

Apprenticeship Curriculum Standard

Transmission Technician

Level 2

310D

2003



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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: <u>skilledtradesontario.ca</u> for the most accurate and up to date information. For information about BOSTA and its regulations, please visit <u>Building</u> <u>Opportunities in the Skilled Trades Act, 2021 (BOSTA).</u>

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Maintained with transfer to Skilled Trades Ontario 2003 (V100)

# Preface

This curriculum standard for the Transmission 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 7) 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 (<u>www.skilledtradesontario.ca</u>) 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 <u>Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 (ontario.ca)</u>

#### **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.

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

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

# Introduction

The Transmission Technician curriculum has been developed in keeping with the prescribed Ministry of Training, Colleges and Universities 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 Transmission Technician apprentices.

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 Training, Colleges and Universities Apprenticeship Training Standards. While these references to various

performance objectives in the Training Standards have been linked to the respective inschool outcomes, employers should not assume complete coverage to a journeyperson 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 that 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 apprentice competency, the review of test question answers is considered to be a valuable learning opportunity.

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

Implementation:

October 2003

# **Stakeholders Information**

A consortium of five colleges of applied arts and technology, working in collaboration with the MTCU (Ministry of Training, Colleges and Universities) and industry stakeholders, participated in the development of this document. A Project Steering Committee was struck to guide the project development process for the Transmission Technician document.

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 MTCU in consultation with industry advisory groups. The format that is used in this document has been approved by the MTCU.

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
0.1	Work Practices	18	11	7
0.2	Automatic Transmission / Transaxle	120	55	65
0.3	Drive Train Components	54	30	24
0.4	Electrical And Electronics	49	30	19
	Total	241	126	115

# **Reportable Subject Summary-Level 2**

Number:	1				
Title:	Work Practices				
Duration:	Total Hours: 18	Theory:11 hours	Practical:7 h	ours	
Prerequisites:	Level I, Section 1				
Co-requisites:	Level II, Section 2,	3, 4			
1.1 - Shop Equipme 3 Total Hours	ent Theory:	2 hours	Practical:	1 hour	
1.2 - Applied Computer Skills					
6 Total Hours	Theory:	3 hours	Practical:	3 hours	
1.3 - Environment 3 Total Hours	Theory:	3 hours	Practical:	0 hours	
1.4 - Oxyacetylene, Heating and Cutting					
6 Total Hours	Theory:	3 hours	Practical:	3 hours	

Number:	1.1		
Title:	Shop Equipmen	t	
Duration:	Total Hours: 3 T	heory: 2 hours	Practical: 1 hour
Cross-Reference 07, 5194.02-04, 5	to Learning Outco 195.02-04	omes: 5190.02- 04,	5191.02-07, 5192.02-07, 5193.02-

#### **General Learning Outcome:**

Demonstrate a working knowledge of the purpose, construction and operating principles of power tools and equipment.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 1.1.1 Define the purpose and fundamentals of shop equipment.
- 1.1.2 Explain the construction features of shop equipment.
- 1.1.3 Explain the principles of operation of power tools and equipment.
- 1.1.4 Demonstrate the ability to operate shop equipment and power tools according to the manufacturers' recommended safe operating procedures.

#### Learning Content:

- 1.1.1 Define the purpose and fundamentals of shop equipment.
  - [5/0]
  - definitions
  - shop layout
- 1.1.2 Explain the construction features of shop equipment.
  - [1/0]

•

- presses
  - o hydraulic press
  - o portable press
  - o mechanical press
- vises
  - $\circ$  solid and swivel
  - o soft and hard jaw
- lifting equipment
  - o hoists
  - o hydraulic jacks
  - o pneumatic jacks
  - blocking equipment (safety stands)

- cleaning equipment
  - o power spray
  - o wash tanks
  - o non corrosive
  - hot caustic corrosive
- 1.1.3 Explain the principles of operation of power tools and equipment. [5/0]
  - hydraulic press
  - washers and degreasers
  - hydraulic jacks
  - safety blocking devices
- 1.1.4 Demonstrate the ability to operate shop equipment and power tools according to the manufacturers' recommended safe operating procedures.[0/1]
  - lifting and jacking equipment
    - lifting techniques single person/two person
    - hydraulic hoists
    - o jacking
      - hydraulic
    - o safety blocking
  - power tools
    - hydraulic press
    - o cleaning of equipment
      - power spray
      - wash tanks
      - degreasing / cleaning agents

Number:	1.2				
Title:	Applied Comp	uter Skills			
Duration:	Total Hours: 6	Theory: 3 hours	Practical: 3 hours		
Cross-reference to Learning Outcomes: 5189.05, 5193.05-07					

#### **General Learning Outcome:**

Demonstrate a working knowledge of the use of a personal computer.

# Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 1.2.1 Define the purpose, functions and application of the computers.
- 1.2.2 Perform the following computer functions.

#### Learning Content:

- 1.2.1 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
  - CDROM
  - software management

#### 1.2.2 Perform the following computer functions.

[1/2]

- create word processed document
- menu structure
- naming / saving
- copy / move
- file saving
  - o floppy
  - o hard drive
- email
  - o accessing
  - o **sending**
  - o attachments
- access internet
  - $\circ$  browsing
  - o file download

Number:	1.3		
Title:	Environment		
Duration:	Total Hours: 3	Theory: 3 hours	Practical: 0 hours
Cross-reference	to Learning Out	comes: 5189.02, 07	

#### **General Learning Outcome:**

Demonstrate a working knowledge of the safe handling and disposal of toxic waste as it relates to the transmission industry.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

1.3.1 Identify industrial toxins and an awareness of their appropriate handling, cleaning, disposal methods and the consequence on the environment if not adhered to.

- 1.3.1 Identify industrial toxins and an awareness of their appropriate handling, cleaning, disposal methods and the consequence on the environment if not adhered to.[3/0]
  - shop separator tanks
  - oil handling and disposal
  - identification of flammable / explosive particulates, liquids and vapours
  - fire hazards
  - asbestos
  - workshop carcinogens
  - safety placard reading
  - torque converter flusher
  - parts solvent washer
  - exhaust gases

Number:	1.4			
Title:	Oxyacetylene,	Heating and Cuttin	g	
Duration:	Total Hours: 6	Theory: 3 hours	Practical: 3 hours	
Cross-reference to Learning Outcomes: 5189.03, 5190.03, 5191.06, 5195.03				

#### **General Learning Outcome:**

Demonstrate a working knowledge of the purpose, construction and safe operating principles for the use of oxyacetylene equipment when heating and cutting

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 1.4.1 Identify the purpose and fundamentals of heating and cutting practices.
- 1.4.2 Describe the construction, composition, types, styles and application of oxyacetylene welding equipment.
- 1.4.3 Explain the safe principles of operation of oxyacetylene welding equipment.
- 1.4.4 Perform heating and cutting procedures following manufacturers' recommendations

#### Learning Content:

- 1.4.1 Identify the purpose and fundamentals of heating and cutting practices. [1/0]
  - oxyfuel gases
  - eye, face, hand, foot and clothing protection
  - setup, ignition and shutdown sequence
  - cylinder handling
  - fire prevention
  - butane lighters
  - flammable container welding precautions
- 1.4.2 Describe the construction, composition, types, styles and application of oxyacetylene welding equipment.

[1/0]

- set-up-of equipment
- gauges and hoses
- tips
  - o heating
  - o cutting
- startup procedures

- flame settings
- gas pressure settings
- torch angles and travel speed
- shutdown procedures
- 1.4.3 Explain the safe principles of operation of oxyacetylene welding equipment. [1/0]
  - tanks
  - pressure regulators
  - manual valves
  - manifold systems
  - gauges and hoses
  - tips
    - o heating
    - $\circ$  cutting
- 1.4.4 Perform heating and cutting procedures following manufacturers' recommendations. [0/3]
  - exhaust system repair
  - seized fastener removal
  - removal or installation of bearing retainers, sleeves, shafts, gears and bleeder screws

# 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 TestingPractical Application TestingFinal AssessmentNotebook and Organizational Skills					
40%	40%	10%	10%		

Number:	2					
Title:	Automatic Transmission / Transaxle					
Duration:	Total Hours:	120 Theor	y: 55 hours	Practical: 65 hours		
Cross-reference to	Learning Outo	omes: 5189.0	03, 5190.03, 5	191.06, 5195.03		
Prerequisites:	Level I, Secti	on 1, 2, 3				
Corequisites:	Level II, Sect	ion 1, 3, 4				
2.1– Torque Conve	rters (Lockup)					
12 Total Hours	Theory:	8 Hours	Practical:	4 Hours		
2.2– Planetary Gea	r Trains					
12 Total Hours	Theory:	12 Hours	Practical:	0 Hours		
2.3– Automatic Trai	nsmission / Tr	ansaxle Disas	ssemble			
18 Total Hours	Theory:	2 Hours	Practical:	16 Hours		
2.4– Automatic Trai	nsmission / Tr	ansaxle Inspe	ection			
18 Total Hours	Theory:	3 Hours	Practical:	15 Hours		
2.5– Automatic Trai	nsmission / Tr	ansaxle Repa	air			
18 Total Hours	Theory:	3 Hours	Practical:	15 Hours		
2.6– Automatic Trai	nsmission / Tr	ansaxle Reas	semble			
12 Total Hours	Theory:	3 Hours	Practical:	9 Hours		
2.7– Diagnosis Of Electronically Managed Automatic Transmission / Transaxle						
18 Total Hours	Theory:	12 Hours	Practical:	6 Hours		
2.8– Auto Transmission / Transaxle Maintenance						
12 Total Hours	Theory:	12 Hours	Practical:	0 Hours		

