Skilled Trades Ontario | Métiers spécialisés Ontario

Apprenticeship Curriculum Standard

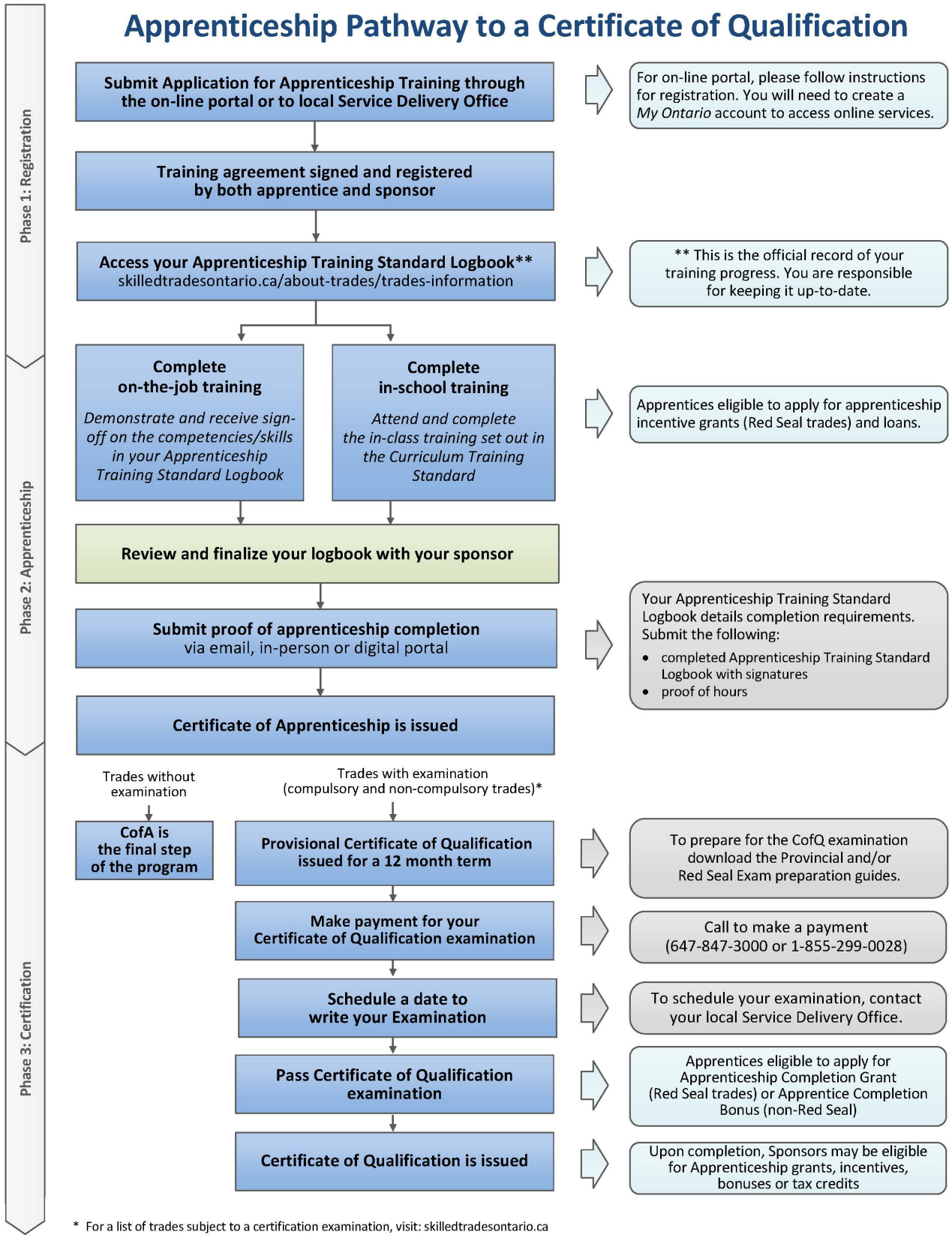
Automotive Service Technician

Levels 1, 2 and 3

310S

2010

Apprenticeship Pathway to a Certificate of Qualification



* For a list of trades subject to a certification examination, visit: skilledtradesontario.ca

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2010

Preface

This curriculum standard for the Automotive Service Technician trade program is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 3 levels of training. The Reportable Subjects Summary chart (located on page 2) summarizes the training hours for each reportable subject.

The curriculum identifies the learning that takes place in-school. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards.

Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on a work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to verify that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

Please refer to Skilled Trades Ontario website (www.skilledtradesontario.ca) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)*) and its regulations, please visit Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 (ontario.ca)

Pre-requisites

In order to advance to Level 2 of the apprenticeship program, an individual must have completed all of the units outlined in Level 1. Similarly, in order to advance to Level 3 of the program, an individual must have completed all of the units outlined in Level 1 and 2.

Hours Disclaimer (if applicable)

It is agreed that Training Delivery Agents (TDAs) may need to make slight adjustments (with cause) according to particular apprentice needs and may deviate from the unit sequencing and the prescribed practical and theoretical hours shown within the standard. However, all TDAs will comply with the hours at the reportable subject level.

Personal and Safety Equipment: Personal protective equipment is at the discretion of the TDA who must conform to Ontario Provincial Health and Safety Regulations.

Please note that all practices described in this standard must be performed according to the appropriate and industry best practice.

Reportable Subjects Summary – Levels 1 - 3

Reportable Subject Summary – Level 1

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1221	Work Practices	30	20	10
1222	Engine Systems	36	22	14
1223	Electrical / Electronic and Emissions Systems	96	64	32
1224	Drive Train Systems	36	24	12
1225	Suspension / Steering and Brake Systems	42	26	16
	Total	**240**	**156**	**84**

Reportable Subject Summary – Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1226	Air Conditioning Systems	30	18	12
1227	Engine Systems	36	22	14
1228	Electrical / Electronic and Emissions Systems	96	64	32
1229	Drive Train Systems	36	24	12
1230	Suspension / Steering and Brake Systems	42	26	16
	Total	**240**	**154**	**86**

Reportable Subject Summary — Level 3

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1231	Work Practices	30	16	14
1232	Engine Systems	36	24	12
1233	Electrical/Electronic and Emissions Systems	96	64	32
1234	Drive Train Systems	36	24	12
1235	Suspension/Steering and Brake Systems	42	26	16
	Total	**240**	**154**	**86**

Level 1

Reportable Subject Summary – Level 1

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1221	Work Practices	30	20	10
1222	Engine Systems	36	22	14
1223	Electrical / Electronic and Emissions Systems	96	64	32
1224	Drive Train Systems	36	24	12
1225	Suspension / Steering and Brake Systems	42	26	16
	Total	**240**	**156**	**84**

Number:	**1221**		
Title:	**Work Practices**		
Duration:	Total Hours: 30	Theory: 20	Practical: 10
Prerequisites:	None		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.1	Fasteners	8	6	2
1.2	Bearings, Seals and Sealants	8	6	2
1.3	Precision Measuring Tools	6	4	2
1.4	Oxyacetylene, Heating & Cutting	4	2	2
1.5	Hoists and Lifting Equipment	2	0	2
1.6	Applied Computer Skills	2	2	0

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**1.1**		
Title:	**Fasteners**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2

Cross Reference to Training Standards: 5161, 62, 63, 64, 65, 66, 67, 68, 69, 5170, 71, 72, 73, 74

General Learning Outcomes

Upon successful completion the apprentice will have the ability to identify fastener characteristics, select proper application, install and removal fasteners according to accepted trade practices.

Learning Outcomes and Content

1.1.1 Explain the fundamental characteristics of fasteners and retention techniques.

- specifications created by Society of Automotive Engineers (SAE) standards
- specifications of International Organization of Standards (ISO)
- bolt strength
  - tensile
  - shear
- fastener grade, pitch, threads per inch, threads per millimeter
- fastener diameter, length, head size
- use of anti-seize application
- factors that affect torque
  - thread condition
  - lubrication
  - compatibility
  - temperature
  - fastener composition

1.1.2 Identify the construction, types, styles and application of the following fasteners.

- bolts / nuts
- screws
- studs
- locking devices
- pins
- rivets
- keys
- washers
- retaining rings
- helicoils, timeserts
- thread sealants

1.1.3 Describe fastener applications, retention techniques and metal working skills.

- thread lockers
- torque to yield fasteners
- torque effects of wet, dry and clean threads
- locking techniques
- drilling
- tapping
- hack sawing
- filing
- riveting

1.1.4 Perform the following metal working operations.

- verify thread strengths and torque requirements for wet and dry
- repair damaged threads
  - free seized threads, remove broken studs / cap screws
  - install helicoils and timeserts
  - apply thread locker and anti-seize
- perform metal working tasks related to
  - drilling
  - tapping
  - hack sawing
  - filing
  - riveting
- perform fastener tightening operations

Number:	**1.2**		
Title:	**Bearings, Seals and Sealants**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Cross Reference to Training Standards: 5161, 66, 67, 69, 71			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to define the purpose, construction, application, inspect, diagnose, remove and install bearings, seals and sealants according to manufacturers' recommendations.

Learning Outcomes and Content

1.2.1 Explain the following fundamentals.

- friction characteristics
- effects of temperature
- lubrication
- bearing loads
  - axial / radial
- pre-load and end play
- hydrodynamic suspension

1.2.2 Identify the purpose, construction and applications of bearings, seals and sealants.

- friction bearings
- anti-friction bearings
  - ball
  - roller
  - needle
- seals
  - dynamic
  - static
- sealants
  - anaerobic
  - non-anaerobic
  - gaskets
- specialty sealants

1.2.3 Describe cause of failure of bearings, seals and sealants.

- scoring / spalling
- clearance
- over-heating
- vibration
- lubrication

1.2.4 Perform bearing, seal and sealant removal, installation.

- remove / install bearings
  - friction
  - non-friction
- remove / install seals
  - static
  - dynamic
- remove / install sealants
- remove / install gaskets

Number:	**1.3**		
Title:	**Precision Measuring Tools**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross Reference to Training Standards: 5161, 62, 63, 63, 65, 66, 67, 68, 69, 5170, 71,72, 73, 74			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform precision measurements and to maintain, calibrate and properly store precision measuring instruments according to the equipment manufactures' guidelines.

Learning Outcomes and Content

1.3.1 Explain Unit conversions

- convert between metric and Imperial measurements including fractions.

1.3.2 Identify the construction, types and application of precision measuring tools.

- micrometers
  - inside
  - outside
  - depth
- small hole gauges
- calipers
- vernier calipers
- telescoping gauges
- straight edges
- dial indicators
- torque wrenches
- straight edges
- cylinder gauges

1.3.3 Describe measuring procedures using the following tools.

- micrometers
  - inside
  - outside
  - depth
- small hole gauges
- calipers
- vernier calipers
- telescoping gauges
- straight edges
- thickness gauges
- dial indicators
- straight edges
- cylinder gauges
- torque wrenches

1.3.4 Perform maintenance and calibration on precision measuring tools and perform precision measurements.

- describe maintenance / calibration procedure
  - storage
  - lubrication
  - adjustment / calibration
  - restoring critical surfaces
- perform measurement and clearance checks

Number:	**1.4**		
Title:	**Oxyacetylene, Heating & Cutting**		
Duration:	Total Hours: 4	Theory: 2	Practical: 2
Cross Reference to Training Standards: 5174.03, 5168.03			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to describe the function, construction, applications of oxy-acetylene equipment and to demonstrate the safe use perform heating and cutting operations according to approved industry standards.

Learning Outcomes and Content

1.4.1 Explain the functions, construction, and applications of oxyacetylene welding equipment.

- tanks
- identification features
- pressure regulators
- manual valves
- gauges
- torch tips
- heating and cutting torches

1.4.2 Describe the safe use of oxy-acetylene equipment.

- personal safety equipment and clothing
- setup, inspection, ignition and shutdown sequence
- cylinder handling
- fire prevention

1.4.3 Perform heating and cutting procedures.

- heating / cutting seized fasteners / components
- heating / cutting damaged fasteners / components

Number:	**1.5**		
Title:	**Hoists and Lifting Equipment**		
Duration:	Total Hours: 2	Theory: 0	Practical: 2
Cross Reference to Training Standards: 5160.06			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform safe vehicle hoisting and lifting according to the equipment manufacturers' recommendations and approved industry standards.

Learning Outcomes and Content

1.5.1 Explain safe practices for hoist and lifting equipment.
- use of safety stands, jacks
- vehicle placement and movement
- finding the lifting points
- equipment maintenance

1.5.2 Identify lifting and hoisting equipment.
- lifting capacities
- adaptors & extensions
- types of hoists and lifting equipment
- safety locks and releases

1.5.3 Perform lifting of vehicles using shop lifts and hoisting equipment.
- position vehicle / wheel chocks
- check overhead environment
- verify correct engagement of lift points
- verify balance
- verify correct use of safety lock

Number:	**1.6**		
Title:	**Applied Computer Skills**		
Duration:	Total Hours: 2	Theory: 2	Practical: 0
Cross Reference to Training Standards: 5160.05, 5163.08, 09, 10			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform necessary trade related computer functions and access trade and service information using a PC and the Internet according to on the job requirements.

Learning Outcomes and Content

1.6.1 Perform the following functions on a Networked PC.

- access trade related information
- access internet
  - browsing
  - file download
- access Email
  - reading attachments
  - send / receive

Number:	**1222**		
Title:	**Engine Systems**		
Duration:	Total Hours: 36	Theory: 22	Practical: 14
Prerequisites:	None		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
2.1	Engine Fundamentals	12	8	4
2.2	Cylinder Block Assembly	6	6	0
2.3	Cylinder Block Applications	12	4	8
2.4	Crankshaft Assemblies	6	4	2

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**2.1**		
Title:	**Engine Fundamentals**		
Duration:	Total Hours: 12	Theory: 8	Practical: 4
Cross Reference to Training Standards: 5161.01, 05			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operating characteristics of internal combustion engines and perform engine disassembly / re-assembly procedures according to accepted industry standards.

