

# Apprenticeship and Industry Training

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## Heavy Equipment Technician Curriculum Guide

019 (2022)

Alberta 



Apprenticeship  
and Industry  
Training

**ALBERTA ADVANCED EDUCATION**

Heavy equipment technician : apprenticeship education program curriculum guide

ISBN 978-1-4601-5199-0

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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 post-secondary 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 Heavy Equipment Technician apprenticeship education program is an individual who will be able to:

- diagnose repair, and maintain by skills and knowledge gained through training and experience any of the working parts of diesel engines as well as the various components of mobile industrial equipment
- 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
- when fully competent in all phases of general repairs, a Heavy Equipment Technician may specialise in any one of several areas of the trade such as, fuel pumps and injectors, track equipment, engine overhaul, hydraulic controls, power shift transmissions and allied equipment
- outstanding individuals may advance to service representatives or supervisory positions
- be familiar with the work in related trades such as Machinist and Welder
- understand the fundamentals of operating a small business.
- 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. M. Larson..... Edmonton  
Mr. D. Scott..... Red Deer  
Mr. G. Atkinson ..... Grand Prairie  
Mr. M. Allen..... Calgary  
Mr. A. Nieuwenkamp ..... Spruce Grove  
Mr. M. Tarrabain ..... Edmonton  
Mr. R. Cosens..... Calgary  
Mr. P. Valgardson ..... Taber  
Mr. A. Paananen..... Stony Plain  
Mr. R. Wizniak ..... Sherwood Park  
Mr. M. Bordeleau ..... Bonnyville

## 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 accreditation 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 more worksite hazards than in other forms of traditional post-secondary 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 education 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 Heavy Equipment Technician trade apprenticeship technical training:

Northern Alberta Institute of Technology  
Southern Alberta Institute of Technology  
Keyano College  
Medicine Hat College  
Olds College

Lakeland College  
Lethbridge College  
Grande Prairie Regional College  
Red Deer College

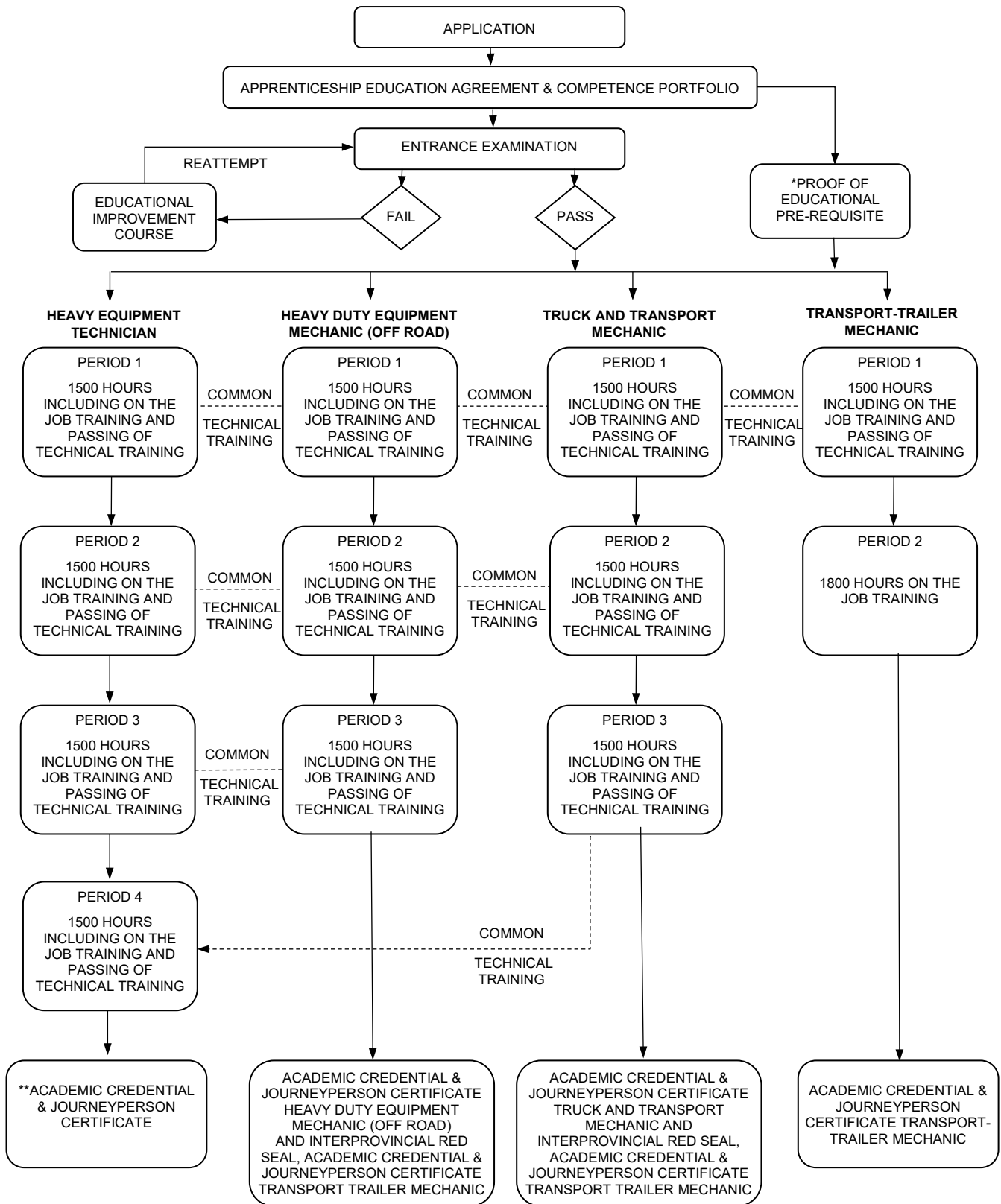
## **Procedures for Recommending Revisions to the Curriculum Guide**