Number:	2.1				
Title:	Torque Converters	s (Lockup)			
Duration:	Total Hours: 12	Theory: 8 hours	Practical: 4 hours		
Cross-reference to Learning Outcomes: 5192.01-04					

#### **General Learning Outcome:**

Demonstrate a working knowledge of the principles of operation, inspecting and testing for lockup converters.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 2.1.1 Define the purpose and fundamentals of lockup torque converters.
- 2.1.2 Explain the principles of operation of lockup torque converters.
- 2.1.3 Perform inspection, testing and diagnostic procedures on lockup torque converters following manufacturers' recommendations.
- 2.1.4 Recommend repair procedures following manufacturers' recommendations.

- 2.1.1 Define the purpose and fundamentals of lockup torque converters. [3/0]
  - type of application
    - centrifugal
      - o pressure plate
      - o **piston**
      - o viscous
  - type of control
    - o hydraulically
    - o electrically
    - o electrical over hydraulic
  - damper plate
  - direct drive shaft
- 2.1.2 Explain the principles of operation of lockup torque converters. [2/0]
  - typical control circuits
  - apply requirements
    - o engine temperature

- o engine rpm
- vehicle speed
- throttle position
- o manifold vacuum
- gear selection
- o brakes released
- release requirements
  - o brakes applied
  - $\circ \quad \text{forced downshift} \quad$
  - vehicle speed
- 2.1.3 Perform inspection, testing and diagnostic procedures for lockup torque converters following manufacturers' recommendations. [2/4]
  - verify lockup and release operation
  - test procedures
  - determine computer stored trouble codes
  - identify and locate electronic sensors and controls
- 2.1.4 Recommend repair procedures following manufacturers' recommendations. [1/0]
  - removal and installation procedures
    - $\circ$  connectors
    - o sensors
    - $\circ$  controls
  - safe handling procedures
    - $\circ$  electronic devices
    - $\circ$  computer protection

Number:	2.2				
Title:	Planetary Gear Train	IS			
Duration:	Total Hours: 12	Theory: 12 hours	Practical: 0 hours		
Cross-reference to Learning Outcomes: 5192.01-02					

#### **General Learning Outcome:**

Demonstrate a working knowledge of the principles of operation of planetary gear trains.

# Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 2.2.1 Define the purpose and fundamentals of planetary gear trains.
- 2.2.2 Explain the principle of operation and power flow through the planetary gear trains.
- 2.2.3 Explain the principle of operation and power flow through overdrive planetary gear train.

#### Learning Content:

- 2.2.1 Define the purpose and fundamentals of planetary gear trains.
  - [3/0]
    - gear trains
      - o simple
      - compound
      - tandem compound
      - o Simpson
      - Ravigneaux
- 2.2.2 Explain the principle of operation and power flow through the planetary gear trains. [6/0]
  - gear trains
    - o simple
    - o compound
    - o tandem compound
    - $\circ$  simpson
    - o Ravigneaux
- 2.2.3 Explain the principle of operation and power flow through overdrive planetary gear train.

[3/0]

- location of overdrive gears
- design of gears used
- control methods

Number:	2.3				
Title:	Automatic Transm	ission / Transaxle I	Disassemble		
Duration:	Total Hours: 18	Theory: 2 hours	Practical: 16 hours		
Cross-reference to Learning Outcomes: 5192.01, 05-06					

#### **General Learning Outcome:**

Demonstrate a working knowledge of disassembly procedures for automatic transmissions / transaxles.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

2.3.1 Disassemble automatic transmissions / transaxles following manufacturers' recommendations.

- 2.3.1 Disassemble automatic transmissions / transaxles following manufacturers' recommendations. [2/16]
  - properly identify transmission and manufacturer
  - check for oil pan deposits
  - determine disassembly sequence
  - note cautions
  - case
  - threads in case and on fasteners
  - check for required end play
  - air test (when applicable)
  - identify and locate special tools
  - check servo pin travel (when applicable)
  - layout parts in order removed
  - disassemble into sub components
  - disassemble sub components
  - locate selective washers
  - locate thrust washers

Number:	2.4			
Title:	Automatic Transm	ission / Transaxle I	nspection	
Duration:	Total Hours: 18	Theory: 3 hours	Practical: 15 hours	
Cross-reference to Learning Outcomes: 5192.01, 05-06				

#### **General Learning Outcome:**

Demonstrate a working knowledge of inspecting automatic transmissions / transaxles.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

