

# Apprenticeship and Industry Training

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## Agricultural Equipment Technician Curriculum Guide

0321 (2022)



Apprenticeship  
and Industry  
Training

**ALBERTA ADVANCED EDUCATION**

Agricultural equipment technician : apprenticeship education program curriculum guide

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## Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding a sponsor. Sponsors guide apprentices, and support on-the-job learning through provision of mentorship. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyman or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution (PSI) – usually a college or technical institute.

To receive their postsecondary credential, apprentices must learn theory and skills, and they must pass examinations. Criteria for the program—including the content and delivery of technical training—are developed and updated by the Registrar.

The graduate of the Agricultural Equipment Technician apprenticeship program is an individual who will be able to:

- repair, diagnose and maintain by skill and knowledge gained through training and experience any of the working parts of diesel engines as well as the various components of mobile farm machinery
- use, competently, both hand and power tools in order to carry out repairs according to manufacturer's specifications
- read and understand work orders, prepare estimates, and interpret technical manuals
- write service reports, diagnose the cause of failures and keep service analysis records
- utilize the knowledge and may advance to service representatives or supervisory positions
- be familiar with the work in related trades such as Heavy Equipment Technician, Machinist and Welder
- perform assigned tasks in accordance with quality and production standards required by industry

### Apprenticeship and Industry Training System

Alberta's apprenticeship programs are supported by industry stakeholders that ensures a highly skilled, internationally competitive workforce in the province. The Registrar establishes the educational standards and provides direction to the system supported by industry and the PSI's. The Ministry of Advanced Education provides the legislative framework and administrative support for the apprenticeship and industry training system.

**Special thanks are offered to the following industry members who contributed to the development of the standard:**

Mr. K. Wood .....Barrhead  
Mr. A. Johnson .....Spruce Grove  
Mr. R. Zook.....Trochu  
Mr. R. Johnson.....Claresholm  
Ms.J. Dixon.....Didsbury  
Mr. G. Long .....Stettler

### Alberta Government

Alberta Advanced Education works with industry, sponsor and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and sponsors
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

## **Apprentice Safety**

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, sponsors, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

### **Occupational Health and Safety**

Persons engaged in, or supporting an individual in an experiential learning environment are often exposed to worksite hazards than in other forms of traditional postsecondary education and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Occupational Health and Safety-OHS (a division of Alberta Labour and Immigration) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at [www.alberta.ca/occupational-health-safety.aspx](http://www.alberta.ca/occupational-health-safety.aspx)

## **Technical Training**

Apprenticeship technical training is delivered by the PSI's throughout Alberta. The PSI's are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All PSI's place a strong emphasis on safety that complements safe workplace practices towards the development of a culture of safety for all professions.

The PSI's work with industry and Alberta Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs across the province. They develop curriculum from the curriculum guides established by the Registrar in consultation with the PSI's and industry and provide the technical training to apprentices.

The following PSI's deliver Agricultural Equipment Technician trade apprenticeship technical training:

Keyano College	Lakeland College
Grande Prairie Regional College	Northern Alberta Institute of Technology
Lethbridge College	Red Deer College
Southern Alberta Institute of Technology	Medicine Hat College

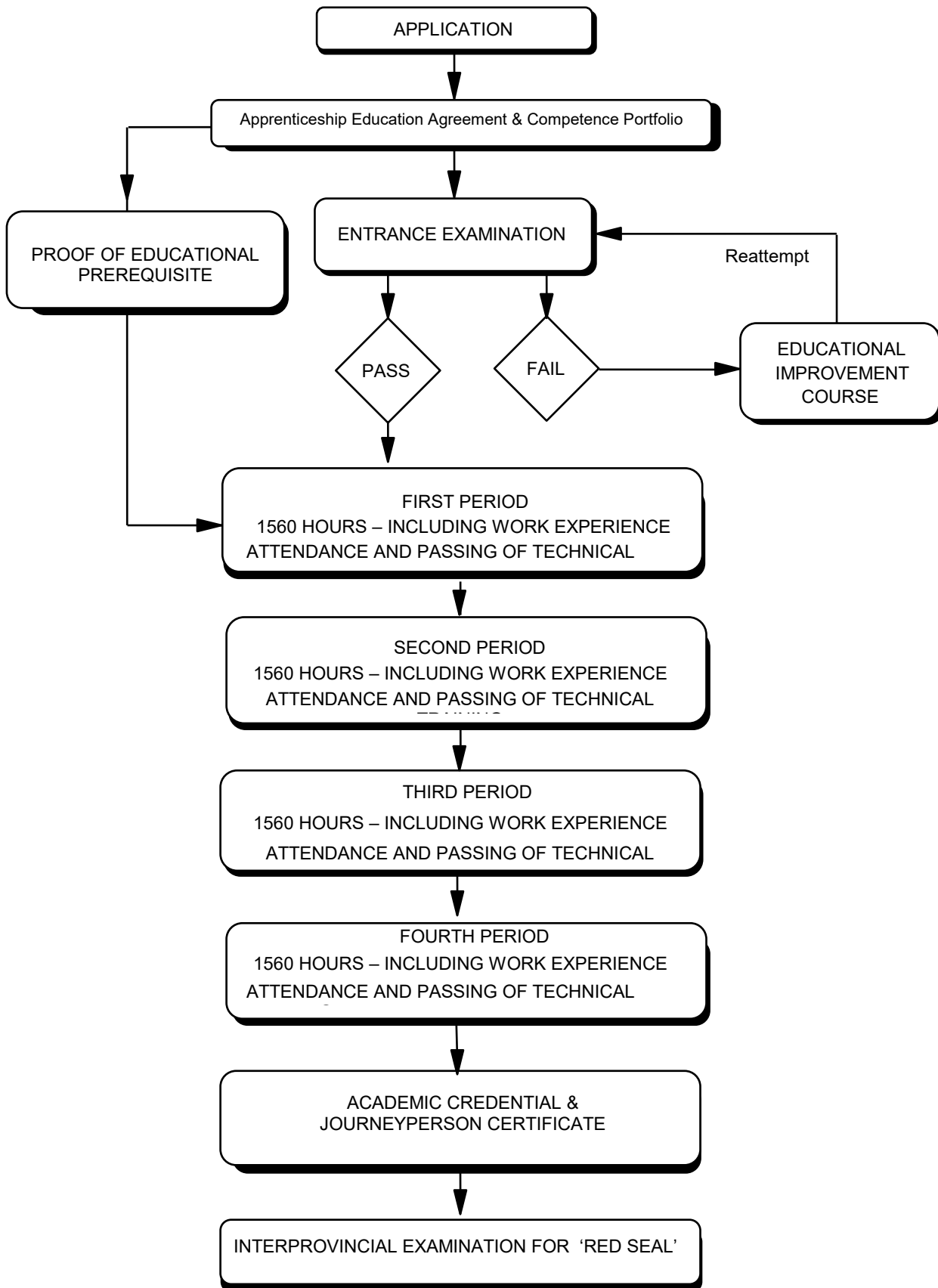
### **Procedures for Recommending Revisions to the Curriculum Guide**

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Registrar of Apprenticeship Programs  
c/o Apprenticeship Delivery and Industry Support Services  
Apprenticeship Delivery and Industry Support  
Advanced Education  
19th floor, Commerce Place  
10155 102 Street NW  
Edmonton AB T5J 4L5

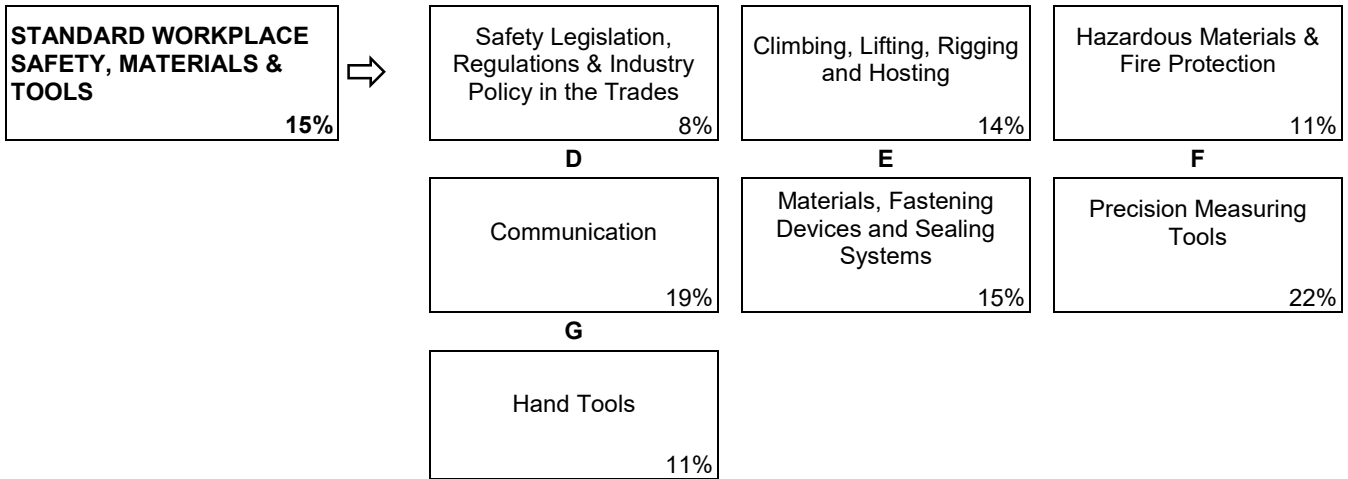
It is requested that recommendations for change refer to specific areas and state references used.