Learning Outcomes and Content

2.1.1 Define engine terminology.

- inertia
- force and energy
- torque
- bore
- stroke
- swept volume
- displacement
- clearance volume
- compression ratio
- compression pressure
- volumetric efficiency
- mechanical efficiency
- thermal efficiency
- power measurement
- mean effective pressure
- Boyle’s Law, Charles’ Law

2.1.2 Explain the principles of operation of internal combustion engines.

- four-stroke cycle gasoline
  - Otto cycle
  - Atkinson cycle
  - Miller cycle
- two-stroke cycle gasoline
- four-stroke diesel
- rotary

2.1.3 Perform applied calculations to verify engine performance measurements.

- swept volume
- piston displacement
- compression ratio
- compression pressure
- thermal efficiency
- power measurements

2.1.4 Perform recommended engine component identification.

- identify moving and stationary engine components
- identify proper disassembly / re-assembly sequence
- identify components requiring marking
- identify areas of components requiring measuring
- identify areas requiring lubrication on assembly
- identify torque requirements

Number:	**2.2**		
Title:	**Cylinder Block Assembly Theory**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross Reference to Training Standards: 5161.11, 12			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the construction and operating principles of cylinder block assembly components according to manufacturers' design.

Learning Outcomes and Content

2.2.1 Explain the design of cylinder block and components.

- cylinder blocks
- cylinders and sleeves
  - wall finish
- pistons and related components
  - alignment
  - thrust offset
- connecting rods
- bearings

2.2.2 Describe the types and configurations of cylinder blocks and components.

- cylinder blocks – inline, rotary, opposed and V type
- cylinders and sleeves
  - wall finish
- pistons and related components
- connecting rods
- bearings

2.2.3 Describe the operations of cylinder block and components.

- cylinder blocks
- cylinders and sleeves
- wall finish
- pistons and related components
- connecting rods
- bearings

Number: **2.3**

Title: Cylinder Block Applications

Cross Reference to Training Standards: 5161.11, 12, 13

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform recommended inspection / testing of cylinder block and components and explain recommended rebuilding procedures according to manufacturers' standards.

Learning Outcomes and Content

2.3.1 Perform recommended inspection / testing procedures on cylinder block and components and evaluate suitability for service.

- perform general cleaning procedures
  - solvents
  - equipment
- inspect carbon buildup on pistons
- inspect for cylinder ridge
- cylinder block dismantling / assembly procedures
- visual inspection of engine short block component assemblies
- perform measurements for:
  - cylinder wear
  - deck warpage
  - main bore alignment
  - piston wear/damage
  - connecting rod alignment

2.3.2 Describe recommended cylinder block rebuilding procedures.

- cylinder boring, honing and deglazing
- replacement of piston and piston pin
- inspect piston ring, replace and check end gap and side clearance
- inspect connecting rod
- line boring or honing
- deck resurfacing, cutters, grinders and sanders

Number:	**2.4**		
Title:	**Crankshaft Assemblies**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross Reference to Training Standards: 5161.11, 12, 13			

General Learning Outcomes

Upon successful completion the apprentice will have the ability explain the operation of crankshafts and bearings and perform recommended inspection / measuring procedures according to manufacturers' design.

Learning Outcomes and Content

2.4.1 Explain the design and application of engine crankshafts and bearings.
- crankshafts
- engine bearings
- balance shafts
- torsional impulse neutralizers
- flywheels

2.4.2 Describe the principles of operation of engine crankshafts and bearings.
- crankshafts journals
- engine block bearings

2.4.3 Describe the procedures and equipment used for servicing engine crankshafts and bearings.
- inspection and reconditioning of the crankshaft
- inspection and fitting of the crankshaft bearings

2.4.4 Describe the effect of the following in relation to engine performance.

- piston speed and acceleration
- balance shafts and gears
- crankshaft counterweights
- number of engine cylinders
- flywheel design features
- intake and exhaust timing
- static and dynamic imbalance

2.4.5 Perform recommended inspection / measuring procedures on engine crankshaft and bearings.

- perform visual inspection
- measure crankshaft end play
- check journal wear
- measure bearing clearance
- check bearing wear
- check crankshaft warpage

Number: **1223**
Title: Electrical/Electronic and Emission Systems
Duration: Total Hours: 96 Theory: 64 Practical: 32
Prerequisites: None

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
3.1	Electrical Fundamentals	14	10	4
3.2	Electrical/Electronic Diagnostic Test Equipment	6	4	2
3.3	Battery Fundamentals	6	4	2
3.4	Electrical Circuit Calculations	10	6	4
3.5	Applied Electrical Schematics	8	4	4
3.6	Circuit Repair and Protection Devices	10	6	4
3.7	Electromagnetic Devices Fundamentals	8	4	4
3.8	Electronic Fundamentals	6	6	0
3.9	Fuel System Fundamental	8	4	4
3.10	Intake and Exhaust System	8	6	2
3.11	Emission Control Systems	8	6	2
3.12	Hybrid Systems	4	4	0

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**3.1**		
Title:	**Electrical Fundamentals**		
Duration:	Total Hours: 14	Theory: 10	Practical: 4
Cross Reference to Training Standards: 5162.01 - .09, 5164.01 - .07, 5174.01, 08 - .13			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the terminology, and principles of operation of electricity according to sound scientific principles.

Learning Outcomes and Content

3.1.1 Identify basic electrical terms.

- atomic structure
- conventional and electron theory
- A/C, D/C
- conductors, insulators & semi-conductors
- magnetism
- electromagnetism
- voltage
- resistance
- power
- current

3.1.2 Identify sources of electricity.

- heat
- pressure
- static
- chemical
- light
- magnetism

3.1.3 Explain the principles of Ohms' Law & Watts' Law.

3.1.4 Identify Systems International (S.I.) units of measurement.
- e.g. mega, kilo, milli, micro

3.1.5 Identify electrical circuit characteristics
- series / parallel
- basic symbols

Number:	**3.2**		
Title:	**Electrical/Electronic Diagnostic Test Equipment**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross Reference to Training Standards: 5161.02, 05, 08, 11, 5162.02, 03, 04, 07, 5163.02, 05, 08, 11, 12, 13, 5164.02, 05, 5165.02,			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to select, measure and use various types of electrical test equipment according to manufacturers' instructions.

Learning Outcomes and Content

3.2.1 Explain the types of electrical test equipment.
- Digital Multimeter (DMM)
- inductive clamp

3.2.2 Explain equipment setup, calibration and techniques used to measure.
- voltage
- resistance
- amperage

3.2.3 Perform the following measurements using electrical test equipment.
- voltage
- resistance
- amperage
- continuity
- impedance
- induction

Number:	**3.3**		
Title:	**Battery Fundamentals**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2

Cross Reference to Training Standards: 5161.02, 05, 08, 11, 5162.02, 03, 04, 07, 5163.02, 05, 08, 11, 12, 13, 5164.02, 05, 5165.02, 05

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, construction, principles of operation, perform inspection and testing of batteries according to manufacturers' standards.

Learning Outcomes and Content

3.3.1 Explain the purpose and principles of operations of batteries.
- battery chemical action during charging and discharging
- temperature effect on charging and internal resistance ratings

3.3.2 Explain the construction, types, styles and applications of batteries.
- lead acid
- low maintenance
- absorbed glass mat
- maintenance-free batteries

3.3.3 Explain battery ratings.
- hot cranking amps (HCA)
- amp-hour rating (AH)
- cranking amps (CA)
- reserve capacity (RC)
- cold cranking amps (CCA)

3.3.4 Describe precautions for servicing and charging.

- temperature adjustments
- conductance testing
- refractometer
- hydrometer

3.3.5 Perform inspect and testing on batteries.

- visually inspect
- test state-of-charge
- perform surface discharge
- perform load test
- perform parasitic draw

3.3.6 Perform assigned operations on batteries.

- clean battery and terminals
- charge
- activation
- removal and replacement

Number:	**3.4**		
Title:	**Electrical Circuit Calculations**		
Duration:	Total Hours: 10	Theory: 6	Practical: 4
Cross Reference to Training Standards: 5161.02, 05, 08, 11, 5162.02, 03, 04, 07, 5163.02, 05, 08, 11, 12, 13, 5164.02, 05, 5165.02, 05			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform circuit calculations to verify Ohms' and Watts' Laws according to sound scientific principles.

Learning Outcomes and Content

3.4.1 Perform circuit calculations to verify Ohms' and Watts' Laws.

- series circuits
- parallel circuits

3.4.2 Perform assigned testing to determine voltage, current and resistance for the following circuits.

- circuit board exercises
- vehicle electrical circuits
- perform comparisons between measured and calculated circuit performances

Number:	**3.5**		
Title:	**Applied Electrical Schematics**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4

Cross Reference to Training Standards: 5161.02, 05, 08, 11, 5162.02, 03, 04, 07, 5163.02, 05, 08, 11, 12, 13, 5164.02, 05, 5165.02, 05

General Learning Outcomes

Upon successful completion the apprentice will have the ability to demonstrate knowledge of wiring schematics, component identification and ability to trace electrical circuits according to accepted trade standards.

Learning Outcomes and Content

3.5.1 Explain the purpose and fundamentals of electrical wiring schematics.
- electrical symbols
- circuit identification methods
- colour codes
- circuit number codes gauge and metric wire sizes
- types of connectors

3.5.2 Explain the function, construction and styles of wiring diagrams.
- layout
- interpretation
- variations by different manufacturers

3.5.3 Locate electrical components and trace electrical circuits of vehicle systems.
- perform on-vehicle verification of wiring diagram circuits
- locate power sources and grounds

Number:	**3.6**		
Title:	**Circuit Repair and Protection Devices**		
Duration:	Total Hours: 10	Theory: 6	Practical: 4
Cross Reference to Training Standards: 5161.02, 05, 08, 11, 5162.02, 03, 04, 07, 5163.02, 05, 08, 11, 12, 13, 5164.02, 05 5165.02, 05			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to describe the purpose, construction and principles of operations of circuit protection devices and perform circuit repairs according to accepted trade standards.

Learning Outcomes and Content

3.6.1 Explain the fundamentals of circuit repairs.

- open circuits
- short circuits
- grounds
- unintentional grounds
- high resistance connections
- temperature effects
- safety when repairing electrical circuits

3.6.2 Explain the construction and application of circuit repairs.

- wiring and terminals
- wire size
- terminal connectors
- soldering
- shielding
- twisted pairs

3.6.3 Explain the principles of operation of circuit protection devices.

- circuit protection devices
  - fuses
  - circuit breakers
  - fusible links

3.6.4 Perform circuit analysis to identify.

- shorts
- opens
- grounds
- unintentional grounds
- high resistance
- dynamic circuit testing and voltage drops

3.6.5 Perform circuit repairs on the following components.

- wiring and connectors
- weather proofing
- circuit protection
- fuses
- circuit breakers
- fusible links
- repair wiring
- clean
- splice
- crimp
- solder
- corrosion protection

3.6.6 Perform tests to verify the correct operation of the following circuit protection devices.

- fuses
- circuit breakers
- fusible links

Number:	**3.7**		
Title:	**Electromagnetic Device Fundamentals**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4

Cross Reference to Training Standards: 5161.02, 05, 08, 11, 5162.02, 03, 04, 07, 5163.02, 05, 08, 11, 12, 13, 5164.02, 05, 5165.02, 05

General Learning Outcomes

Upon successful completion the apprentice will have the ability to describe the purpose, construction and principles of operations of electromagnetic devices according to sound scientific principles.

Learning Outcomes and Content

3.7.1 Explain the purpose and fundamentals of electromagnetic devices.

- magnetism
- electromagnetism
- current flow and magnetic fields applied to relays, solenoids and motors
- right and left-hand rules
- counter-electromotive force effect

3.7.2 Explain the construction, types and principles of operations of electromagnetic devices.

- voltage generation
  - alternators
  - generators
- electric motors
- solenoids
- relays
- coils
- stepper motors

3.7.3 Inspect, test and diagnose electromagnetic devices for proper performance.

- electric motors
- solenoids
- relays
- coils
- stepper motors

Number:	**3.8**		
Title:	**Electronic Fundamentals**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross Reference to Training Standards: 5162.07, 5163.02, 05 08, 12, 5164.02, 5174.11			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, function, construction and applications of electronic devices according to sound scientific principles.

Learning Outcomes and Content

3.8.1 Explain the purpose, function, construction and application of electronic devices.

- power supplies
- voltage regulators
- voltage limiters
- resistors
  - fixed
  - variable
  - potentiometer
  - thermistors
  - capacitors
- semiconductor devices
- diodes
  - rectifying
  - zener
  - light emitting
  - photo

3.8.2 Specify the precautions necessary when working with electronic circuits and components.

- voltage spike
- static electricity buildup
- electrostatic discharge
- maintaining correct safe shielding and grounding

Number:	**3.9**		
Title:	**Fuel System Fundamentals**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4
Cross Reference to Training Standards: 5163.01, 02, 03, 04, 05, 5165.01, 02, 03, 04, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to describe the purpose, function and principles of operation of fuel system components according to manufacturers' standards.

