CASE

Agricultural Equipment Maintenance and Technology Detailed Course Outline

Unit 1: Agricultural Equipment

Lesson 1.1 Equipment Systems

1. Agricultural equipment used by industry varies based on local crops and geographic location.
    - Identify and describe the equipment used in the local area to produce and harvest crops. (Activity 1.1.1)
2. Technicians document plans and processes when servicing equipment.
    - Organize notebooks to record coursework and projects. (Activity 1.1.2)
    - Practice recording assembly and disassembly procedures in a logbook. (Activity 1.1.2)
3. Technicians use tools to make precise measurements.
    - Measure components using a dial caliper, dial indicator, torque wrench, and combination square. (Activity 1.1.2)
    - Use a micrometer to make precise measurements. (Activity 1.1.4)
4. A fastener's strength and size vary based on its purpose.
    - Identify bolt size, type, and grade. (Activity 1.1.5)
5. Power take-off (PTO) systems transfer power to agricultural implements.
    - Disassemble and identify the components of a universal joint. (Activity 1.1.5)
6. Powertrain systems contain belts, chains, and gears to deliver power for work.
    - Identify types of belts, chains, and gears on a piece of equipment. (Activity 1.1.6)
7. Guarding and shielding agricultural equipment prevent injury to an operator.
    - Identify the safety hazards found in the internal motions of equipment. (Project 1.1.7)

Lesson 1.2 Technician Expectations

1. Technicians follow a standard diagnostic procedure to inspect a problem, make repairs, and verify operation.
    - Identify the parts of the six-step diagnostic process during a guest technician presentation. (Activity 1.2.1)
2. Agricultural equipment dealers prefer technicians with strong interpersonal skills.
    - Identify interpersonal skills desired by ag equipment dealers. (Activity 1.2.1)
3. Technicians use digital service procedure manuals to diagnose and repair equipment.
    - Create a picklist for equipment repair using a digital service manual. (Activity 1.2.2)
4. Technicians use a digital multimeter to diagnose and repair electrical systems.
    - Test for voltage, resistance, and continuity in an electrical component using a digital multimeter. (Activity 1.2.3)

5. Technicians utilize written reports, such as work/repair orders, to communicate services provided to a customer.
    - Write a work/repair order using technical writing. (Project 1.2.4)
    - Write a work/repair order for a universal joint repair. (Project 1.2.5)
6. Component failure analysis allows technicians to analyze root cause failures.
    - Diagnose a failed universal joint and identify the root cause using the Five Whys method. (Project 1.2.5)
7. Technicians use service manuals to perform diagnostics and repairs on agricultural equipment, leading to a longer life in powertrain systems and reducing operation costs.
    - Repair a universal joint and identify steps to verify operation using a manufacturer's service manual. (Project 1.2.5)

Unit 2 Drive Systems

Lesson 2.1 Drive Train Components

1. Gears change a drive train's speed and torque.
    - Construct a drive train and measure speed. (Activity 2.1.1)
    - Measure a drive train's torque. (Activity 2.1.3)
2. Clutches engage and disengage torque from the power input to the power output.
    - Identify clutch systems & components present on agricultural equipment. (Activity 2.1.2)
    - Adjust and test the settings for an electromagnetic clutch. (Activity 2.1.2)
3. Bearings reduce friction to increase efficiency in power train systems.
    - Identify and select bearing types used in drive train systems. (Activity 2.1.4)
4. Technicians set and adjust gears to work effectively.
    - Disassemble a gearbox, identify components and inspect for wear and backlash. (Activity 2.1.5)
5. A drive train uses a combination of components to change the direction and speed of moving parts in a system.
    - Construct a drive train modeling agricultural equipment. (Project 2.1.6)

Lesson 2.2 Final Drives

1. Differentials allow implements to maintain equal torque at different speeds.
    - Assemble a model of a differential system. (Activity 2.2.1)
2. Planetary gears affect the torque, speed, and direction of a machine.
    - Simulate planetary gear settings and observe the input and output speeds. (Activity 2.2.2)
3. Technicians use precision measurement tools to set preload and endplay in a powertrain system.
    - Disassemble and adjust tapered bearings on a wheel hub. (Activity 2.1.3)
4. Tire and tracks provide traction in agricultural equipment when proper ground contact is applied.
    - Identify and select tires for a tractor. (Activity 2.2.3)
    - Determine ballast requirements for specific equipment applications. (Activity 2.2.4)
5. Technicians use precision tools to complete a failure analysis and determine the root cause of an equipment failure.
    - Troubleshoot and complete a work/repair order for a broken drive train. (Project 2.2.6)