### Apprenticeship Route toward Academic Credential

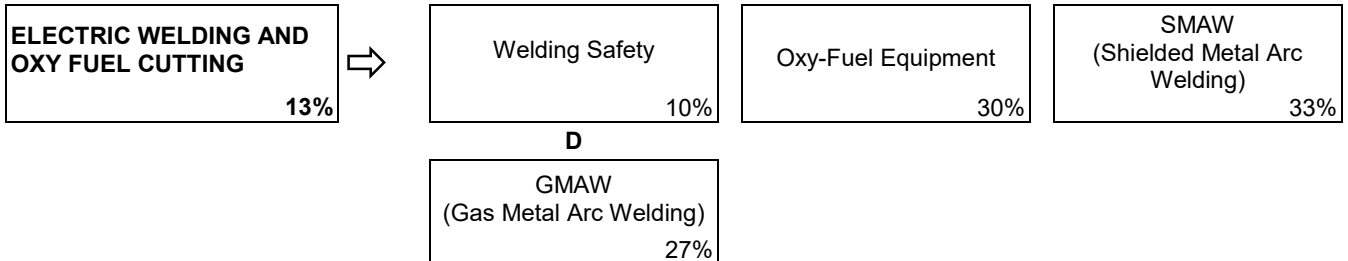


**Agricultural Equipment Technician Training Profile  
FIRST PERIOD  
(8 Weeks 30 Hours per Week – Total of 240 Hours)**

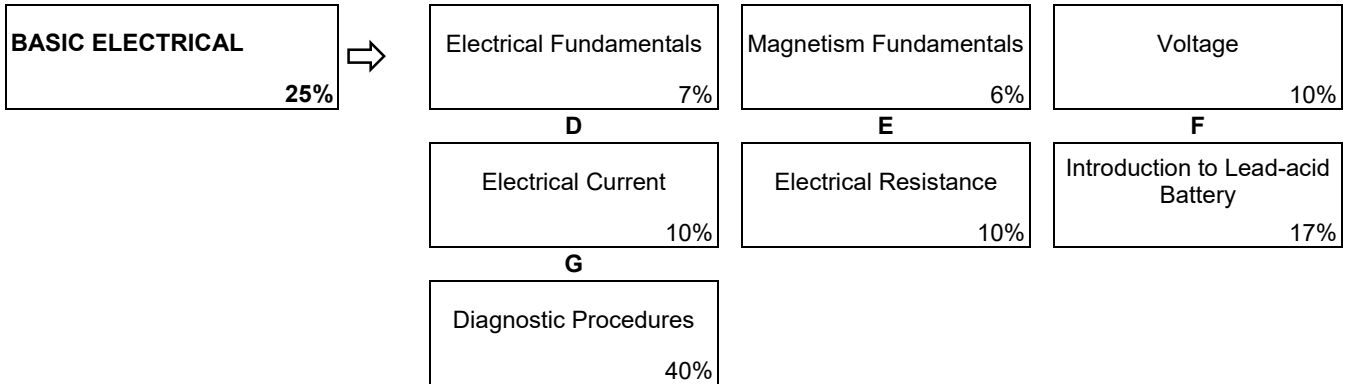
**SECTION ONE**



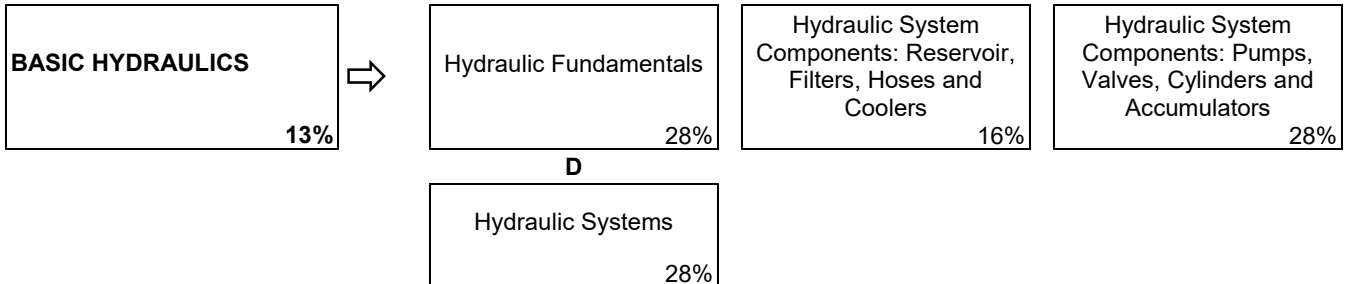
**SECTION TWO**



**SECTION THREE**



**SECTION FOUR**



**SECTION FIVE**

**AGRICULTURAL EQUIPMENT**  
24%



**A**  
Tractor Performance  
10%

**B**  
Steering Systems on Agricultural Equipment  
7%

**C**  
Cutting Equipment (include all types of crop cutting equipment)  
17%

**D**  
Baling Equipment  
38%

**E**  
Tillage Implements  
14%

**F**  
Other Types of Agricultural Equipment  
14%

**SECTION SIX**

**POWER TRAIN I**  
10%



**A**  
Clutch Fundamentals and Service  
38%

**B**  
Drive Line Fundamentals and Service  
25%

**C**  
Gearing Principles  
25%

**D**  
Drive Axle and Differential Fundamentals  
12%



**SECOND PERIOD**  
**(8 Weeks 30 Hours per Week – Total of 240 Hours)**

**SECTION ONE**

**ENGINE FUNDAMENTALS,  
SERVICE AND REPAIR**  
31%



<b>A</b>	<b>B</b>	<b>C</b>
Engine Fundamentals 8%	Engine Block and Cylinder Liner Fundamentals 8%	Engine Block and Cylinder Liner Service 8%
<b>D</b>	<b>E</b>	<b>F</b>
Piston, Piston Rings and Connecting Rod Fundamentals 8%	Piston, Piston Rings and Connecting Rod Service 8%	Crankshaft, Bearings and Related Component Fundamentals 8%
<b>G</b>	<b>H</b>	<b>I</b>
Crankshaft, Bearings and Related Component Service 8%	Camshaft and Follower Fundamentals 8%	Camshaft and Follower Service 8%
<b>J</b>	<b>K</b>	<b>L</b>
Cylinder Head Fundamentals 12%	Cylinder Head Service 12%	Engine Braking System Fundamentals and Service 4%

**SECTION TWO**

**ENGINE SYSTEMS**  
12%



<b>A</b>	<b>B</b>	<b>C</b>
Air Induction and Exhaust Systems 18%	Turbo Charged Air Systems 18%	Lubrication Systems and Crankcase Ventilation 32%
<b>D</b>		
Cooling Systems (Liquid and Air) 32%		

**SECTION THREE**

**DIESEL FUEL INJECTION  
SYSTEMS**  
14%



<b>A</b>	<b>B</b>	<b>C</b>
Diesel Fuel and Storage Tanks (Machine and Bulk Storage) 10%	Combustion Process and Starting Aids 12%	Mechanical Fuel Injection System 18%
<b>D</b>	<b>E</b>	<b>F</b>
Fuel System Service 15%	Advanced Mechanical Fuel Injection System 27%	Basic Diesel Engine and Fuel System Testing and Adjusting 15%
<b>G</b>		
Emergency Shutdown Systems 3%		

**SECTION FOUR**

**ELECTRONICS FUEL  
MANAGEMENT**  
23%



<b>A</b>	<b>B</b>	<b>C</b>
Electronic Fuel System Fundamentals 28%	Electronic Controlled Fuel Injection Systems 22%	Electronic Fuel System Diagnosis 22%
<b>D</b>		
Emission Control / After Treatment 28%		

