



**Skilled
Trades**
Ontario

**Métiers
spécialisés**
Ontario

Apprenticeship
Curriculum Standard

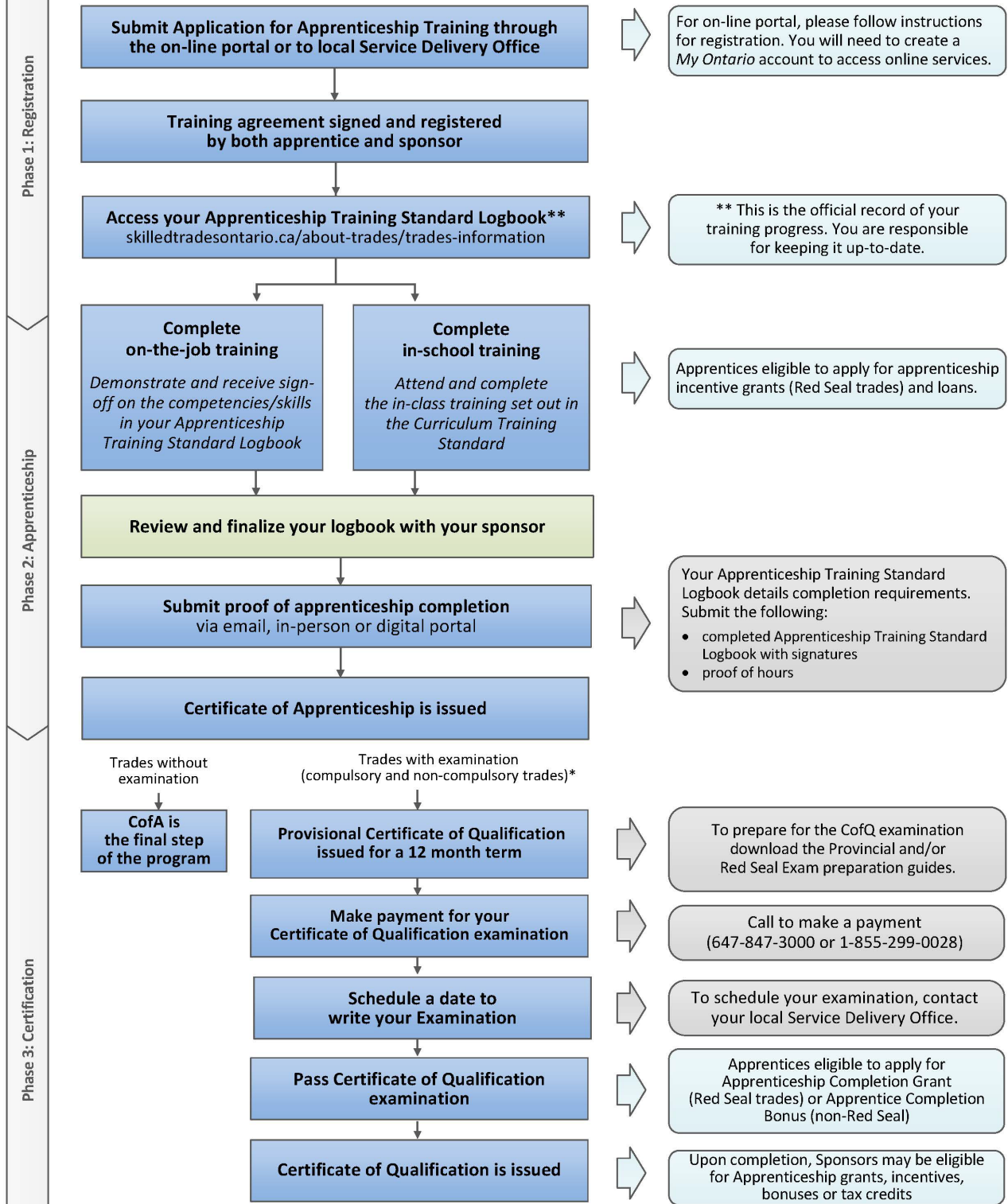
Alignment and Brakes
Technician

Level 2

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 \(BOSTA\)**](#).

Any updates to this publication are available on-line; to download this document in PDF format, please follow the link: [Skilled Trades Ontario.ca](https://skilledtradesontario.ca).

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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.

This is the second level of 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 2

Reportable Subject Summary – Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.0	Work Practices	60	38	22
2.0	Suspension and Steering Systems	60	39	21
3.0	Alignment Procedure and Diagnostics	60	36	24
4.0	Brakes Systems	60	39	21
	Total	240	152	88

Number:	1		
Title:	Work Practices		
Duration:	Total Hours: 60	Theory: 38	Practical: 22
Prerequisites:	Level I, Section I		
Co-requisites:	Level II, Section 2, 3, 4		