Learning Outcomes and Content

3.9.1 Explain the purpose and fundamentals of fuels.

- engine theory
- thermodynamics
- combustion ratios
- fuels chemistry

3.9.2 Describe the function, composition and properties of fuels.

- gasoline fuel
  - volatility
  - octane rating
  - additives
  - hydrocarbons
  - atomization heat energy / calorific value
- diesel fuel
  - volatility
  - cetane number
  - viscosity
  - additives
  - sulfur content, etc.
- alternate fuels
  - Ethanol, E10, E85, biodiesel
  - propane, natural gas and alcohol
  - boiling points
  - volatility
  - pressure requirements

3.9.3 Explain the combustion principles of fuels.

- oxidation reactions
- products of combustion
  - HC
  - CO
  - CO2
  - NOX
- air fuel ratios
- atomization / vaporization
- detonation
- pre-ignition

3.9.4 Locate and identify fuel delivery system components.

- tanks
- filters
- lines
- pumps
- pressure regulators
- injectors

Number:	**3.10**		
Title:	**Intake and Exhaust Systems**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Cross Reference to Training Standards: 5174.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, construction, principles of operations and perform inspection / testing of intake & exhaust systems according to manufacturers' standards.

Learning Outcomes and Content

3.10.1 Explain the purpose and fundamentals of intake and exhaust systems.

- volumetric efficiency
- scavenging
- manifold vacuum and exhaust back pressure
- ported vacuum
- thermal expansion and contraction
- Boyle's Law, Charles Law, and Bernoulli's Theorem

3.10.2 Explain the construction, types, operation, styles and application of intake and exhaust systems.

- air cleaners
- intake and exhaust manifolds
- exhaust pipes
- resonators and mufflers
- intake manifold heating

3.10.3 Inspect and test intake and exhaust systems.

- visually inspect intake and exhaust systems
  - restrictions
  - noise
  - leaks
- perform:
  - test exhaust back pressure
  - test intake manifold vacuum

Number:	**3.11**		
Title:	**Emission Control Systems**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Cross Reference to Training Standards: 5174.08, 09, 10, 11, 12, 13			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the basic operation of emission control systems according to manufacturers' standards.

Learning Outcomes and Content

3.11.1 Explain the basics of emission control systems.

- combustion of fuels
- combustion bi-products
- properties of carbon monoxide, hydrocarbons, oxides of nitrogen.
- photo-chemicals, smog, acid rain, greenhouse effect
- emission standards and model year compliance
- legal consequences of emission equipment tampering
- air / fuel ratio
- temperature of combustion
- thermal expansion and contraction

3.11.2 Explain the basic operation of the emission control components.

- evaporative emission systems
- exhaust gas re-circulation systems
- positive crankcase ventilation
- catalytic converters
- air injection systems

3.11.3 Locate and identify emission control system components.

- manifold heating devices
- evaporative emission systems
- exhaust gas re-circulation systems
- positive crankcase ventilation
- catalytic converters/air injection systems

Number:	**3.12**		
Title:	**Hybrid Systems**		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Cross Reference to Training Standards: OA H-19.01			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, operation and safe working practices associated with hybrid vehicles according to manufacturers' recommendations.

Learning Outcomes and Content

3.12.1 Explain the basic hybrid types.

- hybrid system types
  - Toyota - synergy system
  - Honda - Integrated Motor Assist (IMA)
  - General Motors / Saturn - Belt Alternator Starter (BAS)
  - General Motors / Chrysler / BMW - dual mode

3.12.2 Explanation and identification of hybrid systems.

- high voltage / intermediate voltage
- cooling
  - Internal Combustion Engine (I.C.E.)
  - Inverter
- braking
- accessory
- air conditioning

3.12.3 Explain safe hybrid working practices.

- high voltage / intermediate voltage
- personal safety
- area safety
- protective equipment
- meter requirements
- disconnect procedures
- driving the vehicle into or out of the shop
- lifting / hoisting
- pushing or moving a hybrid

Number:	**1224**		
Title:	**Drive Train Systems**		
Duration:	Total Hours: 36	Theory: 24	Practical: 12
Prerequisites:	None		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
4.1	Clutch Assemblies	8	6	2
4.2	Basic Gear Theory	4	4	0
4.3	Manual Transmission / Transaxle Fundamentals of Operation	12	12	8
4.4	Manual Transmission / Transaxle Service and Diagnosis	12	2	10

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**4.1**		
Title:	**Clutch Assemblies**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Cross Reference to Training Standards: 5166.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to visually inspect, diagnose, troubleshoot and perform repairs on clutch systems and components according to manufacturers' recommendations.

Learning Outcomes and Content

4.1.1 Explain the basic fundamentals of clutch assemblies.

- clamping force
- centrifugal force
- mechanical advantage
- hydraulic advantage
- static and sliding friction
- co-efficient of friction
- friction and heat
- inertia

4.1.2 Identify the specific components of dry disc clutch assemblies.

- dry disc clutch assemblies
- flywheel / ring gear
- pressure plate
- clutch friction disc and hub assembly
- input shaft
- pilot bearing / bushing
- release bearing
- mechanical release mechanisms
- hydraulic release mechanisms
- clutch housings
- clutch control systems
- safety switch

4.1.3 Describe the operation of clutches assemblies.

- disengagement and engagement
- single and dual disc clutches
- wave / cushion spring
- hub / torsional springs
- semi-centrifugal clutches
- flywheel / ring gear
- pressure plate
- power flow
- pilot bushing / bearing
- clutch control systems
- safety switch

4.1.4 Perform inspection, diagnostics and troubleshooting procedures on clutch assemblies.

- perform visual / functional inspection
  - fly wheel
  - ring gear
  - clutch disc
  - pressure plate
  - clutch and housing alignment
  - clutch control system
  - safety switch

4.1.5 Explain repair operations on clutch assemblies.

- familiarization with manufacturers' service procedures
- clutch adjustment
- clutch overhaul procedures
- machining practices
- failure analysis
- lubrication practices
- fluid levels
- verify the repair and operation

Number:	**4.2**		
Title:	**Basic Gear Theory**		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Cross Reference to Training Standards: 5166.01, 05 – 10, 5167.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain basic gear theory and operation according to manufacturers' recommendations.

Learning Outcomes and Content

4.2.1 Explain the basic fundamentals of gears.
- mechanical advantage
- laws of levers as applied to gears
- torque vs speed
- input / output rotational speed
- gear ratios
- shafts, splines and gears

4.2.2 Identify the specific characteristics of gears.
- gear nomenclature
- gear types
- simple, compound, and idler gear trains
- gear ratio calculations
- shafts
- bearings and bushings
- spacers and thrust washers

4.2.3 Describe the operation of gears.
- gears
- timing
- shafts
- power flow
- thrust control
- bearings and bushings

Number:	**4.3**		
Title:	**Manual Transmission / Transaxle Fundamentals of Operation**		
Duration:	Total Hours: 12	Theory: 12	Practical: 0
Cross Reference to Training Standards: 5166.01, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to describe the operation of manual transmissions / transaxles according to manufacturers' standards.

Learning Outcomes and Content

4.3.1 Explain the basic fundamentals of manual transmissions / transaxles.

- purpose
- functions
- types
  - sliding selective
  - constant mesh
- applications

4.3.2 Identify the specific components of manual transmissions and transaxles.

- manual transmission / transaxle
  - case, shafts, gears, synchronizers,
  - bearings, bushings, thrust washers, shims, gaskets, seals
  - transaxle final drive
  - lubrication
- shift controls
  - direct, remote
  - shafts, cables, levers
  - detent, interlock mechanisms, shift blocks

4.3.3 Describe the operation of manual transmissions / transaxles.

- gear ratios
- power flows
- power flow variations
- synchronizer
- shift controls
- lubrication

Number:	**4.4**		
Title:	**Manual Transmission / Transaxle Service and Diagnosis**		
Duration:	Total Hours: 12	Theory: 2	Practical: 10
Cross Reference to Training Standards: 5166.01, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, test, diagnose and repair manual transmission / transaxle according to manufacturers' recommendations.

Learning Outcomes and Content

4.4.1 Perform inspection, testing, and diagnostic procedures on manual transmissions.

- identify component failures and causes
- check fluid level
- adjust linkage
- identify noise
- identify vibration

4.4.2 Perform service and repair procedures.

- describe procedures to remove and install a transmission / transaxle
- dismantle and assemble manual transmission / transaxle
- verify power flow through gears
- check end play / run-out
- verify shift controls
- perform torque procedures for re-assembly
- perform alignment requirement
- identify fluid / lubrication requirements
- verify the repair

Number:	**1225**		
Title:	**Suspension / Steering and Brake Systems**		
Duration:	Total Hours: 42	Theory: 26	Practical: 16
Prerequisites:	None		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
5.1	Suspension System Fundamentals and Design	2	2	0
5.2	Frame, Suspension and Steering Types	9	9	0
5.3	Steering and Suspension Principles of Operation	6	6	0
5.4	Suspension/Steering System Inspection and Testing	7	1	6
5.5	Tires and Rims	6	2	4
5.6	Hydraulic Brakes Fundamentals	12	6	6

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).
Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30x%

Number:	**5.1**		
Title:	**Suspension System Fundamentals**		
Duration:	Total Hours: 2	Theory: 2	Practical: 0
Cross Reference to Training Standards: 5168.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the fundamental theories, characteristics and applications relative to suspension systems according to principles of physics.

Learning Outcomes and Content

5.1.1 Explain the fundamental theories of suspension systems.

- Hook's Law
- centre of gravity
- sprung / un-sprung weight

5.1.2 Explain characteristics and applications of suspension materials.

- spring steel
- tempered steel
- synthetic rubber
- fiber composites
- pneumatics
- hydraulics
- negative effects of heating suspension components

Number:	**5.2**		
Title:	**Frame, Suspension and Steering Types**		
Duration:	Total Hours: 9	Theory: 9	Practical: 0
Cross Reference to Training Standards: 5168.01, 02, 03, 04, 5169.01, 02			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to identify and explain types, and the construction of frames, steering and suspension components according to manufacturers' standards.

Learning Outcomes and Content

5.2.1 Identify various frame types and explain their construction and applications.

- frames and chassis types
- frame and chassis damage

5.2.2 Identify various suspension and steering types and components.

- non independent
- semi independent
- independent
- short- and long-control arms
- twin I beam
- McPherson strut
- modified strut
- wishbone
- multi link
- steering linkage types
  - parallelogram
  - cross steer
  - rack and pinion
  - haltenberger

5.2.3 Explain the application and construction of suspension and steering components.

- springs
- ball joints
- king pins
- strut bearings
- control arms and bushings
- radius rods
- strut rods
- stabilizer bars
- trailing arms wheel hubs
- wheel bearings
- shock absorbers
- steering linkages

Number:	**5.3**		
Title:	**Steering and Suspension Principles of Operation**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross Reference to Training Standards: 5168.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operation of suspension and steering systems and components according to principles of physics.

Learning Outcomes and Content

5.3.1 Explain the operation of suspension and steering systems and components.

- non independent
- semi independent
- independent
- short- and long-control arms
- twin I beam
- McPherson strut
- modified strut
- strut bearings
- wishbone
- multi link- springs
- leaf
- torsion bars
- air springs
- ball joints
- control arms and bushings
- radius rods
- strut rods
- stabilizers
- trailing arms
- steering linkages
- shock absorbers

Number:	**5.4**		
Title:	**Suspension/Steering System Inspection and Testing**		
Duration:	Total Hours: 7	Theory: 1	Practical: 6
Cross Reference to Training Standards: 5168.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to inspect and test suspension and steering systems and components according to manufacturers' recommendations.

Learning Outcomes and Content

5.4.1 Inspect and test suspension and steering components.

- visual inspection
- dry park check
- measure trim height
- check for corrosion
- check for frame damage
- check springs
  - spring condition and deflection
  - effects of contamination on springs
- check shock absorbers
  - leaks
  - action
  - attachment
- perform suspension system inspection
  - control arm bushing
  - control arm sag
- check wheel bearings
  - preload
  - end-play
- check ball joints wear
- check king pins wear
- check steering linkages for wear and alignment

Number:	**5.5**		
Title:	**Tires and Rims**		
Duration:	Total Hours: 6	Theory: 2	Practical: 4
Cross Reference to Training Standards: 5168.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain, test, repair and service tires and wheels in according to manufacturers' recommendations.

Learning Outcomes and Content

5.5.1 Explain the purpose and fundamentals of tires and wheels.

- centrifugal force
- static friction
- kinetic friction
- torquing wheel nuts
- effects of water
- sliding and rolling friction
- sidewall markings
- static and dynamic balance
- nitrogen use

5.5.2 Explain the construction, types, and application of tires.

- wheels for cars and light trucks
- tire materials
- radial tire construction
- bias tire construction
- run flat tires
- tires, wheels
  - balancing
  - air pressure
  - tread design and traction

5.5.3 Perform tests and repairs on tire and wheels assemblies.

- visual inspection
- check tire matching for dual application
- check tire condition
  - wear
  - defects
- identify and measure radial and lateral wheel and tire run-out
- determine factors that affect tire wear
- determine factors that cause cord separation
- perform static and dynamic wheel balance
- perform tire repair
- check tire type mixing and application
- test wheel runout

5.5.4 Service tire pressure monitoring systems.

- reset, re-program and calibrate tire pressure monitoring systems

Number:	**5.6**		
Title:	**Hydraulic Brake Fundamentals**		
Duration:	Total Hours: 12	Theory: 6	Practical: 6
Cross Reference to Training Standards: 5170.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain, identify, inspect and service brake systems and components in according to manufacturers' recommendations.