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 TOWARDS ACADEMIC CREDENTIAL



\* For entrance requirements recommended path as well as minimum requirements, refer to <https://tradesecrets.alberta.ca>

\*\* A person holding an Academic Credential & Journeyman Heavy Equipment Technician Certificate will receive the Transport-Trailer Mechanic, Truck and Transport Mechanic and the Heavy Duty Equipment Mechanic (Off-Road) Academic Credentials & Journeyman Certificates. Candidates are also eligible to receive the Interprovincial Red Seal for Truck and Transport Mechanic and The Heavy Duty Equipment Mechanic (Off Road).

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

**SECTION ONE**

**STANDARD WORKPLACE SAFETY, MATERIALS AND TOOLS**  
 17%



<b>A</b>	<b>B</b>	<b>C</b>
Safety Legislation, Regulations and Industry Policy in the Trades 5%	Climbing, Lifting, Rigging and Hoisting 7%	Hazardous Materials and Fire Protection 7%
<b>D</b>	<b>E</b>	<b>F</b>
Communications and Trade Specific Safety 13%	Materials and Fastening Devices 10%	Hand, Shop and Power Tools 15%
<b>G</b>	<b>H</b>	
Measuring Tools 20%	Oxyacetylene Equipment, Heating and Cutting 23%	

**SECTION TWO**

**SUSPENSIONS, WHEELS AND SYSTEMS**  
 22%



<b>A</b>	<b>B</b>	<b>C</b>
Frame and Suspension Fundamentals 13%	Frame and Suspension Service 17%	Bearings and Seals 11%
<b>D</b>	<b>E</b>	<b>F</b>
Wheels, Tires, and Hubs 17%	Trailer Systems and Components 6%	Coupling Units Fundamentals and Service 11%
<b>G</b>	<b>H</b>	<b>I</b>
Landing Gear Fundamentals and Service 6%	Orientation to Trailer Inspection 8%	Preventive Maintenance 11%