1.1	MIG Welding		
	9 Total Hours	Theory: 3 hours	Practical: 6 hours
1.2	Air Conditioning Fundamentals		
	3 Total Hours	Theory: 3 hours	Practical: 0 hours
1.3	Electromagnetic Device Fundamentals		
	6 Total Hours	Theory: 6 hours	Practical: 0 hours
1.4	Circuit Repair and Protection Devices		
	9 Total Hours	Theory: 6 hours	Practical: 3 hours
1.5	Applied Electrical Schematics		
	6 Total Hours	Theory: 4 hours	Practical: 2 hours
1.6	Electronic Fundamentals		
	12 Total Hours	Theory: 7 hours	Practical: 5 hours
1.7	Computer Fundamentals and Diagnostics		
	15 Total Hours	Theory: 9 hours	Practical: 6 hours

Number:	1.1		
Title:	MIG Welding		
Duration:	Total Hours: 9	Theory: 3	Practical: 6
Cross-Reference to Learning Outcomes: 5182.01,03,04			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the safety precautions, equipment setup and principles of operation for metal inert gas (MIG) welding.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.1.1 Describe metal inert gas safety precautions.
- 1.1.2 Describe metal inert gas welding equipment, consumables and operation.
- 1.1.3 Perform metal inert gas welding and diagnose defects with the prescribed service tools and equipment following manufacturers' recommendations.

Learning Content

- 1.1.1 Describe metal inert gas welding safety precautions.
[.5/0]
 - fire prevention and extinguisher availability
 - clothing and footwear protection
 - eye protection
 - ventilation requirements
 - electric shock protection
 - tank storage and handling
- 1.1.2 Describe metal inert gas welding equipment, consumables and operation.
[2/0]
 - power sources
 - consumables
 - wire type, sizes
 - shielding gas
 - metal preparation
 - equipment settings and trial beads

- arc initiation
- gun angle and travel speeds
- wire drive speeds
- gas flow rate
- electrode protrusion
- power sources required

1.1.3 Perform metal inert gas welding and diagnose defects with the prescribed service tools and equipment following manufacturers' recommendations. [.5/6]

- weld lap and tee joints
- repair exhaust systems / fabrication
- diagnose weld defects and analyze
- determine corrective action

Number:	1.2		
Title:	Air Conditioning Fundamentals		
Duration:	Total Hours: 3	Theory: 3	Practical: 0
Cross-Reference to Learning Outcomes:	5180.02,03,04,07		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of safety issues when working around air-conditioning as well as being able to identify various components.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.2.1 Identify the health and safety issues concerning the handling of ozone depleting substances.
- 1.2.2 Identify the major components and operating principles used in mobile air conditioning systems.

Learning Content

- 1.2.1 Identify the health and safety issues concerning the handling of ozone depleting substances.
[1/0]
 - identify personal safety equipment used when handling CFC/HFC/HCFC
 - eye, hand and face protection
 - identify dangers related to the handling of CFC/HFC/HCFC
 - toxicity
 - flammability
 - handling precautions
 - inhalation
 - skin and eye contact
 - cylinder temperature / pressures

1.2.2 Identify the major components and operating principles used in mobile air conditioning systems.

[2/0]

- identify major components of automotive air conditioning systems
 - condenser
 - receiver dehydration
 - accumulator-dryer
 - evaporator
 - compressor
 - hoses, lines and fittings
- outline major components of air conditioning control systems
 - low and high pressure cutout
 - low charge protection
 - evaporator temperature control
 - cycling clutch control
 - orifice tubes
 - expansion valves
 - fan controls

Number:	1.3		
Title:	Electromagnetic Device Fundamentals		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross-Reference to Learning Outcomes:	N/A		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, principles of operation of electromagnetic devices.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.3.1 Define the purpose and fundamentals of electromagnetic devices.
- 1.3.2 Describe the construction, composition, types, styles and application of electromagnetic devices.
- 1.3.3 Explain the principles of operation of electromagnetic devices.

Learning Content

- 1.3.1 Define the purpose and fundamentals of electromagnetic devices.
[2/0]
 - magnetism
 - electromagnetism
 - current flow and magnetic fields
 - relays
 - solenoids
 - motors
 - right and left handed rules
- 1.3.2 Describe the construction, composition, types, styles and application of electromagnetic devices.
[2/0]
 - electric motor
 - stepper motor
 - generator
 - solenoid
 - relay
 - generator
 - coil

1.3.3 Explain the principles of operation of electromagnetic devices.
[2/0]

- electric motor
 - torque and power
- stepper motor
- solenoid
- relay
- coil
- generator
- stepper motor

Number:	1.4		
Title:	Circuit Repair and Protection Devices		
Duration:	Total Hours: 9	Theory: 6	Practical: 3
Cross-Reference to Learning Outcomes:	5181.01,02,03,04, 5183.01,02,03,04, 5184.01,02,03,04,05,06,07,08,09,10		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the purpose, construction, principles of operation of circuit protection devices and their inspection and testing.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.4.1 Define the purpose and fundamentals of circuit repair and protection devices.
- 1.4.2 Describe the construction, composition, types, styles and application of circuit repair and protection devices.
- 1.4.3 Explain the principles of operation of circuit protection devices.
- 1.4.4 Perform inspection and testing procedures on circuit repair and protection devices with the prescribed service tools and equipment following manufacturers' recommendations.