Learning Outcomes and Content

5.6.1 Explain the fundamentals of braking systems.

- Pascal's Law
- laws of levers, mechanical advantages
- co-efficient of friction
- velocity and acceleration

5.6.2 Identify brake system components.

- brake fluid
- brake lines, hoses and fittings
- master / wheel cylinders
- calipers
- brake shoes and disc pads
- drums and disc
- hydraulic controls
  - metering valves
  - proportional valves
  - pressure differential valves
  - combination valves
- auxiliary mechanical brake assemblies

5.6.3 Explain the construction and operation of brake system components.

- master cylinder
- calipers
- wheel cylinders
- shoes and pads
- brake fluid
- hydraulic controls
- self-adjusting mechanisms
- drums and discs
- auxiliary mechanical brake assemblies

5.6.4 Inspect and service brake systems.

- check brake fluid
  - level
  - bleeding
  - flushing
  - condition
- check disc brakes
  - calipers function / leakage
  - hardware, guides
  - rotor measurements / thickness, runout
- check drum brakes
  - wheel cylinder function / leakage
  - hardware
  - back plate
  - self adjusters
  - drum measurements / diameter, out of round
- clean, lube and adjust
- adjust auxiliary mechanical brake assemblies

5.6.5 Perform steel brake line fabrication.

- bending
- flaring
  - ISO
  - double inverted flare

Level 2

Reportable Subject Summary-Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1226	Air Conditioning Systems	30	18	12
1227	Engine Systems	36	22	14
1228	Electrical / Electronic and Emissions Systems	96	64	32
1229	Drive Train Systems	36	24	12
1230	Suspension / Steering and Brake Systems	42	26	16
	Total	**240**	**154**	**86**

Number:	**1226**		
Title:	**Air Conditioning Systems**		
Duration:	Total Hours: 30	Theory: 18	Practical: 12
Prerequisites:	Level I, Reportables 1, 2, 3		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.1	Heating and Ventilation Systems	4	2	2
1.2	Air Conditioning Fundamentals	22	12	10
1.3	Repairers Rights and Responsibilities	4	4	0

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**1.1**		
Title:	**Heating and Ventilation Systems**		
Duration:	Total Hours: 4	Theory: 2	Practical: 2
Cross Reference to Training Standards: 5172.01, 05			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the functions and perform inspection, testing and diagnose heating and ventilation system according to manufacturers' recommendations.

Learning Outcomes and Content

1.1.1 Explain the fundamentals of heating and ventilation systems.
- air flow characteristics
- inside and outside ventilation
  - cabin pressure relief valve

1.1.2 Identify components of heating and ventilation systems.
- blower motors assemblies
- plenum assemblies
- air doors and controls
- heater cores
- heater control valves
- filter systems
- cabin pressure relief valve

1.1.3 Describe the principles of operation of heating and ventilation systems.
- ventilation systems
- blower assemblies
- plenum air flow
- air doors and controls
- heater cores
- heater control valves

1.1.4 Perform inspection, testing and diagnosis of heating and ventilation systems.
- inspect heater assemblies for
  - air leaks
  - coolant leak
  - door operation
  - blower operation
  - contamination
- diagnose heating and ventilation system for proper operation

Number:	**1.2**		
Title:	**Air Conditioning Systems**		
Duration:	Total Hours: 22	Theory: 12	Practical: 10
Cross Reference to Training Standards: 5172.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the functions and perform inspection, test and diagnose air conditioning system according to manufacturers' recommendations.

Learning Outcomes and Content

1.1.2 Explain the principles of air conditioning systems.

- methods of heat transfer
- temperature and humidity relationship
- solid, liquid and gas states
- gas laws, temperature, pressure and volume
- air conditioning thermo-dynamics
  - heat absorption
  - liquid and gas states
  - temperature effects
  - latent heat
  - ambient heat
- refrigerant waste law requirements

1.2.2 Identify the system types and components of air conditioning systems.

- TXV system components and location
- Orifice tube system components and location

1.2.3 Describe the operating principles of air conditioning systems and components.

- system lubrication
- control valves
  - low and high pressure cutout
- evaporator temperature controls
- condenser
- receiver dryer
- accumulator
- evaporator
- compressors

1.2.4 Describe refrigerants, lubricants and sealants.

- refrigerant characteristics
- alternative refrigerants
- lubricants
- sealants
- aftermarket chemicals

1.2.5 Describe air conditioning service procedures.

- diagnose
  - using gauges
  - using component temperatures
- recovery / recycle refrigerant and oil
- leak test
- evacuation
- recharge
- verify operation

1.2.6 Perform inspection, testing and diagnostic procedures.

- performance tests
- check system operating pressures and control functions
- diagnose system faults using pressure readings
- perform refrigerant recovery
- perform leak testing
  - dyes
  - electronic leak detectors
  - nitrogen testing

Number:	**1.3**		
Title:	**Repairers Rights and Responsibilities**		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Cross Reference to Training Standards: 5160.01, 02, 04			

General Learning Outcomes

Upon successful completion the apprentice will be aware of provincial statues and regulations pertaining to the automotive repair industry as required by law.

Learning Outcomes and Content

1.3.1 Describe *Occupational Health and Safety Act* (OHSA) and *Workplace Hazardous Materials Information Safety* (WHMIS)
- right to know
- safe handling of products
- hazardous materials
- obligations of employer and worker

1.3.2 Describe the *Consumer Protection Act Part VI*.
- responsibilities of the repairer
- obligations to the consumer

1.3.3 Describe the *Repair and Storage Liens Act* (RSLA)
- payment for repairs or storage
- liens
- seizure and sale
- dispute resolution procedures

1.3.4 Describe the *Highway Traffic Act*.
- obligations of repairers to report
- safety inspections (regulation 611)
- equipment
- unsafe vehicles
- detachment of components

1.3.5 Describe the *Workplace Safety & Insurance Act*.
- reporting accidents to company
- reporting accidents to WSIB
- required records
- training requirements
- accident prevention

- safety precautions
- first aid
- personal protection equipment
- house keeping

1.3.6 Describe the *Employment Standards Act*.

- hours of work
- overtime pay
- holidays
- vacations
- termination

1.3.7 Describe the *Environmental Protection Act*.

- liquid waste
- Ozone Depletion Prevention
- emissions

Number:	**1227**		
Title:	**Engine Systems**		
Duration:	Total Hours: 36	Theory: 22	Practical: 14
Prerequisites:	Level I, Reportable 2		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
2.1	Valve Train and Camshaft	12	8	4
2.2	Cylinder Head Theory and Application	18	10	8
2.3	Turbochargers and Superchargers	6	4	2

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**2.1**		
Title:	**Valve Train and Camshaft**		
Duration:	Total Hours: 12	Theory: 8	Practical: 4
Cross Reference to Training Standards: 5161.01, 08, 09, 10			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operating characteristics, perform inspection and service of camshafts and valve train according to manufacturers' standards.

Learning Outcomes and Content

2.1.1 Explain the fundamentals of camshafts and valve train assemblies.

- camshafts
- valve timing
  - lead, lag, overlap, duration
  - valve train alignment
  - degreeing a camshaft
  - relationship of valves to piston position
  - interpret and draw valve timing diagram
- camshaft location and drive mechanisms
- valve train assemblies

2.1.2 Describe the characteristics and application of camshafts and valve train components.

- camshafts
- valve train mechanisms
- bearings, including split and bushing styles
- sprockets and gears
- thrust controls
- chains
- belts
- timing covers
- specific gaskets and seals

2.1.3 Explain the operating principles of valve train and camshaft components.

- camshafts
  - valve train drive mechanisms
  - chains
  - belts
- gears and sprockets
- bearings, including split and bushing styles

- thrust controls
- camshaft bearing removal and installation

2.1.4 Perform recommended inspection and testing procedures on camshafts and valve train components.

- visual inspection
- perform disassembly procedures
- check lobe wear
- check journal wear and thrust wear
- check camshaft warpage
- check bearing wear
- check timing chain, belt wear
- check tensioners, guides and idlers
- check lifters, rocker arms

2.1.5 Perform recommended service operations.

- remove and install timing belts and chains
- adjust timing chains and belts
- perform valve adjustment on a variety of styles

Number:	**2.2**		
Title:	**Cylinder Head Theory and Application**		
Duration:	Total Hours: 18	Theory: 10	Practical: 8
Cross Reference to Training Standards: 5161.08, 09, 10			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the service procedures, perform inspection, measurement and replacement procedures of engine cylinder heads and related components according to manufacturers' standards.

Learning Outcomes and Content

2.2.1 Define the fundamentals of engine cylinder heads and components.

- valves
- seats
- guides
- valve seals
- valve springs
- rocker arms and shafts
- push rods
- lifters, followers, lash controllers and variable valve actuators
- combustion chamber designs
- specific related gaskets

2.2.2 Explain the characteristics and applications of engine cylinder heads and components.

- valves
- seats
- guides
- valve seals
- valve springs
- rocker arms and shafts
- push rods
- lifters, followers, lash controllers and variable valve actuators
- combustion chamber designs
- specific related gaskets

2.2.3 Explain the recommended service procedures for engine cylinder heads and related components.

- cylinder head and intake manifold resurfacing
- cylinder head removal and disassembly procedures
- valve guide reaming, replacement, liner installation
- valve and valve seat interference angles
- valve seat width
- valve seal replacement
- valve spring inspection and installation
- valve retainers and rotators
- cylinder head installation procedures

2.2.4 Perform inspection and measuring procedures on engine cylinder heads and related components.

- disassembly procedures
- perform cleaning procedures
- visual inspection
- check for cracks
- check for cylinder head distortion
- check for valve guide wear
- check valve spring condition
- check valve condition
- check surface finish

2.2.5 Explain recommended service and reconditioning procedures on engine cylinder heads and related components.

- valve resurfacing
- seat cutting, grinding and replacing
- valve guides
- valve spring installation
- head re-surfacing
- verify valve to seat contact and sealing

Number:	**2.3**		
Title:	**Turbochargers and Superchargers**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross Reference to Training Standards: 5174.01, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operation, perform inspection, diagnosis and replacement procedures of turbochargers, superchargers and related components according to manufacturers' standards.

Learning Outcomes and Content

2.3.1 Define the purpose and fundamentals of turbochargers and superchargers.

- relationship to
  - volumetric efficiency
  - air temperature
  - air flow rates
- electronic monitoring and controls

2.3.2 Describe the characteristics and application of turbochargers, superchargers and related components.

- turbochargers
  - housings, shaft, turbine, wheels, drive mechanisms, seals, bearings
  - intercoolers
  - controls
  - wastegate and exhaust system
  - exhaust thrust
  - electronic and mechanical
  - lubrication
  - oils, passages, lines
- cooling
  - cooling
  - liquid coolant, air flow
  - intercoolers
- superchargers
  - housings, drive mechanisms, shaft, rotors, bearings, seals
  - air flow
  - controls
  - power relief
  - boost control
  - electronic and mechanical

2.3.3 Explain the principles of operation of turbochargers and superchargers.

- turbochargers
  - boost pressures
  - wastegate
  - filtered air
  - exhaust gaskets
  - oil feed and pressure
  - exhaust pressures
- superchargers
  - low and high pressure
  - air flow
  - controls

2.3.4 Perform recommended service procedures on turbochargers and related components.

- inspect boost pressure and controls
- examine wastegate operation
- perform axial and radial runout checks
- measure end play
- inspect for air, oil, coolant and exhaust leaks
- verify oil supply and pressure
- research lubrication and cooling requirements
- clean air flow passages
- research replacement procedures
- research startup and shutdown procedures
- check for intercooler leaks and restrictions

2.3.5 Perform recommended service procedures on superchargers and related components.

- inspect boost pressure and controls
- perform clearance checks
- perform axial and radial runout checks
- measure rotor end play
- inspect for air, oil and coolant leaks
- research lubrication and cooling requirements
- clean air flow passages
- research replacement procedures
- research startup and shutdown
- check for intercooler leaks and restrictions

Number:	**1228**		
Title:	**Electrical / Electronics and Emissions**		
Duration:	Total Hours: 96	Theory: 64	Practical: 32
Prerequisites:	Level I, Reportable 3		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
3.1	Electrical Circuit Calculations	6	4	2
3.2	Diagnostic Test Equipment	12	6	6
3.3	Cranking Systems and Control Circuits	12	8	4
3.4	Cranking System Diagnostics and Testing	8	4	4
3.5	Electronic Fundamentals	8	6	2
3.6	Electronic Ignition Fundamentals	16	12	4
3.7	Charging Systems and Control Circuits	14	10	4
3.8	Gasoline Fuel Injection Fundamentals	12	8	4
3.9	Emission Control Systems	8	6	2

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**3.1**		
Title:	**Electrical Circuit Calculations**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross Reference to Training Standards: 5162.01, 5164.01, 02, 03, 04, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the characteristics of various circuit types and perform circuit calculations using a selection of meters according to accepted trade practices.

Learning Outcomes and Content

3.1.1 Explain the characteristics of electrical circuits.
- series circuits
- parallel circuits
- series – parallel circuits

3.1.2 Perform circuit calculations using Ohms' & Watts' Law.
- series circuits
- parallel circuits
- series – parallel circuits

3.1.3 Measure voltage, amperage and resistance.
- circuit board exercises
- simulated electrical circuits
- vehicle electrical circuits
- compare calculated and measured circuit performance

Number:	**3.2**		
Title:	**Diagnostic Test Equipment**		
Duration:	Total Hours: 12	Theory: 6	Practical: 6
Cross Reference to Training Standards: 5161.02, 04, 05, 06, 07, 08, 09			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, principles of operation and usage of diagnostic test equipment according to the equipment's manufacturers' recommendations.

Learning Outcomes and Content

3.2.1 Explain the purpose and principles of operation of diagnostic test equipment.

- pressure gauges
- vacuum gauges
- compression tester
- hand-held scan tools
- oscilloscopes
- smoke generators
- leak down tester
- pressure transducers

3.2.2 Perform diagnostic tests using the following equipment.

- pressure gauges
- vacuum gauges
- compression tester
- hand-held scan tools
- oscilloscopes
- smoke generators
- leak down tester
- pressure transducers

Number:	**3.3**		
Title:	**Cranking Systems and Control Circuits**		
Duration:	Total Hours: 12	Theory: 8	Practical: 4
Cross Reference to Training Standards: 5162.01, 02, 03			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, construction and operating principles of cranking systems according to accepted manufacturers' standards.

