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LESSON 1

OPERATION

Lesson 1 covers the operation of automatic transmissions and transaxles, which includes the torque converter, planetary gear set operation, and the operation of the continuously variable transmission (CVT) and dual clutch transmissions. This lesson also covers hydraulic component operation, including pumps, multiple disc clutches, bands, servos, accumulators, and valve body components such as electronic controls.

ASSIGNMENT 1

OPERATION

Read this section in your study guide. Then read Chapters 127 and 128 in your textbook.

ASSIGNMENT OBJECTIVES

When you complete Assignment 1, you'll be able to

- 1.1 Explain the purpose, function, and operation of torque converters
- 1.2 Discuss planetary gear sets and compound planetary gear sets
- 1.3 Discuss the operation and servicing of continuously variable and dual clutch automatic transmissions
- 1.4 Discuss the different types of automatic transmission fluid
- 1.5 Explain the function of automatic transmission fluid coolers and pumps
- 1.6 Discuss bands, multi-plate clutches, and one-way clutches
- 1.7 Explain the construction of a valve body and discuss the operation of hydraulically-controlled transmission valves
- 1.8 Explain electronically-controlled transmissions and discuss the typical torque flow in these transmissions

Each assignment in this course includes important terms. Most are technical words that you'll encounter many times over the course of your career. You'll find them listed at the beginning of the assignments, **bolded** in the text, and defined in the program glossary. Learning them will be a critical part of your success.



ASSIGNMENT 1

VOCABULARY

The terms you need to know for this assignment are

- Annulus (ring) gear
- Apply devices
- Automatic transmission fluid (ATF)
- Balance valve
- Check balls
- Clutch drum
- Clutch pack
- Continuously variable transmission (CVT)
- Coupling phase
- Creep
- Default gear
- Electronic pressure control
- Force motors
- Governor valve
- Holding devices
- Impeller
- Input member
- Integral accumulator
- Lapelletier gear set
- Limp-in gear
- Lube oil
- Manual valve
- Multiple-plate clutch
- One-way clutch
- One-way valve
- Output member
- Planet carrier
- Pressure control
- Pressure control solenoids
- Pressure plate
- Pressure regulator valve
- Ravigneaux gear set
- Reaction member
- Ring (annulus) gear
- Rotary flow
- Separator plate

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ASSIGNMENT 1

VOCABULARY

- Servo
- Shift valve
- Simpson gear set
- Sprags
- Stall speed
- Stator
- Sun gear
- Torque converter clutch (TCC)
- Transmission band
- Turbine
- Valve body
- Variable force solenoids (VFS)
- Vortex flow
- Worm holes
- Worm tracks

CHAPTER 127: AUTOMATIC TRANSMISSION/TRANSAXLE PRINCIPLES

Chapter 127 explains the purpose, function, and operation of torque converters. It also discusses planetary gear sets, compound planetary gear sets, and the operation and servicing of continuously variable transmissions and dual clutch automatic transmissions.



To view the videos for this chapter, click [here](#).

Click on the links below to view additional videos and animations:

- [Torque Converter Fluid Flows](#)
- [Torque Converter Power Flows](#)
- [Clutch TCC Operation](#)
- [PGS 1, Reduction](#)
- [PGS 2, Rev Reduction](#)
- [PGS 3, Reduction](#)

(Continued)



- [PGS 4, Rev OD](#)
- [Clutch PGS 5](#)
- [PGS 6, OD](#)
- [PGS 7, Direct Drive](#)
- [Power Flow, Simpson Geartrain](#)
- [Power Flow, Simpson Geartrain and Overdrive](#)
- [Clutch Power Flow, Ravigneaux Four-Speed](#)
- [Power Flow, Allison 1000, Five-Speed](#)
- [Power Flow, 6T70/6F50](#)
- [Honda 4-Speed Automatic Transaxle](#)
- [Clutch CVT Forward and Reverse](#)
- [CVT Operation](#)
- [CVT Ratio Control](#)
- [Dual Clutch Transaxle](#)
- [Clutch Dual Clutch Transmission Hydraulic and Electronic Control](#)
- [7-Speed Dual Clutch Transmission](#)



When the stall speed is about $\frac{1}{3}$ of specification, it's an indicator that the one-way (stator) clutch in converter is bad.