**SECTION THREE**

**HYDRAULICS 1 AND HYDRAULIC BRAKE SYSTEMS**  
 20%



<b>A</b>	<b>B</b>	<b>C</b>
Hydraulic Brake System Fundamentals 6%	Hydraulic Brake System (Drum and Disc) 14%	Hydraulic Brake System Diagnosis and Service 15%
<b>D</b>	<b>E</b>	<b>F</b>
Hydraulic Brake Booster System Fundamentals and Service 23%	Parking Brake System Fundamentals and Service 6%	Electric Brake Fundamentals and Service 4%
<b>G</b>	<b>H</b>	<b>I</b>
Hydraulic Fundamentals 12%	Hydraulic System Components: Reservoir, Filters, Hoses and Coolers 12%	Hydraulic System Components: Pumps, Valves and Cylinders 8%

**SECTION FOUR**

**ELECTRICAL I AND ELECTRONICS I**  
 22%



<b>A</b>	<b>B</b>	<b>C</b>
Electrical Theory 8%	Electrical Circuits 13%	Magnetism 9%
<b>D</b>	<b>E</b>	<b>F</b>
Test Equipment 11%	Battery Fundamentals and Service 16%	Electrical Wiring, Lighting Circuits and Circuit Protection 17%
<b>G</b>	<b>H</b>	



**SECTION FIVE**

**AIR BRAKES**

**19%**



Basic Electronics  
11%

**A**

Electronic Control  
Systems  
15%

**B**

Air Brake System  
Fundamentals  
9%

**D**

Air Brake System  
Mechanical Components  
13%

**E**

Truck/Tractor Air Brake  
System Components  
27%

**C**

**F**

Trailer Air Brake System  
Components  
18%

Air Brake Testing and  
Service  
20%

Air Antilock Brake  
System Fundamentals  
13%

**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)**

**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%	Electro-hydraulics 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 25%	Off-Road Electrical Circuit Service 18%	Workplace Coaching Skills 6%
<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%	

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

**SECTION ONE**

**POWERTRAIN (SPECIFIC TO TRUCK AND TRANSPORT)**  
 51%

<b>A</b>	<b>B</b>	<b>C</b>
Clutch Fundamentals and Service 7%	Driveline Fundamentals and Service 10%	Gearing Principles 2%
<b>D</b>	<b>E</b>	<b>F</b>
Transmission Fundamentals 10%	Transmission Shifting 10%	Transmission Service 23%
<b>G</b>	<b>H</b>	<b>I</b>
Transfer Case and Auxiliary Drives 3%	Drive Axle Assembly Fundamentals (On Road) 10%	Drive Axle Assembly Service (On Road) 25%

**SECTION TWO**

**STEERING AND ANTILOCK BRAKE SYSTEMS**  
 20%

<b>A</b>	<b>B</b>	<b>C</b>
Steering Fundamentals 16%	Steering Service 21%	Steering Angles and Alignment 17%
<b>D</b>	<b>E</b>	<b>F</b>
Air Antilock Brake Systems 14%	Air Antilock Brake System Diagnosis 16%	Hydraulic Antilock Brake Systems 16%

**SECTION THREE**

**AIR CONDITIONING**  
 15%

<b>A</b>	<b>B</b>	<b>C</b>
Air Conditioning Fundamentals 22%	Heating, Ventilation and Air Conditioning (HVAC) Control Systems 33%	Air Conditioning Testing and Service 45%

**SECTION FOUR**

**VEHICLE ELECTRICAL DIAGNOSIS, FAILURE ANALYSIS AND APPRENTICESHIP**  
 14%

<b>A</b>	<b>B</b>	<b>C</b>
Truck Electrical Circuit Fundamentals 23%	Truck Electrical Circuit Service 26%	Failure and Fluid Analysis 24%
<b>D</b>	<b>E</b>	<b>F</b>
Orientation to Vehicle Inspection 18%	Workplace Coaching Skills 6%	Interprovincial Standards Red Seal Program 3%

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

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

**SECTION ONE:..... STANDARD WORKPLACE SAFETY MATERIALS AND TOOLS ..... 17%**

**A. Safety Legislation, Regulations and Industry Policy in the Trades ..... 5%**

**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 ..... 7%**

**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 and Fire Protection ..... 7%**

**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. Communications and Trade Specific Safety..... 13%**

**Outcome:** *Demonstrate communication skills and workshop safety as it pertains to the Heavy Equipment Technician trade.*

1. Communicate trade-related information using standards terms for components and operations.
2. Describe applications of wire rope on machinery.
3. Demonstrate the use of jacking and blocking techniques common to off-road and on-road equipment and trailers.