2.4.1 Inspect automatic transmissions / transaxles following manufacturers' recommendations.

- 2.4.1 Inspect automatic transmissions / transaxles following manufacturers' recommendations. [3/15]
  - wash and clean case
  - wash and clean components/sub components
  - identify manufactures specifications
  - inspect and check
    - o drilled and tapped holes
    - o friction material
    - o seals
    - $\circ$  bushings
    - $\circ$  bearings
    - o thrust washers
    - o selective washers
    - o snap rings
    - $\circ$  springs
    - o check balls
    - o gear sets
    - o shafts
    - o hubs
    - o one-way clutches
    - $\circ$  valve body
    - o switches
    - o sensors
    - $\circ$  solenoids
    - o chains and sprockets

- 0
- oil pump air bleed valves 0
  - torque converter
    - end play
    - stator one-way clutch -
    - stator / turbine interference -

Number:	2.5			
Title:	Automatic Transmission / Transaxle Repair			
Duration:	Total Hours: 18	Theory: 3 hours	Practical: 15 hours	
Cross-reference to Learning Outcomes: 5192.01, 05-06				

#### **General Learning Outcome:**

Demonstrate a working knowledge of repairing automatic transmissions / transaxles.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

2.5.1 Repair automatic transmissions / transaxles following manufacturers' recommendations.

- 2.5.1 Repair automatic transmissions / transaxles following manufacturers' recommendations. [3/15]
  - replace necessary components
    - o friction material
    - o seals
    - $\circ$  bushings
    - $\circ$  bearings
    - o thrust washers
    - o selective washers
    - o snap rings
    - $\circ$  springs
    - o check balls
    - o gear sets
    - o shafts
    - o hubs
    - o one-way clutches
    - o valve body
    - o switches
    - o sensors
    - o solenoids
    - o chains and sprockets
    - o oil pump
    - o air bleed valves
    - $\circ$  servo pins
    - o repair sub components

Number:	2.6			
Title:	Automatic Transm	ission / Transaxle I	Reassemble	
Duration:	Total Hours: 12	Theory: 3 hours	Practical: 9 hours	
Cross-reference to Learning Outcomes: 5192.01, 05-06				

#### **General Learning Outcome:**

Demonstrate a working knowledge of reassembling automatic transmissions / transaxles.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

2.6.1 Reassemble automatic transmissions / transaxles following manufacturers' recommendations.

- 2.6.1 Reassemble automatic transmissions / transaxles following manufacturers' recommendations. [3/9]
  - determine required torque specs
  - locate proper fasteners
  - lubricate friction material (soak)
  - apply assembly jell as needed
  - protect seals
  - install thrust washers
  - install selective washers
  - assemble sub components
  - install check balls
  - check clearances
  - check end play
  - make adjustments
  - air test as required

Number:	2.7		
Title:	Diagnosis of Elect Transaxle	ronically Managed	Automatic Transmission /
Duration:	Total Hours: 18	Theory: 12 hours	Practical: 6 hours
Cross-reference to	Learning Outcomes:	5192.05-07, 5193.0	1-04

#### **General Learning Outcome:**

Demonstrate a working knowledge of inspecting and testing electronically controlled automatic transmissions / transaxles.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 2.7.1 Inspect, test and diagnose electronically managed automatic transmissions / transaxles according to manufacturers' recommendations.
- 2.7.2 Outline and demonstrate / perform manufacturers' maintenance procedures for automatic and electronically managed transmissions / transaxles.

- 2.7.1 Inspect, test and diagnose electronically managed automatic transmissions transaxles according to manufacturers' recommendations.
  [6/3]
  - shop floor diagnosis
  - inspect and analyze electrohydraulic controls
    - proper solenoid operation
    - shorted solenoid operation
    - open solenoid operation
    - seized (foreign matter) solenoid operation
    - o prevention of solenoid contamination
  - common failures
    - o current updates
    - technical service bulletins
    - acceptable repair procedures
- 2.7.2 Outline and demonstrate / perform manufacturers' maintenance procedures for automatic and electronically managed transmissions / transaxles.[6/3]
  - identify and verify customer complaints
  - interpretation of wiring schematics and identify the effects of aftermarket inline kits

- interpretation of hydraulic circuits and identify the effects of aftermarket shift kit modifications.
- interpretation of sequential troubleshooting charts
- technical service support
- stall test safety practices
- outline road test procedure
- outline wiring repair and solenoid replacement procedures and precautions

Number:	2.8				
Title:	Auto Transmission / Transaxle Maintenance				
Duration:	Total Hours: 12	Theory: 12 hours	Practical: 0 hours		
Cross-reference to	Cross-reference to Learning Outcomes: 5192. 06-07, 5193.02-03, 06				