**SECTION FIVE**

**HEAVY DUTY CHARGING  
AND CRANKING SYSTEMS**  
20%



**A**

Charging System and  
Control Circuit  
Fundamentals  
24%

**B**

Charging System Testing  
and Service  
36%

**C**

Cranking System  
Fundamentals and Motor  
Drives  
6%

**D**

Cranking System Control  
Circuits  
6%

**E**

Cranking System Testing  
and Service  
24%

**F**

Non-Electric Cranking  
Systems  
4%

**THIRD PERIOD**  
**(8 Weeks 30 Hours per Week – Total of 240 Hours)**

<b>SECTION ONE</b>				
<b>SPRAYING EQUIPMENT</b> 13%	⇒	<b>A</b> Chemical Safety 20%	<b>B</b> Sprayer Systems 27%	<b>C</b> Monitoring Equipment 33%
		<b>D</b> Suspension Systems for Spraying 20%		
<b>SECTION TWO</b>				
<b>AIR CONDITIONING AND HEATING SYSTEMS</b> 18%	⇒	<b>A</b> Air Conditioning Fundamentals 16%	<b>B</b> HVAC Control Systems 30%	<b>C</b> Air Conditioning Testing, Service and Retrofitting 54%
<b>SECTION THREE</b>				
<b>POWER TRAIN II AND PREVENTIVE MAINTENANCE</b> 18%	⇒	<b>A</b> Hydraulic and Power Take-Off Clutches 19%	<b>B</b> Heavy Duty Transmissions and Four Wheel Drives 51%	<b>C</b> Preventative Maintenance 14%
		<b>D</b> Failure and Fluid Analysis 16%		
<b>SECTION FOUR</b>				
<b>AGRICULTURAL HARVESTING EQUIPMENT</b> 19%	⇒	<b>A</b> Forage Harvesting Equipment 22%	<b>B</b> Combines 61%	<b>C</b> Yield Monitors 17%
<b>SECTION FIVE</b>				
<b>BRAKING SYSTEMS</b> 10%	⇒	<b>A</b> Hydraulic Brakes System Fundamentals 17%	<b>B</b> Hydraulic Brakes Systems (Drum and Disc) 17%	<b>C</b> Hydraulic Brakes System Diagnosis and Service 16%
		<b>D</b> Agricultural Braking Systems Fundamentals and Service 50%		
<b>SECTION SIX</b>				
<b>SEEDING AND PRECISION FARMING SYSTEMS</b> 22%	⇒	<b>A</b> GPS Mapping 22%	<b>B</b> GPS Steering Guidance Systems 13%	<b>C</b> Seeding Equipment 43%
		<b>D</b> Variable Rate Application 15%	<b>E</b> Monitors and Sensors 7%	

**FOURTH PERIOD**  
**(8 Weeks 30 Hours per Week – Total of 240 Hours)**

**SECTION ONE**

**HYDRAULICS II**  
 48%



<b>A</b>	<b>B</b>	<b>C</b>
Hydraulic Principles 8%	Hydraulic Pump Fundamentals 8%	Hydraulic Pump Service 11%
<b>D</b>	<b>E</b>	<b>F</b>
Hydraulic Actuator Fundamentals 5%	Hydraulic Actuator Service 8%	Hydraulic Valve II 15%
<b>G</b>	<b>H</b>	<b>I</b>
Hydraulic System Types 16%	Hydraulic System Testing and Service 16%	Electrohydraulics 13%

**SECTION TWO**

**STEERING AND SUSPENSION SYSTEMS AND ACCESSORIES (SPECIFIC TO OFF-ROAD) AND APPRENTICESHIP**  
 13%



<b>A</b>	<b>B</b>	<b>C</b>
Wheeled Equipment Steering Fundamentals and Service 18%	Suspension System Fundamentals and Service 15%	Off-Road Equipment Accessories and Attachments 15%
<b>D</b>	<b>E</b>	<b>F</b>
Off-Road Electrical Circuit Fundamentals 28%	Off-Road Electrical Circuit Service 18%	Workplace Coaching Skills 3%
<b>G</b>		
Interprovincial Standards Red Seal Program 3%		

**SECTION THREE**

**POWERTRAIN (SPECIFIC TO OFF-ROAD)**  
 39%



<b>A</b>	<b>B</b>	<b>C</b>
Gearing Principles 3%	Torque Converter Fundamentals and Service 9%	Powershift and Automatic Transmission Mechanical/Electronic Components 15%
<b>D</b>	<b>E</b>	<b>F</b>
Powershift and Automatic Transmission Control and Shifting 10%	Hydraulic Retarder Fundamentals 3%	Powershift and Automatic Transmission Testing and Service 10%
<b>G</b>	<b>H</b>	<b>I</b>
Tracked Equipment Steering Fundamentals and Service 11%	Undercarriage Systems Fundamentals and Service 12%	Final Drive Fundamentals and Service (Off-Road) 11%
<b>J</b>	<b>K</b>	
Drive Axle and Carrier Fundamentals and Service (Off-Road) 13%	Clutch Fundamentals and Service 3%	

**FIRST PERIOD TECHNICAL TRAINING  
AGRICULTURAL EQUIPMENT TECHNICIAN TRADE  
CURRICULUM GUIDE**

*UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.*

Due to the nature of work of the Agricultural Equipment Technician, it is imperative that safety be taught on a continuous basis throughout the entire course.

**SECTION ONE: ..... STANDARD WORKPLACE SAFETY & TOOLS ..... 15%**

**A. Safety Legislation, Regulations & Industry Policy in the Trades .....8%**

**Outcome:** *Apply legislation, regulations and practices ensuring safe work in this trade.*

1. Demonstrate the application of the Occupational Health and Safety Act, Regulation and Code.
2. Describe the employer's and employee's role with Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information Systems (WHMIS), fire regulations, Workers Compensation Board regulations and related advisory bodies and agencies.
3. Describe industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of worker and employers to apply emergency procedures.
5. Describe tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of employers and employees with the selection and use of personal protective equipment (PPE).
7. Maintain required PPE for tasks.
8. Use required PPE for tasks.

**B. Climbing, Lifting, Rigging and Hoisting ..... 14%**

**Outcome:** *Use industry standard practices for climbing, lifting, rigging and hoisting in this trade.*

1. Describe manual lifting procedures.
2. Describe rigging hardware and associated safety factors.
3. Select equipment for rigging loads.
4. Describe hoisting and load moving procedures.
5. Maintain personal protective equipment (PPE) for climbing, lifting and load moving equipment.
6. Use PPE for climbing, lifting and load moving equipment.

**C. Hazardous Materials & Fire Protection ..... 11%**

**Outcome:** *Apply industry standard practices for hazardous materials and fire protection in this trade.*

1. Describe roles, responsibilities, features and practices related to the Workplace Hazardous Materials Information System (WHMIS) program.
2. Describe three key elements of WHMIS.
3. Describe handling, storing and transporting procedures for hazardous material.
4. Describe venting procedures when working with hazardous materials.
5. Describe hazards, classes, procedures and equipment related to fire protection.

**D. Communication.....19%****Outcome: Explain techniques used to communicate service information to the customer.**

1. Define standard terms used by an agricultural equipment technician.
2. Demonstrate oral and written communication as appropriate to the agricultural equipment technician.
3. Use a computer for communication and information access.
4. Demonstrate the use of service information and service bulletins as they relate to an agricultural technician.
5. Describe the requirements of the Farm Implement Act.

**E. Materials, Fastening Devices and Sealing Systems .....15%****Outcome: Identify materials, fasteners and sealing systems commonly used in the trade.**

1. Describe materials and fastening devices used in agricultural machinery.
2. Demonstrate selected torquing methods.
3. Describe the safe selection, application, and storage of gaskets, sealers, adhesives and cleaners.

**F. Precision Measuring Tools .....22%****Outcome: Use precision measuring tools calibrated in imperial and metric measure.**

1. Demonstrate the use of precision measuring tools.
2. Describe the care and storage of measuring tools.
3. Interpret the dimensions taken with precision measuring tools.

**G. Hand Tools.....11%****Outcome: Describe the use and maintenance of hand tools.**

1. Describe the use and maintenance of selected hand tools.
2. Describe the use and maintenance of air and electrical power tools.

**SECTION TWO: ..... ELECTRIC WELDING AND OXY FUEL CUTTING .....13%**

The instruction under this section is not meant to be the level of a proficient and skilled journeyperson Welder. The intent is to train the apprentices to a level where they may operate the required equipment in a safe manner, and perform such operations of metal cutting and tack welding as to make temporary attachment of component parts, prior to the finish welding required by a certified journeyperson Welder.

**A. Welding Safety .....10%**

**Outcome:** *Describe methods to demonstrate personal safety.*

1. Describe hazards associated with welding applications and activities.
2. Demonstrate the use of personal protective clothing and equipment.
3. Describe methods to protect other personnel in the area.

