Apprenticeship Manitoba

Manitoba

Agricultural Equipment Technician
Level 2

Rev. February 2006

Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: B2 Customer Communications and Work Order Processing

Level: Two

Duration: 7 hours

Theory: 7 hours

Practical: 0 hours

Overview:

This unit of instruction will help the Agricultural Equipment Technician apprentice develop interpersonal skills that facilitate effective and positive interaction with customers and industry peers. The apprentice will also acquire the working knowledge required to process work orders.

Objectives and Content:	**Percent of Unit Mark (%)**

1. Describe aspects of public relations and customer service. **25%**

a. Today's heavy duty technician
b. Effective public relations
c. Professionalism
d. Creating trust
e. Listening skills
f. Telephone etiquette
g. Customer appreciation
h. Use of appropriate language
i. Positive attitude
j. Role of the professional

2. Describe basic communications principles and practices. **15%**

a. Types of communications
   - Verbal
   - Non-verbal communications
   - Awareness of non-verbal codes
   - Your own non-verbal vocabulary

b. Factors influencing interpersonal communication
   - Self-awareness
   - Self-concept
   - Self-esteem

c. Interpersonal skills
   - Assertiveness
   - Supportiveness
   - feedback

d. Small group interaction
   - Small group characteristics

- Small group types
- Panels
- Discussion groups
- Committees
- Group roles
- Task roles
- Maintenance roles
- Negative individual roles

e. Small group interaction
- Conformity
- Cohesiveness
- Consensus
- Conflict and conflict resolution

3. Describe and perform key on-the-job written communications duties. 60%

a. Work orders
b. Work procedures documentation
c. Purchase orders
d. Parts requisition
e. Time sheets
f. Warranty documentation
g. Log books
h. Working drawings

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: C2 Electric/Arc/MIG Welding

Level: Two

Duration: 40 hours

Theory: 20 hours

Practical: 20 hours

Overview:

This unit of instruction will provide the Agricultural Equipment Technician apprentice with the working knowledge required to use equipment and perform tasks related to electric, arc, and MIG welding.

Objectives and Content:	**Percent of Unit Mark (%)**

1. Describe prerequisite knowledge of the electric arc welding process. — **10%**

a. Applied safety precautions
- Eye, face, hand, foot and clothing protection
- Cut and burn treatments
- Fire extinguisher availability
- Setup and shutdown sequence
- Ventilation equipment
- Safety shielding
- Cylinder and shutdown sequence
- Cylinder handling
- Electrical shock protection
- Vehicle electronic systems protection

b. Applied tools and equipment
- Compressed gas cylinders
- Pressure regulators
- Hoses
- Approved welding work place
- Ventilation equipment

c. Applied communications
- Interpretation of manufacturers' service and operating procedures
- Practical report
- Information accessing

2. Describe the fundamentals of the electric arc welding process. — **15%**

a. Metallurgy
b. Arc emissions
c. Electrical fundamentals & polarity

3. Describe the components and applications of electric arc welding equipment and consumables. **10%**

a. Transformers
b. Rectifiers
c. Controls
d. Electrode holders
e. Electrode specifications
   - Codes
   - Current type and polarity
   - Position
   - Penetration
   - Base metal material
   - Material condition

4. Describe the operation of shielded electric arc welding equipment. **10%**

a. Equipment settings
b. Transformers
c. Rectifiers
d. Stationary and portable units
e. Open circuit voltage
f. Closed circuit voltage

5. Perform electric welding procedures with A/C, D/C and MIG welding equipment. **50%**

a. Machine adjustments and welds
b. Single and multi pass butt and fillet welds in flat position
c. Examples of defective welds
d. Trial beads

6. Describe manufacturers' maintenance procedures for shielded metal arc welding equipment. **5%**

a. Welding cables
b. Holding devices
c. Power sources
d. Protective equipment

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: G1 Tillage and Seeding Equipment; Ballasting

Level: Two

Duration: 15 hours

Theory: 8 hours

Practical: 7 hours

Overview:

This unit of instruction will provide the Agricultural Equipment Technician apprentice with the working knowledge required to understand, service, diagnose and repair tillage and seeding equipment.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe tillage practices a. Conservation and conventional tillage b. Conventional tillage	**5%**
2. Describe main tillage systems. a. Primary b. Secondary	**5%**
3. Describe tillage system safety practices. a. Hydraulic fluid b. Towing / transporting safety c. Spring safety d. Correct blocking procedures e. Transport locks f. Safety issues: lighting systems g. Tractor implement matching	**5%**
4. Describe and perform tractor / implement preparation and adjustment. a. Tractor setup • 3-point hitch b. Static weight split and ballast • Two-wheel drive tractors • Four-wheel drive tractors • “Cast vs. calcium” c. Tractor tires • Selection criteria • Tire inflation	**15%**

- Safety procedures: installment & removal

d. Monitoring of tractor performance
   - Power hop
   - Slippage

e. Tillage implement setup and adjustments
   - Surface vs. subsoil compaction
   - First wheel pass issues
   - Tractor considerations
   - Tracked vehicles

5. Describe components, operation, servicing, diagnosis and repair of plows. 5%

a. Overall purpose and design
   - Soil action
   - Levelness

b. Plow types
   - Integral
   - Semi-integral
   - Drawn
   - Reversible or two-way

c. Subsoilers

d. Types, sizes, operation

e. Moldboard plows
   - Moldboard plow bottoms & components

f. Moldboard plows
   - Landsides
   - Standards/types
     -Shear bolt
     -Safety trip
     -Hydraulic automatic reset
     -Spring automatic reset
   - Mouldboard plow attachment types
   - Frames

g. Hitching: in-furrow vs. on-land

h. Moldboard-plow operation
   - Centre of load
   - Centre of pull
   - Line of draft

i. Moldboard-plow adjustments

j. Plowing: required power

6. Describe tractor preparation for plowing. 10%

a. Tractor load-and-depth / draft control systems

b. Preparation
   - Importance of drawbar pull, lift capacity, tractor stability
   - Role of tractor and plow design
   - References: operator manual

7. Describe components, operation, servicing, diagnosis and repair of heavy-duty disks. 5%

a. Overall background and purpose

b. Disk types and sizes
   - Single/double-action, offset, plowing disks

- Integral
- Drawn

c. Disk features
- Blade types
- Blade sizes
  -Criteria for blade thickness and diameter
  -Blade spacing

d. Disk operation
- Gang angle
- Disk penetration
- Disk leveling
- Soil leveling
- Offset disk setup procedure
- Disk plows

8. Describe components, operation, servicing, diagnosis and repair of chisel plows and field cultivators. 5%

a. Overall background and purpose of chisel plows and field cultivators
- Role of vertical clearance

b. Chisel plows
- Types and sizes
- Width
- Clearance
- Shank types
- Operation principles
- Field operation
  -Plowing angle
- Operating speed
- Chiseling methods
- Effect with stubble-mulch

c. Field cultivators: types, sizes and operation
- Shanks
- Soil-engaging tools
- Combination implements
- Toothed harrows
  -Tine-tooth
  -Spike-tooth
  -S-tine/flexible cultivators
  -Spring-tooth

d. Field conditioners

e. Roller harrows and packers

f. Mulch tillers
- Types, sizes, operation
- Anhydrous ammonia applicators

g. Component servicing
- Lubrication
- Leveling
- Field preparation

h. Diagnosis and repair

9. Describe components, operation, servicing, diagnosis and repair of dryland tillers. 5%

a. Wide-sweep plows

b. Rod weeders

c. Disk tillers
d. Listers and bedders

10. Describe components, operation, servicing, diagnosis and repair of planters/seeders. 35%

a. General categories: purpose & operation
   - Planters
   - Drills
   - Air seeders
   - Air drills

b. Opening devices
   - No-till vs. conventional
   - Metering systems
     -Row crops vs. cereal crops
   - Air distribution systems
     -Single-chute & double-chute
   - Closing devices

c. Special equipment and related components
   - Hydraulic down-pressure systems
   - Variable-route technology
     -Manufacturer-specific

d. Seeding implement setup and adjustment

e. Maintaining systems
   - Rate mentoring
   - Population monitoring
   - Blockage monitoring