Learning Content

- 1.4.1 Define the purpose and fundamentals of circuit repair and protection devices.
[1/0]
 - opens
 - shorts
 - ground
 - high resistance connections

- 1.4.2 Describe the construction, composition, types, styles and application of circuit repair and protection devices.
[2/0]
- wiring and terminals
 - wire size and identification, composition, terminal connectors
 - circuit protection devices
 - fuses
 - circuit breakers
 - fusible links
- 1.4.3 Explain the principles of operation of circuit protection devices.
[2/0]
- circuit protection devices
 - fuses
 - circuit breakers
 - fusible links
- 1.4.4 Perform inspection and testing procedures on circuit repair and protection devices with the prescribed service tools and equipment following manufacturers' recommendations.
[1/3]
- wiring and connectors
 - wire size
 - temperature effects
 - weather proofing
 - circuit protection
 - fuses
 - circuit breakers
 - fusible links
 - wiring repair
 - cleaning
 - splicing
 - crimping
 - soldering
 - corrosion protection
 - circuit analysis to identify
 - shorts
 - opens
 - grounds
 - high resistance

Number: 1.5
Title: **Applied Electrical Schematics**
Duration: Total Hours: 6 Theory: 4 Practical: 2
Cross-Reference to Learning Outcomes: 5181.01,02,03,04,05,06,07,
5182.01,02,03,04, 5183.01,02,03,04, 5184.01,02,03,04,05,06,07,08,09,10

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of application of wiring schematics, locating electrical components and tracing electrical circuits.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.5.1 Define the purpose and fundamentals of electrical wiring schematics.
- 1.5.2 Describe the function, construction, composition, types, styles and application of manufacturers' wiring diagrams.
- 1.5.3 Locate electrical components and trace electrical circuits of vehicle systems with the prescribed manufacturers' wiring diagrams.

Learning Content

- 1.5.1 Define the purpose and fundamentals of electrical wiring schematics.
[2/0]
 - electrical symbols
 - circuit identification methods
 - colour codes
 - number codes
- 1.5.2 Describe the function, construction, composition, types, styles and application of manufacturers' wiring diagrams.
[2/0]
 - layout
 - interpretation

1.5.3 Locate electrical components and trace electrical circuits of vehicle systems with the prescribed manufacturers' wiring diagrams.
[0/2]

- demonstrate and perform
- on-vehicle verification of wiring diagram circuits
- colour codes
- connectors
- gauge and metric wire sizes
- circuit number codes

Number:	1.6		
Title:	Electronic Fundamentals		
Duration:	Total Hours: 12	Theory: 7	Practical: 5
Cross-Reference to Learning Outcomes: 5181.01,02,03,04,05,06,07, 5182.01,02,03,04, 5183.01,02,03,04, 5184.01,02,03,04,05,06,07,08,09,10			

General Learning Outcome

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

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.6.1 Define the purpose and fundamentals of electronics.
- 1.6.2 Describe the construction, composition, types, styles and application of electronic devices.
- 1.6.3 Explain the principles of operation of electronic devices.
- 1.6.4 Perform inspection and testing procedures for electronic devices following manufacturers' recommendations.
- 1.6.5 Perform assigned operations for vehicle electronic devices following manufacturers' recommendations.

Learning Content

- 1.6.1 Define the purpose and fundamentals of electronics.
[2/0]
 - semi-conductor materials
 - waveforms
 - voltage spike control
 - static electricity
 - electrostatic discharge
 - shielding
 - grounding

1.6.2 Describe the construction, composition, types, styles and application of electronic devices.

[2/0]

- diodes
- rectifying
- zener
- light emitting
- photo
- transistors
 - PNP
 - NPN
- sensors
 - reluctors
 - thermistors
 - piezoelectric
 - piezoresistive
- variable resistor
 - rheostat
 - potentiometers
- optical devices
- capacitors

1.6.3 Explain the principles of operation of electronic devices.

[3/0]

- diodes
- forward and reverse bias
- current control
- transistors
- forward and reverse bias
 - PNP and NPN
- gate controls
- switching
- amplification
- capacitors
- sensors
 - reluctors
 - thermistors
 - piezoelectric
 - piezoresistive
- variable resistor
 - rheostat
 - potentiometers
- binary logic

1.6.4 Perform inspection and testing procedures for electronic devices following manufacturers' recommendations.
[0/3]

- diodes
- transistors
- capacitors
- resistors
- potentiometer
- variable capacitance sensors

1.6.5 Perform assigned operations for vehicle electronic devices following manufacturers' recommendations.
[0/2]

- moisture protection
- learning of components
- explosion hazards
- control of electrostatic discharge
- control of component damage