#### **General Learning Outcome:**

Demonstrate a working knowledge of maintenance procedures for electronically managed transmissions / transaxles.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

2.8.1 Outline manufacturers' maintenance procedures for electronically managed transmissions / transaxles.

- 2.8.1 Outline manufacturers' maintenance procedures for electronically managed transmissions / transaxles. [12/0]
  - identify manufacturer's operating principles
  - identify and verify customer complaints
  - interpretation of wiring schematics
  - interpretation of hydraulic circuits
  - identify electrical / electronic program / controls
  - identify electrical / electronic components
  - interpretation of sequential troubleshooting charts
  - obtain technical service support
  - stall test safety practices (A.B.S. Brakes Antilock Braking System)
  - outline road test procedure

# 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	Final Assessment	Notebook and Organizational Skills	
40%	40%	10%	10%	

Number:	3				
Title:	Drive Train	Components	6		
Duration:	Total Hours:	54 Theo	ry: 30 hours	Practical: 24 hours	
Cross-reference to	Learning Outo	comes: 5192.	06-07, 5193.0	02-03, 06	
Prerequisites:	Level I, Secti	ion 1, 4			
Corequisites:					
3.1– Driveline Conti	rols and Indica	ators			
6 Total Hours	Theory:	4 Hours	Practical:	2 Hours	
3.2– Final Drive Assembly					
15 Total Hours	Theory:	9 Hours	Practical:	6 Hours	
3.3– All-Wheel and Four-Wheel Drive Systems					
24 Total Hours	Theory:	12 Hours	Practical:	12 Hours	

3.4– Constant Velocity (C.V.) Drive Shaft

9 Total Hours	Theory:	5 Hours	Practical:	4 Hours
	meery.	e neare	i factical.	Thouse

Number:	3.1			
Title:	Driveline Controls and Indicators			
Duration:	Total Hours: 6	Theory: 4 hours	Practical: 2 hours	
Cross-reference to Learning Outcomes: 5191.01, 05, 06, 07				

# **General Learning Outcome:**

Demonstrate a working knowledge of operating principles of driveline controls and indicators and identify their serviceability.

# Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 3.1.1 Define the purpose and fundamentals of driveline controls and indicators.
- 3.1.2 Locate and identify the procedures to determine serviceability of drive train controls and indicators following manufacturers' recommendations.

- 3.1.1 Define the purpose and fundamentals of driveline controls and indicators. [4/0]
  - interlock mechanism
  - detent mechanism
  - shift assembly
    - o direct, remote
    - $\circ$  venting
  - engagement controls
  - controls and indicators
    - o mechanical
    - o vacuum
    - $\circ$  electric / electronic
  - pneumatics
  - vacuum sources
    - $\circ$  manifold
    - o **ported**
    - $\circ$  controlled
  - controls
    - $\circ$  electrical / electronics
    - o hydraulic
    - o vacuum
    - o mechanical
      - check for engagement
      - check for disengagement

- 3.1.2 Locate and identify the procedures to determine serviceability of drive train controls and indicators following manufacturers' recommendations. [0/2]
  - shift components lockout assembly
  - outline road test procedure in order to assess linkage adjustments and operation of transmissions / transaxles.
  - indicator adjustment
    - o linkage
    - o cable
    - $\circ$  electrical

Number:	3.2			
Title:	Final Drive Assembly			
Duration:	Total Hours: 15	Theory: 9 hours	Practical: 6 hours	
Cross-reference to Learning Outcomes: 5190.01, 02, 03, 04				

#### **General Learning Outcome:**

Demonstrate a working knowledge of the principles of operation, inspection and testing for final drive assemblies.

# Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 3.2.1 Define the purpose and fundamentals of final drive assemblies.
- 3.2.2 Describe the construction, types and styles of final drive assemblies.
- 3.2.3 Dismantle, inspect, diagnose and reassemble drive axle assemblies according to manufacturers' recommendations.

- 3.2.1 Define the purpose and fundamentals of final drive assemblies. [3/0]
  - power flow
  - cornering
  - Iubrication
  - final reduction
    - o ratios
    - o torque
- 3.2.2 Describe the construction, types and styles of final drive assemblies [6/0]
  - housing types
    - $\circ$  integral
    - o removable carrier
  - carrier types
    - o integral
    - o removable
  - final drive gearing
    - o spur bevel
    - o spiral bevel
    - o helical

- hypoid and amboid
- bearing pre-loads
- drive axles
  - o full-floating
  - o 3/4 floating
  - o Semi-floating
- limited slip differentials
  - $\circ \quad \text{ loaded types} \quad$
  - o viscous
  - o centrifugal
  - o cone clutch
  - o flat clutch
- 3.2.3 Dismantle, inspect, diagnose and reassemble drive axle assemblies according to manufacturers' recommendations.