**E. Materials and Fastening Devices ..... 10%**

**Outcome:** *Identify materials and fasteners commonly used in the trade.*

1. Identify common metallic materials and their applications.
2. Identify common non-metallic materials and their applications.
3. Identify types of threaded fasteners and their applications.
4. Explain the torque procedures and precautions required when securing fastening devices.
5. Identify types of non-threaded fasteners and their applications.

**F. Hand, Shop and Power Tools ..... 15%**

**Outcome:** *Demonstrate the correct use of hand, shop and power tools common to the trade.*

1. Describe types, uses and care of hand tools.
2. Describe the procedures required to safely operate various types and capacities of shop puller and pressing equipment.
3. Describe and use cutting hand tools common to the trade.
4. Demonstrate proper care and safe use of common power hand tools.

**G. Measuring Tools ..... 20%**

**Outcome:** *Demonstrate the correct use of measuring tools common to the trade.*

1. Perform calculations related to measurement using imperial and metric units.
2. Perform linear measurements using basic measuring tools.
3. Perform linear measurements using precision measuring tools.
4. Perform accurate torque measurements using torquing tools.

**H. Oxyacetylene, Equipment, Heating and Cutting..... 23%**

**Outcome:** *Perform metal cutting and heating operations safely using oxyacetylene equipment.*

1. Describe the characteristics and handling procedures for oxygen, propane and acetylene.
2. Demonstrate handling procedures for regulators and hoses.
3. Demonstrate the use, care, and maintenance of torches and tips.
4. Demonstrate the use of personal protective equipment.
5. Perform heating and cutting operations using oxygen and acetylene.

**SECTION TWO:.....SUSPENSIONS, WHEELS AND SYSTEMS ..... 22%****A. Frame and Suspension Fundamentals..... 13%**

**Outcome:** *Explain the operating principles and design features of common frame and suspension systems.*

1. State the functions of a vehicle frame.
2. Identify types, designs and components of frames commonly used in truck and trailer applications.
3. State the functions of a vehicle suspension system.
4. Explain the operating principles of common suspension systems.

**B. Frame and Suspension Service ..... 17%**

**Outcome:** *Repair common types of frame and suspension systems.*

1. Explain frame inspection and repair procedures.
2. Explain the causes of suspension system malfunction.
3. Explain suspension system repair procedures.

**C. Bearings and Seals..... 11%**

**Outcome:** *Service common bearings and seals.*

1. State bearing functions and applications.
2. State seal functions and applications.
3. Diagnose common bearing and seal faults.
4. Perform bearing and seal service.

**D. Wheels, Tires and Hubs ..... 17%**

**Outcome:** *Service wheels, tires and hubs.*

1. Identify common wheel types and mounting designs.
2. Explain tire construction, care and maintenance in relation to design.
3. State the safety procedures required when handling wheels and tires.
4. Perform wheel removal, inspection and installation.
5. Explain wheel balancing.
6. Diagnose wheel and tire faults.

**E. Trailer Systems and Components..... 6%**

**Outcome:** *Identify common trailer systems and components.*

1. Describe types and configurations of on-highway trailers.
2. Identify trailer configurations according to number of axles and hitch points.
3. Identify trailer axle configurations; fixed and steering.



**F. Coupling Units Fundamentals and Service..... 11%**

**Outcome:**     ***Service trailer coupling systems and landing gear.***

1. Identify common types of trailer coupling units.
2. Service a fifth wheel assembly.
3. Service a no-slack pintle hitch.
4. Explain procedures and safety precautions required when coupling and uncoupling trailer systems.

**G. Landing Gear Fundamentals and Service ..... 6%**

**Outcome:**     ***Service trailer coupling systems and landing gear.***

1. Identify common types of trailer landing gear.
2. Service common types of trailer landing gear.

**H. Orientation To Trailer Inspection ..... 8%**

**Outcome:**     ***Explain trailer inspection according to CVI regulations.***

1. Outline trailer inspection regulations.
2. Identify conditions caused by damage, wear or corrosion, which would make a trailer unsafe or inoperable.