Number:	1.7		
Title:	Computer Fundamentals and Diagnostics		
Duration:	Total Hours: 15	Theory: 9	Practical: 6
Cross-Reference to Learning Outcomes:	5180.05, 5181.01,05, 5182,02, 5183.02, 5184.02,05,08		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction, principles of operation of computers.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 1.7.1 Define the history, purpose and fundamentals of onboard computers, input devices, output actuators and service tools.
- 1.7.2 Describe the function, construction, composition, types, styles and application of computers.
- 1.7.3 Explain the principles of operation of computers.
- 1.7.4 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 1.7.1 Define the history, purpose and fundamentals of onboard computers, input devices, output actuators and service tools.
[2.5/0]
 - analog / digital computers
 - binary systems
 - digital computers
 - logic gates
 - onboard computers
 - multiplexing
 - fibre optics
 - data acquisition equipment
 - scan tools
 - lab scopes
 - pin-out boxes

1.7.2 Describe the function, construction, composition, types, styles and application of computers.
[2.5/0]

- input devices
- central processing unit (CPU)
- random access memory (RAM)
- data storage
- output

1.7.3 Explain the principles of operation of computers.
[4/0]

- analog to digital converters
- signal filtration
- central processing unit (CPU)
- processing cycle
- logic sequencing
- random access memory (RAM)
- data storage
- electrical control module (ECM) integral outputs
- data acquisition equipment
 - scan tools
 - lab scopes
 - pin-out boxes

1.7.4 Perform assigned operations following manufacturers' recommendations.
[0/6]

- retrieve fault codes
- clear fault codes
- perform circuit measurements
- perform signal tracing

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:	2		
Title:	Suspension and Steering Systems		
Duration:	Total Hours: 60	Theory: 43	Practical: 17
Prerequisites:	Level I, Section 1, 2		
Co-requisites:	Level II, Section 1, 3, 4		

- 2.1 Adaptive and Active Suspension Systems
15 Total Hours Theory: 9 hours Practical: 6 hours
- 2.2 Supplemental Restraint Systems
12 Total Hours Theory: 9 hours Practical: 3 hours
- 2.3 Power-assisted Steering Systems
15 Total Hours Theory: 9 hours Practical: 6 hours
- 2.4 Electronically Controlled Power-assisted Steering
12 Total Hours Theory: 10 hours Practical: 2 hours
- 2.5 4 Wheel Steering
6 Total Hours Theory: 6 hours Practical: 0 hours

Number:	2.1		
Title:	Adaptive and Active Suspension Systems		
Duration:	Total Hours: 15	Theory: 9	Practical: 6
Cross-Reference to Learning Outcomes:	5181.01,02,03,04, 5182.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals, construction, principles of operation, inspecting and testing for adaptive and active suspension systems.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.1.1 Define the purpose and fundamentals of adaptive and active suspension systems.
- 2.1.2 Explain the construction of adaptive and active suspension systems.
- 2.1.3 Explain the principles of operation of adaptive and active suspension systems.
- 2.1.4 Inspect, test and diagnose adaptive and active suspension systems with the prescribed tools and equipment following manufacturers' recommendations.
- 2.1.5 Describe manufacturers' maintenance procedures for adaptive and active suspension systems and perform assigned operations.

Learning Content

- 2.1.1 Define the purpose and fundamentals of adaptive and active suspension systems.
[1/0]
 - automatic leveling, ride and handling systems
 - advantages
 - disadvantages

2.1.2 Explain the construction of adaptive and active suspension systems.
[4/0]

- automatic leveling, ride and handling systems
 - input devices
 - speed sensors
 - steering wheel rotation sensor
 - brake sensor
 - electronic control unit
 - height sensors
 - ignition switch
 - ride control switch
- suspension control module
- output devices
 - shock and strut actuator assemblies
 - air shocks
 - air springs
 - air compressor assembly
 - dampening force actuator / stepper motor

2.1.3 Explain the principles of operation of adaptive and active suspension systems.
[4/0]

- automatic leveling, ride and handling systems
 - input devices
 - speed sensors
 - steering wheel rotation sensor
 - brake sensor
 - electronic control unit
 - height sensors
 - ignition switch
 - ride control switch
- suspension control module
- output devices
 - shock and strut actuator assemblies
 - air shocks
 - air springs
 - air compressor assembly
 - dampening force actuator / stepper motor

2.1.4 Inspect, test and diagnose adaptive and active suspension systems with the prescribed tools and equipment following manufactures' recommendations.
[0/4]

- input and output devices
- hydraulic and air circuits
- actuators / solenoids
- system self-diagnostic tests
- access and interpret system fault codes
- perform visual inspection of all fluid levels
- check hydraulic and air hoses, lines and fittings for condition

2.1 5 Describe manufacturers' maintenance procedures for adaptive and active suspension systems and perform assigned operations.
[0/2]

- perform visual inspection of all fluid levels
- perform the specified height sensor adjustments
- check hydraulic and air hoses, lines and fittings for condition
- identify the recommended procedures to follow for:
 - battery recharging
 - system memory retention
 - wiring alterations
 - high voltage interference
 - temperature compensations
 - electromagnetic interference (EMI)

Number:	2.2		
Title:	Supplemental Restraint Systems		
Duration:	Total Hours: 12	Theory: 9	Practical: 3
Cross-Reference to Learning Outcomes: 5181.01,05,06,07			

General Learning Outcome

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

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.2.1 Define the purpose and fundamentals of supplemental inflatable restraint and automatic seat belt systems.
- 2.2.2 Describe the construction, composition, types, styles and application of inflatable restraint and automatic seat belt systems and components.
- 2.2.3 Explain the principles of operation of inflatable restraint and automatic seat belt systems components.
- 2.2.4 Perform inspection and testing procedures on inflatable restraint and automatic seat belt systems components following manufacturers' recommendations.
- 2.2.5 Perform assigned operations on inflatable restraint and automatic seat belt systems following manufacturers' recommendations.

