2. Identify and use welding gloves.
1.3. Identify and use welding jackets.
1.4. Identify and use welding cap.
2. Explain hazards of SMAW welding.
2.1. Explain burns.
2.2. Explain fumes.
2.3. Explain ultraviolet and infrared rays.
2.4. Explain electrocution.
3. Identify and prepare SMAW welding equipment.

   3.1. Adjust amperage.
   3.2. Connect ground.
   3.3. Inspect electrode holder.
4. Identify and explain SMAW electrodes.
   4.1. Choose correct electrode for job
5. Demonstrate correct SMAW welding technique.
   5.1. Demonstrate arc gap.
   5.2. Demonstrate travel speed.
   5.3. Demonstrate electrode angle.
6. Demonstrate SMAW welding in all positions.
   6.1. Demonstrate flat position welding.
   6.2. Demonstrate horizontal welding.
   6.3. Demonstrate vertical down welding.
   6.4. Demonstrate vertical up welding.
   6.5. Demonstrate overhead welding.

AMT 1103: Welding & Fabrication – GMAW (Module 49)

Lecture Contact Hours: 2
Lab Contact Hours: 28

Description:
Provides knowledge of theory, safety practices, equipment and techniques required for gas metal arc welding including different transfer methods and position welding.

Competencies:
1. Identify personal protection equipment.
   1.1. Use welding shield.
   1.2. Use welding glove.
   1.3. Use welding jacket.
   1.4. Use welding cap.
2. Explain hazards of GMAW welding.
   2.1. Explain burns.
   2.2. Explain fumes.
   2.3. Explain ultraviolet and infrared rays.
   2.4. Explain electrocution.
3. Identify and prepare GMAW welding equipment.
   3.1. Inspect welding wire.
   3.2. Inspect drive wheels.
   3.3. Inspect liner.
   3.4. Inspect welding gun.
4. Operate GMAW welding equipment.
   4.1. Adjust voltage.
   4.2. Adjust wire speed.

4.3. Identify and explain GMAW filler metal.
4.4. Identify and load welding wire.
5. Identify and explain GMAW shielding gas.
5.1. Identify and adjust shielding gas.
6. Demonstrate correct GMAW welding technique.
6.1. Demonstrate nozzle to work piece distance.
6.2. Demonstrate welding gun angle.
6.3. Demonstrate travel speed.
7. Demonstrate GMAW welding in all positions.
7.1. Demonstrate flat welding.
7.2. Demonstrate horizontal welding.
7.3. Demonstrate vertical down welding.
7.4. Demonstrate vertical up welding.
7.5. Demonstrate overhead welding.

AMT 1104: Welding & Fabrication – Oxy/Fuel Cutting and Joining (Module 50)

Lecture Contact Hours: 6
Lab Contact Hours: 18

Description:
An introduction to oxy-fuel welding and cutting, including safety, setup and maintenance of oxy-fuel welding and cutting equipment. Techniques taught in this course include cutting, brazing, and welding.

Competencies:
1. Identify personal protection equipment.
1.1. Identify and use burning and welding eye protection.
1.2. Identify and use welding gloves.
1.3. Identify and use welding jackets.
1.4. Identify welding cap.
2. Explain hazards of oxyfuel equipment.
2.1. Explain burns.
2.2. Explain fumes.
2.3. Explain ultraviolet and infrared rays.
3. Identify and prepare oxyfuel equipment.
3.1. Identify and set-up burning/welding outfit.
4. Operate oxyfuel equipment.
4.1. Explain and choose correct tip.
4.2. Set-up torch.
4.3. Correctly light torch.
4.4. Adjust flame for application.
5. Identify and explain oxyfuel gasses.
5.1. Identify and explain Oxy/fuel gasses.
6. Demonstrate correct oxyfuel welding technique.

6.1. Demonstrate flat welding.
6.2. Demonstrate horizontal welding.
6.3. Demonstrate vertical welding.

7. Demonstrate correct oxyfuel brazing technique.
   7.1. Demonstrate flat brazing.
   7.2. Demonstrate horizontal brazing.
8. Demonstrate correct oxyfuel cutting technique.
   8.1. Demonstrate straight line cutting.
   8.2. Demonstrate bevel line cutting.
   8.3. Demonstrate blowing hole.
   8.4. Demonstrate light steel cutting.
   8.5. Demonstrate weld washing.

AMT 1201: Machine Tool – Introduction to Machining (Module 51)

Lecture Contact Hours: 4
Lab Contact Hours: 0

Description:
This module introduces the student to machining operations. Emphasis is on the safe application of the most common machining procedures and machines used by multi-skilled industrial maintenance technicians.