Learning Outcomes and Content

3.3.1 Explain the purpose and fundamentals of cranking systems.

- cranking motors
- control circuits
- torque, load and cranking speed relationship

3.3.2 Explain the construction, types, styles and principles of operation of cranking motor circuits.

- starter control circuits
  - relay controlled cranking circuits
  - neutral switch
- starter solenoid
- cranking motors
  - gear reduction
  - permanent magnet field type
  - wire wound field type
- cranking motor drives

3.3.3 Disassemble and re-assemble cranking motors.

- inspect and test major components of cranking motors
  - armature for shorts, opens, ground, alignment
  - field coils for shorts, opens, ground
  - identify type of winding
  - pole shoes
  - bushings and bearings
  - brushes and springs

Number:	**3.4**		
Title:	**Cranking System Diagnostics and Testing**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4
Cross Reference to Training Standards: 5162.04, 05, 06			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain cranking system operations and perform diagnosis according to manufacturers' standards.

Learning Outcomes and Content

3.4.1 Explain the factors affecting engine cranking system performance.

- ambient temperature
- battery conditions and ratings
- engine mechanical loads
- charging system operation
- oxidation and corrosion of connections
- cable sizes and condition
- engine fuel and ignition system condition
- excessive cranking time and overheating

3.4.2 Perform inspection, testing, and diagnostic procedures on cranking motor circuits.

- Analyze the results.
  - cranking system visual inspection
  - battery load test and verify capacity and performance to application
  - cranking circuit voltage drop tests
  - cranking system current draw test
  - perform ring gear tooth inspection
  - slow cranking
  - no cranking

Number:	**3.5**		
Title:	**Electronic Fundamentals**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Cross Reference to Training Standards: 5162.01, 07, 5163.01, 02, 5164.01, 02			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the construction, principles of operation, inspection and testing of electronic devices according to accepted trade practices.

Learning Outcomes and Content

3.5.1 Explain the construction, composition, types, principles of operation and applications of electronic devices.

- diodes
  - forward and reverse bias
  - current control
- transistors
  - switching
  - gain
- capacitors
- sensors
  - permanent magnet pulse generators
  - piezoelectric
  - galvanic
  - hall effect
  - optical
- variable resistors
  - rheostat
  - thermistors
  - potentiometers
  - piezoresistive

3.5.2 Perform inspection and testing procedures for electronic devices.

- diodes
  - forward and reverse bias
  - LED
  - rectifying / Zener
  - light emitting
  - photo
- capacitors
- sensors
  - permanent magnet pulse generators
  - piezoelectric

    - galvanic
    - hall effect
    - optical
- variable resistors
    - rheostat
    - thermistors
    - potentiometers
    - piezoresistive

Number:	**3.6**		
Title:	**Electronic Ignition Fundamentals**		
Duration:	Total Hours: 16	Theory: 12	Practical: 4
Cross Reference to Training Standards: 5163.01, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the construction, principles of operation, inspection and testing of ignition systems according to manufacturers' standards.

Learning Outcomes and Content

3.6.1 Explain the purpose and fundamentals of electronic ignition systems and controls.

- electronic ignition systems
- computer-controlled timing
- distributorless ignition
- coil over plug
- factors that affect ignition timing
  - engine speed
  - engine load
  - engine temperature
  - input sensors

3.6.2 Explain the construction, types, styles, operation and application of electronic ignition systems devices.

- ignition coils
  - primary windings
  - secondary windings
- distributors
  - magnetic pulse generator
  - Hall Effect device
  - optical device
- secondary voltage circuit
  - high tension spark plug wires
  - spark plugs
  - distributor cap and rotor
- modules
- sensors

3.6.3 Inspect, test and diagnose electronic ignition systems devices.

- identify and locate electronic ignition system components on various vehicles
  - distributor components
  - coils, modules
  - sensors
- check and test ignition timing operation using a scan tool
- diagnose electronic ignition system components
  - high tension wires
  - spark plugs
  - distributor cap and rotor

Number:	**3.7**		
Title:	**Charging Systems and Control Circuits**		
Duration:	Total Hours: 14	Theory: 10	Practical: 4
Cross Reference to Training Standards: 5162.01, 07, 08, 09			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the construction, principles of operation, inspection and testing of charging systems according to manufacturers' standards.

Learning Outcomes and Content

3.7.1 Explain the purpose and fundamentals of charging systems and control circuits.

- alternators
- voltage regulation
- electromagnetic induction principles
- factors affecting alternator output
  - battery condition and temperature
  - circuit condition
  - engine speed
  - electrical loads

3.7.2 Explain the construction, types, principles of operation and application of charging systems and voltage regulations

- alternators
  - rectifier & diodes
  - stator
  - rotor
  - field winding, poles, slip rings
  - brush assemblies
  - bearings
  - pulleys
  - cooling fans
  - idlers and tensioners
- clutch pulleys / damper
- voltage regulator

3.7.3 Inspect, test and diagnose alternator and voltage regulation systems.

- perform charging system visual inspection
  - belt tension and alignment
  - connections and wiring
- perform charging system current and voltage output tests
- disassemble, test and re-assemble alternator
  - rotor field tests
  - rectifier diodes
  - stator

Number:	**3.8**		
Title:	**Gasoline Fuel Injection Fundamentals**		
Duration:	Total Hours: 12	Theory: 8	Practical: 4
Cross Reference to Training Standards: 5165.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, construction, principles of operation, inspection and testing of electronic-controlled gasoline fuel injection systems according to manufacturers' standards.

Learning Outcomes and Content

3.8.1 Explain the purpose and fundamentals of gasoline fuel injection systems.

- port injection
- throttle body injection
- direct injection

3.8.2 Explain the construction, types, styles, operation and application of gasoline fuel injection and delivery systems.

- fuel tanks, lines and fittings
- filters and pumps
- injectors
- pressure regulators
- electronic control units
- returnless fuel systems

3.8.3 Inspect and test fuel injection systems.

- perform fuel pump tests
  - pressure
- visual inspection
  - leaks

Number:	**3.9**		
Title:	**Emission Control Systems**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Cross Reference to Training Standards: 5174.01, 08, 09, 10, 11, 12, 13			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, construction, principles of operation, inspection and testing of emission control systems according to manufacturers' standards.

Learning Outcomes and Content

3.9.1 Explain the principles of operation of emission control systems.

- exhaust gas re-circulation systems
  - vacuum controlled
  - electronic controlled
- positive crankcase ventilation
- evaporative emissions systems
  - carbon canister
  - computer controlled fuel evaporative emission solenoids
- air injection systems
  - air pumps
  - air switching valves
- catalytic converters
  - three-way
- sensors / actuators

3.9.2 Inspect and test emission control systems.

- exhaust gas re-circulation systems
- positive crankcase ventilation
- evaporative emission systems
- air injection systems
- catalytic converters

Number:	**1229**		
Title:	**Drive Train Systems**		
Duration:	Total Hours: 36	Theory: 24	Practical: 12
Prerequisites:	Level 1, Reportable 4		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
4.1	Drive Lines (FWD)	3	3	0
4.2	Drive Lines (RWD)	3	3	0
4.3	Final Drive Assemblies	8	4	4
4.4	Torque Converter Assembly	3	3	0
4.5	Automatic Transmission	9	9	0
4.6	Automatic Transmission Service Procedures	10	2	8

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**4.1**		
Title:	**Drive Lines (FWD)**		
Duration:	Total Hours: 3	Theory: 3	Practical: 0
Cross Reference to Training Standards: 5167.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, diagnose, troubleshoot, repair front wheel drive axle assemblies according to manufacturers' standards.

Learning Outcomes and Content

4.1.1 Identify the specific components and describe the operation of front wheel drive axle assemblies.

- front wheel drive axles
  - half shafts
  - inner and outer constant velocity joints
  - joint types and boot retention
  - vibration damper
  - torque steer
  - bearings and supports

4.1.2 Perform inspection, diagnosis, troubleshooting, and service on front wheel drive axle assemblies.

- visual inspection
- symptom diagnosis / noise and vibration
- removal and installation constant velocity (CV) shaft
- repair constant velocity (CV) shaft
  - component inspection
  - joint replacement
  - boot service
  - lubrication

Number:	**4.2**		
Title:	**Drive Lines (RWD)**		
Duration:	Total Hours: 3	Theory: 3	Practical: 0
Cross Reference to Training Standards: 5167.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, diagnose, troubleshoot, repair rear wheel drive drivelines according to manufacturers' standards.

Learning Outcomes and Content

4.2.1 Explain the basic fundamentals of driveline (RWD) systems.

- angular movement
- linear movement
- centrifugal force
- relationship of drive shaft speed and balance
- phasing and working angles

4.2.2 Identify the specific components and describe the operation of rear wheel drivelines.

- rear wheel drive shaft assemblies
  - single, multiple
  - steel, aluminum, and composite
  - joint types
  - constant velocity
  - slip yoke and flanges
  - bearings and supports
  - vibration damper

4.2.3 Perform inspection, diagnosis, troubleshooting, and service on rear wheel drivelines.

- visual inspection
- symptom diagnosis / noise and vibration
- measurements
  - runout
  - phasing
  - working angles
- shaft removal and installation procedures
- shaft repair
  - component inspection
  - joint replacement
  - indexing
  - boot service
  - lubrication

Number:	**4.3**		
Title:	**Final Drive Assemblies**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4
Cross Reference to Training Standards: 5167.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, diagnose, troubleshoot, repair final drive assemblies according to manufacturers' standards.

Learning Outcomes and Content

4.3.1 Identify the specific components and describe the operation of final drive assemblies.

- hotchkiss
- torque tube
- housing types
  - banjo
  - independent
- carrier types
  - integral, removable
- gear types
  - spur bevel, spiral bevel, helical, hypoid, planetary
- gear set / ratio
  - hunting, non-hunting, partial non-hunting
- pinion mounting
  - straddle, overhung
- axle types
  - full floating, ¾ floating, semi-floating
- differential types
  - open, limited slip, locking, air, hydraulic, electronic, viscous, planetary
- front and rear axle controls
- bearings, seals, and gaskets
- lubricating oils

4.3.2 Perform inspection, diagnosis, troubleshooting, and service on final drive assemblies.

- visual inspection
- symptom diagnosis / noise and vibration
- check unit bearing preload
- check pinion bearing preload
- check differential case side bearing preload
- measure backlash
- measure ring gear runout
- determine tooth contact
  - patterns and corrections
- perform adjustments
  - pinion depth
  - pinion preload
  - backlash and side bearing preload
  - patterns and corrections
- perform axle shaft service procedures
  - retention, bearings and seals
- perform differential service procedures
  - open and limited slip

Number:	**4.4**		
Title:	**Torque Converter Assembly**		
Duration:	Total Hours: 3	Theory: 3	Practical: 0
Cross Reference to Training Standards: 5166.01			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, diagnose, troubleshoot, repair automatic transmission torque converter according to manufacturers' standards.

Learning Outcomes and Content

4.4.1 Explain the basic fundamentals of fluid couplers and torque converters.

- centrifugal force
- torque transmission
- torque multiplication

4.4.2 Identify the specific torque converter components

- impeller
- turbine
- stator, one way clutch
- split guide rings
- vane pitch
- fixed vane
- variable vane
- piston lockup clutch
  - pressure plate, friction material, dampener
  - clutch controls, hydraulically, electronically
- shafts
  - turbine
  - direct drive shaft
  - stator
  - pump drive

4.4.3 Describe the operation of torque converters.

- flow characteristics
  - vortex, rotary, and centrifugal force
- impeller
- turbine
- stator / multi stator
- pitch
- fixed vane

- variable vane
- operational phases
  - stall phase
  - torque multiplication phase
  - coupling phase
  - lock-up phase

4.4.4 Perform inspection, diagnosis, troubleshooting, and service on torque converters and controls.

- perform unit inspection
  - leaks
  - contamination
  - endplay
  - drive surface
  - seal surface
- perform functional / performance test
- check for noise and vibration
- verify torque converter lockup and release operation

Number:	**4.5**		
Title:	**Automatic Transmission / Transaxle**		
Duration:	Total Hours: 9	Theory: 9	Practical: 0
Cross Reference to Training Standards: 5166.01			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to describe the operation of automatic transmissions / transaxles according to manufacturers' standards.

Learning Outcomes and Content

4.5.1 Explain the basic fundamentals of automatic transmissions / transaxles.

- Pascals Law
- basic hydraulics
  - force, area, pressure
  - hydraulic mechanical advantage
  - valve purpose: control, regulation, balanced, differential force.
- simple planetary gear operation

4.5.2 Identify the specific components and describe the basic operation of automatic transmissions / transaxles.

- pumps
  - positive displacement
    - internal / external
    - gearotor
    - vane
- variable displacement
- control system / valve body
  - mainline or control pressure regulator
  - manual, throttle, governor, shift, and modulator valves
  - converter control valves
  - limit valves
- apply devices
  - material types
  - bands
  - single / double wrap
  - flex / rigid
- multiple disc clutches
- one-way clutches
  - sprag
  - roller
  - mechanical diode
- gear sets and power flow

    - Simpson
    - Ravineaux
    - tandem compound
- parking mechanism
    - park pawl and park gear
- transmission / transaxle case passages and fluid circuits
    - filters
    - orifices, check balls
    - accumulators
    - pistons and servos
- cooling / lubrication system
    - heat exchanger
    - lines
    - auxiliary cooling systems
    - air cooled systems

Number:	**4.6**		
Title:	**Automatic Transmission / Transaxle Service Procedures**		
Duration:	Total Hours: 10	Theory: 2	Practical: 8
Cross Reference to Training Standards: 5166.01, 02			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, diagnose, troubleshoot, repair automatic transmission / transaxles according to manufacturers' standards.