**B. Oxy-Fuel Equipment .....30%**

**Outcome:** *Demonstrate the use of the torch for welding, heating, brazing and cutting.*

1. Describe the characteristics and safe handling procedures for gases and cylinders.
2. Describe care and maintenance procedures for oxy-fuel outfit.
3. Demonstrate equipment setup, adjustment, and shut down procedures.
4. Demonstrate use of personal protective equipment and safe operating procedures.
5. Perform heating, welding, and cutting operations using oxy-fuel equipment.
6. Describe temperature indicators and the effect of heat on metal.

**C. SMAW (Shielded Metal Arc Welding) .....33%**

**Outcome:** *Perform welding operations using arc welding equipment.*

1. Define basic electricity terms related to SMAW welding.
2. Describe selected machine types, welding currents, and polarities.
3. Describe care and maintenance procedures of SMAW welding equipment.
4. Demonstrate equipment setup and adjustments.
5. Describe the electrode designation system.
6. Select electrodes for specific applications.
7. Describe arc welding puddle controls.
8. Demonstrate joint preparation and fit up.
9. Demonstrate use of personal protective equipment and safe operating procedures.
10. Perform basic welding techniques (single and multi pass fillets in horizontal and flat positions) using arc welding equipment.

**D. GMAW (Gas Metal Arc Welding) .....27%**

**Outcome:** *Perform welding operations using the MIG welding process.*

1. Describe GMAW welding components and process.
2. Describe GMAW welding puddle controls.

3. Describe care and maintenance of GMAW welding equipment.
4. Demonstrate set up and adjustment procedures for GMAW welding.
5. Perform fillet welds on light gauge plate using the GMAW welding process.

**SECTION THREE: ..... BASIC ELECTRICAL .....25%**

NOTE: All electrical training is to emphasize trouble shooting and the reading of schematics.

**A. Electrical Fundamentals.....7%**

**Outcome: Apply scientific principles to explain electrical theory.**

1. Explain the physical properties of conductors, insulators and semi-conductors.
2. Explain electricity in terms of voltage, current and resistance.

**B. Magnetism Fundamentals.....6%**

**Outcome: Apply scientific principles to explain the theory of magnetism.**

1. Explain the fundamental laws of magnetism.
2. Explain the properties and applications of permanent magnets.
3. Explain the construction, operation, and applications of electromagnets.
4. Explain the principles of electromagnetic induction.

**C. Voltage .....10%**

**Outcome: Use electrical test equipment to measure electrical voltage.**

1. Explain the construction and operation of voltmeters.
2. Measure electrical voltage.
3. Calculate and measure voltage drops in electrical circuits.
4. Demonstrate safe operation of voltmeters.

**D. Electrical Current .....10%**

**Outcome: Use electrical test equipment to measure electrical current (amperes).**

1. Calculate electrical amperage.
2. Explain the construction and operation of ammeters.
3. Measure electrical current.
4. Demonstrate precautions while using ammeters.

**E. Electrical Resistance .....10%**

**Outcome: Use electrical test equipment to measure electrical resistance (ohms).**

1. Calculate electrical resistance.
2. Explain the construction operation of ohmmeters.
3. Use an ohmmeter to measure electrical resistance.
4. Demonstrate precautions while using ohmmeters.



**F. Battery Fundamentals and Service .....17%****Outcome: Service, test and storage of agricultural batteries.**

1. Identify hazards encountered with the use of batteries.
2. Explain battery construction, sizing and capacity.
3. Perform battery maintenance and testing.
4. List safety precautions and procedures for boosting batteries.
5. List safety precautions and procedures for charging batteries.
6. Explain multiple battery circuits in relation to connections and battery compatibility.

**G. Diagnostic Procedures .....40%****Outcome: Interpret electrical circuit schematics.**

1. Identify commonly used schematic symbols.
2. Explain simple electrical schematic drawings.
3. Identify commonly used electrical weather and non-weather sealed connections.
4. Demonstrate wiring and connection repairs.
5. Use appropriate test equipment to test simple machine circuits.
6. Explain precautions related to accessories and electronics when servicing electrical circuits.

**SECTION FOUR: ..... BASIC HYDRAULICS .....13%****A. Hydraulic Fundamentals .....28%****Outcome: Explain hydraulic principles used on agricultural equipment.**

1. Define hydraulic terminology.
2. Using mathematical calculations, explain the hydraulic principles of pressure, force, area, volume, flow rate, cycle times and power.
3. Draw and interpret basic hydraulic schematics.
4. State the safety precautions that must be observed when working with hydraulic systems.

**B. Hydraulic System Components: Reservoir, Filters, Hoses and Coolers .....16%****Outcome: Explain the function of the following hydraulic system components; hydraulic oils, reservoirs, filters, conductors, and heat exchangers.**

1. Explain the properties of hydraulic fluid and the criteria for its selection.
2. State the functions of the hydraulic reservoir and its related components.
3. State the functions and principles of operation of filtration devices.
4. Explain the construction and applications of common types of hydraulic conductors.
5. State the functions and applications of hydraulic heat exchangers.

**C. Hydraulic System Components: Pumps, Valves, Cylinders and Accumulators .....28%****Outcome: Explain the functions and principles of operation of hydraulic system components.**

1. Explain hydraulic sealing methods.
2. Explain selected pump operating principles.

3. Explain the function and principles of operation for a direct acting pressure relief valve.
4. Explain the principles of operation and applications of hydraulic control valves.
5. Explain the principles of operation and applications of hydraulic cylinders.
6. Explain the principles of operation and applications of hydraulic accumulators.

**D. Hydraulic Systems .....28%**

**Outcome:** *Explain the fundamental operating characteristics of hydraulic systems used in agricultural equipment.*

1. Explain the operating principles of an open centre hydraulic system.
2. Explain the operating principles of a closed centre hydraulic system.
3. Explain the operating principles of a closed centre load sensing hydraulic system.
4. Perform selected hydraulic cylinder repair.
5. Perform a basic hydraulic system pressure and flow test.

**SECTION FIVE:..... AGRICULTURAL EQUIPMENT .....24%**

**A. Tractor Performance.....10%**

**Outcome:** *Identify factors that influence tractor field performance.*

1. Define tractor horsepower concepts.
2. Calculate drawbar horsepower requirements.
3. Describe and calculate slippage.
4. Describe Power Hop and its control.
5. Calculate ballasting solutions for tractors.
6. Compare the use of tires and rubber tracks.
7. Interpret Nebraska test results.

**B. Steering Systems on Agricultural Equipment .....7%**

**Outcome:** *Explain steering systems on agricultural equipment.*

1. Describe selected steering systems designs used on wheeled agricultural equipment.
2. Describe service of wheels, tires, and hubs.

**C. Cutting Equipment (Include All Types of Crop Cutting Equipment) .....17%**

**Outcome:** *Describe and adjust cutting equipment.*

1. Describe the operation of a reciprocating knife mower.
2. Perform adjustments and repairs to a reciprocating knife mower.
3. Describe the operation of a rotary disc mower.
4. Perform adjustments and repairs to a disc type mower.
5. Describe types of hay conditioners.
6. Perform adjustments to hay conditioners.
7. Identify reel types and components.
8. Describe adjustments to reels.

**D. Baling Equipment .....38%****Outcome: Describe and adjust hay baling equipment.**

1. Describe the basic procedure of dry hay production.
2. Describe operation and construction of fixed chamber balers.
3. Describe operation and construction of variable chamber balers.
4. Describe operation and construction of balers used for haylage.
5. Perform adjustments and repairs to round balers.
6. Adjust baler monitor systems.
7. Describe operation and construction of small square balers.
8. Perform adjustments and repairs to small square balers.
9. Perform adjustments to knotters.
10. Describe operation and construction of large square balers.
11. Describe adjustments to large square balers.
12. Describe baler accessories.

**E. Tillage Implements.....14%****Outcome: Describe the components and usage of selected types of tillage equipment.**

1. Define common tillage terms.
2. Describe tillage practices.
3. Describe types and components of ground engaging tools.
4. Analyze the levelling controls used on ground engaging tools.
5. Describe the shank protection used on ground engaging tools.
6. Explain the operation of disc implements.
7. Describe selected ground pressure systems.

**F. Other Types of Agriculture Equipment.....14%****Outcome: Describe adjustments and repairs of other selected types of equipment.**

1. Describe selected short-line and materials-handling equipment.
2. Describe the operation and adjustment of selected three point hitch categories.
3. Describe the installation and inspection of agricultural loaders and frames.

