Mechatronics II

8555/36 weeks

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Acknowledgments

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Course Description

Suggested Grade Level: 11 or 12

Students will build on their knowledge of mechatronic systems in this second-year course. Mechatronic systems, comprised of mechanical, electrical, and software systems, form the foundation of robotics, automation, and advanced manufacturing (such as three-dimensional [3D] printing). Students will explore mechanical, electrical, and pneumatic/hydraulic systems related to mechatronics, as well as relevant computer technologies. Upon successful completion, students may qualify for industry certification.

Task Essentials Table

- Tasks/competencies designated by plus icons (✚) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (☒) are omitted
- Tasks marked with an asterisk (*) are sensitive.

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<td>Report personal, environmental, and equipment safety violations to the appropriate authority.</td>
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<td>Trace the flow of electrical and mechanical energy in a mechatronic system.</td>
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<td>Explain the specific roles of various electrical components within a typical circuit schematic.</td>
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59 🔄 Explain the role of various mechanical components within a given system or module.
60 🔄 Describe the basic physical properties of mechanical components.
61 🔄 Identify mechanical components of systems prescribed by drawings.
62 🔄 Calculate gear ratios and horsepower.
63 🔄 Distinguish between various AC motors and DC motors.
64 🔄 Describe power transmission components.
65 🔄 Maintain a mechatronic system.
66 🔄 Assemble the mechanical components in a mechatronic system.

Understanding Fluid Power (Hydraulics and Pneumatics)
67 🔄 Demonstrate fluid-power system safety.
68 🔄 Explain the principles of fluid power.
69 🔄 Differentiate between hydraulic and pneumatic fluid power.
70 🔄 Identify fluid power components.
71 🔄 Read fluid power circuit diagrams.
72 🔄 Explain fluid-power systems.
73 🔄 Identify types of fluid power pumps or compressors.
74 🔄 Identify types of fluid power actuators.
75 🔄 Examine the physical characteristics and compressibility of gases.
76 🔄 Describe the flow of energy in a fluid system.
77 🔄 Construct fluid-power systems from components and symbols.
78 🔄 Explain fluid-power system maintenance.

Exploring Computer Applications
79 🔄 Demonstrate a working knowledge of the personal computer (PC).
80 🔄 Discuss software and hardware.
81 🔄 Explain the function of the Internet and manufacturing networks.

Exploring Digital Circuit Fundamentals
82 🔄 Describe logic gates.
83 🔄 Examine simple logic circuits using a variety of logic gates.

Using Technical Documents
84 🔄 Consult technical documents to assess a mechatronic system and troubleshoot malfunctions in electrical components.
85 🔄 Verify the parts, relationships, and behavior depicted by the technical data sheets for components within a mechatronic system.
86 🔄 Create a document describing the operation of a mechatronic system.

Legend: 🔄 Essential  ◯ Non-essential  ❌ Omitted

Curriculum Framework

Applying Basic Safety Standards for Mechatronics

Task Number 39

Comply with federal, state, and local safety requirements.

Definition

Compliance should include

- understanding the roles of the Occupational Safety and Health Administration (OSHA), Virginia Occupational Safety and Health (VOSH) program, and the U.S. Environmental Protection Agency (EPA)
- identifying the OSHA Hazard Communication Standard (HCS)
- interpreting the information included on safety data sheets (SDS)
- describing the responsibilities of employers and employees under HCS.
Process/Skill Questions

- Where should hazardous materials be stored?
- What information can be found on an SDS?

Task Number 40
Demonstrate lockout-tagout procedures.

Definition
Demonstration should include

- identifying existing and potential energy sources
- using appropriate equipment
- following administrative procedures
- challenging and/or testing the equipment.

Process/Skill Questions

- Why are lockout-tagout procedures important?
- What administrative procedures are part of lockout-tagout? Why are those procedures in place?

Task Number 41
Maintain a safe working environment.

Definition
Maintenance should be ongoing and result in identifying potential hazards on a job site or in the lab, such as unstable or improperly installed electrical components, electrical hazards, job site debris, improperly stored materials, and air quality hazards. When present, hazards must be remedied by appropriate measures in compliance with school and instructor guidelines.