Learning Outcomes and Content

4.6.1 Perform inspection, testing, and diagnosis procedures on automatic transmissions/ transaxles.

- visual inspection
- fluid level checks
- road test procedures
- linkage adjustments
- hydraulic pressure testing
- power flow analysis
- noise and vibration
- identify component failures and causes

4.6.2 Perform service and repair procedures.

- determine disassembly sequence
- note cautions
- check for required end play
- air test
- identify and locate special tools
- disassemble transmission / transaxle
- identify components
- layout parts in order removed
- trace power flow through unit
- disassemble and inspect sub components
- perform required measurements
- locate selective washers
- locate thrust washers
- reassemble and test

Number:	**1230**		
Title:	**Suspension / Steering and Brake Systems**		
Duration:	Total Hours: 42	Theory: 26	Practical: 16
Prerequisites:	Level I, Reportable 1, 3, 5		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
5.1	Suspension System Fundamentals and Servicing	9	4	5
5.2	Manual and Power Assisted Steering Systems	9	6	3
5.3	Alignment Fundamentals	9	9	0
5.4	Alignment Equipment	3	1	2
5.5	Hydraulic Brake Servicing	12	6	6

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**5.1**		
Title:	**Suspension System Fundamentals and Servicing**		
Duration:	Total Hours: 9	Theory: 4	Practical: 5
Cross Reference to Training Standards: 5168.01, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to inspect, test and service suspension and steering systems in accordance with manufacturers' recommendations.

Learning Outcomes and Content

5.1.1 Explain the operation, servicing and inspection of the following suspension and steering components.

- strut assemblies
- wheel hubs
- wheel bearings
  - adjusting
  - packing
- chassis lubrication
- shock absorbers / dampeners
- adjustable shock absorbers / dampeners
  - mechanical
  - electronic
- ball joints
  - movement – axial and radial
  - wear indicating
- steering linkage
  - movement – axial and radial

5.1.2 Perform removal and installation of the following suspension and steering components.

- strut assemblies
- wheel hubs
- wheel bearings

5.1.3 Inspect, test and service the following suspension and steering components.

- inspect strut assemblies
- inspect wheel hubs
- adjust and pack wheel bearings
- check ball joints
  - movement – axial and radial
  - wear indicating
- check steering linkage
  - movement– axial and radial

Number:	**5.2**		
Title:	**Manual and Power Assisted Steering Systems**		
Duration:	Total Hours: 9	Theory: 6	Practical: 3
Cross Reference to Training Standards: 5169.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to identify and explain the construction and operation of steering gear system including inspection and testing procedures in accordance with manufacturers' recommendations.

Learning Outcomes and Content

5.2.1 Identify and explain the following steering components.

- manual steering gears
- power steering
- power steering pumps
- power steering valves
- fluids
- lines, fittings, hoses
- coolers
- electronic power steering

5.2.2 Explain the operation of manual and power- assisted steering systems.

- manual steering gears
- power steering gears
  - recirculating ball
  - rack and pinion
- power steering
  - recirculating ball
  - rack and pinion
- power steering pumps
  - gear
  - vane
  - slipper
  - roller
- power steering valves
  - directional control
  - flow control
  - pressure relief
- fluids
- lines, fittings, hoses
- coolers

- electronic power assist
- four wheel steer

5.2.3 Inspect, test and service power steering pumps and power steering units.

- test manual steering gears
  - proper operation
  - proper adjustment
  - leaks
- test power steering gears
  - proper operation
  - proper adjustment
  - leaks
- test power steering pumps
  - proper operation
  - leaks
  - drive adjustment
- check power steering valves
  - operation
  - leakage internal / external
- inspect fluids
  - cleanliness
  - proper levels
- inspect lines, fittings, hoses
  - leaks
  - fatigue
- inspect coolers
  - leaks
  - air flow

5.2.4 Perform assigned operations.

- dismantling, inspecting, re-assembling and adjusting of power steering
  - gears
  - pumps
- check and adjust drive belt tension
- steering linkage lubrication

Number:	**5.3**		
Title:	**Alignment Fundamentals**		
Duration:	Total Hours: 9	Theory: 9	Practical: 0
Cross Reference to Training Standards: 5169.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to define, explain and calculate wheel alignment angle adjustments according to manufacturers' recommendations.

Learning Outcomes and Content

5.3.1 Define alignment angles and measurements.

- caster
- camber
- toe-in / toe-out
- steering axis inclination
- turning radius
- trim height
- thrust line
- thrust angle
- geometric centre line
- Ackerman's principles
- Included angle
- set back
- scrub radius

5.3.2 Identify alignment types and adjustment styles.

- types of alignment
  - two-wheel geometric center line alignment
  - two-wheel thrust line alignment
  - four-wheel alignment
- eccentrics
- shims / contact shims
- slots
- strut rods
- wedges
- elongating holes

5.3.3 Explain the following wheel alignment adjustments and calculations.

- eccentrics
- shims
- contact shims
- slots
- strut rods
- wedges
- elongating holes

Number:	**5.4**		
Title:	**Alignment Equipment**		
Duration:	Total Hours: 3	Theory: 1	Practical: 2
Cross Reference to Training Standards: 5169.03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to operate wheel alignment equipment in accordance with the manufacturers' recommendations.

Learning Outcomes and Content

5.4.1 Explain the operation of vehicle alignment equipment.

- demonstration of
  - operating procedures of alignment equipment
  - calibration of equipment
  - vehicle setup

5.4.2 Measure four wheel alignment angles.

- set up alignment equipment
- measure and record alignment angles

Number:	**5.5**		
Title:	**Hydraulic Brake Servicing**		
Duration:	Total Hours: 12	Theory: 6	Practical: 6
Cross Reference to Training Standards: 5170.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to inspect, diagnose disc and drum brake systems according to manufacturers' recommendations.

Learning Outcomes and Content

5.5.1 Explain inspection, testing and diagnostic procedures of brake system components in accordance with the manufacturers' recommendations.

- lines
  - flex
  - steel
- disc brakes
  - rotor thickness / runout / parallelism / condition
  - lining thickness / condition
  - resurfacing
- drums brakes
- diameter/out of round / condition
  - lining thickness / condition
  - resurfacing
- brake hydraulic system pressure tests
- brake system operational tests
  - in shop
  - road test

5.5.2 Perform assigned operations for drum and disc brakes.

- removal and installation procedures for drums, discs, pads and shoes
- adjustment and cleaning procedures for drum and disc brake assemblies
- perform drums brake
  - measure diameter / out of round / condition
  - measure lining thickness / condition
  - resurface drums
- perform disc brake
  - measure rotor thickness / runout / parallelism / condition
  - measure lining thickness / condition
  - resurface rotor
- interpret test results and performance problems
  - noises
  - drag or lockup

  - vibrations
  - imbalance
- perform brake system tests
  - hydraulic pressure test
  - performance tests

Level 3

Reportable Subject Summary-Level 3

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1231	Work Practices	30	16	14
1232	Engine Systems	36	24	12
1233	Electrical / Electronic and Emissions Systems	96	64	32
1234	Drive Train Systems	36	24	12
1235	Suspension / Steering and Brake Systems	42	26	16
	Total	**240**	**154**	**86**

Number:	**1231**		
Title:	**Work Practices**		
Duration:	Total Hours: 30	Theory: 16	Practical: 14
Prerequisites:	Level II, Reportable 1, 2, 3		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.1	Diagnose and Repair Climate Control Systems	26	14	12
1.2	Body and Trim	4	2	2

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**1.1**		
Title:	**Diagnose and Repair Climate Control Systems**		
Duration:	Total Hours: 26	Theory: 14	Practical: 12
Cross Reference to Training Standards: 5172.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operating principles, perform inspection, test and diagnose climate control system according to manufacturers' standards.

Learning Outcomes and Content

1.1.1 Explain the principles of compressor control systems.

- drivability controls
  - coolant temperature sensor
  - voltage load shedding
  - RPM
  - throttle position sensor
  - power steering pressure
- compressor protection
  - ambient temp sensor
  - low and high pressure cutout
  - compressor temperature sensor
  - compressor rpm sensor
  - superheat circuit
  - pressure relief valve
  - fan controls
  - electric and viscous drive
  - pressure and temperature
- evaporator temperature controls
  - thermostats and evaporator temperature sensors
  - pressure cycling
  - variable displacement compressors
- suction throttle, evaporator pressure regulator systems

1.1.2 Identify the components of compressor control systems.

- drivability controls
- compressor protection
- evaporator temperature controls
- STV, EPR systems

1.1.3 Explain the operating principles of automatic climate control systems.

- fully automatic, semi-automatic, manual control
  - airflow control
  - blower control
  - mode control
- control units
  - PCM
  - BCM
  - control head
  - programmer
- input sensors
  - ambient
  - in-car
  - coolant/heater core
  - sunload
    driver
- outputs
  - blend door motor
  - temperature and coolant flow controls
  - mode door motors
  - blower control unit
  - vacuum circuits

1.1.4 Describe inspection and testing procedures for climate control systems.

- climate controls
  - visual inspection
  - retrieving data and trouble codes
  - determine faults without trouble codes
  - diagnose temperature and air flow
- refrigeration system
  - visual inspection of all AC components
  - diagnosis using gauges
- diagnose failed compressors and clutches
  - symptoms of hydraulic lock.
  - recognition of oil starvation
  - testing belt tensioners
  - check for low voltage
- leakage repairs
- flushing and filtering
- de-odorizing smells from air plenums

1.1.5 Perform inspection and testing procedures for climate control systems performance tests.

- climate controls
  - visual inspection
  - retrieving data and trouble codes
  - determine faults without trouble codes
  - diagnose temperature and air flow problems
  - movement and actuator performance
- refrigeration system
  - visual inspection
  - diagnosis using gauges
  - diagnosis of failed compressors and clutches
  - replace clutches on compressors
- repair lines and hoses
- leakage repairs by identifying leaky components
- flushing and filtering contaminated components
- de-odorizing smells from air plenums

Number:	**1.2**		
Title:	**Body and Trim**		
Duration:	Total Hours: 4	Theory: 2	Practical: 2
Cross Reference to Training Standards: 5173.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose and construction of body trim and glass components and perform necessary repairs following manufacturers' recommendations.

Learning Outcomes and Content

1.2.1 Explain the purpose of body and trim components.
- weather stripping
- windows and regulators
- windshield/rear glass integrity
- headlamp aiming
- interior and exterior trim

1.2.2 Identify body and trim components.
- weather stripping
- windows and regulators
- windshield sealants
- headlamps
- interior and exterior trim

1.2.3 Describe inspection, testing and repair procedures to body and trim components.
- aim headlamp
- fit and leaks
  - water
  - dust
- noise location and repair
  - squeaks
  - rattles
  - wind

1.2.4 Perform inspection and testing procedures to body and trim components.

- aim headlamp
- check fits to control
  - water leaks
  - dust leaks
- check noise location and repair
  - squeaks
  - rattles
  - wind

Number:	**1232**		
Title:	**Engine Systems**		
Duration:	Total Hours: 36	Theory: 24	Practical: 12
Prerequisites:	Level I, Reportable 2		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
2.1	Engine Cooling Systems and Diagnostics	9	7	2
2.2	Accessory Drive Belts and Pulleys	3	1	2
2.3	Lubrication Systems	9	7	2
2.4	Engine Component Failure Analysis	12	8	4
2.5	Engine Replacement and Start-up Preparation	3	1	2

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**2.1**		
Title:	**Engine Cooling Systems and Diagnostics**		
Duration:	Total Hours: 9	Theory: 7	Practical: 2
Cross Reference to Training Standards: 5161.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operating principles of cooling systems, perform maintenance, diagnose and service according to manufacturers' recommendations.

Learning Outcomes and Content

2.1.1 Define the fundamentals of engine cooling systems.

- fundamentals of coolant
  - convection, conduction and radiation
  - temperature effects
  - heat measurement
  - the effects of pressure on boiling points / ratio

2.1.2 Identify engine cooling system components.

- liquid-cooled systems
- full circulation
  - thermostat
  - radiators and heater cores
  - pressure caps
  - coolant pumps
- fans
  - electrical, viscous, mechanical
  - shrouds and deflectors
- oil coolers
- coolant level sensors

2.1.3 Explain the operation and effect of engine cooling systems.

- liquid cooled systems

2.1.4 Perform inspection and testing for an engines cooling system.

- visual inspection
- PH testing / quality of water
- pressure test liquid cooling system
- test coolant freeze protection, condition and compatibility
- test for both internal and external leakage
  - visual
  - fluorescent dye
  - pressure tester
  - temperature / leak relationship
  - cylinder leakage tester
  - combustion gas tester
- check for presence of transfer between systems
- test for system flow restrictions
- test engine temperature control operation

2.1.5 Research recommended cooling system service and maintenance procedures.

- external cooling system cleaning
- system flushing and anti-freeze replacement
- describe procedures for replacement of
  - thermostats
  - fan or fan drives or belts
  - radiators
  - water pump
  - heater cores
  - core plugs
  - flushing of oil coolers

Number:	**2.2**		
Title:	**Accessory Drive Belts and Pulleys**		
Duration:	Total Hours: 3	Theory: 1	Practical: 2
Cross Reference to Training Standards: 5161.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operating principles of belt and pulley systems, perform maintenance, diagnose and service according the manufacturers' recommendation.

Learning Outcomes and Content

2.2.1 Identify the types and applications of belt and pulley systems.

- double edged serpentine and V-belts
- pulleys
- manual adjusters
- idlers / tensioners
- routing diagrams
- ratios

2.2.2 Perform recommended inspection and service procedures for belts and pulleys.

- identification
- dimensions
- cracks
- wear
- deterioration
- alignment
- tension
- temperature
- pulley wear
- bearings
  - remove, replace and adjust
  - belts
  - pulleys
  - idlers

2.2.3 Diagnose and repair belt and pulley systems.

- check for vibration
- check for noise
- verify system condition

Number:	**2.3**		
Title:	**Lubrication Systems**		
Duration:	Total Hours: 9	Theory: 7	Practical: 2
Cross Reference to Training Standards: 5161.01, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operating principles of lubrication systems, perform maintenance, diagnose and service according to manufacturers' recommendations.

