



**Skilled
Trades**
Ontario

**Métiers
spécialisés**
Ontario

Apprenticeship
Curriculum Standard

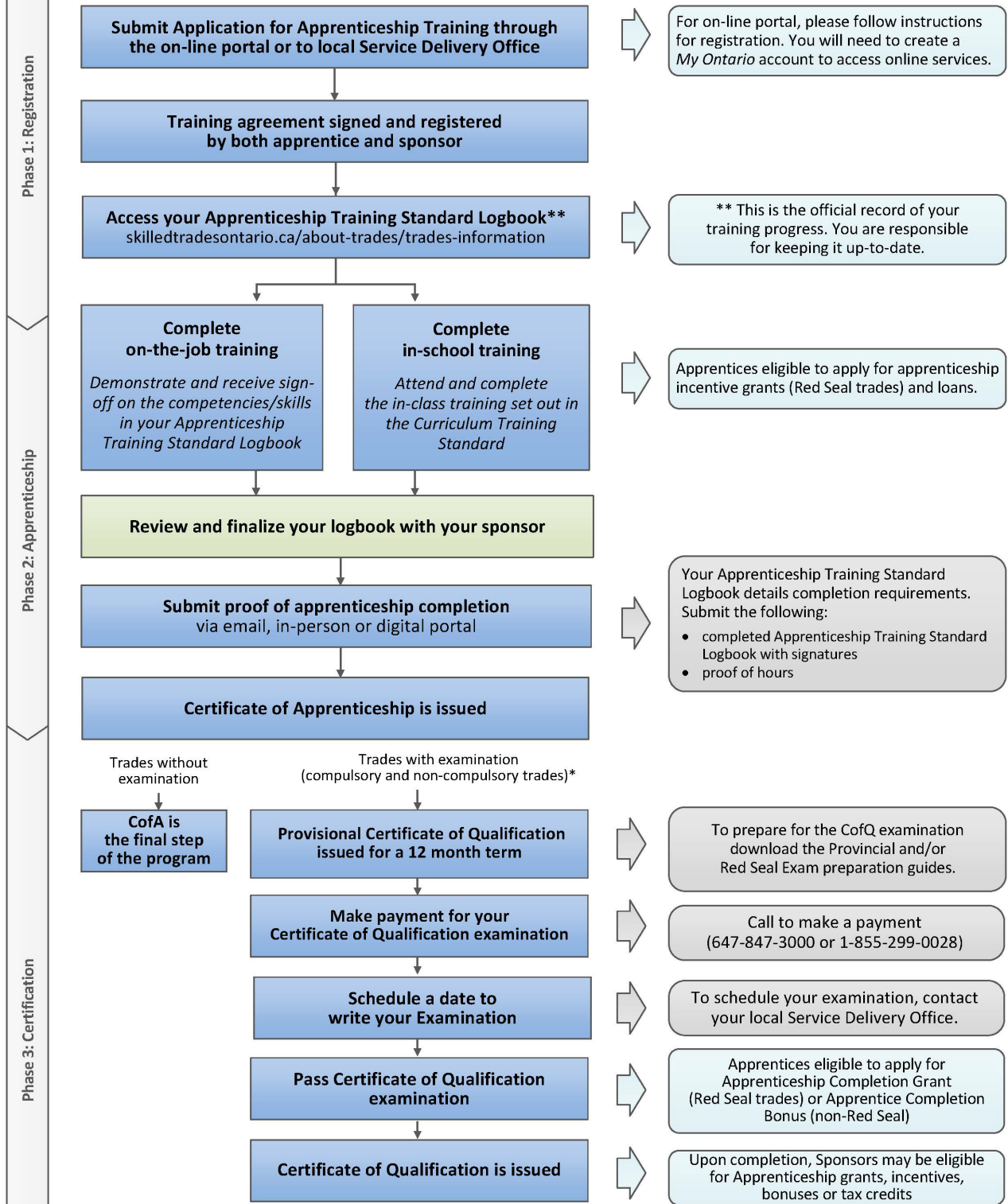
Alignment and Brakes
Technician

Level 1

310E

2004

Apprenticeship Pathway to a Certificate of Qualification



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

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Please Note: This Standard has been revised to reflect the visual identity of Skilled Trades Ontario (STO) which replaced the Ontario College of Trades on January 1, 2022. The content of this Standard may refer to the former organization; however, all trade specific information or content remains relevant and accurate based on the original date of publishing.

Please refer to STO's website: skilledtradesontario.ca for the most accurate and up to date information. For information about BOSTA and its regulations, please visit [Building Opportunities in the Skilled Trades Act, 2021 \(BOSTA\)](#).

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Maintained with transfer to Skilled Trades Ontario 2004 (V100)

Preface

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

The curriculum is organized into 2 levels of training. The Reportable Subjects Summary chart (located on page 5) 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 \(ontario.ca\)](http://www.skilledtradesontario.ca/building-opportunities-in-the-skilled-trades-act-2021-s.o.-2021-c.-28-bill-288)

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.

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.

Suggested Equipment for Training Delivery Agencies

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

Introduction

The Alignment and Brakes Technician curriculum has been developed in keeping with the prescribed Ministry of Labour, Immigration, Training and Skills Development Apprenticeship Training Standards. The curriculum is designed to adhere to the current grade reporting structures for the respective program specialities.

For easy reference, a time allocation has been included for each respective subject and unit, along with the Theory/Practical breakdown for the delivery of the Learning Content. More detailed time allocations for the instructor have been provided for each topic area to assure consistency for each apprentice intake.

The continual introduction of innovative techniques and more complex equipment is resulting in increasing demands for tradespersons who are not only skilled in the practical aspects of the trade, but who also have a sound theoretical knowledge of the inspecting, diagnosing, repair, and servicing requirements. The curriculum has been developed to provide this theoretical knowledge and to offer some practical applications to complement the on-the-job work experiences of Alignment and Brakes Technician.

The objectives of the curriculum, therefore, are to provide a basis for:

- a) Sound theoretical training to meet the challenges presented by the increasingly more complex designs and testing techniques.
- b) A reinforcement of fundamental skills of the trade through the exposure to practical applications.
- c) Developing in the apprentices high standards of craftsmanship, problem-solving skills and personal pride in their trade.
- d) Developing desirable work attitudes and a keen sense of responsibility, particularly concerning public and personal safety.

The curriculum has been designed to give the instructor every reasonable opportunity for flexibility and innovation without deviating to any significant degree from the subject requirements, as determined by the Industry Committees and as prescribed in the Regulations for the Trades. Since the scope of the prescribed curriculum is quite extensive, the apprentices must be expected to reinforce the acquired knowledge through regular independent out-of-classroom assignments. The curriculum has been presented in a chronological sequence in keeping with sound teaching methodologies. However, the actual application of the sequence may differ somewhat between colleges because of scheduling, staffing, and facilities utilization.

The curriculum includes specific references to the Ministry of Labour, Immigration, Training and Skills Development Apprenticeship Training Standards. With these references to various performance objectives in the Training Standards have been linked to the respective in-school outcomes, employers should not assume complete coverage to a journey person level. The in-school delivery focuses primarily on the knowledge required to master the respective objectives outlined in the Training Standards. Employers, therefore, are expected to complete the training of these respective objectives by applying the prescribed in-school knowledge to the required practical learning experienced in the work setting.