Unit 3 Precision Agriculture

Lesson 3.1 Precision Systems

1. Equipment calibration increases the efficiency of outputs and limits overlaps and skips in a field.
    - Calibrate a hand sprayer and fertilizer spreader. (Activity 3.1.1)
2. Precision systems require a wireless connection with satellites to find a geographic location.
    - Locate satellites and determine signal quality for a global positioning system. (Activity 3.1.2)
3. Controller systems in precision agriculture include guidance systems, yield monitors, sensors, and automated outputs.
    - Draw a flow chart explaining the relationship between precision agricultural components found on a combine. (Project 3.1.3)
    - Operate a simulated tractor and guidance system. (Activity 3.1.4)
4. Precision agriculture increases production efficiencies that reduce application costs while improving yields.
    - Calculate the potential savings for using an autosteer tractor and a piece of tillage equipment. (Activity.3.1.5)
5. Agricultural producers use sensors and automated controls to increase production efficiencies.
    - Set up a control system for activating an irrigator. (Activity 3.1.6)
    - Construct a control system modeling a tractor's autosteer system. (Project 3.1.7)

Lesson 3.2 Precision Applications

1. Geographic information systems display vectors, features, and attributes.
    - Use GIS to make field boundaries and display a soil sampling grid. (Activity 3.2.1)
2. A producer can predict a field's productivity by collecting data from specific locations.
    - Use interpolation to display GIS data. (Activity 3.2.2)
3. Variable-rate application systems reduce producer costs while protecting the environment.
    - Analyze data using GIS and recommend a seeding application based on soil type. (Activity 3.2.3)
    - Compare flat-rate and variable-rate applications by creating basic fertilizer recommendations for each scenario. (Project 3.2.4)

Lesson 3.3 The Data Advantage

1. Agricultural producers use remote sensing devices to collect data for making production decisions.
    - Use machine learning software to simulate remote sensing and data analysis. (Activity 3.3.1)
2. Technicians use data to predict future repairs and maintenance.
    - Interpret GIS data and identify machine failure. (Activity 3.3.2)

Unit 4 Electrical and Digital

Lesson 4.1 Electrical Systems

1. Agricultural equipment uses series, parallel, and series-parallel circuits.
    - Construct series, parallel, and series-parallel circuits. (Activity 4.1.1)
    - Calculate total resistance in series, parallel, and series-parallel circuits. (Activity 4.1.1)
2. Diodes protect electrical equipment by allowing power to flow in one direction.

- Test a diode using a digital multimeter. (Activity 4.1.2)
- Construct circuits using silicon diodes. (Activity 4.1.2)
- Construct circuits using Zener diodes. (Activity 4.1.3)

3. Electrical systems use alternating and direct current.
    - Rectify AC voltage to power an LED. (Activity 4.1.3)
    - Troubleshoot a tractor's charging system using a digital multimeter. (Activity 4.1.3)
4. Rheostats and potentiometers vary the resistance in an electrical circuit.
    - Model a rheostat using a graphite pencil. (Activity 4.1.4)
    - Use a potentiometer to change the voltage in a circuit. (Activity 4.1.4)

Lesson 4.2 Electrical Controls

1. Technicians read schematics when designing, constructing, and troubleshooting electrical circuits.
    - Describe a cranking system using an electrical schematic. (Activity 4.2.1)
2. Electrical systems control how engine systems operate and function.
    - Test the continuity of an ignition key switch. (Activity 4.2.2)
    - Assemble a shutdown circuit using a wiring schematic. (Project 4.2.3)
3. Agricultural equipment uses relays to control high amperage circuits that power specific components.
    - Identify common terminals used on relays. (Activity 4.2.4)
    - Assemble a circuit using a relay. (Activity 4.2.4)
4. Electrical systems use resistors, diodes, potentiometers, and relays to control equipment components.
    - Design and construct a circuit to control motor speed and direction. (Project 4.2.5)
5. Technicians manage and troubleshoot controller systems used in precision agriculture.
    - Construct and troubleshoot a transducer. (Project 4.2.6)

Lesson 4.3 Electrical Analysis

1. Technicians use diagnostic tools and Ohm's law as part of a systematic troubleshooting process.
    - Calculate voltage drop in a circuit. (Activity 4.3.1)
    - Troubleshoot voltage drops with a digital multimeter. (Project 4.3.2)
    - Diagnose parasitic battery drain with a digital multimeter. (Activity 4.3.3)
2. Technicians maintain and troubleshoot systems directing electrical current between components.
    - Construct an ignition/shutdown circuit using cables and connectors. (Project 4.3.4)
    - Troubleshoot an ignition/shutdown circuit using a digital multimeter and a schematic. (Project 4.3.4)
3. Technicians use tools to troubleshoot and maintain GPS/GIS equipment.
    - Modify a sprayer to include electrical and GPS controls. (Problem 4.3.5)
    - Develop a troubleshooting and maintenance plan for a GPS sprayer. (Problem 4.3.5)

Unit 5 Diesel Systems

Lesson 5.1 Diesel Components

1. There are functional differences between diesel and gasoline engines.
    - Identify similarities and differences between small gasoline and diesel engines. (Activity 5.1.1)
2. Mechanical diesel injection systems have several components with specific functions.