Learning Content

- 2.2.1 Define the purpose and fundamentals of supplemental inflatable restraint and automatic seat belt systems.
[1/0]
 - electronics fundamentals review
 - inertia
 - deceleration forces
 - gas properties
 - automatic seat belts
 - inflatable restraint systems

- 2.2.2 Describe the construction, composition, types, styles and application of inflatable restraint and automatic seat belt systems and components.
[3/0]
- inflatable restraint systems
 - crash sensors
 - diagnostic and control modules
 - air bags
 - air bags inflators
 - clock spring
 - automatic seat belts
 - track drive
 - pyrobelts
- 2.2.3 Explain the principles of operation of inflatable restraint and automatic seat belt systems components.
[4/0]
- inflatable restraint systems
 - crash sensors
 - diagnostic and control modules
 - air bags
 - air bag inflators
 - clock spring
 - automatic seat belts
 - track drive
 - pyrobelts
- 2.2.4 Perform inspection and testing procedures on inflatable restraint and automatic seat belt systems components following manufacturers' recommendations.
[0/3]
- describe safe handling precautions for service and testing of inflatable restraint systems
 - outline and perform system tests using scan tools, multimeter and specific test equipment
- 2.2.5 Recommend repairs following manufacturers' procedures and perform assigned operations on inflatable restraint and automatic seat belt systems following manufacturers' recommendations.
[1/0]
- outline the removal and replacement procedures for the servicing of inflatable restraint systems

Number:	2.3		
Title:	Power-assisted Steering Systems		
Duration:	Total Hours: 15	Theory: 9	Practical: 6
Cross-Reference to Learning Outcomes:	N/A		

General Learning Outcome

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

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.3.1 Define the purpose and fundamentals of power-assisted steering systems.
- 2.3.2 Describe the construction, composition, types, styles and applications of power-assisted steering systems.
- 2.3.3 Explain the principles of operation of power-assisted assemblies.
- 2.3.4 Inspect and test power steering pumps and power-assisted steering units following manufacturers' recommendations.
- 2.3.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 2.3.1 Define the purpose and fundamentals of power-assisted steering systems. [2/0]
 - full-time
 - part-time
 - non-integral
 - linkage assist
 - integral
 - steering box
 - rack and pinion

2.3.2 Describe the construction, composition, types, styles and applications of power- assisted steering systems.
[3/0]

- power steering pumps
 - vane
 - gear
 - roller
 - slipper
- control valves
 - pressure control
 - pressure relief
 - flow control
- directional control valves
 - axial spool valve
 - rotary spool valve
- hydraulic circuits
 - power steering lines
 - hoses
 - coolers
 - reservoirs

2.3.3 Explain the principles of operation of power-assisted assemblies.
[2/0]

- power steering pumps
 - vane
 - gear
 - roller
 - slipper
- control valves
 - pressure relief
 - flow control
- directional control valves
- axial spool valve
 - modes of operation
 - reaction members
- rotary spool valve
 - modes of operation
 - reaction members
- hydraulic circuits
 - power steering lines
 - hoses
 - coolers
 - reservoirs

2.3.4 Inspect test power steering pumps and power-assisted steering units following manufacturers' recommendations.

[1/3]

- flow (gallons per minute)
- flow vs temperature
- pressure
- line
- hoses
- control valves

2.3.5 Perform assigned operations following manufacturers' recommendations.

[1/3]

- perform removal, replacement and adjustment
 - serpentine belt
 - V-belt
 - tensioners
- perform system flushing
 - lubricants and hydraulic oils
 - precautions of using non-specified oils
- perform the dismantling, inspection and adjustment
 - power steering pumps
 - gear boxes
 - rack and pinion assemblies

Number:	2.4		
Title:	Electronically Controlled Power-assisted Steering		
Duration:	Total Hours: 12	Theory: 10	Practical: 2
Cross-Reference to Learning Outcomes:	5181.01,02,03,04, 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 electronically controlled power-assisted steering.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.4.1 Define the purpose and fundamentals of electronically controlled, power-assisted steering systems.
- 2.4.2 Describe construction, composition, types, styles and applications of electronically controlled power-assisted steering systems.
- 2.4.3 Explain the principles of operation of electronically controlled power-assisted steering systems.
- 2.4.4 Inspect, test and diagnose electronically controlled power-assisted steering systems following manufacturers' recommendations.
- 2.4.5 Perform assigned operations following manufacturers' recommendations.