To ensure the apprentices will be able to successfully demonstrate the learning outcomes according to performance criteria, specific times have been allocated in the respective areas to allow for some applications enhancement. It is of utmost importance that all application assignments relate to prescribed experiences only. Time constraints will not permit engaging apprentices in tasks of limited learning benefits that are unrelated to the curriculum outcomes. In the Learning Content section, whenever an assigned operation for an applied test or repair procedure indicates that a demonstration should be performed, there is only enough time allocated for the instructor to perform the activity. If the statement in the assigned operations begins with “perform,” “outline,” “describe,” or “explain,” the student is expected to complete the activity.

Regular evaluations of the apprentices’ learning achievements must be performed in both theory and practical applications throughout the program to ensure consistency with learning outcome expectations. Testing of apprentice knowledge and skills will take place during the allotted delivery hours for each unit. In addition to providing an evaluation of apprenticeship competency, the review of test questions is considered to be a valuable learning opportunity.

In all practical activities, the apprentices will observe the *Occupational Health and Safety Act* and the application regulations including use of personal protective equipment. Institutional regulations and policies may also apply.

Implementation:
September 2003

Stakeholders Information

A consortium of colleges of applied arts and technology, working in collaboration with the MLITSD (Ministry of Labour, Immigration, Training and Skills Development) and industry stakeholders, participated in the development of this document. A Project Steering Committee was struck to guide the project development process for the Alignment and Brakes Technician documents.

The first step in the development process was to assemble a team, the Project Steering Committee (PSC), consisting of both industry representatives and apprenticeship in-school deliverers. The PSC initiated the plan for the project development that followed. The PSC established two curriculum development groups, each responsible for in-school apprenticeship curriculum documents for the motive power trades identified above.

The two working groups worked with advisory groups, made up of industry representatives, during the development of the curriculum, to ensure content validity. The curriculum development group members also worked with faculty in the colleges they were representing to broaden the consultation spectrum of the project. During various stages of the process, the PSC and participating industry advisory groups evaluated the draft curriculum documents and provided feedback and recommendations for revisions. The revisions to the curriculum documents were based on the new training standards that were developed by the MLITSD in consultation with industry advisory groups. The formal that is used in this document has been approved by the MLITSD.

Level 1

Reportable Subject Summary – Level 1

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.0	Work Practices	60	41	19
2.0	Suspension and Steering Systems	60	40	20
3.0	Tires, Wheels, Hubs and Alignment	60	36	24
4.0	Brakes Systems	60	37	24
	Total	240	154	87

Number:	1		
Title:	Work Practices		
Duration:	Total Hours: 60	Theory: 41	Practical: 19
Prerequisites:	None		
Co-requisites:	Level I, Section 2, 3, 4		

- 1.1 Fasteners
 - 6 Total Hours Theory: 3 hours Practical: 3 hours
- 1.2 Measuring Tools
 - 6 Total Hours Theory: 3 hours Practical: 3 hours
- 1.3 Diagnostic Test Equipment
 - 9 Total Hours Theory: 6 hours Practical: 3 hours
- 1.4 Applied Computer Skills
 - 6 Total Hours Theory: 3 hours Practical: 3 hours
- 1.5 Oxyacetylene Welding
 - 6 Total Hours Theory: 3 hours Practical: 3 hours
- 1.6 Electrical Fundamentals
 - 12 Total Hours Theory: 12 hours Practical: 0 hours
- 1.7 Electrical Circuit Calculations
 - 6 Total Hours Theory: 3 hours Practical: 3 hours
- 1.8 Battery Fundamentals
 - 3 Total Hours Theory: 2 hours Practical: 1 hours
- 1.9 Safe Working Practices and Techniques
 - 6 Total Hours Theory: 6 hours Practical: 0 hours

Number:	1.1		
Title:	Fasteners		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Cross-Reference to Learning Outcomes: 5181.01-07, 5182.01-04, 5183.01-04, 5184.01-10, 5185.01-04, 5186.01-04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction and principles of operation for fasteners.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.1.1 Define the purpose and fundamentals of fasteners.
- 1.1.2 Describe the functions, construction, composition, types, styles and application of the following fasteners.
- 1.1.3 Explain the principles of operation of fasteners.
- 1.1.4 Perform installation and removal procedures for fasteners.

Learning Content

- 1.1.1 Define the purpose and fundamentals of fasteners.
[1/0]
 - thread terminology, fastener grades/application
 - Society of Automotive Engineers (SAE) Standards, International (IS) Standards
 - tensile strength, shear strength
 - grade, pitch, threads per inch
 - diameter, length, head size, yield point and fatigue
 - dynamic and static seal applications
 - loctite grades
 - never-seize
 - sealant applications

1.1.2 Describe the functions, construction, composition, types, styles and application of the following fasteners.
[1/0]

- bolts
- nuts
- screws
- studs
- locking devices
- pins
- rivets
- keys
- washers
- retaining rings
- helicoils
- thread sealants and adhesives

1.1.3 Explain the principles of operation of fasteners.
[1/0]

- torque to yield bolts and capscrews
- torque effects of wet, dry and clean threads
- locking devices
- helicoil thread repair principles
- temperature
- compatibility
- clamping force

1.1.4 Perform installation and removal procedures for fasteners.
[0/3]

- verify thread strengths and torque requirements for wet and dry
- thread repair
 - freeing seized threads, removal of broken studs / capscrews
 - installation of helicoils, locking devices
- metal working practices
 - drilling
 - tapping
 - hack sawing
 - filing
- sealant selection, removal and installation practices
- loctite and never-seize application

- factors that affect torque
 - thread condition
 - lubrication
 - temperature
 - fastener composition

Number:	1.2		
Title:	Measuring Tools		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Cross-Reference to Learning Outcomes: 5181.03,04,06,07, 5182.03,04, 5183.03,04, 5184.03,04,06,07,09,10, 5185.03,04, 5186.03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction and principles of operation, calibration of precision and non-precision measuring tools.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.2.1 Define the purpose and fundamentals of precision and non-precision tools.
- 1.2.2 Describe the functions, construction, composition, types, styles and application of precision measuring tools.
- 1.2.3 Explain the principles of operation of precision measuring tools.
- 1.2.4 Perform the manufacturers' maintenance and calibration procedures of precision and non- precision measuring tools.

Learning Content

- 1.2.1 Define the purpose and fundamentals of precision and non-precision tools.
[1/0]
 - metric and imperial measurements, and conversions
- 1.2.2 Describe the functions, construction, composition, types, styles and application of precision measuring tools.
[1/0]
 - micrometers
 - inside, outside, depth
 - small hole gauges
 - calipers
 - vernier

- telescoping gauges
- straight edges
- dial indicators
- universal gauges
- non-precision

1.2.3 Explain the principles of operation of precision measuring tools.
[1/0]

- micrometers
 - inside, outside, depth
- small hole gauges
- calipers
- vernier
- telescoping gauges
- straight edges
- thickness gauges
- dial indicators
- universal gauges
- non-precision

1.2.4 Perform the manufacturers' maintenance and calibration procedures of precision and non- precision measuring tools.
[0/3]

- demonstrate precision measuring activities as applied to various components and clearance checks
- describe basic tool maintenance procedures
 - storage
 - lubrication
 - methods of restoring critical surfaces
 - adjustments, calibration
 - micrometer calibrating kit

Number:	1.3		
Title:	Diagnostic Test Equipment		
Duration:	Total Hours: 9	Theory: 6	Practical: 3
Cross-Reference to Learning Outcomes: 5181.02,04,05, 5182.02,04, 5183.02,04, 5184.02,04,05,07,08,10, 5185.02,04, 5186.02,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction and principles of operation of diagnostic test equipment.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.3.1 Define the purpose and fundamentals of diagnostic test equipment.
- 1.3.2 Describe the construction, composition, types, styles and application of diagnostic test equipment.
- 1.3.3 Explain the operating principles of diagnostic test electronic equipment.
- 1.3.4 Connect and operate diagnostic test equipment according to manufacturers' operating procedures.