Process/Skill Questions

- What are examples of job-site hazards?
- Why is it important to maintain safe workspace standards on a job site?
- Why is it important to store materials and tools in their proper places?

Task Number 42
Explain safe working practices around electrical hazards.

Definition
Explanation should include

- identifying equipment used to test electrical circuits
- describing safe working conditions (e.g., grounding, using ground-fault circuit interrupters [GFCIs] and cords)
- demonstrating safe work habits.
- outlining lockout-tagout procedures.
Process/Skill Questions

- What is the definition of proximity work?
- What are safe working clearances, according to the National Electrical Code (NEC)?
- What are considered safe working conditions and safe working habits?
- What is the unseen hazard with electrical work?
- What are lockout-tagout procedures?

Task Number 43
 Identify emergency first-aid procedures.

Definition
Identification should include procedures for accidents involving

- bodily fluids
- electrical injuries
- eye injuries
- hydraulic fluid injection injury
- falls
- burns.

Process/Skill Questions

- What steps should be followed in the event of an accident?
- Why is the knowledge of cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) use important in the electrical trades?
- Why is it important to be certified to administer first aid?
- What are the different classifications (degrees) of electrical burns?
- What is CPR/AED?

Task Number 44
 Identify the types of fires and the methods used to extinguish them.

Definition
Identification should include classifications of fires (e.g., Classes A, B, C, and D), causes and prevention of fires, types of extinguishers, and, when possible, the demonstrated use of a fire extinguisher, in accordance with government regulations and instructor guidelines.

Process/Skill Questions

- Why do fires have different classifications, and what are they?
- What is the fire triangle and the fire tetrahedron?
- What are the three things necessary to start a fire?
- Why is it important to know the classification of fire when trying to extinguish it?
- Why should extinguishers be inspected, and how often should they be inspected?
- What are the classifications of extinguishers?
Task Number 45
Demonstrate the use of a fire extinguisher.

**Definition**
Demonstration should include the use of the pull, aim, squeeze, sweep (PASS) method. Also, should address safety procedures for extinguishing electrical related fires (e.g., securing the power).

**Process/Skill Questions**
- Why is it important to know how to use a fire extinguisher?
- When is a fire extinguisher used?

Task Number 46
Identify personal protective equipment (PPE) requirements.

**Definition**
Identification could include procedures for inspecting, wearing, and removing

- eye protection
- respirator
- hard hat
- gloves
- safety harness
- hearing protection
- safety shoes.

Identification should also include explaining when a particular PPE is required.

**Process/Skill Questions**
- What are some dangerous effects of exposure, and how can these risks be mitigated?
- Why is wearing jewelry prohibited while in the lab or on the job site?

Task Number 47
Inspect hand and power tools to ensure safety and usability.

**Definition**
Inspection should include

- verifying that components of machinery (e.g., guards, blades, moving parts, start/stop switches) are in good working condition
- identifying any defects in tools, parts, or functions
- adhering to standard safety procedures (i.e., shop practices and manufacturer’s recommendations)
- demonstrating the safe operation and use of all equipment, tools, and machines.

**Process/Skill Questions**
- What are some of the basic power tools?
- What are the proper actions to take before using a band saw?
- Why must a power tool with a three-prong plug be grounded?
Task Number 48
Demonstrate lifting and carrying techniques.

Definition
Demonstration should include

- lifting with legs
- keeping back straight
- holding load close to the body
- getting help, if necessary.

Process/Skill Questions

- What are common injuries associated with improper lifting techniques?
- What can one do to prevent injury?
- How does proper positioning affect proper technique?

Task Number 49
Report injuries.

Definition
Report should consist of an immediate oral statement of the job-related or non-job-related injury to the instructor or supervisor, which may be followed by a written confirmation reporting the date, extent of the injury, and circumstances of the incident.

Process/Skill Questions

- Why is it important to report injuries?
- What are common reporting procedures?
- Why is it important to report an injury promptly, before leaving the job site?
- What is workers' compensation?
- What are the key components of a report?

Task Number 50
Report personal, environmental, and equipment safety violations to the appropriate authority.