**SECTION SIX: ..... POWER TRAIN I .....10%****A. Clutch Fundamentals and Service .....38%****Outcome: Service and diagnose common clutch types.**

1. Explain the function and operating principles of spring loaded clutch systems.
2. State the function of spring loaded clutch components.
3. Diagnose spring loaded clutch systems.
4. Perform service procedures for spring loaded friction clutches.
5. Explain the operation and maintenance of over-centre clutches.

6. Explain the operation principles of overrunning, dog, cone and bevel clutches.
7. Explain the operating principles of electromagnetic clutches.

**B. Drive Line Fundamentals and Service .....25%**

**Outcome: Diagnose and service drive lines and universal joints.**

1. Explain the function and operating principles of common drive line assemblies.
2. Explain the construction and design features of common drive line components.
3. Diagnose and service universal joints.
4. Explain driveline phasing and angle limitations.
5. Evaluate drive line phasing and angles.

**C. Gearing Principles .....25%**

**Outcome: Explain basic gearing principles.**

1. Define gear terminology.
2. Explain gear relationships with regards to ratios and input/output direction.
3. Identify common gear types and applications.
4. Identify and calculate speed and torque relationships in single reduction planetaries.

**D. Drive Axle and Differential Fundamentals .....12%**

**Outcome: Explain the functions and operating principles of mechanical front wheel assist drive axle assemblies.**

1. State the functions of a drive axle assembly.
2. Identify single reduction drive axle configurations.
3. Explain common axle shaft configurations.

**SECOND PERIOD TECHNICAL TRAINING  
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*UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.*

**SECTION ONE:..... ENGINE FUNDAMENTALS, SERVICE AND REPAIR ..... 31%**

**A. Engine Fundamentals ..... 8%**

**Outcome:**     ***Explain the operating principles and design features of two and four stroke internal combustion engines.***

1.     Explain the stages of development of the internal combustion engine.
2.     Explain common engine terms and definitions.
3.     Explain common methods of classifying engines.
4.     Explain the principles of operation for two and four stroke cycle engines.
5.     Compare diesel and gasoline engine operation.

**B. Engine Block and Cylinder Liner Fundamentals..... 8%**

**Outcome:**     ***Describe the functions and design features of cylinder block assemblies.***

1.     State the functions of the engine cylinder block.
2.     Identify cylinder block construction and design features.
3.     Describe the construction and design features of removable cylinder liners.

**C. Engine Block and Cylinder Liner Service ..... 8%**

**Outcome:**     ***Inspect an engine block assembly for serviceability.***

1.     Inspect engine blocks for cracks, thread, bearing bore and machined surface condition.
2.     Explain cylinder block repair procedures for cracks, threads, bearing bores and machined surfaces.
3.     Explain inspection and reconditioning procedures for a cylinder block with integral cylinders.
4.     Perform removable cylinder liner service.

**D. Piston, Piston Rings and Connecting Rod Fundamentals..... 8%**

**Outcome:**     ***Describe the functions and design features of pistons, piston rings and connecting rods.***

1.     Explain the function, construction and design features of pistons and piston pins.
2.     Explain the function, construction and design features of piston rings.
3.     Explain the function, construction and design features of connecting rods.

**E. Piston, Piston Rings and Connecting Rod Service ..... 8%**

**Outcome:**      *Service a piston and connecting rod assembly.*

1. Remove and disassemble piston and connecting rod assemblies.
2. Inspect piston and pin for reuse.
3. Explain connecting rod service procedures.
4. Install piston and connecting rod assemblies.

**F. Crankshaft, Bearings and Related Component Fundamentals ..... 8%**

**Outcome:**      *Describe the functions and design features of crankshafts and their related components.*

1. Explain the function and design features of crankshafts.
2. Explain methods used to achieve engine balance.
3. State the functions of crankshaft seals, gears and flywheels.
4. Describe the function and design features of friction bearings specific to engines.
5. Explain the lubrication principles of engine friction bearings.

**G. Crankshaft, Bearings and Related Component Service ..... 8%**

**Outcome:**      *Service crankshafts, friction bearings and related components.*

1. Remove crankshaft and bearings from an engine block.
2. Inspect and measure crankshafts to determine serviceability.
3. Inspect flywheel and vibration damper to determine serviceability.
4. Identify common crankshaft and bearing failures.
5. Install crankshafts and related components.

**H. Camshaft and Follower Fundamentals ..... 8%**

**Outcome:**      *Describe the functions and design features of camshafts and related components.*

1. Explain the function and design features of camshafts, camshaft bearings and seals.
2. Explain the function and design features of camshaft followers.
3. Explain camshaft drive mechanisms and timing.

**I. Camshaft and Follower Service ..... 8%**

**Outcome:**      *Service camshaft and related components.*

1. Remove camshaft and related components from an engine block.
2. Inspect and measure camshafts and related components to determine serviceability.
3. Install camshaft and related components.

**J. Cylinder Head Fundamentals ..... 12%**

**Outcome:**      *Describe the functions and design features of cylinder heads and valve train components.*

1. Explain the function, construction and design features of cylinder heads.
2. Describe the construction and design features of engine valves and related components.

3. Describe the construction and design features of valve train components.
4. Identify cylinder head sealing and retention devices.

**K. Cylinder Head Service..... 12%**

**Outcome: Service cylinder heads and valve train components.**

1. Demonstrate cylinder head removal and disassembly.
2. Clean and inspect cylinder heads.
3. Explain cylinder head and valve reconditioning procedures.
4. Inspect valve train components.
5. Demonstrate cylinder head assembly and installation.

**L. Engine Braking System Fundamentals and Service..... 4%**

**Outcome: Explain the operation of engine compression and exhaust brakes.**

1. State the function of an engine brake.
2. Explain the operation of an engine compression brake.
3. Explain basic adjustment and diagnosis of an engine compression brake.
4. Explain the functions and operation of an engine exhaust brake.

**SECTION TWO:..... ENGINE SYSTEMS..... 12%**

**A. Air Induction and Exhaust Systems ..... 18%**

**Outcome: Service air induction, exhaust systems and related components.**

1. State the functions of an air induction system.
2. Identify and state the function of air induction system components.
3. State the function of an exhaust system.
4. Identify and explain the operation of exhaust system components.
5. Explain the service procedures for air induction and exhaust systems.
6. Explain the use of test equipment to measure air inlet restriction and exhaust backpressure.

**B. Turbocharged Air Systems..... 18%**

**Outcome: Service turbocharged air induction systems.**

1. State the purposes for turbocharging the engine air induction system.
2. Explain the construction and operation of a turbocharged air induction system and components.
3. Test, inspect and service a turbocharger.
4. Explain the function, construction and testing procedures for typical aftercoolers/intercoolers.
5. Explain the function of variable displacement turbo technology and wastegate systems.

**C. Lubrication Systems and Crankcase Ventilation ..... 32%**

**Outcome: Service lubrication systems and related components.**

1. State the functions and characteristics of engine oil.
2. Describe the use of oil analysis as a diagnostic tool.

3. Explain the operating principles of a typical lubrication system and related components.
4. State the purpose of crankcase ventilation systems.
5. Perform lubrication system inspection and service.
6. Diagnose and repair faults related to lubrication systems and components.

**D. Cooling Systems (Liquid and Air)..... 32%**

**Outcome: Service liquid and air-cooling systems and related components.**

1. Explain the function of the engine cooling system.
2. Explain the operation and maintenance of an air-cooling system.
3. Explain the operation of a typical liquid cooling system and its components.
4. Perform engine liquid cooling system repair and maintenance.
5. Explain the functions and design features of temperature sensors and warning devices.

**SECTION THREE: ..... DIESEL FUEL INJECTION SYSTEMS..... 14%**

**A. Diesel Fuel and Storage Tanks (Machine and Bulk Storage)..... 10%**

**Outcome: Handle and store diesel fuel using safe and efficient practices.**

1. State the safety precautions, characteristics and properties of diesel fuel.
2. Explain diesel fuel storage concerns.
3. Identify construction requirements and design features of fuel storage and supply tanks.

**B. Combustion Process and Starting Aids..... 12%**

**Outcome: Apply the theory of the combustion process to engine operation and diagnosis.**

1. Explain the characteristics and factors affecting the diesel engine combustion process.
2. Explain diesel engine emission concerns.
3. Identify and state the purpose of common combustion chambers.
4. Identify types and function of common diesel engine starting aids.

**C. Basic Mechanical Fuel Injection System ..... 18%**

**Outcome: Explain the operation of a basic fuel injection system.**

1. List the requirements of a fuel injection system.
2. Identify the layout and components of a basic fuel injection system.
3. Explain the function of the components required in the basic diesel fuel injection system.

**D. Fuel System Service..... 15%**

**Outcome: Explain the operation of a basic fuel injection system.**

1. Identify types and service procedures for common fuel filters.
2. Explain the operating principles and design features of common fuel transfer pumps.
3. Perform testing and diagnosis of a fuel transfer system.
4. Explain fuel transfer pump inspection and service procedures.