Learning Content

- 1.3.1 Define the purpose and fundamentals of diagnostic test equipment.
[1/0]
 - gauges
 - pressure
 - vacuum
 - electrical equipment
 - ammeter
 - voltmeter
 - ohmmeter
 - electronic scan tools
 - continuity circuit testers
 - heavy duty carbon pile load tester
 - high impedance multi-meters

1.3.2 Describe the construction, composition, types, styles and application of diagnostic test equipment.
[2/0]

- gauges
 - pressure
 - vacuum
- electrical equipment
 - ammeter
 - voltmeter
 - ohmmeter
 - electronic scan tools
 - continuity circuit testers
 - heavy duty carbon pile load tester
 - high impedance multi-meters

1.3.3 Explain the operating principles of diagnostic test electronic equipment.
[3/0]

- gauges
 - pressure
 - vacuum
- electrical equipment
 - ammeter
 - voltmeter
 - ohmmeter
 - electronic scan tools
 - continuity circuit testers
 - heavy duty carbon pile load tester
 - high impedance multi-meters

1.3.4 Connect and operate diagnostic test equipment according to manufacturers' operating procedures.
[0/3]

- gauges
 - pressure
 - vacuum
- electrical equipment
 - ammeter
 - voltmeter
 - ohmmeter
 - electronic scan tools
 - continuity circuit testers
 - heavy duty carbon pile load tester
 - high impedance multi-meters

Number:	1.4		
Title:	Applied Computer Skills		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Cross-Reference to Learning Outcomes: 5180.05, 5181.01-07, 5182.01-04, 5183.01-04, 5184.01-10, 5185.01-04, 5186.01-04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction and principles of operation of personal computers (PC).

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.4.1 Define the purpose, functions and application of the computers.
- 1.4.2 Perform the following computer functions.

Learning Content

- 1.4.1 Define the purpose, functions and application of the computers.
[2/1]
 - introduction to the computer
 - components
 - device names and designations
 - hard / floppy disk data retention
 - CD-ROM
 - software management
- 1.4.2 Perform the following computer functions.
[1/2]
 - menu structure
 - create word processed document
 - file saving
 - floppy
 - hard drive
 - naming
 - copy/ move
 - access trade related information

- email
 - accessing
 - sending
 - attachments
- access internet
 - browsing
 - file download

Number:	1.5		
Title:	Oxyacetylene Welding		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Cross-Reference to Learning Outcomes: 5182.03, 5184.03,06,09, 5185.03, 5186.03			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the safety precautions, equipment set-up and principles of operation for oxyacetylene heating and cutting.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.5.1 Describe oxyacetylene safety precautions.
- 1.5.2 Describe equipment set-up and operation.
- 1.5.3 Perform oxyacetylene heating and cutting procedures according to manufacturers' recommendations.

Learning Content

- 1.5.1 Describe oxyacetylene safety precautions.
[2/0]
 - tank storage, security and handling
 - pressure settings and ignition procedures
 - eye protection
 - clothing and footwear
 - fire extinguisher application
- 1.5.2 Describe equipment set-up and operation.
[1/0]
 - set-up of equipment
 - start-up procedures
 - flame settings
 - gas pressure settings
 - torch angles and travel speed
 - shut-down procedures

- 1.5.3 Perform oxyacetylene heating and cutting procedures according to manufacturers' recommendations.
[0/3]
- stud removal
 - heat / cut seized fasteners and other components
 - remove nuts from corroded cap screws and studs, leaving threads undamaged
 - cut exhaust pipe with cutting torch
 - exhaust system repair / fabrication

Number:	1.6		
Title:	Electrical Fundamentals		
Duration:	Total Hours: 12	Theory: 12	Practical: 0
Cross-Reference to Learning Outcomes: 5181.01-07, 5182.01-04, 5183.01-04, 5184.01-010			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of fundamentals, principles of operation and applications of electrical concepts.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.6.1 Define the purpose, fundamentals and principles of electricity.
- 1.6.2 Describe the application of electrical concepts.

Learning Content

- 1.6.1 Define the purpose, fundamentals and principles of electricity.
[8/0]
 - atomic structure
 - conductors and insulators
 - magnetism
 - electromagnetism
 - electron and conventional theories
 - sources of electricity
 - heat
 - pressure
 - friction
 - chemical
 - light
 - magnetism
 - Ohm's Law
 - current flow, heat and resistance
 - electromagnetic induction
 - Standard International (S.I.) System, eg. mega, kilo, milli, micro

1.6.2 Describe the application of electrical concepts.
[4/0]

- voltage
- amperage
- resistance
- wattage
- electrical circuit schematics

Number:	1.7		
Title:	Electrical Circuit Calculations		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Cross-Reference to Learning Outcomes:	5181.01-07, 5182.01-04, 5183.01-04, 5184.01-10		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of performing circuit calculations to verify Ohm's, Watts and Kirchoff's Laws.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.7.1 Define the purpose and fundamentals of electrical circuits.
- 1.7.2 Describe the function, construction, composition, types and application of electrical circuits.
- 1.7.3 Perform circuit calculations to verify Ohm's, Watts and Kirchoff's Laws.
- 1.7.4 Demonstration and application of the selection of meters for voltage, amperage and resistance tests.

Learning Content

- 1.7.1 Define the purpose and fundamentals of electrical circuits.
[1/0]
 - series
 - parallel
 - series-parallel

- 1.7.2 Describe the function, construction, composition, types and application of electrical circuits.
[2/0]
- basic electrical schematics and symbols (battery, resistor, switch and ground)
 - electric circuit formulae
 - series circuits
 - parallel circuits
 - series-parallel circuits
- 1.7.3 Perform circuit calculations to verify Ohm's, Watts and Kirchoff's Laws for the following types of circuits.
[0/1.5]
- series circuits
 - parallel circuit
 - series-parallel circuit
- 1.7.4 Demonstration and application of the selection of meters for voltage, amperage and resistance tests.
[0/1.5]
- circuit board exercises
 - simulated electrical circuits
 - vehicle electrical circuits
 - comparisons between measured and calculated circuit performance

Number:	1.8		
Title:	Battery Fundamentals		
Duration:	Total Hours: 3	Theory: 2	Practical: 1
Cross-Reference to Learning Outcomes:	5181.01-07, 5182.02,03, 5183.02,03, 5184.02,03,05,06,08,09		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, principles of operation, inspection and testing for batteries.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.8.1 Define the purpose and fundamentals of batteries.
- 1.8.2 Describe the construction, composition, types, styles and application of batteries.
- 1.8.3 Explain the principles of operation of batteries.
- 1.8.4 Perform inspection and testing procedures on batteries with the prescribed service tools and equipment according to manufacturers' recommendations.
- 1.8.5 Perform assigned operations on batteries according to manufacturers' recommendations.