**I. Preventive Maintenance ..... 11%**

**Outcome:**     ***Explain typical maintenance programs used with off-road and on road equipment.***

1. Explain the types of maintenance systems.
2. Explain the principles of preventive maintenance.
3. Explain the principles of predictive maintenance.
4. Demonstrate basic preventive maintenance and service procedures.

**SECTION THREE: ..... HYDRAULICS 1 AND HYDRAULIC BRAKE SYSTEMS..... 20%**

**A. Hydraulic Brake System Fundamentals ..... 6%**

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

1. Explain braking principles with emphasis on heat, friction and hydraulic forces.
2. Explain brake fluids with regards to properties and handling procedures.

**B. Hydraulic Brake System (Drum and Disc)..... 14%**

**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 calipers.
6. Explain the purpose and operation of the metering, proportioning and pressure differential valves.

**C. Hydraulic Brake System Diagnosis and Service ..... 15%****Outcome: Service hydraulic drum and disc brake systems.**

1. List safety responsibilities required when servicing and repairing brake systems.
2. Diagnose brake system faults.
3. Service a typical drum brake assembly.
4. Service a typical disc brake assembly.
5. Describe reconditioning procedures required for master cylinders, wheel cylinders and brake calipers.
6. Demonstrate brake flushing and bleeding procedures on hydraulic brake systems.

**D. Hydraulic Brake Booster System Fundamentals and Service ..... 23%****Outcome: Explain power braking systems service procedures.**

1. Identify common power assist braking systems.
2. Explain the principles of operation for vacuum brake booster systems.
3. Describe the diagnosis and repair procedures for vacuum brake booster systems.
4. Explain the principles of operation for air-over-hydraulic brake booster systems.
5. Describe the diagnosis and repair procedures for air-over-hydraulic brake booster systems.
6. Explain the principles of operation for hydraulic-over-hydraulic brake booster systems.
7. Describe the diagnosis and repair procedures for hydraulic-over-hydraulic brake booster systems.

**E. Parking Brake System Fundamentals and Service ..... 6%****Outcome: Explain service procedures of parking brake systems.**

1. Explain the principles of operation for common parking brake systems.
2. Describe the adjusting procedures for common parking brake systems.
3. Describe repair procedures for common parking brake systems.

**F. Electric Brake Fundamentals and Service ..... 4%****Outcome: Explain service procedures of electric braking systems.**

1. Explain the principles of operation for electric braking systems.
2. Identify basic electric braking system failures.

**G. Hydraulic Fundamentals ..... 12%****Outcome: Explain hydraulic principles.**

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

**H. Hydraulic System Components: Reservoir, Filters, Hoses and Coolers ..... 12%**

**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.

**I. Hydraulic System Components: Pumps, Valves and Cylinders ..... 8%**

**Outcome:** *Explain the functions and principles of operation of hydraulic system components.*

1. Explain gear pump operating principles.
2. Explain the principles of operation of the basic types of hydraulic control valves (direct acting pressure relief valve, open center directional control valve).
3. Explain the principles of operation of basic hydraulic cylinders.

**SECTION FOUR: ..... ELECTRICAL I AND ELECTRONICS I ..... 22%**

**A. Electrical Theory ..... 8%**

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

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

**B. Electrical Circuits ..... 13%**

**Outcome:** *Identify electrical circuit types and circuit defects.*

1. List the components of a basic electrical circuit.
2. Identify the three circuit types and their properties.
3. Explain electrical laws and formulas that apply to the operation of electrical circuits.
4. Apply electrical laws and formulas to mathematically calculate circuit values.
5. Explain the effects of circuit defects on circuit operation.

**C. Magnetism ..... 9%**

**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 application of electromagnets.
4. Explain the principles of electromagnetic induction.