11. Describe components, operation, servicing, diagnosis and repair of toolbars. 5%

a. Overall purpose and design
b. Safety issues: toolbar transport
c. Toolbar components
   - Toolbar hitches
   - Gauge wheels
   - Standards and shanks
     -Soil engaging tools
     -Markers

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: G2 Harvesting & Hay Equipment

Level: Two

Duration: 30 hours

Theory: 10 hours

Practical: 20 hours

Overview:

This unit of instruction will provide the Agricultural Equipment Technician apprentice with the working knowledge required to service, diagnose and repair hay harvesting equipment.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe general safety issues for harvesting and hay equipment.	**6%**
a. Environmental issues / biohazard • Dust • Mould • Fungi • Airborne viruses b. Confined space c. Overhead power lines d. Height-related problems e. Loose clothing / hair f. Augers / rotating shafts	
2. Describe types of hay equipment.	**6%**
a. Forage harvesters b. Mower conditioners c. Balers d. Hay rakes	
3. Describe the components, operation, service and repair of forage harvesters.	**19%**
a. Specific safety issues • Rotating parts • Knifeheads; shear bars • Rotating shafts • Augers b. Components and operation • Crop-mat controls • Cutterheads; shear bars • Augers	

- Blowers
- Tongue followers
- Wagons
- Hitches
- Electrohydraulic controls
- Metal detectors

c. Servicing
- Sharpening
- Adjustments
- Lubrication

d. Diagnosis
- Feeding problems
- Cutting problems
- Electrical problems
- Controls and monitoring

e. Repair procedures
- Removal and replacement of components
- Repair of faulty components
- Corrective field adjustments
- Availability of specialty repairs and exchange components
- Balance and setup of cutterhead
- Correct blower adjustment
- Post-repair inspection checklist

4. Describe the components, operation, service and repair of mowers. 6%

a. Related safety issues
- Rotary parts
- PTOs and shafts

b. Types
- Mower conditioners
  -Cutterbars
  -Conditioning rolls
  -Crimping edges
  -Drydown
- Flail mowers
- Rotary mowers
- Sickle cutter bar mowers
- Rotary disc

c. Components and operation
- Rotary cutters
  -Wide-cut
  -Flex-wing
- Flails
- Blades
- Sickle bars

d. Diagnosis
- Equipment problems
  -Causes of breakage
  -Other problems
- Operator errors
- Field conditions
- Required adjustments
- Equipment wear issues

- Isolation of defective components

e. Service and repair procedures
   - Servicing
   - Roll timing
     -Sickle bar repair
     -Rotary disk knife replacement
   - Repair
     -Removal and replacement of components
     -Repair of faulty components
     -Corrective field adjustments
     -Availability of specialty repairs and exchange components
     -Post-repair inspection checklist

5. Describe the components, operation, service and repair of hay handling equipment. 19%

a. Related safety issues
   - Plunger knife safety issues
   - Knotter knife safety isues
   - Sileage balers

b. Rake types
   - Hay rakes
   - Twin rakes

c. Baler types
   - Round balers
   - Square balers

d. Components and operation
   - Square balers
     -Pickups
     -Feeder forks
     -Flywheel
     -Plungerhead
     -Compressors
     -Augers
   - Round balers
     -Twine wraps
     -Knotters
     -Belts
     -Monitoring systems
     -Ejectors

e. Diagnosis
   - Belt tracking: round balers
   - Tying problems: square balers
   - Equipment problems
     -Causes of breakage
     -Other problems
   - Operator errors
   - Field conditions
   - Required adjustments
   - Equipment wear issues
   - Isolation of defective components

f. Servicing and repair
   - Lubrication
   - Removal and replacement of components
   - Repair of faulty components
   - Corrective field adjustments

- Post-repair inspection checklist

6. Describe the components, operation, service and repair of combines. 25%

a. Related safety issues
b. Combine types
   - Conventional
   - Rotary
c. Combine theory, operation and components
   - Cutting / gathering
   - Threshing
   - Separating
   - Cleaning
   - Handling
d. Field operation adjustments
   - Deterring grain loss
e. Servicing and repair
   - Service techniques
   - Scheduled maintenance tasks
   - Lubrication types and applications
   - Lubrication procedures
   - Removal and replacement of components
   - Repair of faulty components
   - Corrective field adjustments
   - Availability of specialty repairs and exchange components
   - Post-repair inspection checklist