Module Competencies:
1. Demonstrate knowledge of standard machine tools.
   1.1. Define machining.
   1.2. Describe the purpose of a drill press.
   1.3. Describe the purpose of an engine lathe.
   1.4. Describe the purpose of a metal saw.
   1.5. Describe the purpose of a milling machine.
   1.6. Describe the purpose of a grinder.
2. Demonstrate satisfactory knowledge of metal cutting safety.
   2.1. Demonstrate knowledge of general shop safety.
   2.2. Demonstrate knowledge of safety specific to metal cutting.
3. Describe metal cutting.
   3.1. Explain machinability and chip formation.
   3.2. Calculate speeds and feeds for machine tools.
   3.3. Identify the types of cutting tools used in machining.
   3.4. Demonstrate knowledge of the principles of machining.
   3.5. Describe the use of cutting fluids.

AMT 1202: Machine Tool Operations – Measuring and Layout Tools (Module 52)

Lecture Contact Hours: 4
Lab Contact Hours: 14

Description:
This module explains the measuring and layout tools commonly found in industrial environments. Emphasis will be on the safe application of the most common tools used by multi-skilled industrial maintenance technicians.

Competencies:
1. Demonstrate satisfactory knowledge of measurement and layout safety.
   1.1. Demonstrate knowledge of general shop safety.
   1.2. Demonstrate knowledge of safety specific to measurement.
   1.3. Demonstrate knowledge of safety specific to layout.
2. Perform basic and precision measurement.
   2.1. Describe the inch and metric dimensioning systems.

2.2. Perform basic measurement using rules and inside/outside calipers.
2.3. Perform measurement using squares, surface places, and angle plates.
2.4. Perform measurement using micrometers.
2.5. Perform measurement using Vernier calipers.
2.6. Perform measurement using inside, depth, and height measuring devices.
2.7. Describe the use and application of gage blocks in measurement and set-up.
2.8. Perform angular measurement using a bevel protractor.
2.9. Describe the use of the sine bar, gage block, and a dial indicator in angular measurement.

3. Perform basic and precision layout.
   3.1. Describe the use and care of the surface plate.
   3.2. Perform basic layout of lines, arcs, and holes using a scriber, dividers, square, combination set, surface gage, angle plate, and layout punch.
   3.3. Perform precision layout using a Vernier height gage.
   3.4. Describe the use of a sine plate in layout.

AMT 1203: Machine Tool Operations – Hand and Power Tools (Module 53)

Lecture Contact Hours: 4
Lab Contact Hours: 12

Description:
This module explains the safe and effective use of hand and power tools. Emphasis is on the application of the most common tools used by multi-skilled industrial maintenance technicians.

Competencies:
1. Demonstrate satisfactory knowledge of hand and power tool safety.
   1.1. Demonstrate knowledge of general shop safety.
   1.2. Demonstrate knowledge of safety specific to hand and power tools.
2. Use hand and bench tools properly.
   2.1. Use holding, striking, and assembly tools properly
   2.2. Use hand-type cutting tools properly.
   2.3. Use thread-cutting tools properly.
   2.4. Use finishing hand tools properly.
3. Use power tools properly.
   3.1. Use power hand tools properly.
   3.2. Use power saws properly.
   3.3. Use hand grinders and sanders properly.
   3.4. Use power wrenches properly.

AMT 1204: Machine Tool Operations – Saws (Module 54)

Lecture Contact Hours: 2
Lab Contact Hours: 8

Description:
This module explains the safe operation of saws, primarily the horizontal and contour bandsaw. Included are the various types of metal saws used in industry, their component parts, and associated safety precautions. Emphasis is on the most common sawing operations required by multi-skilled industrial maintenance technicians.

Competencies:
1. Describe the operation of a metal cutting saw.
   1.1. Describe the primary function of metal cutting saws.
   1.2. Describe the types of metal cutting saws found in industry.
   1.3. Identify the parts of a horizontal and vertical bandsaw and their functions.
   1.4. Identify and describe accessories used on horizontal and vertical bandsaws.
2. Demonstrate satisfactory knowledge of sawing safety.
   2.1. Demonstrate knowledge of general shop safety.
   2.2. Demonstrate knowledge of safety specific to metal saw operation.
3. Demonstrate knowledge of bandsaw blades
   3.1. Identify the types of bandsaw blades.
   3.2. Select the appropriate blade in regard to tooth form, pitch, and set.
   3.3. Select the appropriate blade in regard to width and gage.
   3.4. Calculate the bandsaw blade length for a specific saw.
   3.5. Properly mount a bandsaw blade
4. Perform sawing operations
   4.1. Calculate cutting speeds and feeds (where appropriate) for bandsaw operations.
   4.2. Describe use of cutting fluids.
   4.3. Perform cutoff operations with horizontal bandsaw.
   4.4. Perform contour sawing operations with vertical bandsaw.
   4.5. Describe welding a bandsaw blade.
   4.6. Describe band filing.
   4.7. List additional sawing operations.