**D. Test Equipment ..... 11%**

**Outcome:**     *Use electrical test equipment to measure electrical values and check circuit operation.*

1. Explain the construction and operation of voltmeters, ammeters and ohmmeters.
2. Explain meter precautions when measuring voltage, current and resistance.
3. Measure voltage at various points on a circuit and interpret the results.
4. Measure current flow at various points on a circuit and interpret the results.
5. Measure resistance using an ohmmeter.

**E. Battery Fundamentals and Service ..... 16%**

**Outcome:**     *Service, test and charge a lead-acid battery.*

1. Identify hazards encountered with lead-acid storage 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 the safety precautions and procedures for charging batteries.
6. Explain multiple battery circuits in relation to connections and battery compatibility.

**F. Electrical Wiring, Lighting Circuits and Circuit Protection ..... 17%**

**Outcome:**     *Test and repair electrical circuits.*

1. Trace electrical circuits using symbols that are common to the industry.
2. Perform wiring harness inspection and repair.
3. Identify and repair wiring harness connectors that are common to the industry.
4. Test circuit protection devices, switches, relays and solenoids.
5. Repair an electrical lighting circuit for a short circuit, ground fault, open circuit and high resistance.

**G. Basic Electronics ..... 11%**

**Outcome:**     *Test discrete electronic components used in the trade.*

1. Compare and contrast solid state electronic and electrical circuitry.
2. Explain the properties, applications and test procedures for resistors.
3. Explain the properties, applications and test procedures for diodes.
4. Identify the conditions that affect the life of electronic devices.

**H. Electronic Control Systems ..... 15%**

**Outcome:**     *Describe the operation of basic computer-controlled systems.*

1. Identify the terminology commonly used with computer controls and components.
2. Explain the function of electronic control system components.
3. Explain the interaction between inputs, processors and outputs and multiplexing to control a circuit or a system.
4. Identify electronic test equipment used for diagnosis of electronic systems.

**SECTION FIVE:..... AIR BRAKES ..... 19%**

**A. Air Brake System Fundamentals..... 9%**

**Outcome:** *Explain the fundamental principles of operation of an air brake system.*

1. Explain the principles of operation of an air brake system.
2. Develop a simple air brake system consisting of a compressor, dryer, reservoir, brake valve, steer axle and drive axle brake chambers, and connecting lines.

**B. Air Brake System Mechanical Components..... 13%**

**Outcome:** *Explain the operating principles of air brake mechanical components.*

1. Explain the operating principles of a typical cam-operated foundation brake.
2. Explain the operating principles of a typical air disc foundation brake.

**C. Truck/Tractor Air Brake System Components..... 27%**

**Outcome:** *Explain the principles of operation of truck/tractor air brake systems.*

1. Explain the functions and principles of operation of common air brake supply circuit components.
2. Explain the functions and principles of operation of common primary service brake circuit components.
3. Explain the functions and principles of operation of common secondary service brake circuit components.
4. Explain the functions and principles of operation of common parking/emergency brake circuit components.
5. Explain the functions and principles of operation of common trailer control circuit components.

**D. Trailer Air Brake System Components ..... 18%**

**Outcome:** *Explain the principles of trailer brake system component operation.*

1. Explain the functions and principles of operation of pre-CMVSS 121 single trailer brake circuit components.
2. Explain the functions and principles of operation of CMVSS 121 single trailer brake circuit components.
3. Explain functions and principles of operation of common components used on multiple trailer combinations.

**E. Air Brake System Testing and Service ..... 20%**

**Outcome:** *Service and diagnose truck/tractor and trailer air brake systems.*

1. State the safety precautions that must be observed prior to performing air brake system testing and service.
2. Perform a visual inspection of the air brake system.
3. Perform air brake system testing.
4. Analyse test results and state possible causes for system malfunction.
5. Service cam-operated foundation brakes.

F. Air Antilock Brake System Fundamentals ..... 13%

**Outcome:**      *Describe the basic operation of an air antilock brake system.*

1. List the advantages of operating a vehicle equipped with an antilock brake system.
2. Explain the operation of an antilock air brake system.
3. Identify typical system layout and component locations on a vehicle equipped with an antilock air brake system.
4. Describe antilock air brake system service precautions.