Definition
Report should include

- providing a verbal or written statement
- identifying the violation
- documenting the date when the incident or behavior was observed
- following the protocol for submitting the report to the instructor, supervisor, or the local OSHA inspector.

Process/Skill Questions

- What ethical considerations might be involved when reporting coworkers?
• Why is it important to follow reporting procedures?
• What is liability?

Task Number 51

Pass the safety exam.

Definition
Passing the safety exam should allow the instructor to approve the student for working with course materials and equipment.

Process/Skill Questions
• How often should one participate in safety training programs? Why?
• How does insurance affect the requirement of continuous retraining for safety?
• What is workers’ compensation?

Understanding Electrical Components in a Mechatronic System

Task Number 52

Trace the flow of electrical and mechanical energy in a mechatronic system.

Definition
Tracing the flow of energy could include a computational model or other representation of the transfer of energy from one system to another.

Process/Skill Questions
• Where is useful energy lost throughout a mechatronic system?
• How is the flow of electrical energy different from mechanical energy?

Task Number 53

Explain the specific roles of electrical components within a typical circuit schematic.

Definition
Explanation should include predicting the effects of changing electrical components.

Process/Skill Questions
• How are the schematic representations of a component and the actual physical part similar and different?
• What devices can be used to sequence operations in a circuit?
• What are ways to create OR and AND logic?
Compute wire and fuse sizes based on the load required by the motor.

Definition
Computation should include

- power wire size
- overload size
- fuse size.

Process/Skill Questions

- Why is proper sizing important in this example?
- What could happen if wire and/or fuse sizing is incorrect?
- Why is it critical to understand the physical load limitations of wires and/or fuses?

Task Number 55

Analyze basic direct current (DC) circuits to predict and verify circuit behavior.

Definition
Analysis should include creating and measuring the circuits. Analysis should include reading and interpreting schematics.

Analysis should also include the application of Ohm’s law, Kirchhoff’s laws, and Watt’s law to troubleshoot simple circuits and document the steps taken.

Process/Skill Questions

- How accurately do the equations match experimental results?
- What is the difference between a schematic and a line diagram?
- What are the standards used in the U.S. for electrical schematics?

Task Number 56

Analyze circuits to predict and verify the behavior of series circuits vs. parallel DC circuits or resistances.

Definition
Analysis should include creating and measuring the circuits as prescribed by schematics.

Process/Skill Questions

- How is series resistance calculated?
- How is parallel resistance calculated?

Task Number 57
Explain the physical operation of electromagnetic components in a mechatronic system.

Explanation should incorporate the use of technical documentation and may include components such as coils, solenoids, relays, and various sensors.

Process/Skill Questions

- What is the role of a flyback (snubber) diode?
- What are the most common causes of failure with solenoids? How are problems identified?
- What are the different types of relays?

Task Number 58

Evaluate circuits to predict and verify the behavior of the electrical and physical properties of components.

Definition

Evaluation may include connecting and measuring the circuits as prescribed by schematics.

Evaluation may include components such as
- resistors
  - capacitors
  - diodes
  - transformers
  - relays
  - power supplies.

Process/Skill Questions

- What is a potentiometer?
- How is a four-way bridge with a digital multimeter checked?
- How does a Wheatstone bridge work?

Understanding Mechanical Components in a Mechatronic System

Task Number 59

Explain the role of various mechanical components within a given system or module.

Definition

Explanation should include understanding the function of
- levers
- gear drives
- belt drives
- chain drives
- lead screws/ball screws.
Process/Skill Questions

- What is backlash between gears, and what causes it?
- What are the audible differences between the drive trains?

Task Number 60
Describe the basic physical properties of mechanical components.

Definition
Description should include materials, lubrication requirements, and surface properties, and how each component is cleaned, lubricated, and mounted.

Process/Skill Questions

- Why is lubrication important?
- How does cost factor into the selection of materials?

Task Number 61
Identify mechanical components of systems prescribed by drawings.

Definition
Identification should include

- springs and spring-like effects
- linkages
- gears
- fasteners
- bearings
- couplings
- dampers and energy dissipation.