Learning Content

- 2.4.1 Define the purpose and fundamentals of electronically controlled, power-assisted steering systems.
[1/0]
 - fundamentals
 - variable assist steering principles
 - electronic steering control

2.4.2 Describe construction, composition, types, styles and applications of electronically controlled power-assisted steering systems.
[3/0]

- hydraulic / electronic
- input devices
 - steering rotation sensor
 - vehicle speed sensor
 - ignition switch
- control module
- output devices
 - electronic variable orifice actuator
- steering gear assembly
- torque sensor

2.4.3 Explain the principles of operation of electronically controlled power-assisted steering systems.
[4/0]

- hydraulic / electronic
- input devices
 - steering rotation sensor
 - vehicle speed sensor
 - ignition switch
- control module
- output devices
 - electronic variable orifice actuator
- steering gear assembly
- torque sensor

2.4.4 Inspect, test and diagnose electronically controlled power-assisted steering systems following manufacturers' recommendations.
[1/1]

- input devices
- control module
- wiring
- output actuator
- sensors
- fault code retrieval and interpretation
- self-diagnostics

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

- calibration procedures for actuators and sensors
- electronic circuit repairs
- troubleshooting
- code clearing

Number:	2.5		
Title:	4 Wheel Steering		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
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 and applications of 4 wheel steering.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 2.5.1 Define the purpose, fundamentals and types of 4 wheel steering systems.
- 2.5.2 Describe functions, construction, composition, types, styles and applications of 4 wheel steering systems.

Learning Content

- 2.5.1 Define the purpose, fundamentals and types of 4 wheel steering systems.
[3/0]
 - fundamentals
 - principles
 - terminology
- 2.5.2 Describe functions, construction, composition, types, styles and applications of 4 wheel steering systems.
[3/0]
 - hydraulic / electronic 4 wheel steering
 - input devices
 - steering angle sensor
 - vehicle speed sensor
 - control module
 - flow control solenoid
 - power cylinder
 - electromechanical 4 wheel steering

- input devices
 - steering angle sensors
 - vehicle speed sensor
 - wheel speed sensors
- control module
- rear steering actuator

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:	3		
Title:	Alignment Procedure and Diagnostics		
Duration:	Total Hours: 60	Theory: 36	Practical: 24
Prerequisites:	Level I, Section 3		
Co-requisites:	Level II, Section 1, 2, 4		

- 3.1 Alignment Fundamentals
18 Total Hours Theory: 18 hours Practical: 0 hours
- 3.2 Vehicle Pre-alignment Checks
12 Total Hours Theory: 3 hours Practical: 9 hours
- 3.3 Vehicle Alignment Equipment Procedures
6 Total Hours Theory: 3 hours Practical: 3 hours
- 3.4 Vehicle Alignment Equipment Procedures
18 Total Hours Theory: 6 hours Practical: 12 hours
- 3.5 Vehicle Dynamics of Handling
6 Total Hours Theory: 6 hours Practical: 0 hours

Number:	3.1		
Title:	Alignment Fundamentals		
Duration:	Total Hours: 18	Theory: 18	Practical: 0
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 of steering geometry and principles of different type of adjustments.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 3.1.1 Define the purpose and fundamentals of steering geometry and alignment factors for vehicles.
- 3.1.2 Describe applications of alignment angles and measurements.
- 3.1.3 Explain the principles of operation of the following type of adjustments.

Learning Content

- 3.1.1 Define the purpose and fundamentals of steering geometry and alignment factors for vehicles.
[3/0]
 - steering geometry and alignment
 - center of gravity
 - pre-alignment inspection
 - two-wheel / four-wheel
 - thrust alignment
 - measurements
 - decimals
 - fractions
 - degrees
 - Imperial
 - metric

3.1.2 Describe applications of alignment angles and measurements.
[9/0]

- caster
- camber
- toe-in / toe-out
- steering axis inclination (SAI)
- turning radius
- thrust line / angle
- included angle or combined angle
- Ackerman's Principle
- define the following terms:
 - scrub radius
 - lead
 - road crown
 - wheel track
 - set back
 - wheel base
 - thrust angle / tracking
- pre-alignment inspection
 - curb weight / trim height
- - suspension analysis
- - tire pressure and condition

3.1.3 Explain the principles of operation of the following type of adjustments:
[6/0]

- adjustments
 - cams
 - eccentrics
 - shims and calculations
 - slots
 - strut arms
 - toe
 - cradle adjustments
- steering wheel alignment
 - air bag precautions
 - steering wheel centered
 - steering gear in middle of travel
 - twisted sector shaft
 - equal toe

Number:	3.2		
Title:	Vehicle Pre-alignment Checks		
Duration:	Total Hours: 12	Theory: 3	Practical: 9
Cross-Reference to Learning Outcomes: 5186.01,02			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of inspecting and testing vehicles prior to alignments.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 3.2.1 Perform inspection and testing of vehicle pre-alignment checks following manufacturers' recommendations.

Learning Content

- 3.2.1 Perform inspection and testing of vehicle pre-alignment checks following manufacturers' recommendations.
[3/9]

- tires
- vehicle weight
- trim height
- bearing condition and adjustment
- suspension system condition
- requirements for tailoring alignment settings
- steering linkage / column condition
- steering centre
- damaged components
- damaged frame
- damaged unit-body
- load requirements

Number:	3.3		
Title:	Vehicle Alignment Equipment Procedures		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Cross-Reference to Learning Outcomes:	5186.01,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of maintenance and calibration procedures for alignment equipment.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 3.3.1 Describe and perform manufactures' maintenance and calibration procedures for using alignment equipment.