Learning Content

- 1.8.1 Define the purpose and fundamentals of batteries.
[1/0]
 - amp-hour rating (AH)
 - cranking amps (CA)
 - reserve capacity (RC)
 - cold cranking amps (CCA)
 - temperature effects
 - internal resistance factors
 - specific gravity and temperature compensation for electrolyte

- 1.8.2 Describe the function, construction, composition, types, styles and application of batteries.
[.5/0]
- lead acid
 - low maintenance
 - maintenance-free batteries
 - gelled cell batteries
- 1.8.3 Explain the principles of operation of batteries.
[.5/0]
- battery chemical action during charging and discharging
 - temperature effect on charging and internal resistance ratings
 - describe safe handling precautions for servicing, charging and handling
- 1.8.4 Perform inspection and testing procedures on batteries with the prescribed service tools and equipment according to manufacturers' recommendations.
[0/.5]
- visual inspection
 - state of charge
 - surface discharge
 - load test
 - describe safe handling precautions for servicing, charging and handling
 - temperature adjustments
 - conductance testing
- 1.8.5 Perform assigned operations on batteries according to manufacturers' recommendations.
[0/.5]
- maintenance
 - state of charge
 - storage
 - activation
 - charging procedures
 - cleaning precautions
 - removal and replacement procedures
 - outlines
 - adding electrolyte/water

Number:	1.9		
Title:	Safe Working Practices and Techniques		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross-Reference to Learning Outcomes:	1.1-4, 1.7, 1.11-12		

General Learning Outcome

The apprentice is able to describe the pertinent information relating to *Workplace Hazardous Materials Information Safety (WHMIS)*, *Occupational Health and Safety Act (OHSA)*, *Repair and Storage Liens Act (RSLA)* and *Workplace Safety Insurance Board (WSIB)*.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.9.1 Describe *Workplace Hazardous Materials Information Safety (WHMIS)*.
- 1.9.2 Describe *Occupational Health and Safety Act (OHSA)*.
- 1.9.3 Describe the *Repair and Storage Liens Act (RSLA)*.
- 1.9.4 Describe the *Workplace Safety Insurance Board (WSIB)*.

Learning Content

- 1.9.1 Describe *Workplace Hazardous Materials Information Safety (WHMIS)*.
[2/0]
 - right to know
 - legislation
 - safe handling of products
 - hazardous materials
 - Material Safety Data Sheets (MSDS)
- 1.9.2 Describe *Occupational Health and Safety Act (OHSA)*.
[1/0]
 - legislation
 - obligation of employer and worker

- 1.9.3 Describe the *Repair and Storage Liens Act (RSLA)*.
[2/0]
- payment for repairs or storage
 - lien
 - search for
 - Personal Property Security Registration (PPSP)
 - registration by vehicle identification number(VIN)
 - registration by individuals names
 - registration by business name
 - dispute over lien
- 1.9.4 Describe the *Workplace Safety Insurance Board (WSIB)*.
[1/0]
- reporting accidents to company
 - reporting accidents to WSIB
 - required records
 - training requirements
 - accident prevention
 - safety precautions
 - personal protection equipment
 - house keeping

Evaluation:

The following evaluation structure is only a suggested format. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.

Evaluation Structure		
Theory Testing	Practical Application Testing	Notebook and Organizational Skills
60%	30%	10%

Number:	2		
Title:	Suspension and Steering Systems		
Duration:	Total Hours: 60	Theory: 40	Practical: 20
Prerequisites:	None		
Co-requisites:	Level I, Section 1, 3, 4		

2.1 Belts and Pulleys

3 Total Hours Theory: 2 hours Practical: 1 hour

2.2 Frames

9 Total Hours Theory: 6 hours Practical: 3 hours

2.3 Non-Independent Suspension

6 Total Hours Theory: 4 hours Practical: 2 hours

2.4 Independent and Semi-Independent Suspension

9 Total Hours Theory: 6 hours Practical: 3 hours

2.5 Spring Devices

6 Total Hours Theory: 5 hours Practical: 1 hour

2.6 Suspension Control Devices

9 Total Hours Theory: 6 hours Practical: 3 hours

2.7 Steering Linkage

6 Total Hours Theory: 3 hours Practical: 3 hours

2.8 Manual Steering

6 Total Hours Theory: 3 hours Practical: 3 hours

2.9 Steering Column

6 Total Hours Theory: 5 hours Practical: 1 hours

Number:	2.1		
Title:	Belts and Pulleys		
Duration:	Total Hours: 3	Theory: 2	Practical: 1
Cross-Reference to Learning Outcomes: 5181.01-04, 5183.01-04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, principles of operation, inspection and testing for belts and pulleys.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.1.1 Define the purpose and fundamentals of various belts and pulleys.
- 2.1.2 Describe the construction, composition, types, styles and application of belts and pulleys.
- 2.1.3 Explain the principles of operation of belts and pulleys.
- 2.1.4 Perform inspection and testing procedures of belts and pulleys according to manufacturers' recommendations.
- 2.1.5 Perform assigned operations according to manufacturers' recommendations.

Learning Content

- 2.1.1 Define the purpose and fundamentals of various belts and pulleys.
[.5/0]
 - belts
 - routing diagrams
 - ratios
- 2.1.2 Describe the construction, composition, types, styles and application of belts and pulleys.
[.5/0]
 - pulleys
 - belts
 - "V"
 - serpentine
 - cog

2.1.3 Explain the principles of operation of belts and pulleys
[.5/0]

- pulleys
- belts
 - “V”
 - serpentine
 - cog

2.1.4 Perform inspection and testing procedures of belts and pulleys according to manufacturers’ recommendations.
[.5/1]

- identification
 - cracks
 - wear
 - deterioration
 - alignment
- tension
- pulley wear
- bearings

Number:	2.2		
Title:	Frames		
Duration:	Total Hours: 9	Theory: 6	Practical: 3
Cross-Reference to Learning Outcomes:	5182.01,02,03,04, 5186.01-04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, application and testing procedures for frames.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.2.1 Define the purpose and fundamentals of frame and chassis types.
- 2.2.2 Describe the functions, construction, composition, types, styles and application of frame and chassis types.
- 2.2.3 Demonstrate measuring procedures on frames following manufacturers' recommendations.
- 2.2.4 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 2.2.1 Define the purpose and fundamentals of frame and chassis types.
[1/0]
 - frame chassis types
 - perimeter
 - ladder
 - "X" type
 - unitized
 - unitized with sub-frame

2.2.2 Describe the functions, construction, composition, types, styles and application of frame and chassis types.
[2/0]

- frame chassis types
 - perimeter
 - ladder
 - “X” type
 - unitized
 - unitized with sub-frame

2.2.3 Demonstrate measuring procedures on frames following manufacturers' recommendations.
[2/0]

- frame damage
 - sag
 - sway
 - mash
 - twist
 - diamond
 - tracking
 - raised
 - fractures
 - corrosion
 - door gaps
 - truck/hood fit
 - glass fit
- measuring
 - tram gauge
 - self-centering gauge
 - measuring tape
 - datum line
 - comparable measurement
 - visual indicators
 - laser
 - ultra sound

2.2.4 Perform assigned operations following manufacturers' recommendations.
[1/3]

- explain the recommended procedures to remove and replace an engine cradle assembly
- identify frame repair procedures and precautions
 - welding
 - drilling
- observe the setup and procedures for frame and body alignment using Datum charts and service bulletins
- damage from heating

Number:	2.3		
Title:	Non-Independent Suspension		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Cross-Reference to Learning Outcomes:	5182.01,02,03,04, 5186.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, application, inspection and testing procedures for non-independent suspension systems.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.3.1 Define the purpose and fundamentals of non-independent suspension systems.
- 2.3.2 Describe the functions, construction, composition, types, styles and applications of non-independent suspension systems.
- 2.3.3 Perform inspection and testing procedures of Elliott, reverse Elliott and modified Elliott axles according to manufactures' recommendations.
- 2.3.4 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 2.3.1 Define the purpose and fundamentals of non-independent suspension systems.
[1/0]
 - solid axles
 - advantages
 - load capacity
 - durability
 - disadvantages
 - weight transfer
 - handling