[0/6]

- verify power flow
- inspect gear tooth contact pattern
- check gear backlash
- ring gear run-out
- pinion depth
- side bearing preload
- pinion preload
- demonstrate pinion bearing preload adjustment
- identify component failure
- determine and use proper special tools
  - housing spreader
  - pinion depth gauge
  - o ring adjusters

Number:	3.3			
Title:	All Wheel and Four Wheel Drive Systems			
Duration:	Total Hours: 24	Theory: 12 hours	Practical: 12 hours	
Cross-reference to Learning Outcomes: 5190.01-04				

#### **General Learning Outcome:**

Demonstrate a working knowledge of principles of operation for all-wheel and four-wheel drive systems, as well as inspection, testing and maintenance.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 3.3.1 Define the purpose and fundamentals of all-wheel and 4-wheel drive systems.
- 3.3.2 Define the construction purpose, function, and operation of all-wheel and 4-wheel drive systems.
- 3.3.3 Dismantle, inspect, diagnose and reassemble all-wheel and 4-wheel drive systems following manufacturers' recommendations.
- 3.3.4 Perform assigned operations and maintenance procedures for all-wheel and 4wheel drive systems following manufacturers' recommendations.

#### Learning Content:

- 3.3.1 Define the purpose and fundamentals of all-wheel and 4-wheel drive systems. [4/0]
  - function, type, styles and application
    - o all-wheel drive
    - o 4-wheel drive
    - power dividers
    - traction controls
- 3.3.2 Define the construction purpose, function, and operation of all-wheel and 4-wheel drive systems.

[4/0]

- all-wheel drive components and variations
- 4-wheel drive components and variations
  - front differential
- locking hubs
  - o manual
  - o automatic

- controls and indicators
- electronic sensors
- full-time engaged
- part-time engaged
  - power dividers

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- o full-time
- o Part-time
- $\circ$   $\,$  chain and gear  $\,$
- o controls
- viscous couplings
- 3.3.3 Dismantle, inspect, diagnose and reassemble all-wheel and 4-wheel drive systems following manufacturers' recommendations. [2/10]
  - dismantle and assemble all-wheel and four-wheel drive systems
  - verify power flow through gears
  - identify component failure primary and secondary causes
  - determine procedures recommended for diagnosis of noises
  - tire size/diameter/wear
  - electronic components
  - switches
- 3.3.4 Perform assigned operations and maintenance procedures for all-wheel and 4wheel drive systems following manufacturers' recommendations.
   [2/2]
  - outline road test procedures
  - identify procedures to determine serviceability
    - o shift components
    - $\circ$  interlocks
  - outline procedures to remove and install all-wheel / 4-wheel drive systems
  - adjusting and torquing procedure
  - proper towing procedures

Number:	3.4			
Title:	Constant Velocity	(C.V.) Drive Shaft		
Duration:	Total Hours: 9	Theory: 5 hours	Practical: 4 hours	
Cross-reference to Learning Outcomes: 5190.01-02				

#### **General Learning Outcome:**

Demonstrate a working knowledge of purpose and fundamentals of constant velocity (CV) drive shafts, as well as inspecting and testing procedures.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 3.4.1 Define the purpose and fundamentals of constant velocity (CV) driveshafts.
- 3.4.2 Perform inspection and testing procedures according to manufacturers' recommendations.

#### Learning Content:

- 3.4.1 Define the purpose and fundamentals of constant velocity (CV) driveshafts. [5/0]
  - drive axles
  - half-shaft retention
  - types and styles
  - bearings
  - boots
  - vibration damper
  - intermediate shaft and bearing
  - torque steer
- 3.4.2 Perform inspection and testing procedures following manufacturers' recommendations.

[0/4]

- constant velocity (CV) shaft diagnosis
  - o noise/vibration on acceleration/deceleration
  - o noise/vibration when cornering
- constant velocity (CV) shaft removal and replacement
  - procedures and cautions
- constant velocity (CV) joint servicing
  - o **removal**
  - o disassembly
  - o cleaning and reassembly

- installation and lubrication
- constant velocity (CV) boot servicing
  - o identification
  - o **lubrication**
  - o purging
  - $\circ$  banding

#### Evaluation:

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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	Final Assessment	Notebook and Organizational Skills		
40%	40%	10%	10%	