Learning Content

- 3.3.1 Describe and perform manufacturers' maintenance and calibration procedures for using alignment equipment.
[3/3]

- procedures for setup and usage
- perform equipment calibration procedures
- turn tables and hoisting equipment
 - clean
 - maintain
 - inspect
- apply required lubricants
- inspect components, fasteners and locks
- inspect cables, chains and air circuits for integrity
- check safety lockouts
- required software

Number:	3.4		
Title:	Vehicle Alignment and Diagnosis		
Duration:	Total Hours: 18	Theory: 6	Practical: 12
Cross-Reference to Learning Outcomes: 5186.01,02			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of diagnostic procedures for vehicle alignment, handling characteristics and perform two / four wheel alignment.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 3.4.1. Observe and perform recommended diagnostic procedures for vehicle alignment following manufacturers' recommendations.
- 3.4.2. Perform two wheel thrust, four-wheel alignments and diagnose handling characteristics following manufacturers' recommendations.

Learning Content

- 3.4.1 Observe and perform recommended diagnostic procedures for vehicle alignment diagnosis following manufacturers' recommendations.

[6/3]

- 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
- frame irregularities
- - damage
- - fatigue

3.4.2 Perform two wheel thrust, four-wheel alignments and diagnose handling characteristics following manufacturers' recommendations.
[0/9]

- adjust and correct vehicle alignment for:
 - rear wheels
 - camber, toe settings
 - caster
 - camber
 - toe
 - steering axis inclination
 - included angle
 - set back
 - turning angle
 - scrub radius
 - chassis trim height
 - frame damage
 - tire wear
 - pulls
 - wander
 - bump steer

Number:	3.5		
Title:	Vehicle Dynamics		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Cross-Reference to Learning Outcomes:	5182.01,02,03,04, 5183.01,02,03,04, 5186.01,02,03,04		

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of the fundamentals of vehicle handling.

Learning Outcomes

Upon successful completion, the apprentice is able to:

3.5.1 Define the purpose and fundamentals of vehicle handling characteristics

Learning Content

3.5.1 Define the purpose and fundamentals of vehicle handling characteristics [6/0]

- vehicle centre
- geometric centre
- center of gravity
 - longitudinal
 - roll
 - lateral
- pitch
- dive
- squat
- yaw
- roll
- “G” force
- instant center
- roll center
- over-steer
- under-steer
- thrust angle
- tire slip angle
- weight transfer
- scrub on suspension movement
- static and dynamic weight characteristics

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:	Brake Systems		
Duration:	Total Hours: 60	Theory: 39	Practical: 21
Prerequisites:	Level I, Section 1, 4		
Co-requisites:	Level II, Section, 1, 2, 3		

4.1 Power-assisted Brake Systems

12 Total Hours Theory: 10 hours Practical: 2 hours

4.2 Anti-lock Brake Fundamentals

21 Total Hours Theory: 21 hours Practical: 0 hours

4.3 Anti-lock Brake Diagnostics

12 Total Hours Theory: 3 hours Practical: 9 hours

4.4 Anti-lock Brake Servicing

12 Total Hours Theory: 3 hours Practical: 9 hours

4.5 Electric Brake System Fundamentals

3 Total Hours Theory: 2 hours Practical: 1 hours

Number:	4.1		
Title:	Power-assisted Brake Systems		
Duration:	Total Hours: 12	Theory: 10	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, inspection and testing for power-assisted brakes.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.1.1 Define the purpose and fundamentals of power-assisted brake systems.
- 4.1.2 Describe the construction, composition, types, styles and application of power-assisted brake systems.
- 4.1.3 Explain the principles of operation of power-assisted brake systems.
- 4.1.4 Perform inspection, testing and diagnostic procedures on power-assisted brake assemblies following manufacturers' recommendations.
- 4.1.5 Perform assigned operations on power-assisted brake systems following manufacturers' recommendations.

Learning Content

- 4.1.1 Define the purpose and fundamentals of power-assisted brake systems.
[2/0]
 - vacuum-assist
 - air suspended
 - vacuum suspended
 - hydra-boost
 - electric-assist

- 4.1.2 Describe the construction, composition, types, styles and application of power- assisted brake systems.
[3/0]
- vacuum-assist
 - air suspended
 - vacuum suspended
 - hydra-boost
 - electric assist
- 4.1.3 Explain the principles of operation of power-assisted brake systems.
[3/0]
- vacuum-assist
 - air suspended
 - vacuum suspended
 - hydra-boost
 - electric-assist
- 4.1.4 Perform inspection, testing and diagnostic procedures on power-assisted brake assemblies following manufacturers' recommendations.
[0/2]
- visual inspection
 - operational and static test
 - vacuum-assist
 - vacuum test
 - hydra-boost
 - power steering pressure test
- 4.1.5 Perform assigned operations on power-assisted brake systems following manufacturers' recommendations.
[2/0]
- outline the recommended removal and replacement procedures of power brakebooster assemblies and related components

