

# Agricultural and Environmental Systems Career Field

## Mechanical Principles

Subject Code: 010120

### Outcome & Competency Descriptions

#### **Course Description:**

Students will engage in the mechanical principles utilized in animal and plant production systems. They will learn electrical theory, design, wiring, hydraulic and pneumatic theory, along with metallurgy in relation to hot and cold metals. Students will apply knowledge of sheet metal fabrication applicable to the agricultural industry along with identify, diagnose, and maintain small air-cooled engines. Throughout the course, students will learn critical components of site and personal safety as well as communication and leadership skills.

#### **Strand 1. Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

#### **Outcome: 1.1. Employability Skills**

Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

#### **Competencies**

- 1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.
- 1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience.
- 1.1.3. Develop a career plan that reflects career interests, pathways and secondary and postsecondary options.
- 1.1.4. Describe the role and function of professional organizations, industry associations and organized labor and use networking techniques to develop and maintain professional relationships.
- 1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.
- 1.1.8. Identify the correlation between emotions, behavior and appearance and manage those to establish and maintain professionalism.
- 1.1.9. Give and receive constructive feedback to improve work habits.
- 1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.

#### **Outcome: 1.2. Leadership and Communications**

Process, maintain, evaluate and disseminate information in a business. Develop leadership and team building to promote collaboration.

#### **Competencies**

- 1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.
- 1.2.4. Use negotiation and conflict-resolution skills to reach solutions.
- 1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.
- 1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.
- 1.2.8. Identify the strengths, weaknesses and characteristics of leadership styles that influence internal and external workplace relationships.

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- 1.2.10. Use interpersonal skills to provide group leadership, promote collaboration, and work in a team.

**Outcome: 1.12. Site and Personal Safety Procedures**

Follow site and personal safety procedures in specific situations with specialized tools and equipment, evaluate the situation and take corrective action.

**Competencies**

- 1.12.1. Use Occupational Safety and Health Administration (OSHA) defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries and labeling.
- 1.12.2. Interpret safety signs and symbols.
- 1.12.4. Describe how working under the influence of drugs and alcohol increases the risk of accident, lowers productivity, raises insurance costs and reduces profits.
- 1.12.5. Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.
- 1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions and materials.
- 1.12.8. Identify safety hazards and take corrective measures.
- 1.12.9. Identify, inspect and use safety equipment appropriate for the task.
- 1.12.10. Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.
- 1.12.13. Demonstrate the proper use of American National Standards Institute (ANSI) hand signals.
- 1.12.15. Select and operate fire extinguishers based on the class of fire.

*An "X" indicates that the pathway applies to the outcome.*

<b>Pathways</b>	Agribusiness and Production Systems		Animal Science and Management		Bioscience		Horticulture
	Natural Resource Management	X	Power Technology				
<b>Green Practices</b>	Green-specific		Context-dependent		Does not apply		

**Strand 4. Power Systems**

Learners apply principles of tool use, power transmission, hydraulics, two- and four-stroke cycle combustion, heating and cooling, exhaust, ignition, starting and charging, steering and lubrication systems to operate, to maintain or repair equipment.

**Outcome: 4.1. Tool, Stationary and Mobile Equipment Maintenance**

Inspect, clean, maintain and perform planned preventative maintenance on tools, machinery, implements and equipment.

**Competencies**

- 4.1.1. Identify the types of hand tools, power tools and stationary equipment and describe their functions.
- 4.1.2. Ensure the presence and functionality of safety systems and hardware.
- 4.1.3. Identify potential hazards and limitations related to the use of hand tools, power tools and stationary equipment.

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- 4.1.4. Maintain machinery, equipment, instrument and facility cleanliness, appearance and safety.
- 4.1.5. Inspect and service the electrical connections and lamps.
- 4.1.6. Inspect for fluid leakage, fluid levels and the condition of fluids.
- 4.1.7. Clean, lubricate and adjust machinery and equipment.
- 4.1.8. Select fluids, maintain fluid levels and replace system filters.
- 4.1.9. Inspect and maintain fluid conveyance and storage components (e.g., hoses and lines, valves, nozzles).
- 4.1.11. Calibrate metering, monitoring and sensing equipment.