**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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**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..... 25%**

**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 ..... 6%**

**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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**SECTION ONE:.....POWERTRAIN (SPECIFIC TO TRUCK AND TRANSPORT) ..... 51%**

**A. Clutch Fundamentals and Service ..... 7%**

**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 operating faults.
4. Perform service procedures for spring-loaded clutches.
5. Explain the function and operating principles of auto adjust clutches.
6. Explain the function and operating principles of the no pedal clutch systems.

**B. Driveline Fundamentals and Service ..... 10%**

**Outcome:      *Diagnose and service drivelines and universal joints.***

1. Explain the function and operating principles of common driveline assemblies.
2. Explain the construction and design features of common driveline components.
3. Diagnose and service universal joints.
4. Explain and check driveline phasing, angles and angle limitations.
5. Explain the procedure to rectify driveline vibrations.

**C. Gearing Principles ..... 2%**

**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.

**D. Transmission Fundamentals ..... 10%**

**Outcome:      *Explain the principles of operation and design features of mechanical transmissions.***

1. Explain vehicle powertrain requirements in relation to engine performance characteristics and vehicle applications.
2. Explain the operation of a synchronizer.
3. Explain the operating principles of transmission main section mechanical components.
4. Explain the operation of transmission auxiliary section mechanical components.
5. Explain the lubrication of transmissions.

6. Explain the fundamentals of Hybrid drive systems.
7. Explain the safety precautions of Hybrid drive systems.

**E. Transmission Shifting ..... 10%**

**Outcome:** *Explain mechanical and electronic transmission shift controls.*

1. Explain the operation of the components of a mechanical air shift system.
2. Explain mechanical transmission air shift system operation.
3. Explain the operating principles of an electronic automated top gear shifting system.
4. Explain the basic operation of mechanical transmission electronic shift controls.

**F. Transmission Service ..... 23%**

**Outcome:** *Repair mechanical transmissions.*

1. Explain how to service and maintain constant mesh transmissions.
2. Diagnose operational faults associated with typical constant mesh transmissions.
3. Overhaul a non-synchromesh transmission to manufacturer’s specifications.
4. Overhaul a synchromesh transmission to manufacturer’s specifications.
5. Perform failure analysis on the components of a typical constant mesh transmission.
6. Explain transmission installation procedures.
7. Perform air shift system diagnosis and troubleshooting.
8. Explain the safety precautions when servicing vehicles with Hybrid drive systems.

**G. Transfer Case and Auxiliary Drives ..... 3%**

**Outcome:** *Explain the operating principles and repair procedures of transfer cases and auxiliary drive units.*

1. Explain how to service and maintain constant mesh transmissions.
2. Explain the diagnosis and service of a typical transfer case.
3. Explain the principles of operation and design features of typical power takeoff (PTO) units.
4. Explain PTO installation procedures and precautions.
5. Explain PTO diagnosis and service procedures.

**H. Drive Axle Assembly Fundamentals (On-Road) ..... 10%**

**Outcome:** *Explain the functions and operating principles of drive axle assemblies.*

1. Explain drive axle requirements in relation to vehicle applications.
2. State the functions of a drive axle assembly.
3. Identify drive axle configurations and components.
4. Explain the operating principles of a differential assembly.
5. Explain the operating principles of an inter-axle differential assembly.
6. Explain common axle shaft configurations.
7. Explain the lubrication of a drive axle.
8. Explain the operating principles of wheel lock assemblies.

**I. Drive Axle Assembly Service (On-Road)..... 25%**

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

1. Diagnose a drive axle assembly for operational faults.
2. Explain differential carrier assembly removal and installation procedures.
3. Overhaul a typical differential carrier assembly to manufacturer's specifications.
4. Overhaul a typical inter-axle differential assembly.

**SECTION TWO:..... STEERING SYSTEMS AND ANTILOCK BRAKE SYSTEMS ..... 20%**

**A. Steering Fundamentals ..... 16%**

**Outcome:**     **Diagnose truck steering systems.**

1. Explain the operating principles of steering systems.
2. Explain the construction and design features of steering components.
3. Identify the components of a truck power steering system.
4. Explain the operation of power steering system components.