7. Describe and perform the setup and pre-delivery of haying, forage and harvesting equipment. 19%

a. Setup procedures
b. Hitching procedures
c. Setup procedures: attachments, drives, controls & control systems
d. Preliminary adjustments
e. Storage procedures

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: G3 Spraying

Level: Two

Duration: 10 hours

Theory: 5 hours

Practical: 5 hours

Overview:

This unit of instruction will provide the Agricultural Equipment Technician apprentice with the working knowledge required to diagnose and repair spraying equipment.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe safety issues for spraying equipment.	**10%**
a. Knowledge of chemicals used in application	
b. Safety equipment	
• Gloves	
• Coveralls	
• Respirator	
c. Flushing / cleaning	
d. Manufacturers' specifications	
e. Discussions with operator	
2. Describe sprayer plumbing systems and maintenance.	**50%**
a. Possible sprayer problems and solutions	
b. Pumps	
• Positive displacement	
• Non-positive displacement	
• Pump types and characteristics -Centrifugal -Diaphragm -Piston -Roller -Turbine	
c. Pump plumbing systems	
• Nozzle capacity	
• Hoses and lines	
• Agitation	
• Maintenance and care	
d. Control systems	
• Speed sensors -Radar -Mechanical	

- Monitors
  -Calibration
  -Types (e.g.: Midtech, Raven, Dickey John)
- Flow meters
  -Types
  -Calibrator
  -Mainframe
  -Testing
- Control valves
  -Hydraulic
  -Product

e. Squeeze pumps (chemical injection systems)
f. Liquid system
   - Pump operation
   - Values
   - Hoses
   - Pump seal leaks
   - Strainers
g. Preventative maintenance
   - Overall role
   - Safety-related components
   - Use of checklists

3. Describe spray nozzles. 20%

a. Types
b. Nozzle materials
c. Changing of application volume
   - Role / importance of pressure
   - Role / importance of speed
   - Nozzle tip size
d. Nozzle selection
   - Job requirements
   - Product selection / choices
   - Checking of manufacturers' specs
   - Determination of operating conditions
   - Verification of nozzle size
   - Wear on nozzles
e. Broom shutoff operation
f. Program monitors / operation
g. Broom breakaway
h. Hose clamps
i. Ball valves

4. Describe sprayer setup and "fine tuning" (for operator). 20%

a. "Ounce" calibration method
b. Calibration: gallons/acre
c. Nozzle discharge / uniformity check
d. Ground speed check

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: H2 Basic Hydraulic Operating Principles; Schematics

Level: Two

Duration: 30 hours

Theory: 30 hours

Practical: 0 hours

Overview:

This unit of instruction will provide the Agricultural Equipment Technician apprentice with a broad background of hydraulic systems and concepts. As well, this unit will provide apprentices with the working knowledge required to interpret schematics and blueprints.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe basic hydraulic principles.	**40%**
a. Pascal's Law b. Multiplication of force c. Formulas: area, pressure, force d. Displacement e. Thermal expansion f. Bermoulli's principle g. Advantages of hydraulic systems h. Hydrodynamics i. Hydrostatic j. Force k. Energy (potential, heat, kinetic) l. Work m. Power n. Torque o. Pressure gauge p. Absolute pressure	
2. Describe hydraulic oil properties and service requirements.	**20%**
a. Hydraulic fluid properties • Viscosity • Friction • Flow rate • Volume • Velocity • Laminar • Pressure	

- Cavitation
- Imperial/metric
- Pour point
- Lubricating ability
- Oxidation resistance
- Corrosion & rust protection
- Foaming & emulsion resistance

b. Safety precautions
   - Blocking procedures prior to removal
   - Releasing of system pressure

c. Indicators of oil contamination and other indicators re: oil change
d. Draining of oil
e. Cleaning or replacement of filtration devices
f. Appropriate selection of hydraulic oil
g. Refilling the system
h. Type and grade
i. Cleanliness; avoidance of contaminants
j. Proper oil level
k. Machinery operation re: oil
   - Flushing the system