- Identify the high and low-pressure components of a fuel system. (Activity 5.1.2)
- Flare and assemble a fuel line. (Activity 5.1.2)
- Inspect a fuel injector for faults. (Activity 5.1.2)

3. Diesel engines have systems that clean and pressurize the air and clean the exhaust.
    - Inspect and identify the components of a turbocharger and air filter. (Activity 5.1.3)
    - Measure the urea content in diesel exhaust fluid samples. (Activity 5.1.3)
4. Diesel engine systems have a variety of lubrication and liquid cooling systems.
    - Change oil and oil filter using OEM specifications. (Activity 5.1.4)
    - Inspect a cooling system using industry equipment. (Activity 5.1.4 and Project 5.1.5)
    - Model a cooling system to cool the engine coolant. (Project 5.1.5)
5. Technicians use customer complaints combined with an inspection to determine the cause of engine failure.
    - Determine the cause of broken engine components and complete a work repair order. (Project 5.1.6)

Lesson 5.2 Diesel and Electrical

6. Diesel engines control connected systems using Controller Area Network (CAN) bus systems with Electronic Control Units (ECU) to monitor and control the engine.
    - Diagnose faults in a CAN bus model using a DMM. (Activity 5.2.1)
    - Identify how a circuit fault in CAN bus impacts an 8-bit signal. (Activity 5.2.1)
7. A CAN bus allows a system of microcontrollers to control agricultural equipment.
    - Simulate CAN bus data in response to sensor data. (Activity 5.2.2)
    - Inspect an oil pressure transducer for faults. (Activity 5.2.2)
8. High-pressure common rail diesel fuel systems have essential components with specific functions.
    - Develop a flowchart of CAN bus operations within fuel and intake systems. (Project 5.2.3)

Unit 6 Hydraulics

Lesson 6.1 Hydraulic Principles

1. A hydraulic system has a pump, control valves, actuators, fluid, and hoses.
    - Virtually assemble a fluid power system. (Activity 6.1.1)
2. Technicians use schematics to identify fluid power components and systems.
    - Draw and identify the components found in a hydraulic system schematic. (Activity 6.1.2)
3. The hydraulic systems can be closed or open-loop systems using positive or non-positive pumps.
    - Construct example models of hydraulic systems (Activity 6.1.3)
4. A technician can control the fluid flow and pressure in a hydraulic system.
    - Add flow and pressure gauges and adjust the fluid pressure and flow in a hydraulic system. (Activity 6.1.4)
    - Calculate pressure drop in a hydraulic system. (Activity 6.1.4)
5. Pascal's Law determines the system pressure and components needed for a machine to operate.
    - Find the force exerted by hydraulic cylinders. (Activity 6.1.5)
    - Use Pascal's Law to find the needed pressure and cylinder size for equipment. (Activity 6.1.5)

Lesson 6.2 Hydraulic Systems and Safety

1. Hydraulic fluids have specifications and properties that meet industry standards.
    - Read an SDS and identify the ISO Standards for hydraulic fluids. (Activity 6.2.1)
    - Compare the physical properties of hydraulic fluids. (Activity 6.2.1)
2. Technicians need to be aware of the potential safety hazards when working with hydraulic equipment.
    - Inspect a hydraulic system for safety hazards. (Activity 6.2.2)
    - Record and practice the steps to place a hydraulic system in a zero energy state. (Activity 6.2.2)
3. Hydrostatic transmissions use variable displacement pumps to transfer energy in a power train.
    - Model and calculate the advantage of variable displacement pumps. (Activity 6.2.3)
4. Electro-hydraulic systems control cylinders in agricultural implements.
    - Evaluate a solenoid and relay for functionality on electro-hydraulic components. (Activity 6.2.4)
    - Construct an electro-hydraulic system. (Project 6.2.5)
5. Hydraulics provide power in agricultural equipment for steering, braking, drivetrains, and axillary equipment.
    - Inspect and document the physical characteristics of fluid power systems found on a tractor. (Activity 6.2.6)

Lesson 6.3 Hydraulic Maintenance

1. Hydraulic components need to seal correctly and be free of air and contaminants to prevent wear and damage.
    - Disassemble a hydraulic cylinder and valve to inspect for wear and damage. (Activity 6.3.1)
    - Disassemble a hydraulic pump and complete a work/repair order. (Project 6.3.2)
2. Technicians select fittings based on design and purpose.
    - Identify the fittings needed for a hydraulic system. (Activity 6.3.3)
3. Routine repair of a hydraulic system includes flushing a system and inspecting for particulate matter.
    - Inspect used hydraulic oil for potential causes of contamination. (Project 6.3.4)
    - Fill out a work/repair order for hydraulic parts damaged by contaminated oil. (Project 6.3.4)

Unit 7 Partnering in the Field

Lesson 7.1 Practical Evaluation

1. Technicians work with producers to periodically maintain equipment for optimum agricultural production.
    - Assess the mechanical systems of a tractor and implement and write a work/repair order for recommended maintenance. (Project 7.1.1)
2. Troubleshooting and service procedures are essential for long-term equipment performance.
    - Complete service procedures for hydraulic, electrical, and power train systems. (Activity 7.1.2)
3. Practical experiences are essential when preparing for a technical career.
    - Compile a work portfolio of technical skill competencies. (Foundational SAE Checklist)