**E. Advanced Mechanical Fuel Injection System..... 27%**

**Outcome:** *Explain the operation of an advanced mechanical fuel injection system.*

1. Explain the testing and timing procedures of port and helix fuel metering systems.
2. Explain the testing and timing procedures of inlet fuel metering for opposed plunger pump designs.
3. Explain the operating principles of hydraulic fuel injection nozzles.
4. Explain governor operation according to design characteristics and application.

**F. Basic Diesel Engine and Fuel System Testing and Adjusting..... 15%**

**Outcome:** *Explain basic testing and adjustment procedures on diesel engines and mechanical fuel injection systems.*

1. Explain the benefits of maintaining engine adjustments.
2. Explain engine performance testing and demonstrate diagnosis.

**G. Emergency Shutdown Systems ..... 3%**

**Outcome:** *Explain the operating principles of engine shutdown and warning systems.*

1. Explain the operation of an engine emergency warning and shutdown systems that monitors oil pressure, coolant temperature, coolant level and engine over-speed.

**SECTION FOUR: ..... ELECTRONICS FUEL MANAGEMENT ..... 23%**

**A. Electronic Fuel System Fundamentals ..... 28%**

**Outcome:** *Retrieve and interpret basic diagnostic information from a typical diesel engine electronic control system.*

1. Explain the operation of a computer controlled fuel injection system.
2. Explain the operation of engine sensors that measure pressure, temperature, speed, fluid level, and throttle position.
3. Explain integral warning, shutdown and fault codes systems used with electronic controls.
4. Demonstrate the use of a personal computer (PC) and other appropriate tools for electronic system interface.
5. Demonstrate the adjustment of electronic fuel control system parameters.

**B. Electronically Controlled Fuel Injection Systems ..... 22%**

**Outcome:** *Identify and explain components of electronically controlled fuel injection systems.*

1. Explain the operation of an electronic unit fuel injection system.
2. Explain the operation of a hydraulic electronic unit injection (HEUI) fuel injection system.
3. Explain the operation of a common rail fuel injection system.
4. Explain the operation of an electronic unit pump fuel injection system.

**C. Electronic Fuel System Diagnosis..... 22%**

**Outcome:** *Diagnose and service electronic controlled diesel fuel injection systems.*

1. Diagnose and repair an electronic fuel control system malfunction.
2. Demonstrate removal and installation procedures of an electronic fuel pump or injector.

**D. Emission Control/After Treatment Systems ..... 28%**

**Outcome:** *Explain the operation of emission control systems.*

1. State the purposes of an emission control system to Environmental Protection Agency (EPA) guidelines.
2. Describe the theory of Exhaust Gas Recirculation (EGR)
3. Explain the purpose of Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPI).
4. Explain the purpose of a Selective Catalyst Reduction (SCR) and Diesel Exhaust Fluid (DEF).
5. Explain effect on other vehicle systems; fuel, oil, coolants, intake/turbo systems.
6. Discuss emerging technologies.

**SECTION FIVE: .....HEAVY DUTY CHARGING AND CRANKING SYSTEMS..... 20%**

**A. Charging System and Control Circuit Fundamentals..... 24%**

**Outcome:** *Explain the operation of 12 volt and 24 volt charging systems.*

1. Explain the purpose of the charging system in relation to equipment operation.
2. Identify charging system components.
3. Describe the operational characteristics of an alternator.
4. Identify and state the function of common alternator components.
5. Describe the operation of an alternator in regards to induction, rectification and output control.
6. Identify the variations to common alternator designs.
7. Identify common regulator types and designs.
8. State the purpose of auxiliary terminals on integrally regulated alternators.
9. Explain the operation of charging system indicator circuits.

**B. Charging System Testing and Service..... 36%**

**Outcome:** *Diagnose and service 12 volt and 24 volt charging systems.*

1. Perform on-equipment charging system tests.
2. Demonstrate the procedure to test an alternator for output and voltage control.
3. Identify alternator defects.
4. Demonstrate charging system maintenance procedures.

**C. Cranking System Fundamentals and Motor Drives ..... 6%**

**Outcome:** *Explain the operation of 12 volt and 24 volt cranking systems.*

1. Identify components of a typical cranking system.
2. Describe the principles of operation of a cranking motor.
3. Identify cranking motor construction in regards to electrical design.

4. Identify and state the function of common cranking motor components.
5. Identify and explain the operation of overrunning clutch type motor drives.
6. Explain operational limitations of a cranking motor.

**D. Cranking System Control Circuits ..... 6%**

**Outcome:** *Explain the operation of cranking motor control circuits.*

1. Trace a cranking system circuit diagram.
2. Explain the operation of a cranking motor solenoid switch.
3. Explain the operation of a magnetic switch.

**E. Cranking System Testing and Service ..... 24%**

**Outcome:** *Diagnose and service cranking systems.*

1. Perform on-equipment cranking system diagnostics.
2. Identify cranking motor defects by no-load test results.
3. Demonstrate the procedure to bench test a cranking motor.
4. Diagnose possible cranking system failures from specific symptoms.

**F. Non-Electric Cranking Systems ..... 4%**

**Outcome:** *Service and maintain air and hydraulic cranking systems.*

1. State the function, system requirements and troubleshooting procedures required on air cranking systems.
2. State the function, system requirements and troubleshooting procedures required on hydraulic motor cranking systems.

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Due to the nature of work of the Agricultural Equipment Technician, it is imperative that safety be taught on a continuous basis throughout the entire course.

**SECTION ONE:.....SPRAYING EQUIPMENT ..... 13%**

**A. Chemical Safety..... 20%**

**Outcome: Describe safe practices when working with and around agricultural chemicals.**

1. Describe the rating system, which assesses agricultural chemical toxicity.
2. Describe safe transport, handling, and disposal of chemical containers.
3. Describe potential field application difficulties.
4. Describe environmental systems and clothing used to protect the operator when handling chemicals.

**B. Sprayer Systems..... 27%**

**Outcome: Describe the operation of sprayer systems.**

1. Describe the components of sprayer systems.
2. Explain the operation of a sprayer system.
3. Describe selected nozzles.
4. Interpret application charts.
5. Perform stationary calibrations.

**C. Monitoring Equipment ..... 33%**

**Outcome: Program electronic devices used in the agricultural spraying industry.**

1. Describe controllers used to monitor and adjust sprayer functions.
2. Program and calibrate a sprayer electronic rate controller.
3. Diagnose operating problems of a sprayer rate controller.
4. Describe GPS applications in spraying.

**D. Suspension Systems for Spraying ..... 20%**

**Outcome: Explain suspension system features used on high-clearance sprayers.**

1. Describe suspension systems used to support sprayer booms.
2. Describe selected suspension systems used to support sprayer chassis.
3. Describe the methods utilized to adjust wheel tread spacing on high clearance sprayers.

**SECTION TWO:..... AIR CONDITIONING AND HEATING SYSTEMS ..... 18%**

**A. Air Conditioning Fundamentals ..... 16%**

**Outcome:** *Explain the operating principles of basic air conditioning systems.*

1. Explain the thermodynamic principles related to air conditioning.
2. Explain the properties and handling precautions of refrigerants and refrigerant oils.
3. Identify the basic components of an air conditioning system.
4. Explain the operation of a cycling clutch air conditioning system using an expansion valve.

**B. HVAC Control Systems (Heating, Ventilation and A/C) ..... 30%**

**Outcome:** *Explain the operating principles of HVAC (Heating Ventilation and Air Conditioning) control systems.*

1. Identify the components of an air conditioning control system.
2. Explain the operation of air conditioning control systems.
3. Identify the components of an air distribution system.
4. Explain the operation of an air distribution system.
5. Explain the procedure to test HVAC control system operation.
6. Describe agricultural HVAC processor driven controls.

**C. Air Conditioning Testing, Service and Retrofitting ..... 54%**

**Outcome:** *Diagnose and service air conditioning systems.*

1. State the safety precautions required when servicing air conditioning systems.
2. Identify air conditioning service tools.
3. Perform air conditioning system diagnosis.
4. Perform air conditioning service within legislated guidelines.
5. Explain replacement procedures for defective air conditioning components.
6. Describe the procedure for retrofitting A/C hoses.
7. Describe the procedure for retrofitting receiver dryers.
8. Describe the procedure for retrofitting compressors.
9. Describe the procedure for retrofitting expansion valves.
10. Describe the use of alternative refrigerants.