3. Interpret and use hydraulic symbols and diagrams. 40%

a. Common hydraulic symbols and diagrams
b. Interpretation of schematics and diagrams
   - Pictorial, cutaway and symbol drawings
   - Exploded views

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: H3 Basic Hydraulic Components: Disassembly and Reassembly

Level: Two

Duration: 50 hours

Theory: 0 hours

Practical: 50 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with a working knowledge of working on basic hydraulic components.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe fluid circuits.	**15%**
a. Open centre	
b. Closed centre	
c. Pressure and flow compensated	
2. Describe hydraulic pumps and their operation.	**25%**
a. Overall purpose	
b. Basic pump cycle	
c. Pump displacement	
• Non-positive displacement pumps	
• Positive displacement pumps	
d. Pump flow ratings	
e. Horsepower rating	
f. Pump efficiency	
• Mechanical efficiency	
• Volumetric efficiency	
g. Pressure rating	
h. Pump inlet design	
• Cavitation	
• Aeration	
i. Gear type pumps	
• Overall purpose	
• External gear pumps	
• Internal gear pumps	
j. Vane pumps	
• Overall purpose	
• Unbalanced vane pumps	
• Balanced vane pumps	

k. Piston type pumps
   - Overall purpose
   - Radial piston pumps
   - Axial piston pumps
   - Bent-axis piston pumps

3. Describe hydraulic motors and their operation. 5%

a. Overall purpose and function
b. Motor ratings
   - Displacement
   - Maximum pressure rating
     -Torque generation
   - Horsepower rating
c. Motor types
   - Gear motors
     -External gear motors
     -Gerotor motors
   - Vane motors
   - Piston motors
     -Radial: crankshaft & cam type
     -Axial
     -Bent-axis

4. Describe hydraulic valves and their operation. 25%

a. Overall purpose
b. Pressure control valves
   - Direct acting
   - Pilot-operated
c. Flow control valves
   - Principles of hydraulic flow control
   - Types
     -Fixed & variable
d. Directional control valves
   - Construction
     -Poppet
     -Rotary
     -Spool directional
   - Actuation methods
     -Mechanical
     -Pilot
     -Electrical
     -Electronic
   - Valve centre & work port condition
     -Open centre
     -Closed centre

5. Describe hydraulic cylinders and their operation. 10%

a. Overall purpose
b. Single acting
c. Double acting
d. Construction

6. Describe hydraulic accumulators and their operation. 10%

a. Overall purpose
   - Energy storage

- Shock absorption
- Pressure buildup
- Constant pressure maintenance

b. Component and system-specific safety issues
c. Weighted
d. Spring loaded
e. Gas-charged
   - Piston
   - Bladder

7. Describe hydraulic heat exchangers and their operation. 5%

a. Overall purpose
b. Oil heaters
c. Oil coolers
   - System efficiency
   - System duty cycles

8. Describe hoses, fluids, fittings, tubing, filters and their installation. 5%

a. Filters and strainers
   - Construction
     -Surface
     -Depth
     -Sizes
     -Micron rating
     -Beta ratio
   - Contamination
     -Internal and external sources
   - Ratings
     -Absolute, nominal and beta
   - Locations
     -Strainer
     -Pressure line filters
     -Return line filters

b. Filter bypass devices and restriction indicators
   - Oil viscosity
   - Filter media permeability

c. Pipes and tubes
   - Copper, aluminum, plastic and steel
   - Sizing
   - Pipe connections and fittings
   - Flared tubing connections

d. Pipe couplers
e. Quick disconnect couplers
f. Tube fittings
   - Flared
   - Compression fittings
   - Tightening procedures

g. Hoses
   - Fabric braid
   - Single-wire braid
   - Double-wire braid
   - Spiral-wire fittings & couplers
   - Sizes

- Connectors & couplers
- Adapters

h. Hose fittings
   - Permanent
   - Reusable
     -Installation

i. Seals
   - Static and dynamic (positive & non-positive)

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: I2 Electrical Components and Schematics; Body Electrical and Warning Safety Systems