Number:	4			
Title:	Electrical And Electronics			
Duration:	Total Hours: 49 Theory: 30 hours Prac			Practical: 19 hours
Prerequisites:	Level I, Section 5			
Co-requisites:	Level II Section 1, 2, 3			
4.1–Electronics Fur	ndamentals			
9 Total Hours	Theory:	6 hours	Practical:	3 hours
4.2–Computer Fund	damentals			
4 Total Hours	Theory:	4 hours	Practical:	0 hours
4.3–Transmission Input Devices				
12 Total Hours	Theory:	8 hours	Practical:	4 hours
4.4–Transmission Output Devices				
6 Total Hours	Theory:	4 hours	Practical:	2 hours
4.5–Electronically Controlled Transmission / Transaxle Diagnosis And Maintenance				
18 Total Hours	Theory:	8 hours	Practical:	10 hours

Number:	4.1		
Title:	Electronics Funda	mentals	
Duration:	Total Hours: 9	Theory: 6 hours	Practical: 3 hours
Cross-reference to Learning Outcomes: 5193.01-08			

#### **General Learning Outcome:**

Demonstrate a working knowledge of the construction, principles of operation, inspection and testing of electronic devices.

# Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 4.1.1 Define the purpose and fundamentals of electronics.
- 4.1.2 Describe the construction, composition, types, styles and application of electronic devices.
- 4.1.3 Explain the principles of operation of electronic devices.
- 4.1.4 Perform inspection and testing procedures for electronic devices following manufacturers' recommendations.
- 4.1.5 Perform assigned operations for vehicle electronic devices following manufacturers' procedures.

# Learning Content:

- 4.1.1 Define the purpose and fundamentals of electronics. [2/0]
  - semi-conductor materials
  - static electricity
    - electrostatic discharge
    - voltage spike control
  - shielding
  - grounding
- 4.1.2 Describe the construction, composition, types, styles and application of electronic devices.

[2/0]

- sensors
  - o reluctors
  - o thermistors
  - o piezoelectric

- o piezoresistive
- variable resistor
- o **rheostat**
- potentiometers
- diodes

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- o rectifying
- o **zener**
- o light emitting
- o photo
- transistors
  - PNP (Positive Negative Positive)
  - NPN (Negative Positive Negative)
- optical devices
- capacitors
- 4.1.3 Explain the principles of operation of electronic devices.
  - [2/0] • se

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- sensors
  - reluctors
  - thermistors
  - piezoelectric
  - o piezoresistive
- variable resistor
  - o rheostat
- potentiometers
- diodes
  - forward and reverse bias
  - o current control
- transistors
  - o forward and reverse bias
  - PNP and NPN
  - o switching
  - amplification
- capacitors
- 4.1.4 Perform inspection and testing procedures for electronic devices following manufacturers' recommendations.

[0/2]

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

- 4.1.5 Perform assigned operations for vehicle electronic devices following manufacturers' procedures.
  [0/1]
  - control of electrostatic discharge
  - control of component damage
  - cautions on wire probing
  - moisture protection
  - explosion hazards

Number:	4.2		
Title:	Computer Fundam	ientals	
Duration:	Total Hours: 4	Theory: 4 hours	Practical: 0 hours
Cross-reference to Learning Outcomes: 5192.01-02, 05, 5193.01, 05			

#### **General Learning Outcome:**

Demonstrate a working knowledge of the fundamentals , construction and principles of operation of vehicle computers.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 4.2.1 Define the purpose and fundamentals of onboard computers, input devices and output actuators.
- 4.2.2 Describe the construction, composition, types, styles and application of computers.
- 4.2.3 Explain the principles of operation of computers.

- 4.2.1 Define the purpose and fundamentals of onboard computers, input devices and output actuators. [2/0]
  - analog/digital computers
  - binary systems
  - digital computers
  - logic gates
  - onboard computers
  - multiplexing
  - fiber optics
- 4.2.2 Describe the construction, composition, types, styles and application of computers. [1/0]
  - input devices
  - central processing unit (CPM)
  - random access memory (RAM)
  - data storage
  - output

# 4.2.3 Explain the principles of operation of computers. [1/0]

- analogue of digital converters
- signal filtration
- central processing unit (CPU)
- processing cycle
- logic sequencing
- random access memory (RAM)
- data storage
- electronic control module (ECM) integral outputs

Number:	4.3		
Title:	Transmission Inpu	It Devices	
Duration:	Total Hours: 12	Theory: 8 hours	Practical: 4 hours
Cross-reference to Learning Outcomes: 5191.01, 05, 5192.01-02, 05, 5193.01, 05-07			

#### **General Learning Outcome:**

Demonstrate a working knowledge of the principles of operation, inspection and testing for transmission / transaxle computer input devices.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 4.3.1 Define the purpose and fundamentals of transmission / transaxle computer input devices.
- 4.3.2 Define the principles of operation of semiconductor devices, capacitors, resistors, automotive computers and input devices.
- 4.3.3 Inspect and test transmission / transaxle computer input devices following manufacturers' recommendations.