**B. Steering Service..... 21%**

**Outcome:**     **Diagnose and service truck steering systems.**

1. Explain steering component service procedures.
2. Diagnose power steering system faults.
3. Explain hydraulic system testing and adjustment procedures.
4. Describe the procedures required to remove and replace power steering components.
5. Describe the procedures for adjusting an integral power steering gearbox.
6. Service a power steering gear.

**C. Steering Angles and Alignment ..... 17%**

**Outcome:**     **Identify steering angles and their effects on vehicle handling.**

1. Explain steering system geometric principles and their effects on vehicle handling and tire wear.
2. List pre-alignment inspection procedures.
3. Describe common methods of adjusting wheel alignment angles to achieve manufacturer's guidelines.

**D. Air Antilock Brake Systems ..... 14%**

**Outcome:**     **Explain the operation of antilock braking systems (ABS) and automatic traction control (ATC) systems.**

1. Explain the operation of an antilock brake systems (ABS).
2. Explain the operation of the individual ABS components.
3. Explain the interface between the tractor and the trailer.
4. Explain the operation of the individual ATC components.
5. List ABS and ATC service precautions.
6. Explain the operation of roll stability systems.

**E. Air Antilock Brake System Diagnosis..... 16%****Outcome: Diagnose and service air antilock braking systems (ABS).**

1. Explain a logical procedure to troubleshoot an air ABS.
2. Identify service tools for ABS diagnosis.
3. Describe methods used to test failed ABS components.
4. Diagnose and repair ABS faults.

**F. Hydraulic Antilock Brake Systems ..... 16%****Outcome: Explain the operation of typical hydraulic antilock braking systems (ABS).**

1. Identify the components of a hydraulic ABS.
2. Explain hydraulic system operation.
3. Explain electronic system operation.
4. Describe hydraulic ABS service and diagnostic procedures.
5. Demonstrate the procedure to bleed a hydraulic ABS.

**SECTION THREE: ..... AIR CONDITIONING..... 15%****A. Air Conditioning Fundamentals ..... 22%****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 clutch cycling air conditioning system using an expansion valve or an orifice tube.

**B. Heating, Ventilation and Air Conditioning (HVAC) Control Systems ..... 33%****Outcome: Explain the operating principles of heating, ventilation and air conditioning (HVAC) 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 automatic temperature control system.
4. Identify the components of an air distribution system.
5. Explain the operation of an air distribution system.
6. Explain the operation of a typical sleeper temperature control system.
7. Explain the procedure to test HVAC control system operation.

**C. Air Conditioning Testing and Service..... 45%****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.

**SECTION FOUR: ..... VEHICLE ELECTRICAL DIAGNOSIS,..... 14%**  
**FAILURE ANALYSIS AND APPRENTICEHSIP**

**A. Truck Electrical Circuit Fundamentals ..... 23%**

**Outcome:** *Explain the operation of typical truck electrical and warning circuits.*

1. Explain the operation of truck lighting circuits.
2. Explain the operation of truck accessory circuits.
3. Explain the operation of audible and visual warning devices.
4. Explain multiplexing systems in on highway equipment.

**B. Truck Electrical Circuit Service ..... 26%**

**Outcome:** *Diagnose and repair truck electrical circuits.*

1. Perform basic test procedures on truck lighting circuits.
2. Perform basic test procedures on truck accessory circuits.
3. Explain precautions when servicing electronic dash systems.
4. Describe safety precautions related to supplemental restraint systems (SRS).

**C. Failure and Fluid Analysis ..... 24%**

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

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

**D. Orientation to Vehicle Inspection ..... 18%**

**Outcome:** *Explain truck inspection according to Commercial Vehicle Inspection (CVI) regulations.*

1. Outline provincial truck inspection regulations.
2. Identify conditions caused by damage, wear or corrosion that would make a truck unsafe or inoperable.
3. Identify conditions that would require further inspection.

**E. Workplace Coaching Skills ..... 6%**

**Outcome:** *Use coaching skills when training an apprentice.*

1. Describe the process for coaching an apprentice.



F. 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.



# Apprenticeship and Industry Training

Alberta Trades. World Ready.