Level: Two

Duration: 48 hours

Theory: 24 hours

Practical: 24 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with the working knowledge required to repair and replace basic electronic components. The unit also provides the advanced working knowledge required to diagnose service and repair body-related electrical systems.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe electrical components, their operation and schematic symbols, semiconductor and transistor design.	**10%**

a. Capacitors
   - Purpose (construction, charge, discharge cycle)
   - Uses (noise suppressor, counter voltage spikes)
   - Types (fixed, variable); identification (size, farads)

b. Circuit breakers vs. fuse
c. Flashers
d. Light bulbs
e. Coils
f. Transformers
g. Relays
h. Buzzers
i. Solenoids
j. Motors
k. Semiconductor material
   - Crystal material
   - Sand – silica or silicon
   - Doping of silicon (adding phosphorus, boron, etc.)

l. N-type semiconductor
m. P-type semiconductor
n. Diode construction
   - Joining of P and N material
   - Blocking and passing of current
   - Design of electrical check valve
   - Forward and reverse bias

o. Diode types and applications

- Conventional diode
- Rectifying
- Light emitting
- Zener diode

p. Common semiconductor types
- Thermistors
- Piezo crystals
- Photonic semiconductors
  -Light emitting diodes
  -Photoresistors
  -Solar cells
  -Phototransistors

q. Purpose and design
- Use in solid circuitry
- Change from a resistor to conductor
- Construction: joining of three semiconductor chips
- NPN & PNP
- Bonding of chips
- Small wire attached to each type material

r. Transistor connections
- Emitter
- Collector
- Base

s. Transistor operation

t. Common types of transistors
- Signal transistor
- Power transistor
- PNP and NPN

2. Perform the inspection and testing of electrical components listed in Objective 1. 10%

a. Diodes

3. Describe lighting systems and interpret schematic diagrams. 20%

a. Exterior lighting
- Bulb identification
- Headlights and circuits
- Park lights
- Brake lights
- Signal lights
- Emergency flashers

b. Interior lighting
- Dome lights
- Dash lights
- Courtesy lights

c. Repair manuals and troubleshooting charts
- Common abbreviations
- Service manual illustrations section
- Reference section
- Diagnosis charts
  -Flow chart
  -Troubleshooting
  -Component location

d. Role of wiring diagrams
   - Wire connections
   - Component locations

4. Diagnose and repair/replace malfunctions in wiring harnesses and related components. **25%**

a. Wiring harness
   - Schematics
   - Connectors
   - Routing
   - Routing of mini-communication wires
   - Circuit protection
   - Fault tracing

b. Diagnosis of electrical system problems
   - Use of wiring diagrams

c. Weather and weather-proof connectors

d. Wire repair
   - Weatherproof connectors
   - Correct pin removal
   - Wire protection & retaining devices
   - Wiring harness
   - Soldering of wires and terminals
   - Connector types
   - Use of correct tools
   - Crimp type connector and tool
   - Proper wire repair procedures
   - Proper installation procedures of terminal ends from connectors

e. Wire terminals

f. Wire types and colour coding
   - Solid and stranded
   - Number vs. size
   - American Wire Gauge System
   - Metric size = cross-sectional area = (mm^2)
   - Types of wiring identification

5. Describe the fundamentals of monitoring and safety devices. **10%**

a. Instrument gauges and indicators
   - Magnetic gauges
   - Thermal and bimetallic gauges
   - Oil, temperature and fuel gauges
   - Indicator lights
   - Pressure gauges

b. Safety devices
   - Park brake warning
   - Travel alarms
   - Neutral start
   - Seat switches

c. Horns
   - Horn
   - Controls
   - Relays

d. Windshield wiper and washers
e. Equipment monitoring devices
   - Speed monitors
   - Yield monitors
   - Moisture sensors
   - Seed monitoring