- 2.3.2 Describe the functions, construction, composition, types, styles and applications of non-independent suspension systems.
[2/0]
- Elliott axles
 - reverse Elliott axles
 - modified Elliott axles
- 2.3.3 Perform inspection and testing procedures of Elliott, reverse Elliott and modified Elliott axles according to manufacturers' recommendations.
[1/0]
- definition of axial clearance
 - definition of radial clearance
 - use of dial indicator and other special tools to measure actual clearance
 - compare to manufacturers' specifications
- 2.3.4 Perform assigned operations following manufacturers' recommendations.
[0/2]
- bushing and king pin replacement
 - skim pack
 - maintenance of axle assembly

Number:	2.4		
Title:	Independent and Semi-Independent Suspension		
Duration:	Total Hours: 9	Theory: 6	Practical: 3
Cross-Reference to Learning Outcomes:	5182.01,02,03,04, 5186.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, application, inspection and testing procedures for independent and semi-suspension systems.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.4.1 Define the purpose and fundamentals of independent and semi-independent suspension.
- 2.4.2 Describe the construction, composition, types, styles and application of independent and semi-independent suspension.
- 2.4.3 Explain the principles of operation of independent and semi-independent suspension.
- 2.4.4 Perform inspection and testing procedures on suspension system components following manufacturers' recommendations.
- 2.4.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 2.4.1 Define the purpose and fundamentals of independent and semi-independent suspension.
[1/0]
 - independent
 - equal length control arm
 - short and long control arms (SLA)
 - wishbone
 - multi-link
 - MacPherson strut
 - modified strut
 - twin I beam

- semi-independent
 - beam axle
 - trailing arms
 - modified strut

2.4.2 Describe the construction, composition, types, styles and application of independent and semi-independent suspension.
[1/0]

- independent
 - equal length control arm
 - short and long control arms (SLA)
 - wishbone
 - multi-link
 - MacPherson strut
 - modified strut
 - twin I beam
- semi-independent
 - beam axle
 - trailing arms
 - types of ball joints (load carrying, tension or follower)
 - control arm bushings (torsilastic)

2.4.3 Explain the principles of operation of independent and semi-independent suspension.
[2/0]

- independent
 - equal length control arm
 - short and long control arms (SLA)
 - double wishbone
 - multi-link
 - MacPherson strut
 - modified strut
 - twin I beam
- semi-independent
 - beam axle
 - trailing arms
 - types of ball joints (load carrying, tension or follower)
 - control arm bushings (torsilastic)

2.4.4 Perform inspection and testing procedures on suspension system components following manufacturers' recommendations.
[1/2]

- ball joint types
 - load carrying
 - tension or follower joints)
- built-in wear indicators)
 - axial and radial movement
- control arm bushing wear, deterioration
- control arm shaft wear, etc.
- beam axle
- trailing arms

2.4.5 Perform assigned operations following manufacturers' recommendations.
[1/1]

- methods of ball joint installation
 - pressed
 - bolted
 - welded
 - threaded
 - part of control arm
 - adjustable ball joints
- control arm bushing and shafts

Number:	2.5		
Title:	Spring Devices		
Duration:	Total Hours: 6	Theory: 5	Practical: 1
Cross-Reference to Learning Outcomes: 5182.01,02,03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the construction, application, principles of operation, inspection and testing procedures for spring devices.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.5.1 Define the purpose and fundamentals of springs and spring terminology.
- 2.5.2 Describe the construction, composition, types, styles and applications of spring assemblies.
- 2.5.3 Explain the principles of operation of spring assemblies.
- 2.5.4 Perform inspection and testing procedures on spring assemblies following manufacturers' recommendations.

Learning Content

- 2.5.1 Define the purpose and fundamentals of springs and spring terminology.
[3/0]
 - Hook's Law (variable rate, constant rate, linear, non-linear)
 - curb weight
 - center of gravity
 - braking torque
 - acceleration torque
 - tensile, compression, shear stress
 - synthetic, rubber, fiber-composite
 - spring steel
 - un-sprung weight
 - sprung weight
 - jounce
 - rebound

- curb, ride or trim height
- tapered plate
- mono-leaf
- symmetrical and asymmetrical
- full, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$, elliptical springs
- frequency

2.5.2 Describe the construction, composition, types, styles and applications of spring assemblies.

[1/0]

- leaf (single and multi-leaf)
- coil
- torsion bars
- air spring

2.5.3 Explain the principles of operation of spring assemblies.

[1/0]

- leaf
- coil
- torsion bars
- air spring

2.5.4 Perform inspection and testing procedures on spring assemblies following manufacturers' recommendations.

[0/1]

- leaf
- coil
- torsion bars
- air spring

Number:	2.6		
Title:	Suspension Control Devices		
Duration:	Total Hours: 9	Theory: 6	Practical: 3
Cross-Reference to Learning Outcomes: 5182.01,02,03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction, principles of operation, inspection and testing procedures for suspension control devices.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.6.1 Define the purpose and fundamentals of suspension control devices.
- 2.6.2 Describe the construction, composition, types, styles and applications of suspension control devices.
- 2.6.3 Explain the principles of operation of suspension control devices.
- 2.6.4 Perform inspection and testing procedures on suspension control devices following manufacturers' recommendations.
- 2.6.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 2.6.1 Define the purpose and fundamentals of suspension control devices.
[2/0]
 - full frame / unibody
 - shock absorbers / struts
 - hydraulic
 - air
 - gas charged
 - radius rods
 - sway bars
 - steering dampers
 - rear tie rod (panhard rod)
 - differential torque control devices
 - torque arms

- quad shocks
- traction bars
- torque tube
- torque rod

2.6.2 Describe the construction, composition, types, styles and applications of suspension control devices.
[2/0]

- full frame / unibody
- shock absorbers / struts
 - hydraulic
 - air
 - gas charged
- radius rods
- sway bars
- steering dampers
- rear tie rod (panhard rod)
- differential torque control devices
 - torque arms
- quad shocks
- traction bars
- torque tube / rod

2.6.3 Explain the principles of operation of suspension control devices.
[2/0]

- full frame / unibody
- shock absorbers / struts
 - hydraulic
 - air
 - gas charged
- radius rods
- sway bars
- steering dampers
- rear tie rod
- panhard rod
- differential torque control devices
 - torque arms
- quad shocks
- traction bars
- torque tube
- torque rod

2.6.4 Perform inspection and testing procedures on suspension control devices following manufacturers' recommendations.

[0/2]

- full frame / unibody
- shock absorbers / struts
 - hydraulic
 - air
 - gas charged
- radius rods
- sway bars
- steering dampers
- rear tie rod
- panhard rod
- differential torque control devices
 - torque arms
- quad shocks
- traction bars
- torque tube
- torque rod

2.6.5 Perform assigned operations following manufacturers' recommendations.

[0/1]

- full frame / unibody
- shock absorbers / struts
 - hydraulic
 - air
 - gas charged
- radius rods
- sway bars
- steering dampers
- rear tie rod
- panhard rod
- differential torque control devices
 - torque arms
- quad shocks
- traction bars
- torque tube
- torque rod

Number:	2.7		
Title:	Steering Linkage		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Cross-Reference to Learning Outcomes:	5183.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, application, inspection and testing procedures for steering linkage.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.7.1 Define the purpose and fundamentals of steering linkages
- 2.7.2 Describe the functions, construction, composition, types, styles and applications of steering linkages.
- 2.7.3 Perform inspection and testing of steering linkage components following manufacturers' recommendations.
- 2.7.4 Perform assigned operations on steering linkage components following manufacturers' recommendations.