**SECTION THREE: .....POWER TRAIN II AND PREVENTIVE MAINTENANCE ..... 18%**

**A. Hydraulic and Power Take-Off Clutches ..... 19%**

**Outcome:** *Identify, diagnose, and repair hydraulic and power take-off clutches.*

1. Identify the components of a hydraulic clutch.
2. Explain the principles of operation of hydraulic clutches.
3. Perform service and diagnostic procedures of hydraulic clutches.
4. Identify types and designs of power take-offs.

5. Describe principles of operation power take-offs.
6. Perform service and diagnostic procedures for power take-offs.

**B. Heavy Duty Transmissions and Four Wheel Drives ..... 51%**

**Outcome: Identify and repair heavy duty mechanical transmissions and four wheel drive units.**

1. Discuss heavy duty transmission nomenclature.
2. Identify design and types of transmissions.
3. Describe power flow, gear ratios, and shift procedures of transmissions.
4. Discuss service and diagnostic procedures of transmissions.
5. Discuss four wheel drive nomenclature and principles of operation.
6. Describe power flow and shift procedures through four wheel drive transfer units.
7. Describe power flow and shift procedures through four wheel drive axles.
8. Perform service and diagnostic procedures of four wheel drive power trains.

**C. Preventive Maintenance..... 14%**

**Outcome: Explain typical maintenance programs used with agricultural equipment.**

1. Explain the types of maintenance systems.
2. Explain the principles of preventive maintenance.
3. Explain the principles of predictive maintenance.

**D. Failure and Fluid Analysis ..... 16%**

**Outcome: Explain predictive maintenance procedures utilizing failure and fluid analysis.**

1. Explain fluid (oil and coolant) analysis.
2. Interpret component failure analysis.

**SECTION FOUR: ..... AGRICULTURAL HARVESTING EQUIPMENT ..... 19%**

**A. Forage Harvesting Equipment ..... 22%**

**Outcome: Describe and adjust forage harvesters.**

1. Describe the procedure of silage making.
2. Describe the operation of forage harvesters.
3. Perform adjustments and repairs to forage harvesters.
4. Describe repair procedures for metal detection systems.

**B. Combines ..... 61%**

**Outcome: Describe and adjust combines.**

1. Describe the functions of a combine.
2. Describe the differences between conventional and rotary combines.
3. Describe components of conventional combines.
4. Describe components of rotary combines.
5. Identify the in-field trouble-shooting and adjustments of combines.

6. Perform feeder adjustments.
7. Perform thresher and separator adjustments.
8. Perform residue management adjustments.
9. Perform grain handling system component adjustments.

**C. Yield Monitors ..... 17%**

**Outcome:** *Explain the application of yield monitors as it pertains to precision farming techniques, taking field variability into account.*

1. Describe yield mapping equipment for combines.
2. Set-up a yield monitor utilizing a laptop computer and PC card interface.
3. Compare yield map details displaying raw data and smoothed data.
4. Query a yield map for average and site specific details.
5. Diagnose operating problems of a yield mapping system.

**SECTION FIVE: ..... BRAKING SYSTEMS ..... 10%**

**A. Hydraulic Brakes System Fundamentals ..... 17%**

**Outcome:** *Apply scientific principles to braking system operation.*

1. Explain braking principles with emphasis on hydraulic forces, friction and heat.
2. Describe the properties and handling procedures of brake fluid and hydraulic oil.
3. Identify common power assist braking systems.
4. Explain the principles of operation for selected brake booster systems.

**B. Hydraulic Brake Systems (Drum and Disc) ..... 17%**

**Outcome:** *Explain the operation of hydraulic drum and disc brake systems.*

1. Explain the principles of operation of drum brake systems.
2. Explain the principles of operation of disc brake systems.
3. Explain the construction and operation of master cylinders.
4. Explain the purpose and construction of brake lines and hoses.
5. Explain the construction and operation of wheel cylinders and callipers.
6. Explain the purpose and operation of valves.

**C. Hydraulic Brake System Diagnosis and Service ..... 16%**

**Outcome:** *Service hydraulic drum and disc brake systems.*

1. List safety responsibilities required when servicing and repairing brake systems.
2. Diagnose brake systems faults.
3. Service a drum brake assembly.
4. Service a disc brake assembly.
5. Describe agricultural brake flushing and bleeding procedures on hydraulic brake systems.

**D. Agricultural Braking Systems Fundamentals and Service ..... 50%**

**Outcome:** *Explain and service various agricultural braking systems.*

1. Describe selected agricultural based braking systems.
2. Describe selected agricultural hydraulic brake control systems.
3. Describe common brake nomenclature and safety procedures.
4. Describe multidisc wet brake systems.
5. Describe agricultural ABS braking and electronic controls.
6. Describe selected agricultural park brakes and controls.
7. Disassemble/assemble selected agricultural brake components.
8. Adjust agricultural park and service brake systems.
9. Identify common agricultural brake component failures.
10. Identify common agricultural hydraulic brake control components.

**SECTION SIX:..... SEEDING AND PRECISION FARMING SYSTEMS ..... 22%**

**A. GPS Mapping ..... 22%**

**Outcome:** *Explain the application of GPS mapping as it pertains to precision farming techniques, taking field variability into account.*

1. Describe GPS system operation relating to space, user, and control components.
2. Describe datum measuring systems and units used in GPS.
3. Record waypoints and lines in a field mapping exercise with a handheld GPS unit.
4. Create a map on a computer after unloading information from a GPS unit.
5. Assess selected types of differential correction systems used to enhance GPS accuracy.

**B. GPS Steering Guidance Systems ..... 13%**

**Outcome:** *Identify GPS steering guidance systems.*

1. Identify the types of steering guidance systems.
2. Describe the operation of GPS steering guidance systems.
3. Describe the setup of a guidance system.

**C. Seeding Equipment ..... 43%**

**Outcome:** *Describe and adjust seeding equipment.*

1. Describe seeding theory.
2. Identify selected types of seeding equipment.
3. Describe the operating procedures of seeding equipment.
4. Identify selected types of soil openers and their seed placement.
5. Describe styles of seed metering systems.
6. Describe types of air stream loading and manifold systems.
7. Describe styles of packing systems and their applications.
8. Compare air systems to gravity systems.



- 9. Calculate in-field calibrations.
- 10. Perform stationary calibrations.
- 11. Describe repairs to seeding equipment (planters).
- 12. Describe repairs to air seeding equipment.
- 13. Perform adjustments and repairs to air seeding equipment.

**D. Variable Rate Application ..... 15%**

**Outcome:** *Explain the use of variable rate application as it pertains to precision farming techniques, taking field variability into account.*

- 1. Describe variable rate technology (VRT) for crop inputs.
- 2. Compare the differences between manual variable rate and map based variable rate systems.
- 3. Describe controller functions relating to setup, calibration, sensor input and operator readout information.
- 4. Program a variable rate monitor to control an air drill.
- 5. Calibrate a variable rate applicator for seed or fertilizer.
- 6. Diagnose operating problems of a variable rate applicator.

**E. Monitors and Sensors ..... 7%**

**Outcome:** *Identify features of monitoring systems and controller area networks.*

- 1. Describe the function of performance monitors.
- 2. Describe the operating principles of ISO compliant communication.
- 3. Record diagnostic and warning messages produced by the ISO compliant communication system.

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**SECTION ONE:..... HYDRAULICS II ..... 48%**

**A. Hydraulic Principles ..... 8%**

**Outcome:**     ***Explain principles of hydraulics.***

1.     Explain the principles of hydraulic energy transfer.
2.     State the characteristics of hydraulic oil.
3.     Explain common hydraulic contamination.

**B. Hydraulic Pump Fundamentals..... 8%**

**Outcome:**     ***Identify common hydraulic pumps.***

1.     Explain common hydraulic pump configurations.
2.     Explain gear pump operating principles.
3.     Explain vane pump operating principles.
4.     Explain piston pump operating principles.

**C. Hydraulic Pump Service ..... 11%**

**Outcome:**     ***Diagnose and repair common hydraulic pumps.***

1.     Explain start up procedures and precautions.
2.     Service a gear pump.
3.     Service a vane pump.
4.     Service a piston pump.

**D. Hydraulic Actuator Fundamentals ..... 5%**

**Outcome:**     ***Identify hydraulic cylinders and motors.***

1.     Explain the operating principles of hydraulic cylinders.
2.     Explain the operating principles of hydraulic motors.

**E. Hydraulic Actuator Service..... 8%**

**Outcome:**     ***Service hydraulic cylinders and motors.***

1.     Service hydraulic cylinders.
2.     Service hydraulic motors.

**F. Hydraulic Valve II ..... 15%**

**Outcome:**     ***Service hydraulic pressure, flow and directional control valves.***

1. Explain the operation and service procedures of hydraulic pressure control valves.
2. Explain the operation and service procedures of hydraulic flow control valves.
3. Explain the operation and service procedures of hydraulic directional control valves.
4. Explain the operation and service procedures of directional control valve accessories.
5. Explain methods used to connect multiple directional control valves.