Process/Skill Questions

- What is the function of a coupling?
- What are gears?
- What is the function of dissipating energy with dampers?

Task Number 62
Calculate gear ratios and horsepower.

Definition
Calculation should include

- gear ratios
- tradeoff between rotational speed and torque
- horsepower (e.g., sizing of motors)
- efficiency.

Process/Skill Questions

- How do gears on a bicycle make it easier to pedal at different speeds across varying terrain?
- What is the disadvantage of using a motor without enough horsepower to consistently move the load?

Task Number 63

Distinguish between various AC motors and DC motors.

Definition

Distinction should include measuring and comparing behaviors of various motors such as single-phase, three-phase, variable-frequency-drive (VFD), stepper, and servos.

Process/Skill Questions

- What types of motors use brushes? What are the advantages of brushless motors?
- How does a variable frequency drive enhance the operation of AC motors?
- How does a microstepper driver enhance the operation of a stepper motor?
- What are the differences among unipolar, bipolar, and universal stepper motors?
- What does the term *servo* imply?

Task Number 64

Describe power transmission components.

Definition

Description should include components such as clutches, continuously variable transmission (CVT), and brakes. Description should also include measuring the operation of working equipment.

Process/Skill Questions

- What are the advantages of using a brake with a servos system as opposed to a stepper motor system?
- Why do stepper motors typically not require gear reduction transmissions?

Task Number 65

Maintain a mechatronic system.

Definition

Maintenance should include preventative maintenance as well as necessary adjustments to the system. Maintenance should be documented.

Process/Skill Questions

- What could happen if a mechatronic system is not maintained?
- What kind of maintenance information should be documented?
Task Number 66

**Assemble the mechanical components in a mechatronic system.**

**Definition**

Assembly could include

- mounting the motor
- balancing the motor
- aligning shafts
- aligning belts
- tensioning chains
- tensioning belts.

**Process/Skill Questions**

- How is a motor balanced?
- What is the process of aligning belts on a belt drive train?

**Understanding Fluid Power (Hydraulics and Pneumatics)**

Task Number 67

**Demonstrate fluid-power system safety.**

**Definition**

Demonstration should include reviewing procedures for hydraulic injection injury.

**Process/Skill Questions**

- What response is appropriate for a hydraulic injection injury?
- How should damaged equipment be handled?
- What PPE is necessary when working with pneumatic or hydraulic systems?

Task Number 68

**Explain the principles of fluid power.**

**Definition**

Explanation should include the definition of fluid power.

**Process/Skill Questions**

- How is a fluid-power system similar to a mechanical lever system?
- What are the advantages to using fluid power?

Task Number 69
Differentiate between hydraulic and pneumatic fluid power.

Definition
Differentiation should include describing when to use control systems based upon hydraulic vs. pneumatic power.

Process/Skill Questions

- What are the cost and benefit differences between hydraulic and pneumatic equipment?
- What factors determine whether to use a pneumatic or hydraulic system (e.g. environmental, hygiene, power requirements)?

Task Number 70
Identify fluid power components.

Definition
Identification should include

- reservoirs
- accumulators/bladders
- valves
- gauges
- cylinders
- limit switches
- solenoids
- supply elements (pumps/compressors)
- actuators.

Process/Skill Questions

- What are some everyday uses of fluid-power systems?
- What are the opposing forces of a single acting cylinder?
- What are the different types of solenoids?
- What symbols are used for various fluid power components?
- What is the significance of variations to fluid power symbols?
- What are the functions of various valves?
- What components are common to both pneumatic and hydraulic systems? Which are not?

Task Number 71
Read fluid power circuit diagrams.

Definition
Reading fluid power circuit diagrams should include identification and interpretation of fluid power symbols.

Process/Skill Questions

- What are the standards used in the U.S. for fluid power diagrams?
- What are the international standards for fluid power diagrams?
- Why do hydraulic diagrams show multiple reservoirs?
Task Number 72
Explain fluid-power systems.

Definition
Explanation should include

- forces
- speed
- friction
- flow
- pressure
- power

within fluid-power systems.

Process/Skill Questions

- How does a fluid power system work?
- Where is energy converted from one form to another in a fluid power system?