Learning Content

- 2.7.1 Define the purpose and fundamentals of steering linkages
[1/0]
 - parallelogram
 - rack and pinion
 - steering linkage
- 2.7.2 Describe the functions, construction, composition, types, styles and applications of steering linkages.
[1/0]
 - parallelogram
 - rack and pinion
 - drag link
 - steering linkage
 - malleable iron
 - leverage

2.7.3 Perform inspection and testing of steering linkage components following manufacturers' recommendations.

[1/1]

- inner and outer tie rods (rubber bonded sockets)
- inner tie rod sockets (rack and pinion), articulate effort
- idler arms
- Pitman arm
- center link
- drag link

2.7.4 Perform assigned operations on steering linkage components following manufacturers' recommendations.

[0/2]

- inner and outer tie rods (rubber bonded sockets)
- inner tie rod sockets (rack and pinion), articulation effort
- idler arms
- Pitman arm
- center link
- drag link

Number:	2.8		
Title:	Manual Steering		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Cross-Reference to Learning Outcomes:	5183.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction, principles of operation, inspection and testing for manual steering gear.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.8.1 Define the purpose and fundamentals of manual steering gear assemblies.
- 2.8.2 Describe the construction, composition, types, styles and applications of manual steering gear assemblies.
- 2.8.3 Explain the principles of operation of manual steering gear assemblies.
- 2.8.4 Perform inspection and testing of manual steering gear assemblies following manufacturers' recommendations.
- 2.8.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 2.8.1 Define the purpose and fundamentals of manual steering gear assemblies.
[1/0]
 - worm and sector
 - worm and roller
 - recirculating ball
 - rack and pinion
- 2.8.2 Describe the construction, composition, types, styles and applications of manual steering gear assemblies.
[1/0]
 - recirculating ball
 - rack and pinion

- 2.8.3 Explain the principles of operation of manual steering gear assemblies.
[1/0]
- recirculating ball
 - rack and pinion
 - steering gear ratio (mechanical advantages)
- 2.8.4 Perform inspection and testing of manual steering gear assemblies following manufacturers' recommendations.
[0/1.5]
- recirculating ball
 - rack and pinion
 - identify and observe precautions when disconnecting steering linkages regarding clock spring damage
- 2.8.5 Perform assigned operations following manufacturers' recommendations.
[0/1.5]
- recirculating ball
 - worn bearings preload
 - over-center preload
 - sector shaft end play
 - rack and pinion
 - pinion bearing preload
 - rack yoke preload

Number:	2.9		
Title:	Steering Column		
Duration:	Total Hours: 6	Theory: 5	Practical: 1
Cross-Reference to Learning Outcomes: 5183.01,02,03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction, principles of operation, inspection and testing for steering column.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.9.1 Define the purpose and fundamentals of steering columns.
- 2.9.2 Describe the construction, composition, types and styles of steering columns.
- 2.9.3 Explain the principles of operation of steering columns.
- 2.9.4 Perform inspection and testing procedures on steering columns following manufacturers' recommendations.
- 2.9.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 2.9.1 Define the purpose and fundamentals of steering columns.
[1/0]
 - collapsing
 - tilt
 - telescoping
 - locking plates
 - cylinders
 - conventional
 - electronic coded (vehicle security)
 - supplemental inflatable restraint (SIR)
 - steering wheel
 - diameter vs lever principle
 - master spline
 - collapsing

2.9.2 Describe the construction, composition, types and styles of steering columns.
[2/0]

- collapsing
- tilt
- telescoping
- locking plates
- cylinders
 - conventional
 - electronic coded (vehicle security)
- supplemental inflatable restraint (SIR)
- steering wheel
 - diameter vs lever principle
 - master spline
- collapsing

2.9.3 Explain the principles of operation of steering columns.
[2/0]

- collapsing
- tilt
- telescoping
- locking plates
- cylinders
 - conventional
 - electronic coded (vehicle security)
- supplemental inflatable restraint (SIR)
 - steering wheel
 - diameter vs lever principle
 - master spline
 - collapsing

2.9.4 Perform inspection and testing procedures on steering columns following manufacturers' recommendations.
[0/1]

- collapsing
- tilt
- telescoping
- locking plates
- cylinders
 - conventional
 - electronic coded (vehicle security)

- supplemental inflatable restraint (SIR)
 - steering wheel
 - diameter vs lever principle
 - master spline
 - collapsing

Evaluation:

The following evaluation structure is only a suggested format. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.

Evaluation Structure			
Theory Testing	Practical Application Testing	Research Assignment	Notebook and Organizational Skills
50%	30%	10%	10%

Number:	3		
Title:	Tires, Wheels, Hubs and Alignment		
Duration:	Total Hours: 60	Theory: 36	Practical: 24
Prerequisites:	None		
Co-requisites:	Level I, Section 1, 2, 4		

3.1 Bearings, Seals and Sealants

9 Total Hours Theory: 6 hours Practical: 3 hours

3.2 Tires and Wheels

12 Total Hours Theory: 6 hours Practical: 6 hours

3.3 Hubs, Bearings and Drive Assemblies

24 Total Hours Theory: 12 hours Practical: 12 hours

3.4 Introduction to Alignment

15 Total Hours Theory: 12 hours Practical: 3 hours

Number:	3.1		
Title:	Bearings, Seals and Sealants		
Duration:	Total Hours: 9	Theory: 6	Practical: 3
Cross-Reference to Learning Outcomes:	5183.01,02,03,04, 5185.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, principles of operation, inspection and testing for bearings, seals and sealants.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 3.1.1 Define the purpose and fundamentals of bearings, seals and sealants.
- 3.1.2 Describe the construction, composition, types, styles and application of bearings, seals and sealants.
- 3.1.3 Explain the principles of operation of bearings, seals and sealants.
- 3.1.4 Perform inspection and testing procedures following manufacturers' recommendations.
- 3.1.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 3.1.1 Define the purpose and fundamentals of bearings, seals and sealants.
[1/0]
 - friction
 - temperature
 - lubrication
 - preload

3.1.2 Describe the construction, composition, types, styles and application of bearings, seals and sealants.
[1.5/0]

- friction bearings
- anti-friction bearings
 - ball
 - roller
 - needle
- seals
 - dynamic
 - static
- sealants
 - hardening
 - hardening
- gaskets

3.1.3 Explain the principles of operation of bearings, seals and sealants.
[3/0]

- friction bearings
 - hydrodynamic suspension
- anti-friction bearings
 - ball
 - roller
 - needle
- seals
 - dynamic
 - static
- sealants
 - anaerobic
 - non-anaerobic
- gaskets
 - yield
 - creep

3.1.4 Perform inspection and testing procedures following manufacturers' recommendations.
[.5/2]

- failure analysis
 - scoring
 - spalling
 - over-heating
 - noise
 - vibration
 - clearance
 - migration
- checks for leakage of seals or gaskets
- shaft and housing bore condition
- fluid compatibility

3.1.5 Perform assigned operations following manufacturers' recommendations.
[0/1]

- bearings
 - friction
 - non-friction
- seals
 - static
 - dynamic
- sealants
- gaskets