**Outcome: 4.2. Equipment Operations**

Operate and maintain mechanical equipment and power systems.

**Competencies**

- 4.2.1. Follow manufacturer's recommended operating procedures and adjustment specifications.
- 4.2.2. Differentiate among the functions, limitations and proper use of equipment, equipment controls and instrumentation.
- 4.2.3. Perform pre- and post-operation inspections and adjustments and report malfunctions.
- 4.2.4. Perform appropriate start-up, operating and shut-down procedures.
- 4.2.5. Select and operate the equipment and attachments needed to complete the task including levers, pedals or valves.

**Outcome: 4.3. Engines**

Apply concepts to service components of both small and large internal combustion engines.

**Competencies**

- 4.3.3. Locate the name plate and determine engine specifications.
- 4.3.4. Analyze, evaluate and troubleshoot an engine.
- 4.3.5. Compare and contrast two-cycle and four-cycle engines and their operating principles.
- 4.3.6. Evaluate engine head and engine block components to determine serviceability according to the manufacturer's specifications.

**Outcome: 4.4. Lubrication and Cooling Systems**

Inspect lubrication and cooling systems operation.

**Competencies**

- 4.4.1. Explain principles of engine lubrication and cooling.

**Outcome: 4.5. Fuel, Air Induction and Exhaust System**

Diagnose and repair fuel, air induction and exhaust systems.

**Competencies**

- 4.5.3. Check fuel for contaminants and quality.

**Outcome: 4.11. Hydraulic Systems**

Diagnose, repair and rebuild hydraulic systems.

**Competencies**

- 4.11.1. Interpret symbols and schematic drawings related to hydraulic system design.
- 4.11.2. Describe the physical and mechanical principles of hydraulics.

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- 4.11.3. Explain the features, benefits and applications of the different types of hydraulic and hydrostatic systems.
- 4.11.4. Describe the application and operation of major components, including pumps, motors, valves and accumulators.
- 4.11.8. Evaluate system cleanliness to determine efficiency.
- 4.11.9. Locate hydraulic fittings and ports.
- 4.11.11. Measure flow rate, pressure and temperature.
- 4.11.12. Prevent contamination of a hydraulic system.

An "X" indicates that the pathway applies to the outcome-

<b>Pathways</b>	Agribusiness and Production Systems		Animal Science and Management		Bioscience		Horticulture
	Natural Resource Management	X	Power Technology				
<b>Green Practices</b>	Green-specific		Context-dependent		Does not apply		

#### **Strand 5. Structural Engineering**

Learners apply the principles of engineering related to electricity, structural repair and design, use of brick, block and concrete, water distribution, and metal working to design, construct, manage and maintain structures and biological systems used in agriculture, food and natural resources.

#### **Outcome: 5.1. Electrical Theory**

Interpret and apply electrical and electronic principles and theories.

##### **Competencies**

- 5.1.1. Interpret symbols and wiring diagrams.
- 5.1.2. Describe the features, benefits and applications of electrical and electronic systems.
- 5.1.5. Explain methods of producing electrical current.
- 5.1.6. Describe the differences between alternating current (AC) and direct current (DC).
- 5.1.7. Compare and contrast conductors and insulators.
- 5.1.8. Differentiate the relationships between voltage, current, resistance and power in circuits.
- 5.1.9. Measure the amperage of AC and DC electrical systems and system components.
- 5.1.10. Calculate voltage, current, resistance, impedance and power in circuits using Ohm's Law, Kirchhoff's Law and Watt's Law.
- 5.1.11. Describe the purpose of grounding and common methods used for grounding.
- 5.1.12. Describe the uses of series, parallel and series-parallel circuits.
- 5.1.13. Use a digital multimeter to determine voltage, current, frequency and phase.