Task Number 73
Identify types of fluid power pumps or compressors.

Definition
Identification should include

- positive displacement
  - vane
  - piston
  - gear
- non-positive displacement
  - turbine
  - centrifugal.

Process/Skill Questions

- What are the advantages and disadvantages of types of pumps and compressors?
- Where are turbines or centrifugal pumps commonly used?
- What are other examples of positive displacement pumps?
- What does cavitation mean?

Task Number 74
Identify types of fluid power actuators.

Definition
Identification should include

- linear (cylinders)
  - single acting
  - double acting
- rotary (motors)
  - piston
Process/Skill Questions

- Why is a rotary hydraulic actuator used instead of an electric motor?
- When are fluid power actuators used? Where can they be found in common applications?
- What physical factors should be considered in selecting actuators?

Task Number 75

Examine the physical characteristics and compressibility of gases.

Definition
Examination should include the definition and application of Pascal’s law and Boyle’s law.

Process/Skill Questions

- How are the physical characteristics and compressibility of gases evident in the world?
- How does a pressure regulator work?
- What happens to the pressure of a compressed air tank when the room temperature increases?
- What is the formula for Pascal’s law?
- What is the significance of Boyle’s law?
- Why are gases compressible?

Task Number 76

Describe the flow of energy in a fluid system.

Definition
Description should include components that convert energy from one form to another and from one component to another within a fluid system. Description should include a graphic illustration representing the transfer of energy from one component to others in the mechatronic system.

Process/Skill Questions

- What components convert energy from one form to another in a fluid-power system?
- What causes flow in a fluid-power system?
- What determines whether the fluid-power system is operating properly?

Task Number 77

Construct fluid-power systems from components and symbols.

Definition
Construction should include connecting a supply element to a control device and an actuator and describing how the system functions. Construction should also include reading and interpreting symbols and diagrams.
Process/Skill Questions

- What components are required for a basic fluid-power system?
- Why does the system perform or not perform as expected?

Task Number 78

**Explain fluid-power system maintenance.**

Explanation should include referencing service manuals for installation, as well as preventive maintenance techniques, for fluid-power systems.

Process/Skill Questions

- What are common breakdown points in a fluid-power system?
- What routine maintenance functions should be performed on a pneumatic or hydraulic system?
- What is the benefit of a maintenance program?

Exploring Computer Applications

Task Number 79

**Demonstrate a working knowledge of the personal computer (PC).**

Definition

Demonstration should include

- file management
- folders and subfolders
- storage systems
- cloud-based options for saving and retrieving data.

Process/Skill Questions

- What is a digital thread?
- How are files related to maintenance of a mechatronic system managed?
- What are bills of materials and work orders? How might a PC be used to maintain bills of materials and work orders?

Task Number 80

**Discuss software and hardware.**

Definition

Discussion should include

- memory
- user privileges
- cybersecurity considerations
- communication ports and protocols
- software interfacing
- acceptable-use policies (AUPs).
Process/Skill Questions

- Why would an organization have an acceptable-use policy (AUP)?
- What are common communication protocols?
- Why are cybersecurity considerations important?

Task Number 81

Explain the function of the Internet and manufacturing networks.

Definition

Explanation should include

- local area networks (LAN)
- firewalls
- cybersecurity
- Internet of Things (IoT).

Process/Skill Questions

- Why do firewalls exist?
- What is the Internet?
- How is the Internet different from an intranet?

Exploring Digital Circuit Fundamentals

Task Number 82

Describe logic gates.

Definition

Description should include

- NOT gate
- AND gate
- OR gate
- NAND gate
- NOR gate
- XOR gate.

Process/Skill Questions

- What type of logic do two (normally closed and normally open) switches in parallel represent?
- What type of logic do two (normally closed and normally open) switches in series represent?
- Why are NAND and NOR considered universal logic gates?

Task Number 83

Examine simple logic circuits using a variety of logic gates.
Definition
Examination may include building or simulating the circuit.

Process/Skill Questions
- Why are logic gates the fundamental building blocks of computers?

Using Technical Documents

Task Number 84

Consult technical documents to assess a mechatronic system and troubleshoot malfunctions in electrical components.