Number:	3.2		
Title:	Tires and Wheels		
Duration:	Total Hours: 12	Theory: 6	Practical: 6
Cross-Reference to Learning Outcomes: 5185.01,02,03,04, 5186.01,02,03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction, principles of operation, inspection and testing for tires and wheels.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 3.2.1 Define the purpose and fundamentals of tires and wheels.
- 3.2.2 Describe the construction, composition, types, styles and application of tires and wheels.
- 3.2.3 Explain the principles of operation of tires and wheels.
- 3.2.4 Inspect, test, remove and replace tires and wheels with the prescribed service tools and equipment following manufacturers' recommendations.
- 3.2.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 3.2.1 Define the purpose and fundamentals of tires and wheels.
[1/0]
 - tires
 - tube
 - tubeless
 - bias ply
 - bias / belted
 - radial purpose
 - traction / braking
 - shock absorption
 - run flat

- wheels
 - one-piece
 - two-piece
 - split
 - stamped / cast
- sliding and rolling friction
- centrifugal and centripetal forces

3.2.2 Describe the construction, composition, types, styles and application of tires and wheels.

[2/0]

- tires
 - tread designs
 - load ratings
 - size
 - speed
 - uniform tire quality grading system (U.T.Q.G.S.)
 - components
 - compact spares
 - differences between radial and bias / ply tire construction
 - slip angle / slip ratio
- wheels
 - cast (ferrous / non-ferrous)
 - offset design
 - size designations

3.2.3 Explain the principles of operation of tires and wheels.

[2/0]

- tires
 - tread designs
 - rates
 - speed
 - load
 - temperature
 - components
 - compact spares
 - run flat
 - differences between radial and bias / ply tire construction
 - slip angle / slip ratio
- wheels
 - stamped / cast
 - offset design
 - size designation
 - ferrous and non-ferrous

- centrifugal forces on rotating assemblies
 - vibration
 - thrust and radial loads
- balance factors
 - tire static and dynamic balance
 - tire action under various operating conditions
 - effect of heat and load

3.2.4 Inspect, test, remove and replace tires and wheels with the prescribed service tools and equipment following manufacturers' recommendations. [0/4]

- perform tire and rim safety inspections
- perform measurement of radial and lateral wheel and tire runout
- observe and perform static and dynamic balancing
- tire wear and damage
 - normal and abnormal wear
 - misalignment
 - braking
 - road surface
 - inflation pressure / cord abuse
 - driver abuse
- tire rotation
- fastener torque

3.2.5 Perform assigned operations following manufacturers' recommendations. [1/2]

- tire and wheel run-out
 - on vehicle
 - off vehicle
- tire and wheel balance
 - on vehicle
 - off vehicle
- mounting procedures
- collision impact damage
- sizing / application
- corrosion / porosity
- tire service
 - patch
 - plugs
 - inspection of casting
 - rim sealing

Number:	3.3		
Title:	Hubs, Bearings and Drive Assemblies		
Duration:	Total Hours: 24	Theory: 12	Practical: 12
Cross-Reference to Learning Outcomes:	5185.01,02,03,04, 5186.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction, principles of operation, inspection and testing for hubs, bearings and drive assemblies.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 3.3.1 Define the purpose and fundamentals of hubs, bearings and drive assemblies.
- 3.3.2 Describe the construction, composition, types, styles and applications of hubs, bearings and drive assemblies.
- 3.3.3 Explain the principles of operation of hubs and drive assemblies.
- 3.3.4 Perform inspection and testing procedures of hubs, bearings and drive assemblies following manufacturers' recommendations.
- 3.3.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 3.3.1 Define the purpose and fundamentals of hubs, bearings and drive assemblies.
[2/0]
 - hubs
 - driving
 - front wheel, rear wheel
 - four-wheel drive
 - manual and automatic locking
 - non-driving
 - front-wheel
 - rear-wheel
 - bearing assembly type

- seal designs
- front-wheel drive axles
- half-shafts
- constant velocity (CV) joints
- tripod
- rzeppa
- constant velocity (CV) boots
- vibration damper
- rear-wheel drive axles
 - shafts
 - universal joints
 - single and double cardin
 - axles
 - semi-floating
 - full floating
 - $\frac{3}{4}$ floating

3.3.2 Describe the construction, composition, types, styles and applications of hubs, bearings and drive assemblies.
[4/0]

- hubs
 - driving
 - front wheel, rear wheel
 - four-wheel drive
 - manual and automatic locking
 - non-driving
 - front-wheel
 - rear-wheel
 - bearing assembly type
 - seal designs
 - front-wheel drive axles
 - half-shafts
 - constant velocity (CV) joints
 - tripod
 - rzeppa
 - constant velocity (CV) boots
 - vibration damper
- rear-wheel drive axles
 - shafts
 - universal joints
 - single and double cardin
 - axles
 - semi-floating
 - full floating
 - $\frac{3}{4}$ floating

- 3.3.3 Explain the principles of operation of hubs and drive assemblies.
[4/0]
- constant velocity (CV) joints
 - fixed joint
 - plunge joint
 - compound angles
 - cardin / double cardin U-joints
 - phasing
 - canceling angles
 - operating angles
 - loads on constant velocity (CV) joints and U-joints
 - locking hubs
- 3.3.4 Perform inspection and testing procedures of hubs, bearings and drive assemblies following manufacturers' recommendations.
[0/4]
- bearings
 - end play / free play
 - pre-load
 - wear
 - drive assemblies
 - U-joints
 - constant velocity (CV) joints
 - boots
 - Locking hubs
 - automatic
 - manual
- 3.3.5 Perform assigned operations following manufactures' recommendations.
[2/8]
- bearing service according to manufacturers' recommended practices
 - removal
 - cleaning
 - inspection
 - lubricating
 - replacement
 - adjustment
 - constant velocity (CV) joints boot replacement
 - axle service according to manufacturers' recommended practices
 - removal and installation

- hubs
 - bearing assemblies
 - symptoms
 - noise, lubrication leakage, seizure, vibration
 - causes
 - overtopping
 - driver abuse
 - service abuse
 - improper applications
 - locking hubs
 - removal and installation of front wheel drive and four wheel drive wheel bearings

Number:	3.4		
Title:	Introduction To Alignment		
Duration:	Total Hours: 15	Theory: 12	Practical: 3
Cross-Reference to Learning Outcomes: 5186.01,02,03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, applications of vehicle suspension system alignment and adjustment.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 3.4.1 Define the purpose and fundamentals of vehicle alignment.
- 3.4.2 Describe the functions, construction, composition, types, styles and application of vehicle suspension system alignment and adjustment.
- 3.4.3 Define alignment angles and measurements.
- 3.4.4 Explain the wheel alignment adjustments and calculations.
- 3.4.5 Explain the principles of operation and setup of vehicle alignment equipment following manufacturers' recommendations.