#### **Outcome: 5.2. Structural Electrical Circuits**

Describe features of an electrical schematic that illustrates a wiring system and interpret and install the design.

##### **Competencies**

- 5.2.1. Describe over-current protective devices and their functions.
- 5.2.3. Map circuits and label the service panel directory to reflect devices installed on each circuit.
- 5.2.4. Calculate service requirements for an electrical installation and evaluate for safe capacity.

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- 5.2.5. Identify types of cable, conduit, boxes, switches, outlets and other common wiring devices.
- 5.2.7. Select materials and lay out rough-in wiring runs according to specifications, drawings and code requirements.
- 5.2.10. Install lighting fixtures, wiring devices and covers.

**Outcome: 5.3. Design and Estimate**

Plan and design a basic site plan for a desired outcome.

**Competencies**

- 5.3.9. Prepare sketches, drawings, prints, specifications and construction details.

**Outcome: 5.6. Construction**

Follow architectural plans to construct and repair simple outdoor structures and minor building additions.

**Competencies**

- 5.6.1. Compare and contrast the structural properties, grades and types of construction materials.
- 5.6.2. Lay out, cut, smooth, shape and bore construction materials.
- 5.6.14. Contrast options and install fencing.

**Outcome: 5.8. Water Distribution Systems**

Calculate the demand for specific water applications and design and install water supply and drainage components.

**Competencies**

- 5.8.1. Calculate water demand for specific applications.
- 5.8.16. Test a water supply and drainage system for leaks and pressure using soap, inert gas, electronic sensors and fluorescent dye.

**Outcome: 5.9. Physics and Metallurgy of Welding**

Apply the physics and metallurgy of welding in joining materials.

**Competencies**

- 5.9.1. Assess how the welding arc produces a weld.
- 5.9.2. Identify the factors that affect heat transfer and melting.
- 5.9.3. Describe the effects of arc length and shielding gases on the arc.
- 5.9.4. Identify key variables that determine the type of metal transfers.
- 5.9.5. Analyze the relationship between wire feed speed and welding current.
- 5.9.7. Apply the effects of wire size to deposition rate and current ranges.
- 5.9.9. Explain conditions when arc blow occurs and how to reduce arc blow.
- 5.9.13. Critique the types of weld imperfections and indicate their effects on material properties.

**Outcome: 5.10. Joining and Cutting Metals with Heat**

Join and cut steel using heat in horizontal and vertical positions.

**Competencies**

- 5.10.1. Classify, select, handle and store electrodes and match them to the job requirements based on the desired level of penetration and heat range.
- 5.10.2. Determine the correct welder type, wire diameter and gas to be used in a specific welding situation.

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- 5.10.3. Compare and contrast metal welding operating characteristics and performance (e.g., oxy-fuel, shielded metal arc, gas tungsten arc, braising, soldering).
- 5.10.4. Select the joint design, weld type and welding position.
- 5.10.5. Set up and adjust the welder according to the material being welded and influencing conditions.
- 5.10.6. Store, handle and install high pressure gas cylinders.
- 5.10.7. Clean, prepare, align and secure the metal to be welded.
- 5.10.8. Compensate for the effects of expansion and contraction forces when joining metals.
- 5.10.9. Employ protective methods for surrounding equipment and materials during welding and cutting operations.
- 5.10.10. Perform continuous, stitch, tack, plug, butt and pinch welds with and without backing and fillet welds.
- 5.10.11. Conduct tests on each weld type and causes of defects.
- 5.10.12. Cut steel using oxy fuel and plasma equipment.

**Outcome: 5.11. Fabricating with Cold Metals**

Repair metal structures and equipment through cutting, shaping, forming and joining metal stock.

**Competencies**

- 5.11.1. Evaluate metal structures and equipment and plan the method of repair.

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		Natural Resource Management	X	Power Technology				
<b>Green Practices</b>		Green-specific		Context-dependent				Does not apply