6. Describe diagnostic procedures; perform the repair of electrical systems. 25%

a. Procedures for diagnosing faults
   - Shorts
   - Opens
   - Grounds
   - Resistance
b. Intermittent faults
   - Possible causes: wire chafing, poor connections, connector damage, corroded terminals
   - Visual inspection
   - Damage to sensors and actuators
   - Connections to sensors, actuators, control modules, ground points
   - Damage to wiring
c. Sequential troubleshooting techniques
   - High impedance digital multimeter
   - Circuit damage precautions
   - Electrostatic discharge
d. Wiper and warning system component tests
e. Circuit analysis following manufacturers' troubleshooting charts
f. Removal and replacement procedures for instrument gauges and display systems
g. Safety precautions for electronic devices
h. Proper circuit wiring routing (reduction of magnetic field interference)
i. Radio interference factors

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: I3 Starting and Charging Systems

Level: Two

Duration: 36 hours

Theory: 10 hours

Practical: 26 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with the working knowledge required to diagnose as well as repair starting and charging systems.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe magnetism and inductance.	**5%**
a. Inductance	
b. Examples of induction, self-induction and mutual induction	
• Ignition coil	
• Alternator	
• Starter	
c. Natural magnet	
• Permeability	
• Retentivity	
d. Electromagnet construction	
e. Electron flow and magnetism	
f. Use of electromagnets on vehicles	
g. Conversion of energy by magnetism	
• Electrical energy into mechanical energy	
• Mechanical energy into electrical energy	
• Electrical energy into other forms	
2. Define the purpose and fundamentals of starting systems.	**5%**
a. Electromagnetic principles	
• Permanent magnet and electromagnetism	
• Ohm's Law	
• Torque and wattage	
• Counter-electromotive force	
• Centrifugal force	
• Voltage drop of high current circuits	
• Batteries	
b. Cranking motors	
• Series	

- Series-shunt
- Series-parallel
- Counter-electromotive force effect on current flow
- Temperature effect on load and torque output

c. Control systems
d. Prelube circuits

3. Describe the design and operation of starter motor circuits and drives. 5%

a. Starter circuit
   - Battery and cables
   - Relay controlled cranking circuits
   - Solenoid controlled cranking circuits
   - Combination relay and solenoid-controlled cranking circuits
   - Control circuits (starting safety switch)
   - Thermal protection circuit

b. Starting motors
   - Motor components
     -Armature & windings
     -Commutator
     -Brushes
     -Springs
   - Gear reduction
   - Permanent magnet type
   - Positive engagement moveable pole shoe drive
   - Series & parallel-wound
   - Compound-wound

c. Starting motor drives
   - Over-running clutch
   - Bendix/inertia
   - Dyer
   - Follow through
   - Sprag
   - Positork
   - Friction-clutch

d. Types of starters
   - Electric
   - Air
   - Hydraulic

e. Starter switches
   - Magnetic
   - Solenoid
   - Series-parallel
   - Manual

4. Describe the factors affecting starting system operation. 1%

a. Temperature
b. Battery conditions and ratings
c. Engine loads
d. Oxidation and corrosion of connections
e. Cable sizes and condition
f. Excessive starting time and overheating

5. Perform the inspection, testing and maintenance of starting motors, circuits and control devices. **20%**

a. Starting system visual inspection
b. Starting system problems
   - Engine not cranking
   - Engine cranking slowly
   - Starter not disengaging
   - Starter turns but not engaging
   - Noise and vibration
   - Cable protection
c. Review of battery load test
d. Available voltage check
e. Control circuit test
f. Cranking circuit voltage drop tests
g. Starting system current draw test
h. Relay and solenoid tests
   - Winding resistance
   - Current draw
i. Procedures for removing and replacing a cranking motor
j. Disassembly, reassembly & cleaning procedures
k. Major component test and inspection of cranking motors
   - Armature for shorts, opens, ground, alignment
   - Field coils for shorts, opens, ground
   - Pole shoes
   - Bushings and bearings; brushes and springs
   - Solenoids
l. Cranking motor no-load tests (comparison of results to specifications)
m. Importance of pinion to ring gear clearances for proper gear tooth contact
n. Ring gear tooth inspection
o. Starter and circuit performance tests
   - Engine cranking speed
   - No-load
   - Amperage draw
   - Voltage drop
p. Component failure analysis
q. Removal and replacement procedures for relays and solenoids
r. Resurfacing commutator