**G. Hydraulic System Types ..... 16%**

**Outcome:**     ***Analyze common mobile equipment hydraulic systems.***

1. Interpret common mobile equipment hydraulic system schematics.
2. Explain the operation of mobile open centre hydraulic systems.
3. Explain the operation of mobile closed centre hydraulic systems.
4. Explain the operation of a mobile hydrostatic transmission hydraulic system.

**H. Hydraulic System Testing and Service ..... 16%**

**Outcome:**     ***Diagnose common mobile equipment hydraulic systems.***

1. Perform visual inspection and operational tests on common hydraulic systems.
2. Perform pressure and flow testing on common hydraulic systems.
3. Determine hydraulic system faults.

**I. Electro-hydraulics ..... 13%**

**Outcome:**     ***Analyze basic electrical and electronically controlled hydraulic systems.***

1. Explain the operating principles of electrically controlled hydraulic system components.
2. Explain the operating principles of electronically controlled hydraulic system components.
3. Explain joystick and pulse width modulated control systems.
4. Diagnose electrohydraulic system faults.

**SECTION TWO:..... STEERING AND SUSPENSION SYSTEMS AND ACCESSORIES ..... 13%**  
**(SPECIFIC TO OFF-ROAD) AND APPRENTICESHIP**

**A. Wheeled Equipment Steering Fundamentals and Service ..... 18%**

**Outcome:**     ***Diagnose and service off-road equipment steering systems.***

1. Identify common off-road steering configurations and applications.
2. Identify full time power steering system components.
3. Explain the operation of common off-road power steering systems and components.
4. Explain off-road power steering system diagnostic and service procedures.
5. Identify skid steering system components.
6. Explain the operation of a skid steering system.
7. Explain skid steering system diagnostic and service procedures.

**B. Suspension System Fundamentals and Service..... 15%**

**Outcome:** *Explain off-road suspension system diagnostic and service procedures.*

1. State the functions and applications of common off-road suspension systems.
2. Explain the operation of a motor scraper cushion hitch system.
3. Explain cushion hitch diagnostic and service procedures.
4. Explain the operation of common haul truck suspension systems.
5. Explain common haul truck suspension system diagnostic and repair procedures.

**C. Off-Road Equipment Accessories and Attachments ..... 15%**

**Outcome:** *Service and maintain accessories and attachments used with off-road equipment.*

1. Explain the functions and operating principles of operator protective structures.
2. Explain operator protective structures in regards to service and maintenance precautions.
3. Identify and explain the purpose of automatic fire suppression systems used on off-road equipment.
4. Identify and explain the functions of common ground engaging tools and tool mounting components.
5. Explain the procedures required to service common ground engaging tools.
6. Explain the operating principles and service procedures required for common types of winches.

**D. Off-Road Electrical Circuit Fundamentals ..... 28%**

**Outcome:** *Explain the operation of typical off-road equipment electrical and warning circuits.*

1. Explain the operation of off-road equipment lighting circuits.
2. Explain the operation of off-road equipment accessory circuits.
3. Explain the operation of audible and visual warning devices.
4. Explain multiplexing systems in off-road equipment.

**E. Off-Road Electrical Circuit Service ..... 18%**

**Outcome:** *Diagnose and repair off-road equipment electrical circuits.*

1. Perform basic test procedures on off-road equipment lighting circuits.
2. Perform basic test procedures on off-road equipment accessory circuits.
3. Explain precautions when servicing electronic dash systems.

**F. Workplace Coaching Skills..... 3%**

**Outcome:** *Display coaching skills.*

1. Describe coaching skills used for training apprentices.

**G. Interprovincial Standards Red Seal Program ..... 3%**

**Outcome:**     ***Use Red Seal products to challenge an Interprovincial examination.***

1.     Identify Red Seal products used to develop Interprovincial examinations.
2.     Use Red Seal products to prepare for an Interprovincial examination.

**SECTION THREE: .....POWERTRAIN (SPECIFIC TO OFF-ROAD) ..... 39%**

**A. Gearing Principles ..... 3%**

**Outcome:**     ***Explain basic gearing principles.***

1.     Define gear terminology.
2.     Explain gear relationships with regards to ratios and input/output direction.
3.     Identify common gear types and applications.

**B. Torque Converter Fundamentals and Service..... 9%**

**Outcome:**     ***Diagnose and repair common off-road equipment torque converters.***

1.     Describe the function and concepts of fluid converters.
2.     Describe the components and operation of torque converters.
3.     Explain the operation of a torque divider.
4.     Explain basic torque converter mounting, diagnostic and repair procedures.

**C. Powershift and Automatic Transmission Mechanical/Electronic Components ..... 15%**

**Outcome:**     ***Explain the operation of powershift and automatic transmission mechanical components.***

1.     Compare functions and applications of powershift and automatic transmissions.
2.     Explain gearing principles of single and multiple planetary gear seats.
3.     Explain the operation of a typical planetary type transmission.
4.     Explain the operation of typical countershaft type powershift/automatic transmissions.

**D. Powershift and Automatic Transmission Control and Shifting..... 10%**

**Outcome:** *Explain the operation of powershift and automatic transmission shift control mechanisms.*

1. Explain the operation of hydraulic shift control systems for powershift transmissions.
2. Explain the operation of hydraulic shift control systems for automatic transmissions.
3. Explain the operation of electronic shift control systems for automatic transmissions.

**E. Hydraulic Retarder Fundamentals ..... 3%**

**Outcome:** *Explain the operating principles for off-road equipment hydraulic retarders.*

1. Identify the components of a typical off-road equipment hydraulic retarder.
2. Explain the operation of a typical off-road equipment hydraulic retarder.

**F. Powershift and Automatic Transmission Testing and Service ..... 10%**

**Outcome:** *Diagnose and service powershift and automatic transmissions.*

1. Perform powershift and automatic transmission visual inspections and operational tests.
2. Perform powershift and automatic transmission hydraulic shift control system testing.
3. Perform powershift and automatic transmission electronic shift control system testing.
4. Explain the procedures to remove and reinstall a powershift and automatic transmission.

**G. Tracked Equipment Steering Fundamentals and Service ..... 11%**

**Outcome:** *Explain tracked equipment steering system diagnostic and service procedures.*

1. Explain the operation of a steering clutch and brake crawler tractor steering system.
2. Explain the diagnostic and service procedures for a steering clutch and brake crawler tractor steering system.
3. Explain the operation of a hydrostatic crawler tractor steering system.
4. Explain diagnostic and service procedures for a hydrostatic crawler tractor steering system.
5. Explain the operation of a differential type crawler tractor steering system.
6. Explain the diagnostic and service procedures for a differential type crawler tractor steering system.

**H. Undercarriage Systems Fundamentals and Service..... 12%**

**Outcome:** *Explain diagnostic and service procedures for tracked equipment undercarriage and related components.*

1. Describe the functions, applications and configurations of undercarriage systems.
2. Explain the functions and operation of the components of typical undercarriage systems.
3. Perform undercarriage inspection and adjustment procedures.
4. Explain the procedures required for safely removing and replacing undercarriage components.
5. Explain procedures for remanufacturing undercarriage components.

**I. Final Drive Fundamentals and Service (Off-Road)..... 11%**

**Outcome:** *Explain diagnostic and service procedures for off-road equipment final drive systems.*

1. Describe the functions, applications, and configurations of final drive systems.
2. Explain the operation of wheeled equipment final drive systems.
3. Explain the fundamentals of alternating current (ac) drive systems.
4. Explain the safety precautions when servicing units equipped with ac drive systems.
5. Explain the operation of tracked equipment final drive systems.
6. Explain maintenance and service procedures for final drive systems.

**J. Drive Axle and Carrier Fundamentals and Service (Off-Road) ..... 13%**

**Outcome:** *Repair drive axle and carrier assemblies.*

1. State the functions of single reduction drive axle assemblies.
2. Identify single reduction drive axle components.
3. Explain the operating principles of a single reduction drive axle and differential assembly.
4. Identify common types of carrier assemblies used in the trade.
5. Explain the lubrication of a single reduction drive axle.
6. Diagnose a drive axle and carrier assembly for operational faults.
7. Explain drive axle and carrier assembly removal and replacement procedures.
8. Overhaul a typical drive axle and carrier assembly to manufacturer's specifications.

**K. Clutch Fundamentals and Service ..... 3%**

**Outcome:** *Service and diagnose common clutch types.*

1. Explain the operation and maintenance of overcentre clutches.
2. Explain the operation principles of special application clutches such as overrunning, dog, cone and bevel and electromagnetic.



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