Learning Outcomes and Content

2.3.1 Define the fundamentals of engine lubrication systems.
- friction
- hydrodynamic lubrication
- engine lubrication components
- oil characteristics, properties, additives and classification
- lubrication system cooling

2.3.2 Describe the characteristics and application of engine lubrication system components.
- types oil pumps
- oil coolers and heat exchangers
- oil filters and protection valve
- oil pressure sending unit and pressure relief valve

2.3.3 Explain the operating principles of engine lubrication systems.
- oil pumps
- oil filtering methods and characteristics
- engine oils
- heat exchangers
- protection and pressure relief devices
- oil life monitoring

2.3.4 Perform recommended inspection, testing and service procedures on lubrication systems.
- visual inspection for oil leaks
  - engine running
  - engine off
- perform engine oil pressure test
- inspect engine oil condition and level

- perform oil life monitor reset
- identify the sources and detrimental effects of engine oil contamination
  - worn bearings
  - leaking gaskets and seals
  - auxiliary cooler defects
  - filters
  - fuel dilution
  - engine temperatures
  - oxidation
  - sludge
  - chemical reaction of oil and contaminants
  - oil additives
  - engine oil sampling
- describe engine oil and filter replacement procedures
- identify the significance of
  - selecting the correct engine oil
  - priming oil pumps and filters
  - oil and filter change intervals for all driving conditions

2.3.5 Research manufacturers' recommendations for lubrication system service and maintenance.

- prepare summary of oil pump overhaul and replacement procedures
- oil pressure sending units and regulators
- cleaning procedures

Number:	**2.4**		
Title:	**Engine Component Failure Analysis**		
Duration:	Total Hours: 12	Theory: 8	Practical: 4
Cross Reference to Training Standards: 5161.01, 02, 05, 08, 11			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain and perform the recommended engine diagnostic and testing procedures following manufacturers' recommendations.

Learning Outcomes and Content

2.4.1 Explain the fundamentals of engine component failure analysis and diagnosis.

- define diagnosis as applied to internal combustion engine failures
- identify diagnostic procedures for primary and secondary causes of component failure
- explain diagnostic procedures for:
  - lubricating systems
  - cooling systems
  - power loss
  - oil consumption
  - engine-related noises
  - vibrations
  - mechanical failure
  - normal wear

2.4.2 Perform recommended inspection and testing procedures to determine causes of engine failures.

- perform engine component assessment for failure analysis on:
  - valve timing mechanism
  - effect of wear on gears, chains and belts
  - valve timing
  - valve lash
  - balance shafts
  - camshafts
  - blocks and crankshafts
  - cylinders, pistons and rings
  - connecting rods and pins
  - bearings and seals
  - mechanical failure
  - normal wear

2.4.3 Explain the principles of operation of engine testing and diagnostic equipment.

- vacuum testers
- compression
- cylinder leakage

2.4.4 Perform assigned operations using vacuum, compression and cylinder leakage equipment.

- vacuum testing
- compression testing
- cylinder leakage
- valve adjustment
- identify and verify valve marks and correct valve timing

Number:	**2.5**		
Title:	**Engine Replacement and Start-up Preparation**		
Duration:	Total Hours: 3	Theory: 1	Practical: 2
Cross Reference to Training Standards: 5161.01, 5163.11			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain recommended replacement and start-up procedures according manufacturers' recommendation and trade practices.

Learning Outcomes and Content

2.5.1 Research manufacturers' recommendations for engine removal and installation.

- sequence
- lifting techniques
- storing and supporting components
- explain the procedures to remove and replace an engine
- draining of fluids and recovery of refrigerants
- replacement precautions

2.5.2 Describe the principles and procedures used in the initial start-up of an overhauled engine assembly.

- oil circuit priming
- oil levels
- basic timing adjustments
- supercharger and turbocharger precautions

Number:	**1233**		
Title:	**Electrical / Electronics and Emissions**		
Duration:	Total Hours: 96	Theory: 64	Practical: 32
Prerequisites:	Level II, Reportable 1, 2, 3, 4, 5		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
3.1	Computer Fundamentals	6	4	2
3.2	Supplemental Restraint Systems	8	6	2
3.3	Distributorless Ignition Systems	8	4	4
3.4	Computer Controlled Charging Systems	8	4	4
3.5	Power Accessories and Electrical Options	18	12	6
3.6	Gasoline Fuel Ignition Diagnosis and Repair	16	10	6
3.7	Diesel Electronic Fuel Injection Fundamentals	8	6	2
3.8	Emissions Control Diagnosis and Repair	20	14	6
3.9	Hybrid Systems	4	4	0

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**3.1**		
Title:	**Computer Fundamentals**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross Reference to Training Standards: 5163.01, 08, 09, 10, 5164.01, 02, 03			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the principles of operations of vehicle on board computers according to manufacturers' specifications.

Learning Outcomes and Content

3.1.1 Explain the principles of operation of vehicle on board computers.

- onboard computers
- multiplexing
- fibre optics
- data bus communication lines
- CAN bus
- central processing unit (CPU)
- random access memory (RAM)
- read only memory (ROM)

3.1.2 Perform data retrieval with appropriate test equipment.

- oscilloscope
- scan tool
- flight recorder

Number:	**3.2**		
Title:	**Supplemental Restraint Systems**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Cross Reference to Training Standards: 5164.01, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the fundamentals, construction, principles of operation, inspection, and testing procedures of supplemental restraint systems according to manufacturers' standards.

Learning Outcomes and Content

3.2.1 Explain the purpose, construction, types, applications and fundamentals of supplemental restraint systems.

- deceleration forces
- inflatable supplemental restraint systems
- pretension seat belts
- crash sensors
- control modules
- air bags
- air bags inflators
- clock spring
- seat occupancy sensors
- passenger-side airbag disabling system
- explain safe handling precautions for service and testing of inflatable and non- inflatable restraint systems

3.2.2 Inspect, test and explain safe handling procedures for restraint system components.

- safely disable restraint systems
- perform system tests using scan tools, multimeter and specific test equipment

Number:	**3.3**		
Title:	**Distributorless Ignition Systems**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4
Cross Reference to Training Standards: 5163.01, 05, 06			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the principles of operation, construction, types, inspection, and testing procedures for distributorless ignition systems according to manufacturers' standards.

Learning Outcomes and Content

3.3.1 Explain the purpose, construction, types, applications and fundamentals of distributorless ignition systems.

- coils
- coil over plug
- modules
- sensors
  - crankshaft position
  - camshaft position

3.3.2 Inspect and test distributorless ignition systems.

- identify and locate ignition system components
  - coils
  - modules
  - sensors
  - wiring and connections
- test for correct operation of distributorless ignition systems

Number:	**3.4**		
Title:	**Computer Controlled Charging Systems**		
Duration:	Total Hours: 8	Theory: 4	Practical: 4
Cross Reference to Training Standards: 5162.01, 07, 08, 09			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the principles of operation, construction, types, inspection, and testing procedures for computer- controlled charging systems according to manufacturers' standards.

Learning Outcomes and Content

3.4.1 Explain the purpose, construction, types, applications and fundamentals of computer-controlled charging systems and electronic regulators.

- computer-controlled charging system
  - alternator field current control
  - ambient temperature sensing
  - battery voltage sensing
  - battery temperature sensing
- voltage regulator operation
  - location
  - alternator output monitoring
- charging system indicators

3.4.2 Inspect and test computer-controlled charging systems.

- test computer-controlled charging systems
- identify and isolate faulty charging system components

Number:	**3.5**		
Title:	**Power Accessories and Electrical Options**		
Duration:	Total Hours: 18	Theory: 12	Practical: 6
Cross Reference to Training Standards: 5164.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the principles of operation, inspection, and testing procedures of electrical accessories according to manufacturers' standards.

Learning Outcomes and Content

3.5.1 Explain the fundamentals, types, principles of operation of electrical accessories.

- lighting system
  - daytime running lights
  - automatic operation
  - light emitting diode
  - high intensity discharge
- power accessories
  - power windows
  - power door locks
  - wiper washer systems
- power seats
- inverters
- security systems
- remote entry and remote starting systems
- instrumentation
- cruise control systems
- communication and entertainment systems

3.5.4 Inspect, test and diagnose electrical accessories.

- diagnose faults, i.e., shorts, opens, grounds, high resistance
- analysis circuit with wiring diagrams and troubleshooting charts
- perform safety precautions when dealing with electronic devices

Number:	**3.6**		
Title:	**Gasoline Fuel Injection Diagnosis and Repair**		
Duration:	Total Hours: 16	Theory: 10	Practical: 6
Cross Reference to Training Standards: 5163.01, 02, 03, 04, 5165.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain principles of operation, construction, inspection, and testing procedures for gasoline fuel injection systems according to manufacturers' standards.

Learning Outcomes and Content

3.6.1 Explain the construction, types, and principles of operation of fuel injection systems and components.

- input sensors
  - temperature sensors
  - manifold absolute pressure sensors
  - air flow sensors
  - oxygen sensors
  - throttle position sensors
  - throttle-pedal position sensors
  - crank & cam position sensors
  - switch inputs
- electronic control module
  - powers & grounds
  - data communication lines
  - diagnostics
- output actuators
  - malfunction indicator light
  - fuel injectors
  - idle speed control
  - exhaust gas recirculation
  - electronic throttle actuator
  - evaporative emission controls
  - cooling fans
  - spark control
  - air pumps
  - solenoids
  - relays
  - modules

3.6.2 Identify, inspect and test electronic fuel injection systems.

- input sensors
  - temperature sensors
  - manifold absolute pressure sensors
  - air flow sensors
  - oxygen sensors
  - throttle position sensors
  - throttle-pedal position sensors
  - crank & cam position sensors
  - switch inputs
- electronic control module
  - powers & grounds
  - data communication lines
  - diagnostics
    - data stream
    - diagnostic trouble codes
    - freeze frame data
- output actuators
  - malfunction indicator light
  - fuel injectors
  - idle speed control
  - exhaust gas recirculation
  - electronic throttle actuator
  - evaporative emission controls
  - cooling fans
  - spark control
  - air pumps
  - solenoids
  - relays
  - modules
- perform an injector balance test
- diagnose fault(s)
  - retrieve trouble code
  - access diagnostic information
  - diagnose
  - repair & verify

Number:	**3.7**		
Title:	**Diesel Electronic Fuel Injection Fundamentals**		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Cross Reference to Training Standards: 5165.01, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the purpose, construction, principles of operation, inspection and testing for diesel fuel systems according to manufacturers' standards.

Learning Outcomes and Content

3.7.1 Explain the purpose and fundamentals of diesel fuel injection systems.
- fundamentals of diesel fuel
- principles of compression ignition
- principles of fuel metering

3.7.2 Explain the construction, types, application and principles of operation of diesel fuel injection components.
- transfer pumps
- common rail fuel systems
- tanks, lines, filters, hoses and fittings
- water separators / fuel heater
- mechanical injectors
- injection inline pumps
- injection distributor pumps
- glow plugs systems
- emission controls
- bio diesel

3.7.3 Explain inspection and testing procedures.
- visual inspection of lines, filters, fuel delivery pumps and water separators
- interpret data for electronic management systems
- common rail fuel systems
- demonstration of fuel delivery pump test
- capacity, pressure, vacuum, return flow
- demonstrate fuel injector testing adhering to required safety procedures
- pressure (pop) opening, spray pattern, leakage, leak-back, chatter
- describe low and high-pressure fuel priming procedures and fuel filters
- describe the replacement procedures for fuel filters

Number:	**3.8**		
Title:	**Emissions Control Diagnosis and Repair**		
Duration:	Total Hours: 20	Theory: 14	Practical: 6
Cross Reference to Training Standards: 5174.01, 08, 09, 10, 11, 12, 13			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain inspection and testing of emission control systems to On Board Diagnostics II (ODB II) standards.

Learning Outcomes and Content

3.8.1 Explain the government standards and regulations for exhaust emissions and different methods used for annual emissions inspections.

- IM240
- RG240
- ASM
  - carbon monoxide
  - carbon dioxide
  - hydrocarbons
  - oxides of nitrogen
  - oxygen

3.8.2 Explain the effects of component malfunctions on exhaust emissions.
exhaust gas recirculation

- evaporative emission systems
- catalytic convertor
- positive crankcase ventilation
- air injection systems
- ignition system

3.8.3 Inspect, test and analyze emission control devices using scan tools, gas analyzers, oscilloscopes, smoke generator and temperature probes.

- exhaust gas recirculation valves
- air injection pump
- catalytic converters
- spark timing control devices
- oxygen sensors
- evaporative emission controls

Number:	**3.9**		
Title:	**Hybrid Systems**		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Cross Reference to Training Standards: OA H-19.01			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the principles of operation and diagnosis of fuel, electrical drive and regenerative braking systems associated with hybrid vehicles according to manufacturers' standards.

Learning Outcomes and Content

3.9.1 Explain code extraction, diagnostic routines, diagnosis and testing procedures associated with hybrid fuel and electrical system types.