6. Describe and perform procedures to service and repair starting aid components and functions. **5%**

a. Glow plugs
b. Intake manifold heater
c. Fluid starting aids
d. Battery warmer

7. Describe the fundamentals of charging systems and control circuits. **5%**

a. Overall concept of generators
b. Alternators (AC generators)
c. Voltage regulation
d. Factors affecting voltage and amperage output
   - Battery condition and temperature
   - Circuit condition

- Engine speeds
- Hysteresis
- Copper loss (resistance)
- Charging circuit resistance

8. Describe the design and function of alternators, voltage regulators and charging systems. 20%

a. Charging systems by field control
   - A-type vs. B-type

b. AC generator (alternator) types
   - Brushless
   - 12 & 24-volt
   - Oil-cooled

c. AC generator (alternator) construction
   - Rectifier
   - Diodes
   - Stator
     -Delta
     -Wye
   - Rotor
     -Field winding
     -Poles
   - Brush assemblies
   - Bearings
   - Pulleys
   - End frame assemblies
   - Cooling fans
   - Brushless alternators

d. Voltage regulators
   - External electronic
   - Internal electronic
   - Transistorized

e. Charge indicators
   - Lights & gauges
     -Volts
     -Amps
   - Monitoring systems

9. Describe and perform diagnostic procedures on charging systems. 34%

a. Visual inspection
   - Belt tension and alignment
   - Connections and wiring
   - Battery and alternator capacity

b. Charging system testing
   - Battery condition
   - Charging system current and voltage output test
   - Diode tests
   - Circuit and ground resistance

c. Analysis of test results

d. Removal and replacement procedures - precautions

e. Disassembly procedures and testing of components
   - Internal circuitry
   - Stator test

- Rotor field tests
- Rectifier diodes test
- Regulator test
- Bearing condition check
- Slip ring condition check
- Cleaning procedures
- Reassembly procedures

f. Alternator bench testing: output current
- Voltage
- Amperage
- Appropriate testing equipment

g. Diagnosis of charging system problems
- No alternator output
- Low alternator output
- High alternator output
- Noisy alternator
- Overcharging

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Apprenticeship Manitoba

Agricultural Equipment Technician

Unit: J1 Standard and Electronic Tuneup

Level: Two

Duration: 14 hours

Theory: 7 hours

Practical: 7 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with the working knowledge required to perform standard and electronic ignition tune-ups.

Objectives and Content:	**Percent of Unit Mark (%)**

1. Define the fundamentals and purpose of ignition systems and controls. **10%**

a. Combustion burn time
b. Engine load and spark timing
c. Factors that affect ignition timing
   - Engine speed, load, and temperature
   - Air and fuel ratio (AFR)
d. System types
   - Standard
   - Electronic
   - Distributorless

2. Describe the various types of ignition components. **10%**

a. Coils
   - Conventional
   - Primary and secondary wiring
b. rotors
c. Triggering devices
   - Hall Effect device
   - Pulse generator
d. Spark timing advance mechanisms
   - Mechanical
   - Vacuum
e. Secondary voltage circuit
   - High tension spark plug wires
     -Spark plugs (construction)
f. Control unit

3. Inspect and test ignition components. **10%**

a. Pickup coil

b. Control unit
c. Ignition coil
d. Distribution cap
e. Rotor
f. Primary wiring
g. Secondary wiring

4. Describe procedures to remove, service and install spark plugs. 10%

a. Spark plug construction and types
b. Heat range
c. Removal procedures
d. Inspections
e. Gapping
f. Installation procedures

5. Describe procedures to perform tune-ups on gasoline and propane engines. 50%

a. Testing procedures
b. Tune-up procedures
c. Tune-up intervals
d. Visual inspection of engine
e. Check of air intake system
f. Check of engine compression
g. Adjustment of ignition timing
h. Carburetors
i. Propane

6. Describe the diagnosis of ignition system problems. 10%

a. No spark at plugs
b. Weak or intermittent spark at plugs
c. Missing at idle or low speed
d. Missing during acceleration
e. Circuit analysis following manufacturers' troubleshooting charts
f. Coil failure
g. Shortened spark plug life
h. Pre-ignition
i. Detonation
j. Backfire in intake manifold
k. Backfire in exhaust manifold

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