Definition
Consultation should include
- data sheets
- timing diagrams
- operating manuals
- schematics.

Process/Skill Questions
- When should technical documents be consulted?
- Why is a line diagram usually easier to use for troubleshooting than a wiring diagram?

Task Number 85

Verify the parts, relationships, and behavior depicted by the technical data sheets for components within a mechatronic system.

Definition
Verification may be based upon observation and measurements for the mechanical and electrical components within a mechatronic system.

Process/Skill Questions
- How could this technical data sheet have been improved?
- What is normally found in technical data sheets?

Task Number 86

Create a document describing the operation of a mechatronic system.

Definition
Creation should include a description of mechatronic system components.
Process/Skill Questions

- What could happen if a document is misinterpreted or contains an error or ambiguous statement?
- How can an error be corrected in the document?

### SOL Correlations by Task

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<tr>
<td>Explain safe working practices around electrical hazards.</td>
<td>11.5, 11.6, 11.7, 12.5, 12.6, 12.7</td>
<td></td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Identify emergency first-aid procedures.</td>
<td>11.5, 12.5</td>
<td></td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Identify the types of fires and the methods used to extinguish them.</td>
<td>11.5, 12.5</td>
<td>CH.1</td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Demonstrate the use of a fire extinguisher.</td>
<td>11.5, 12.5</td>
<td>CH.1</td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Identify personal protective equipment (PPE) requirements.</td>
<td>11.5, 12.5</td>
<td></td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Inspect hand and power tools to ensure safety and usability.</td>
<td>11.5, 12.5</td>
<td></td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Demonstrate lifting and carrying techniques.</td>
<td></td>
<td></td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Report injuries.</td>
<td>11.5, 11.6, 11.7, 12.5, 12.6, 12.7</td>
<td></td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Report personal, environmental, and equipment safety violations to the appropriate authority.</td>
<td>11.5, 11.6, 11.7, 12.5, 12.6, 12.7</td>
<td></td>
<td>WHII 8, 14; VUS 8, 14; Govt 7, 8, 9</td>
</tr>
<tr>
<td>Task</td>
<td>Subjects</td>
<td>English:</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
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<td></td>
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<tr>
<td>Pass the safety exam.</td>
<td></td>
<td>11.5, 12.5</td>
<td></td>
</tr>
<tr>
<td>Trace the flow of electrical and mechanical energy in a mechatronic system.</td>
<td>Science: PH.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the specific roles of electrical components within a typical circuit schematic.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compute wire and fuse sizes based on the load required by the motor.</td>
<td></td>
<td></td>
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<tr>
<td>Analyze basic direct current (DC) circuits to predict and verify circuit behavior.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
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<tr>
<td>Analyze circuits to predict and verify the behavior of series circuits vs. parallel DC circuits or resistances.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the physical operation of electromagnetic components in a mechatronic system.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluate circuits to predict and verify the behavior of the electrical and physical properties of components.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the role of various mechanical components within a given system or module.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
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<tr>
<td>Describe the basic physical properties of mechanical components.</td>
<td>English: 11.5, 12.5</td>
<td></td>
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<tr>
<td>Identify mechanical components of systems prescribed by drawings.</td>
<td>English: 11.5, 12.5</td>
<td></td>
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<tr>
<td>Calculate gear ratios and horsepower.</td>
<td>English: 11.5, 12.5</td>
<td></td>
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</tr>
<tr>
<td>Distinguish between various AC motors and DC motors.</td>
<td>English: 11.5, 12.5</td>
<td></td>
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</tr>
<tr>
<td>Describe power transmission components.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintain a mechatronic system.</td>
<td>English: 11.5, 11.6, 11.7, 12.5, 12.6, 12.7</td>
<td></td>
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</tr>
<tr>
<td>Assemble the mechanical components in a mechatronic system.</td>
<td>English: 11.5, 11.6, 11.7, 12.5, 12.6, 12.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demonstrate fluid-power system safety.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the principles of fluid power.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differentiate between hydraulic and pneumatic fluid power.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
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<tr>
<td>Identify fluid power components.</td>
<td>English: 11.5, 12.5</td>
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</tr>
<tr>
<td>Read fluid power circuit diagrams.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain fluid-power systems.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify types of fluid power pumps or compressors.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify types of fluid power actuators.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examine the physical characteristics and compressibility of gases.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe the flow of energy in a fluid system.</td>
<td>English: 11.5, 12.5</td>
<td></td>
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<tr>
<td>Construct fluid-power systems from components and symbols.</td>
<td>English: 11.5, 12.5</td>
<td></td>
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</tr>
<tr>
<td>Task Description</td>
<td>English: 11.5, 12.5</td>
<td>Mathematics: COM.1</td>
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<td>---------------------------------------------------------------------------------</td>
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<tr>
<td>Explain fluid-power system maintenance.</td>
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<tr>
<td>Demonstrate a working knowledge of the personal computer (PC).</td>
<td>English: 11.5, 12.5</td>
<td>Mathematics: COM.1</td>
<td></td>
</tr>
<tr>
<td>Discuss software and hardware.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
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<tr>
<td>Explain the function of the Internet and manufacturing networks.</td>
<td>English: 11.5, 12.5</td>
<td>Mathematics: COM.16</td>
<td></td>
</tr>
<tr>
<td>Describe logic gates.</td>
<td>English: 11.5, 12.5</td>
<td>Mathematics: COM.8</td>
<td></td>
</tr>
<tr>
<td>Examine simple logic circuits using a variety of logic gates.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consult technical documents to assess a mechatronic system and troubleshoot malfunctions in electrical components.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify the parts, relationships, and behavior depicted by the technical data sheets for components within a mechatronic system.</td>
<td>English: 11.5, 12.5</td>
<td></td>
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</tr>
<tr>
<td>Create a document describing the operation of a mechatronic system.</td>
<td>English: 11.5, 12.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Teacher Resources**