- hybrid system types
  - Toyota - Synergy system
  - Honda - Integrated Motor Assist (IMA)
  - General Motors / Saturn - Belt Alternator Starter (BAS)
  - General Motors / Chrysler / BMW - Dual Mode
- high voltage disconnect
- meter use
- high and intermediate voltage drive systems
- start up
- idle stop
- inverter
- transmission pump operation
- vacuum pump operation

Number:	**1234**		
Title:	**Drive Train Systems**		
Duration:	Total Hours: 36	Theory: 24	Practical: 12
Prerequisites:	Level 2, Reportable 2, 3, 4		

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
4.1	Automatic Transmission / Transaxle Hydraulic Control Systems	3	3	0
4.2	Automatic Transmission / Transaxle Operations	6	6	0
4.3	Automatic Transmission / Transaxle Diagnosis and Service Procedures	12	4	8
4.4	Automatic Transmission / Transaxle Electronic Controls	7	4	3
4.5	Transfer Cases / 4 Wheel Drive / All Wheel Drive	5	4	1
4.6	Alternate Drive Lines / Hybrid Driveline	3	3	0

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**4.1**		
Title:	**Automatic Transmission / Transaxle Hydraulic Control Systems**		
Duration:	Total Hours: 3	Theory: 3	Practical: 0
Cross Reference to Training Standards: 5166.01, 08, 09, 10			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, diagnosis, troubleshoot, and repair automatic transmission / transaxle hydraulic systems according to manufacturers' standards.

Learning Outcomes and Content

4.1.1 Identify the specific components and describe the detailed operation of automatic transmission / transaxle hydraulics.

- pumps
- control system / valve body
  - mainline or control pressure regulator
  - manual, throttle, governor, shift, and modulator valves
  - converter control valves
  - limit valves
  - flow control
  - detent valves
  - hydraulic, mechanical, electrical and electronic control
  - hydraulic circuits and schematics

4.1.2 Perform inspection, testing, and diagnosis procedures on automatic transmissions/ transaxle hydraulics.

- test hydraulic system pressure
- perform pump service
  - visual inspection
  - measurements
  - clearance checks
- inspect and service valve body
- perform failure analysis

Number:	**4.2**		
Title:	**Automatic Transmission / Transaxle Operations**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross Reference to Training Standards: 5166.01, 08, 09, 10			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the detailed operation of automatic transmissions / transaxles according to manufacturers' standards.

Learning Outcomes and Content

4.2.1 Explain the detailed operation of automatic transmission / transaxle applied and mechanical devices

- applied hydraulic circuits and schematics
  - driving and holding devices
    - bands
    - servos and pistons
    - clutches
    - one-way clutches
- gear train power flow
  - Simpson
  - Ravigneaux
  - Tandem compound

Number:	**4.3**		
Title:	**Automatic Transmission / Transaxle Diagnosis and Service Procedures**		
Duration:	Total Hours: 12	Theory: 4	Practical: 8
Cross Reference to Training Standards: 5166.01, 08, 09, 10			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, diagnosis, troubleshoot, and repair automatic transmission / transaxles following manufacturers' recommendations.

Learning Outcomes and Content

4.3.1 Perform inspection, testing, and diagnosis procedures on automatic transmissions / transaxles.

- visual inspection
- evaluate fluid level and condition
- interpret road test results
- access on board diagnostics and analyze data
- access applicable service information / technical service bulletins
- adjust linkage
- interpret hydraulic pressure test results
- power flow analysis
- shift evaluation
- symptom based diagnosis of transmission / component failures
- identify specific component failure and causes

4.3.2 Perform and explain service and repair procedures.

- determine disassembly sequence
- note cautions
- air test
- identify and locate special tools
- perform required measurements
- identify and determine manufacturers specific corrections
  - selective washers
  - clutch components
- disassemble transmission / transaxle
- identify components
- trace power flow through unit
- disassemble and inspect sub components
- perform failure analysis

- re-assemble and verify correct function
- change automatic transmission fluid and filters
- perform flushing of assemblies
- identify cautions to be observed during removal and replacement

Number: **4.4**
Title: Automatic Transmission / Transaxle Electronic Controls
Duration: Total Hours: 7 Theory: 4 Practical: 3
Cross Reference to Training Standards: 5166.11, 12, 13

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform preliminary checks, diagnosis, troubleshoot, and repair automatic transmission / transaxles electronic controls according to manufacturers' recommendations.

Learning Outcomes and Content

4.4.1 Identify and describe specific applications of automatic transmission / transaxle electronic controls.

- power train control units (PCU)
- input devices (sensors) speed, position, pressure, temperature
- output devices (solenoids, relays) pressure, shift, torque converter clutch controls (TCC)
- data lines / communications
- on board diagnostics
  - scan tool utilization
  - code access
- effects on performance characteristics
  - shift timing
  - shift feel
  - torque
  - fuel economy
- integrated vehicle control systems
  - engine control module
  - body control module
  - suspension / traction control / electronic brake control module

4.4.2 Perform and interpret results of functional and diagnostic tests on automatic transmission / transaxle electronic controls

- component testing
  - input devices
  - output devices
- scan tool utilization
  - data lines / communications
  - on board diagnostics
  - code access
  - shift adaptives
- perform performance testing

- test pressure controls
- test shift controls
- test TCC control
- test integrated vehicle control systems
  - engine control module
  - body control module
  - suspension / traction control / electronic brake control module

Number:	**4.5**		
Title:	**Transfer Cases / 4 Wheel Drive / All Wheel Drive**		
Duration:	Total Hours: 5	Theory: 4	Practical: 1
Cross Reference to Training Standards: 5167.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform visual inspection, diagnosis, troubleshoot, repair 4 wheel drive and all wheel drive systems according to manufacturers' recommendations.

Learning Outcomes and Content

4.5.1 Explain the fundamentals of 4 wheel drive and all wheel drive systems.

- function, types, styles and applications
  - 4 wheel drive
  - part time
  - full time

4.5.2 Describe the operation of 4 wheel and all-wheel drive systems.

- 4 wheel drive components and variations
- all-wheel drive components and variations
- automatic / manual locking hubs
- axle disconnects
  - electric / vacuum actuators
- viscous drive
- rear drive modules (RDM)
- controls and indicators
- electronic sensors

4.5.3 Perform inspection, testing, and diagnostic procedures on 4 wheel drive and all wheel drive systems.

- inspect wheel circumference
- identify operating ranges
- describe the removal and installation procedures
- perform measurements and adjustments
- identify component failures and causes

Number:	**4.6**		
Title:	**Alternate Drive Trains / Hybrid Driveline**		
Duration:	Total Hours: 3	Theory: 3	Practical: 0
Cross Reference to Training Standards: OA H-19.01			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to identify and define the basic operation of Hybrid / Alternate Drive Trains according to manufacturers' standards.

Learning Outcomes and Content

4.6.1 Identify and define hybrid / alternate drive trains applications.

- CVT / continuously variable transmission
- Sentronic / manual transmission automatically controlled (manumatic)
- Hybrid Drive Trains
  - CVT
  - Transmission / transaxle
  - BAS / belt alternator starter
  - IMA / integrated motor assist
  - ISAD / integrated starter alternator dampner
  - 2 Mode
  - Motor / Generator (MG1, MG2)
- Auxiliary Drive Trains
- Electric Drive Trains

4.6.2 Servicing Hybrid Vehicles.

- identify safety precautions
  - manufacturers safety procedures
  - high voltage
  - protective equipment
  - battery disconnect procedures

Number: **1235**
Title: Suspension / Steering Systems and Brakes
Duration: Total Hours: 42 Theory: 26 Practical: 16
Cross Reference to Training Standards: Level II, Reportable 2, 3, 4,

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
5.1	Power Assisted Brake	6	4	2
5.2	Anti-Lock Brake Fundamentals	10	10	0
5.3	Anti-Lock Brake Diagnostics	6	0	6
5.4	Electronic Braking	2	2	0
5.5	Tire Pressure Monitoring Systems	1	1	0
5.6	Electronic Suspension Systems	2	2	0
5.7	Vehicle Pre-alignment Inspection	3	1	2
5.8	Vehicle Alignment Diagnostics	6	6	0
5.9	Vehicle Alignment	6	0	6

Evaluation Structure

The following evaluation structure is only a suggested format. Specific evaluation of the theory and practical components of training will vary due to the institutional evaluation protocol, available resource material, training aides utilized and learning level of the individual student(s).

Evaluation should be broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Evaluation Structure	
Theory Testing	Practical Application Testing
70%	30%

Number:	**5.1**		
Title:	**Power Assisted Brakes**		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross Reference to Training Standards: 5170.01, 02, 03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to describe and explain the construction and operation of power assisted brakes; including inspection, testing and diagnostic procedures in accordance with manufacturers' recommendations.

Learning Outcomes and Content

5.1.1 Describe the construction and types of power assisted brake systems.
- vacuum assist
- hydraulic assist
- electric / hydraulic

5.1.2 Explain the operation of power assisted brake systems.
- vacuum assist
- hydraulic assist
- electric / hydraulic

5.1.3 Inspect, test and diagnose power assisted brakes.
- visual inspection
  - leaks
  - fluid levels
- operational and static test
- test vacuum assist
- test hydraulic assist
- test electric / hydraulic
- diagnosis
  - vacuum assist
  - hydraulic assist
  - electric / hydraulic

Number:	**5.2**		
Title:	**Anti-Lock Brake Fundamentals**		
Duration:	Total Hours: 10	Theory: 10	Practical: 0
Cross Reference to Training Standards: 5170.01			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to inspect, test and diagnose anti lock, stability and traction control systems including performing bleeding of the hydraulic system in accordance with manufactures' recommendations.

Learning Outcomes and Content

5.2.1 Define the fundamentals of anti-lock brake, traction and stability control systems.

- hydraulic pressure modulation
- electronic controls
- performance / advantages

5.2.2 Identify and explain the construction, types, and application of anti-lock brake systems, stability and traction control systems and components.

- integrated / non-integrated designs
- electric pumps
- accumulators
- sensors
- acceleration / yaw / pitch / roll sensors
- valve body assembly
- electronic controller
- one-channel
- two-channel
- three-channel
- four-channel

5.2.3 Explain the principles of operation of anti-lock, stability and traction control systems.

- safety procedures
- integrated / non-integrated designs
- electric pumps
- accumulators
- sensors
- acceleration / yaw / pitch / roll sensors
- valve body assembly

- electronic controller
- one-channel
- two-channel
- three-channel
- four-channel
- malfunction indicator lamps
- ABS action during apply, hold and release
- effects of tires

Number:	**5.3**		
Title:	**Anti-Lock Brake Diagnostics**		
Duration:	Total Hours: 6	Theory: 0	Practical: 6
Cross Reference to Training Standards: 5170.01, 05, 06, 07			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to inspect, test, diagnose anti lock, stability and traction control systems including performing bleeding of the hydraulic system in accordance with manufactures' recommendations.

Learning Outcomes and Content

5.3.1 Inspect, test and diagnose anti-lock, stability and traction control systems.

- visual inspection
  - leaks
  - fluid levels
- test system pressures
- test accumulator operation
- test control and sensor operation
- extract and analyze data
- retrieve fault codes
- retrieve live data

5.3.2 Perform assigned operations on anti-lock brake, stability and traction control systems.

- bleed the air from the hydraulic systems
  - manual procedure
  - electronic service tool procedure

Number:	**5.4**		
Title:	**Electronic Braking**		
Duration:	Total Hours: 2	Theory: 2	Practical: 0
Cross Reference to Training Standards: 5170.01, 08, 09, 10			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operation and components of electronic braking systems in accordance with manufactures' recommendations.

Learning Outcomes and Content

5.4.1 Explain the operation and components of electronic braking systems.

- control units
- wiring
- calipers
- solenoids

Number:	**5.5**		
Title:	**Tire Pressure Monitoring**		
Duration:	Total Hours: 1	Theory: 1	Practical: 0
Cross Reference to Training Standards: OA F16			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operation and components of tire pressure monitoring systems in accordance with manufactures' recommendations.

Learning Outcomes and Content

5.5.1 Explain the operation and components of tire pressure monitoring systems.

- sensors
- control units

Number:	**5.6**		
Title:	**Electronic Suspension Systems**		
Duration:	Total Hours: 2	Theory: 2	Practical: 0
Cross Reference to Training Standards: 5168.01			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to explain the operation and components of tire electronic suspension systems in accordance with manufactures' recommendations.

Learning Outcomes and Content

5.6.1 Explain the operation and components of electronic suspension system.

- sensors
- wiring
- control units

Number:	**5.7**		
Title:	**Vehicle Pre-alignment Inspection**		
Duration:	Total Hours: 3	Theory: 1	Practical: 2
Cross Reference to Training Standards: 5169.01, 02			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform pre-alignment inspections in accordance with manufactures recommendations.

Learning Outcomes and Content

5.7.1 Perform pre-alignment checks following manufacturers' recommendations.

- tires
- weight distribution / proper loading
- trim height
- bearing condition and adjustment
- suspension system condition
- requirements for tailoring alignment settings
- steering linkage condition

Number:	**5.8**		
Title:	**Vehicle Alignment Diagnostics**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross Reference to Training Standards: 5168.02			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to identify and explain vehicle handling problems in accordance with manufactures standards.

Learning Outcomes and Content

5.8.1 Identify and explain vehicle handling problems.

- vehicle pulls to one side
- vehicle instability
- vehicle wander
- bump steer
- excessive lean on corners
- vibration at cruise or deceleration
- low speed shimmy
- slow steering wheel return
- steering effort
  - heavy
  - light
- excessive steering wheel free-play
- steering stability
- steering kickback
- vehicle roll
- high speed shimmy
- abnormal tire wear
  - front tires
  - rear tires

Number:	**5.9**		
Title:	**Vehicle Alignment**		
Duration:	Total Hours: 6	Theory: 0	Practical: 6
Cross Reference to Training Standards: 5168.03, 04			

General Learning Outcomes

Upon successful completion the apprentice will have the ability to perform a wheel alignment in accordance with manufactures' recommendations.

Learning Outcomes and Content

5.9.1 Perform wheel alignment in accordance with specific vehicle application.

- obtain required specifications
- record alignment readings
- determine required adjustment
- perform required adjustments
- recheck readings
- verify final readings

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Automotive Service Technician