AMT 1205: Machine Tool Operations – Drill Press (Module 55)

Lecture Contact Hours: 2
Lab Contact Hours: 12

Description:
This module explains the safe operation of drill presses, primarily the sensitive drill press. Included are the various types of drilling machines used in industry, their component parts, and associated safety precautions. Emphasis is on the most common drilling operations required by multi-skilled industrial maintenance technicians.

Competencies:
1. Describe the operation of a drill press
   1.1. Describe the primary function of drilling machines.
   1.2. Describe the types of drilling machines found in industry.

1.3. Identify the parts of a drill press and their function.
1.4. Identify and describe accessories used on drill presses.
2. Demonstrate satisfactory knowledge of drill press safety.
2.1. Demonstrate knowledge of general shop safety.
2.2. Demonstrate knowledge of safety specific to drill press operation.
3. Demonstrate knowledge of twist drills.
3.1. Identify the parts of a twist drill.
3.2. Describe drill point characteristics.
3.3. Demonstrate knowledge of drill size systems.
3.4. Identify the various types of drills.
3.5. Grind (sharpen) a twist drill.
3.6. Describe common drill failures and causes.
4. Perform drill press operations.
4.1. Calculate cutting speeds and feeds for drilling machines.
4.2. Describe use of cutting fluids.
4.3. Drill lathe center holes.
4.4. Spot drill using a center drill.
4.5. Drill holes to an accurate layout.
4.6. Drill large holes.
4.7. Perform reaming operations.
4.8. Perform counterboring and countersinking operations.
4.9. Tap holes.

AMT 1206: Machine Tool – Turning (Module 56)

Lecture Contact Hours: 2
Lab Contact Hours: 14

Description:
This module explains the safe operation of lathes, primarily engine and toolroom lathes. Included are the various types of lathes used in industry, their component parts, and associated safety precautions. Emphasis is on the most common lathe operations required by multi-skilled industrial maintenance technicians.

Module Competencies:
1. Describe the operation of a lathe.
1.1. Describe the primary function of a lathe.
1.2. Describe the types of lathes found in industry.
1.3. Identify the parts of a lathe and their functions.
1.4. Identify and describe common tools and accessories used on lathes.
1.5. Calculate cutting speed, feed rate, and depth of cut in performing lathe operations.
2. Demonstrate satisfactory knowledge of lathe safety.
2.1. Demonstrate knowledge of general shop safety.
2.2. Demonstrate knowledge of safety specific to lathe operation.
3. Set up tools and work on an engine or toolroom lathe.

3.1. Mount O.D. cutting tools on lathe.
3.2. Mount work in three-jaw chuck for machining.
3.3. Mount work in four-jaw chuck for machining.
3.4. Mount I.D. cutting tools on lathe.
4. Perform machining operations on an engine or toolroom lathe
4.1. Perform facing operations.
4.2. Perform turning operations.
4.3. Describe taper turning operations.
4.4. Describe threading operations.
4.5. Perform grooving operations.
4.6. Perform drilling, reaming, and tapping operations.
4.7. Describe boring operations.

AMT 1207: Machine Tool Operations – Milling (Module 57)

Lecture Contact Hours: 2
Lab Contact Hours: 20

Description:
This module explains the safe operation of milling machines, primarily vertical milling machines. Included are the various types of milling machines used in industry, their component parts, and associated safety precautions. Emphasis is on the most common milling operations required by multi-skilled industrial maintenance technicians.

Competencies:
1. Describe the operation of a milling machine.
1.1. Describe the primary function of a milling machine.
1.2. Describe the types of milling machines found in industry.
1.3. Identify the parts of a vertical milling machine and their functions.
1.4. Identify and describe common tools and accessories used on milling machines.
1.5. Calculate cutting speed, feed rate, and depth of cut in performing milling operations.
2. Demonstrate satisfactory knowledge of milling machine safety.
2.1. Demonstrate knowledge of general shop safety.
2.2. Demonstrate knowledge of safety specific to milling machine operation.
3. Set up tools and work on a vertical milling machine.
3.1. Install and remove tools in a vertical milling machine.
3.2. Align the head of a vertical milling machine.
3.3. Mount and align vise, fixture, or other workholding device.
3.4. Use an edge finder to locate an edge, corner, or center of workpiece.
3.5. Zero and utilize the digital readout for axes movement.
4. Perform machining operations on a vertical milling machine.
4.1. Perform face or end milling operations.
4.2. Perform side milling operations.
4.3. Perform drilling, reaming, and tapping operations.