**Mechatronics I/II/III Teacher Resources**

- All About Circuits: Educational Resources
- Amatrol curriculum
- ASME Resources: [Mechatronics and the role of engineers](#)
- ASTM Fastener Standards
- Hand Tools and Safety
- Hydraulic Injection Injuries
- IEEE Educational Resources
- NOCTI Job Ready Assessment Blueprint: Mechatronics Level I
- Penn State University Lockout/Tagout Policy:
  - Overview
  - Resources
- SkillsUSA Resources:
  - [Mechatronics Contest Standard](#)
  - [Mechatronics Contest Rules](#)
- Try Engineering: Differentiating between Mechatronics and Robotics
Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Automated Manufacturing Technology Examination
- College and Work Readiness Assessment (CWRA+)
- Festo NC3 Introduction to Mechatronics STEM Lab Certification
- Festo NC3 Level 1 Fundamentals Certifications
- Manufacturing Specialist Certification Examination
- Manufacturing Technician Level I Certification Examination
- Manufacturing Technology Assessment
- Mechatronic Systems Certification Examinations
- Mechatronics Level 1 Assessment
- National Career Readiness Certificate Assessment
- Pre-Manufacturing Technician I (PreMT1) Examination
- Robotics Certification Examinations
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.

- Mechatronics I (8554/36 weeks)

<table>
<thead>
<tr>
<th>Career Cluster: Manufacturing</th>
<th>Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathway</td>
<td></td>
</tr>
<tr>
<td>Manufacturing Production</td>
<td>Electro-Mechanical Technician</td>
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<tr>
<td>Process Development</td>
<td>Industrial Engineer</td>
</tr>
<tr>
<td></td>
<td>Industrial Engineering Technician</td>
</tr>
<tr>
<td></td>
<td>Manufacturing Systems Engineer</td>
</tr>
<tr>
<td>Production</td>
<td>Automated Manufacturing Technician</td>
</tr>
</tbody>
</table>

Career Cluster: Science, Technology, Engineering and Mathematics

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Occupations</th>
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<tbody>
<tr>
<td>Engineering and Technology</td>
<td>Electrical Engineering Technician</td>
</tr>
<tr>
<td></td>
<td>Electro-Mechanical Technician</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineer</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineering Technician</td>
</tr>
</tbody>
</table>