Learning Content

- 3.4.1 Define the purpose and fundamentals of vehicle alignment.
[2/0]
 - Ackerman's Principles
 - parallelogram
 - center of gravity
 - mechanical advantage
 - decimals, fractions, negative fractions
 - metric
 - centrifugal force
 - vehicle thrust angles

- 3.4.2 Describe the functions, construction, composition, types, styles and application of vehicle suspension system alignment and adjustment.
[2/0]
- types of alignment
 - two-wheel geometric center line alignment
 - four-wheel thrust alignment
 - eccentrics
 - shims
 - slots
 - strut rods
- 3.4.3 Define alignment angles and measurements.
[4/0]
- caster
 - camber
 - toe-in / toe-out
 - steering axis inclination
 - turning radius
 - trim height
 - thrust line
 - center line
 - scrub radius
- 3.4.4 Explain the wheel alignment adjustments and calculations.
[3/0]
- shim adjustments
 - eccentric adjustments
 - strut rod adjustments
 - elongated holes (slots)
- 3.4.5 Explain the principles of operation and setup of vehicle alignment equipment following manufacturers' recommendations.
[1/3]
- demonstration of:
 - operating procedures of alignment equipment
 - vehicle setup
 - equipment setup

Evaluation:

The following evaluation structure is only a suggested format. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.

Evaluation Structure			
Theory Testing	Practical Application Testing	Research Assignment	Notebook and Organizational Skills
40%	40%	10%	10%

Number:	4		
Title:	Brakes Systems		
Duration:	Total Hours: 60	Theory: 37	Practical: 24
Prerequisites:	None		
Co-requisites:	Level I, Section 1, 2, 3		

- 4.1 Fluid Power Fundamentals
9 Total Hours Theory: 9 hours Practical: 0 hours
- 4.2 Hydraulic Brakes Fundamentals
6 Total Hours Theory: 6 hours Practical: 0 hours
- 4.3 Braking System Components
15 Total Hours Theory: 13 hours Practical: 2 hours
- 4.4 Brake System Diagnosis
6 Total Hours Theory: 2 hours Practical: 4 hours
- 4.5 Brake Repairs and Servicing
24 Total Hours Theory: 6 hours Practical: 18 hours

Number:	4.1		
Title:	Fluid Power Fundamentals		
Duration:	Total Hours: 9	Theory: 9	Practical: 0
Cross-Reference to Learning Outcomes: 5183.01,02,03,04, 5184.01-10			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, application and principles of operation for fluid power systems.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.1.1 Define the purpose and fundamentals of fluid power systems.
- 4.1.2 Describe the composition, types, styles and applications of fluid power systems.
- 4.1.3 Explain the basic principles of fluid power systems.

Learning Content

- 4.1.1 Define the purpose and fundamentals of fluid power systems.
[3/0]
 - Pascal’s Law and the application to static fluids
 - Boyle’s Law, Charles’ Law, Pascal’s Law and their effects on hydraulic and pneumatic systems
 - laws of levers
 - pressure, force and area
 - flow and volume (rate)
 - measure of flow loss
- 4.1.2 Describe the composition, types, styles and applications of fluid power systems.
[3/0]
 - brakes
 - power steering
 - suspension

4.1.3 Explain the basic principles of fluid power systems.
[3/0]

- pumps
- control valves
- actuators
- master cylinders
- slave cylinders
- reservoirs
- oil coolers
- schematics

Number:	4.2		
Title:	Hydraulic Brakes Fundamentals		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross-Reference to Learning Outcomes:	5184.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals of a hydraulic brake system.

Learning Outcomes

Upon successful completion, the apprentice is able to:

4.2.1 Define the purpose and fundamentals of hydraulic brake systems.

Learning Content

4.2.1 Define the purpose and fundamentals of hydraulic systems.
[6/0]

- Pascal's Law
- laws of levers, mechanical advantages
- friction, edge codes (hot and cold)
- co-efficient of friction
- brake fluid, Department of Transport (DOT) types
- servo-action
- self-energizing
- velocity and acceleration, Kinetic energy, formulas, calculations, mass vs speed
- torque multiplication
- conversion of decimals and fractions
- displacement
- fade- mechanical, lining, gassing

Number:	4.3		
Title:	Braking System Components		
Duration:	Total Hours: 15	Theory: 13	Practical: 2
Cross-Reference to Learning Outcomes: 5184.01,02,03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction, principles of operation for brake systems and components.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.3.1 Define the purpose and fundamentals of braking system components.
- 4.3.2 Describe the construction, composition, types, styles and applications of brake system components.
- 4.3.3 Explain the principles of operation of brake systems and components.
- 4.3.4 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 4.3.1 Define the purpose and fundamentals of braking system components.
[4/0]
 - disc brakes
 - drum brakes
 - single-acting
 - external band
 - servo-action
 - self-energizing
 - velocity and acceleration
 - torque multiplication
 - effects of weight transfer on brake design and efficiency

- 4.3.2 Describe the construction, composition, types, styles and applications of brake system components.
[5/0]
- brake lines, hoses and fittings
 - master cylinders
 - wheel cylinders
 - calipers
 - brake shoes and disc pads
 - drums and rotors
 - control and metering devices
 - self-adjusting devices
 - parking brake
 - drum type
 - disc type
 - warning lamp
- 4.3.3 Explain the principles of operation of brake systems and components.
[4/0]
- master cylinders
 - wheel cylinders
 - calipers
 - self-adjusters
 - hand and parking brake
 - conventional hydraulic system
 - diagonal split
- 4.3.4 Perform assigned operations following manufacturers' recommendations.
[0/2]
- master cylinders
 - wheel cylinders
 - calipers
 - self-adjusters
 - hand and parking brake
 - conventional hydraulic system
 - diagonal split

Number:	4.4		
Title:	Brake System Diagnosis		
Duration:	Total Hours: 6	Theory: 2	Practical: 4
Cross-Reference to Learning Outcomes:	5184.02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of diagnostic procedures for brake systems and components.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.4.1 Perform inspection, testing and diagnostic procedures on brake systems and components with the prescribed service tools and equipment following manufacturers' recommendations.

Learning Content

- 4.4.1 Perform inspection, testing and diagnostic procedures on brake system and components with the prescribed service tools and equipment following manufacturers' recommendations.

[2/4]

- visual inspection
- fluid level and condition
- brake lines for integrity
- rotor and drum measurement for minimum recommended thickness and condition
- brake lining condition
- brake hydraulic system pressure tests
- brake system performance tests
 - electrical performance tests
 - mechanical performance tests
- master cylinders
- wheel cylinders
- calipers
- control and metering devices
- self-adjusters
- conventional hydraulic systems
- diagonal split system

Number:	4.5		
Title:	Brake Repair and Servicing		
Duration:	Total Hours: 24	Theory: 6	Practical: 18
Cross-Reference to Learning Outcomes: 5184.02,03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of repair procedures for brake systems and components.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.5.1 Perform assigned operations on brake systems and components following manufacturers' recommendations.

Learning Content

- 4.5.1 Perform assigned operations on brake systems and components following manufacturers' recommendations.

[6/18]

- hydraulic brake service
- replacement and repairs to D.O.T. minimum standards
 - hoses
 - lines
 - fittings
 - observe heating precautions
 - appropriate environmental brake dust removal
 - components removal and replacement
 - caliper and wheel cylinder removal and replacement
 - Anti-Lock Brake Systems (A.B.S.) safety precautions
 - determine safety precautions
 - flushing of lines and removing of fluid and bleeding of air
 - drum removal and machining
 - rotor removal and machining
 - caliper removal or rebuilding
 - pad and shoe removal
 - wheel cylinder removal or rebuilding
 - backing plate inspection and / or replacement and appropriate lubrication
 - removal of bleeder screws and brake lines

- adjustments
 - parking cable
 - drum brakes

Evaluation:

The following evaluation structure is only a suggested format. Specific evaluation of theory and practical components of training varies due to the resource material and training aides utilized.

Evaluation Structure			
Theory Testing	Practical Application Testing	Research Assignment	Notebook and Organizational Skills
50%	30%	10%	10%



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