Number:	4.2		
Title:	Anti-lock Brake Fundamentals		
Duration:	Total Hours: 21	Theory: 21	Practical: 0
Cross-Reference to Learning Outcomes: 5184.01			

General Learning Outcome

The apprentice is able to demonstrate the fundamentals, construction and principles of operation of anti-lock brakes.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.2.1 Define the purpose and fundamentals of anti-lock brakes, traction and stability control systems.
- 4.2.2 Describe the construction, composition, types, styles and application of anti-lock brake systems and components.
- 4.2.3 Explain the principles of operation and identify components of anti-lock, traction and stability control systems.

Learning Content

- 4.2.1 Define the purpose and fundamentals of anti-lock brake, traction and stability control systems.
[6/0]
 - anti-lock brakes (ABS)
 - mechanical
 - electronic
 - rear-wheel anti-lock (RWAL)
 - 1 channel
 - 2 channel
 - 3 channel
 - 4 channel

4.2.2 Describe the construction, composition, types, styles and application of anti-lock brake systems and components.
[8/0]

- anti-lock power booster and master cylinder
- electric pump and accumulator
- valve body assembly
- electronic controller
- wheel sensors
 - 1 channel
 - 2 channel
 - 3 channel
 - 4 channel
- integral
- non-integral
- warning lamp
- self-check system
- longitudinal, lateral, acceleration sensors

4.2.3 Explain the principles of operation and identify components of anti-lock, traction and stability control systems.
[7/0]

- anti-lock brakes
- slip ratio
- power booster and master cylinder
- electric pump and accumulator
- valve body assembly
- electronic controller
- wheel sensors
 - 1 channel
 - 2 channel
 - 3 channel
 - 4 channel
- integral
- non-integral
- warning lamp
- ABS controller action during apply, hold and release
- stability control systems
- traction control systems

Number:	4.3		
Title:	Anti-lock Brake Diagnostics		
Duration:	Total Hours: 12	Theory: 3	Practical: 9
Cross-Reference to Learning Outcomes: 5184.01, 08,09,10			

General Learning Outcome

The apprentice is able to demonstrate a working knowledge of inspection, testing and diagnostic procedures for anti-lock brakes.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.3.1 Perform inspection, testing and diagnostic procedures on anti-lock, traction and stability control and power-assist brake assemblies following manufacturers' recommendations.

Learning Content

- 4.3.1 Perform inspection, testing and diagnostic procedures on anti-lock, traction and stability control and power-assist brake assemblies following manufacturers' recommendations.
[3/9]

- visual inspection
- identify system
 - non-integral
 - integral
- identify components
- booster pressure
- control and sensor operation
- extract and analyze data
- fault codes
 - hard codes
 - soft codes
- tire size
- sensor inputs

Number:	4.4		
Title:	Anti-lock Brake Servicing		
Duration:	Total Hours: 12	Theory: 3	Practical: 9
Cross-Reference to Learning Outcomes: 5184.01, 08,09,10			

General Learning Outcome:

The apprentice is able to demonstrate a working knowledge of servicing and repairs for anti-lock brake systems.

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.4.1 Perform assigned operations on anti-lock brake, traction and stability control systems following manufacturers' recommendations.

Learning Content:

- 4.4.1 Perform assigned operations on anti-lock brake, traction and stability control systems following manufacturers' recommendations.
[3/9]

- observe and perform system diagnostic fault code clearing procedures
- outline the recommended removal and replacement procedures for electronic controlled anti-lock brake components
- observe and perform the recommended procedures for releasing system hydraulic pressures
- observe and perform the recommended system fluid air bleeding procedures
- verify system is operating correct
- differential service

Number:	4.5		
Title:	Electric Brake System Fundamentals		
Duration:	Total Hours: 3	Theory: 2	Practical: 1
Cross-Reference to Learning Outcomes:	N/A		

General Learning Outcome:

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

Learning Outcomes

Upon successful completion, the apprentice is able to:

- 4.5.1 Define the purpose and fundamentals of electric brake systems.
- 4.5.2 Describe the construction, composition, types, styles and application of electric brake system components.
- 4.5.3 Explain the principles of operation of electric brake systems.
- 4.5.4 Perform inspection and testing procedures of electric brake systems.

Learning Content:

- 4.5.1 Define the purpose and fundamentals of electric brake systems.
[.5/0]
 - electric / magnetic application for foot brake and hand control
- 4.5.2 Describe the construction, composition, types, styles and application of electric brake system components.
[.5/0]
 - hand controller
 - electric
 - electronic
 - foot controller
 - magnets
 - related brake components

- 4.5.3 Explain the principles of operation of electric brake systems.
[1/0]
- brake released
 - brake applied
- 4.5.4 Perform inspection and testing procedures of electric brake systems.
[0/1]
- wires and connections
 - amperage and voltage measurements
 - brake adjustments
 - magnet wear
 - shoes, drums
 - adjustments
 - replace or repair

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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