# 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.

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

**Outcome 1.3. Business Ethics and Law**

Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competencies:**

1.3.2. Follow protocols and practices necessary to maintain a clean, safe and healthy work environment.

**Outcome 1.4. Knowledge Management and Information Technology**

Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies:**

1.4.4. Use system hardware to support software applications.

**Outcome 1.9. Financial Management**

Use financial tools, strategies and systems to develop, monitor and control the use of financial resources to ensure personal and business financial well-being.

**Competencies:**

1.9.2. Identify tax obligations.

**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.

**Strand 4. Power Systems**

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

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

Inspect, clean, maintain and perform preventative maintenance on equipment.

**Competencies**

4.1.1. Inspect, clean, maintain and perform preventative maintenance on equipment.

4.1.2. Identify the types of hand tools, power tools and equipment and describe their functions.

4.1.3. Ensure the presence and functionality of safety equipment.

4.1.4. Identify potential hazards and limitations related to the use of equipment.

4.1.5. Maintain organization, and cleanliness of facilities, machinery, equipment and tools for safety and appearance.

4.1.6. Inspect and service the electrical systems and components.

4.1.7. Inspect for fluid leakage, fluid levels and the condition of fluids.

4.1.8. Inspect, clean, lubricate and adjust equipment for safe operation.

4.1.9. Select fluids, maintain fluid levels and replace system filters per OEM (original equipment manufacturer) specification.

4.1.10. Inspect and maintain fluid conveyance and storage components.

4.1.11. Identify and maintain accuracy of tooling, machinery, and equipment when performing preventative maintenance and repairs.

4.1.12. Compare alternative sources of power for equipment.

**Outcome: 4.2. Equipment Operations**

Operate and maintain mechanical equipment and power systems.

**Competencies**

4.2.1. Follow original equipment manufacturer (OEM) recommended operating procedures and adjustment specifications as found in the operator's manual.

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 per original equipment manufacturer (OEM) operator's manual.

**Outcome: 4.3. Engines**

Apply concepts to service components of both small and large internal combustion engines per the original equipment manufacturer (OEM) operator’s manual.

**Competencies**

4.3.3. Locate data 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 per the original equipment manufacturer (OEM) specification.

**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, exhaust systems and aftertreatment devices (ATD).

**Competencies**

4.5.1. Explain principles of exhaust, intake, aftertreatment and turbocharger on designs and operations.

**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.

4.11.4. Identify and describe the applications and operations of major hydraulic system components.

4.11.7. Identify and describe the purpose of fluid sampling, perform fluid sampling procedures and interpret sample reporting.

**Outcome: 4.14. Pneumatic Systems**

Diagnose, repair and rebuild pneumatic systems.

**Competencies**

4.14.1. Interpret symbols and schematic drawings related to pneumatic system design.

4.14.2. Describe the physical and mechanical principles of pneumatics.

4.14.4. Identify and describe the applications and operations of major pneumatic system components.

4.14.7. Identify and describe the pneumatic system contaminates and methods of testing and control.

**Strand 5. Elements of Production**

Learners apply the principles of practice related to the management and maintenance of food, agriculture and natural resources systems.

**Outcome: 5.1. Electrical Theory**

Interpret and apply electrical and electronic principles and theories.

**Competencies**

5.1.1. Read and interpret wiring diagrams and symbols.

5.1.2. Describe the features, benefits and applications of electrical and electronic systems.

5.1.4. Explain methods of producing electrical current.

5.1.5. Describe the differences between alternating current (AC) and direct current (DC).

5.1.6. Compare and contrast conductors and insulators.

5.1.7. Differentiate the relationships among voltage, current, resistance and power in circuits and understand the basics of transformers.

5.1.8. Measure the amperage of AC and DC electrical systems and system components.

5.1.9. Calculate voltage, current, resistance, impedance and power in circuits using Ohm’s Law, Kirchhoff’s Law and Watt’s Law.

5.1.10. Describe the purpose of grounding and common methods used for grounding.

5.1.11. Describe the uses of series, parallel and series-parallel circuits.

5.1.12. 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.

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.

5.2.8. Select and install lighting technologies and systems.

**Outcome: 5.3. Design and Estimate**

Interpret basic site plan for a desired outcome or company specification.

**Competencies**

5.3.1. Identify and interpret symbols, drawings, prints, and blueprints.

5.3.2. Apply proportional measurement and scale techniques.

5.3.9. Identify construction documents, common scales, specifications and materials used in construction or fabrication.

**Outcome: 5.6. Construction**

Follow architectural plans to construct and repair agricultural structures and hardscapes.

**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.

**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 the deposit of weld metal and melting (e.g., speed, metal type, travel speed, amps, voltage, angles of electrode).

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. Compare and contrast the relationship of wire size to deposition rate and current ranges.

5.9.9. Explain conditions when arc blow occurs and how to reduce arc blow.

5.9.12. Identify and describe the types of weld imperfections and indicate their effects on material properties.

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

Join and cut ferrous and non-ferrous materials 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.

5.10.3. Compare and contrast ferrous and non-ferrous material welding operating characteristics and performance.

5.10.4. Identify and 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 post-weld material.

5.10.8. Compensate for the effects of expansion and contraction forces when joining ferrous and non-ferrous materials.

5.10.9. Employ protective methods for surrounding equipment and materials during welding and cutting operations.

5.10.10. Perform continuous, stitch, tack, plug and butt welds with and without backing and fillet welds.

5.10.11. Cut ferrous and non-ferrous materials using oxy fuel and plasma equipment based on the various applications.

**Outcome: 5.11. Fabricating with Cold Ferrous and Non-Ferrous Material**

Repair ferrous and non-ferrous material structures and equipment through cutting, shaping, forming and joining stock.

**Competencies**

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

5.11.2. Lay out and cut ferrous and non-ferrous material.

**Outcome: 5.13. Electronic Systems**

Learners apply principles of electronics related to electronic theory, alternating and direct current, electronic components, electronic circuits, digital electronics and power supply.

**Competencies**

5.13.7. Perform solder repair of electrical wiring.