#### Learning Content:

4.3.1 Define the purpose and fundamentals of transmission / transaxle computer input devices.

[4/0]

- inputs
  - o vehicle speed sensor
  - wheel speed sensors
  - throttle position sensor
  - temperature sensor
  - o manual selector lever position sensor/switch
  - o overdrive switch
  - o kick down switch
  - o air volume sensors
    - Manifold Absolute Pressure (MAP) sensor
    - Mass Air Flow (MAF) sensor
  - overdrive sensor
  - o brake light switch
  - shift mode switch
  - traction control switch
  - cruise control input
  - o fluid temperature sensor
  - winter mode switch
  - multiplex communications

- 4.3.2 Define the principles of operation of semiconductor devices, capacitors, resistors, automotive computers and input devices.
  [4/0]
  - input devices
    - Hall effect sensor
    - o pressure/vacuum sensor
    - permanent magnet generator
    - o potentiometers
    - Piezo electric sensors
    - variable capacitance sensors
    - reed switches
- 4.3.3 Inspect and test transmission/ transaxle computer input devices following manufacturers' recommendations.
  [0/4]
  - input devices
    - Hall effect units
    - o pressure/vacuum sensors
    - permanent magnet generator (PMG)
  - multiplex communications
    - Electronic Control Module (ECM)
    - Power Control Module (PCM)
    - Electronic Body Control Module (EBCM)
    - o collision deterent / detection
    - traction control

Number:	4.4		
Title:	Transmission Outp	out Devices	
Duration:	Total Hours: 6	Theory: 4 hours	Practical: 2 hours
Cross-reference to Learning Outcomes: 5191.01, 05, 5192.01-05, 5193.01-02, 05			

#### **General Learning Outcome:**

Demonstrate a working knowledge of principles of operation, inspection and testing for transmission / transaxle output devices.

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 4.4.1 Define the purpose and principles of operation for transmission / transaxle output devices.
- 4.4.2 Inspect and test transmission / transaxle output devices following manufacturers' recommendations.

#### Learning Content:

- 4.4.1 Define the purpose and principles of operation for transmission / transaxle output devices. [4/0]

  - outputs devices •
    - shift solenoids 0
    - lock up solenoids 0
    - pressure control solenoids 0
    - overdrive indicator 0
    - relays 0
    - solenoids 0
    - stepper motors 0
    - 0 display lamps
- 4.4.2 Inspect and test transmission / transaxle output devices following manufacturers' recommendations.

[0/2]

- outputs devices
  - shift solenoids 0
  - lock up solenoids 0
  - pressure control solenoids 0
  - overdrive indicator 0
  - relays 0
  - solenoids 0
  - stepper motors 0
  - display lamps 0

Number:	4.5		
Title:	Electronically Controlled Transmission / Transaxle Diagnosis and Maintenance		
Duration:	Total Hours: 18	Theory: 8 hours	Practical: 10 hours
Cross-reference to Learning Outcomes: 5192.01, 05, 5193.01, 05-07			

#### **General Learning Outcome:**

Demonstrate a working knowledge of diagnosing and maintaining an electronically controlled transmission / transaxle

#### Learning Outcomes:

Upon successful completion, the apprentice is able to:

- 4.5.1 Describe manufacturers' maintenance procedures for automatic and electronically controlled automatic transmissions / transaxles.
- 4.5.2 Inspect, test and diagnose electronically controlled automatic transmissions / transaxles using the prescribed service tools and equipment following manufacturers' recommendations.

#### Learning Content:

- 4.5.1 Describe manufacturers' maintenance procedures for automatic and electronically controlled automatic transmissions / transaxles.
  [4/0]
  - identify and verify customer complaints
    - interpretation of wiring schematics
    - interpretation of hydraulic circuits
    - interpretation of sequential troubleshooting charts
    - technical service support
    - stall test safety practices
    - o outline road test procedure
- 4.5.2 Inspect, test and diagnose electronically controlled automatic transmissions / transaxles using the prescribed service tools and equipment following manufacturers' recommendations. [4/10]
  - shop floor diagnosis
    - o retrieval and interpretation of trouble codes
    - o digital scan tools
    - o oscilloscopes
      - single and dual trace

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- wave forms
- PC diagnostics
- o basics of electronic troubleshooting using a digital multimeter
- $\circ$  limp mode
- wiring schematics and sequential troubleshooting practice
  - testing of electronic components
  - o assembly of sealed electronic connectors
    - multiple lock connectors
  - o diagnostics
    - fault codes / ODB II
    - digital scanners
    - generic scan tools
    - data recorders
    - proprietary scan tools
    - personal computer diagnostic programs
    - breakout boxes
    - engine analyzers

#### 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	Final Assessment	Notebook and Organizational Skills	
50%	30%	10%	10%	



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