ASSIGNMENT 1

DISCOVER MORE

OPTIONAL EXPERIMENT: TORQUE CONVERTER OPERATION

This experiment will help you explain the purpose, function, and operation of torque converters. You'll need a table and two electric fans with multiple speeds.

Place the two fans on a table about 12 inches apart as shown in Figure 127–4 on page 1553 of your textbook. Turn one fan on to the lowest speed and the other fan off. Note what you see. Now, set the powered fan to the highest speed.

What did you observe?



Planetary Gear Set Ratios

It's important that you understand how different ratios are obtained by holding various gears in the planetary system. Please be sure to pay particular attention to pages 1558–1559 in your textbook.



Use the Internet to research what manufacturers use dual clutch and CVT transmissions for.



ASSIGNMENT 1

REFLECT AND RESPOND

CHAPTER 127 KEY TERMS

You may wish to review the key terms of this chapter by completing the crossword puzzle [here](#).

Click [here](#) to check your answers.

CHAPTER 128: HYDRAULIC COMPONENTS AND CONTROL SYSTEMS

Chapter 128 discusses the different types of automatic transmission fluid and explains the function of automatic transmission fluid coolers, pumps, bands, multi-plate clutches, and one-way clutches. It also explains the construction of a valve body and discusses the operation of hydraulically controlled transmission valves, electronically controlled transmissions, and the typical torque flow in both types.



To view the videos for this chapter, click [here](#).

Click on the links below to view additional videos and animations:

- [Basic Hydraulic System](#)
- [Pressure Regulator Valve](#)
- [EPC Solenoid](#)
- [Auto Transmission Band and Servo Operation](#)
- [Accumulator](#)
- [Electronic Clutch Control](#)
- [Electronic/Hydraulic Shift Control](#)
- [One-Way Roller Clutch](#)

(Continued)



- [Sprag Clutch](#)
- [Simple Hydraulic Shifts](#)
- [Simple Electronic Controlled Shifts](#)
- [Orifice with Check Valve](#)
- [Orifice](#)
- [Mechanical Diode](#)
- [Manual Valve](#)
- [Manual Lever Position Switch](#)
- [Vacuum Modulator Valve](#)
- [Governor Operation](#)
- [Shift Valve Forces](#)
- [Shift Valve](#)
- [Shuttle Valve](#)
- [Simple Electronic Controlled Shifts](#)
- [Simple Hydraulic Shifts](#)
- [Electronic Transmission Control](#)



An overheated transmission can cause major engine damage by causing the torque converter to balloon. This could cause the crankshaft thrust bearing to wear very quickly, damaging the crankshaft and block.



A plastic playing card makes a great clutch pack piston seal installer.



ASSIGNMENT 1

WORK IT OUT

INCREASE ORIFICE SIZE FOR FASTER UPSHIFTS

This activity will help you learn about the construction of a valve body and the operation of hydraulically controlled transmission valves. The objective is to determine the impact of increasing the original orifice size in the valve body spacer plate from 0.125" to 0.185" on the force needed to open the valve.

- Assume the hydraulic pressure is 200 psi.
- The area formula is $A = 0.785d^2$. (The orifice size is the diameter.)
- Calculate the force for each of the two orifices 0.125" and 0.185" using the formula $F = P \times A$.

P = pressure

A = area

A. The force needed for the 0.125" orifice is _____.

B. The force needed for the 0.185" orifice is _____.

Click [here](#) to check your answers.



ASSIGNMENT 1

REFLECT AND RESPOND

CHAPTER 128 KEY TERMS

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Click [here](#) to check your answers.



ASSIGNMENT 1

SELF-CHECK

1. You can double engine torque by using the _____ inside the torque converter.
2. A stator _____ hydraulic flow against the turbine section of the torque converter.
3. The elements of a typical _____ gear set include a ring gear, sun gear, and planet carrier.
4. Driving one element and _____ another element of a planetary gear set results in various gear ratios and reverse.
5. In a continuously variable transmission the _____ of the looped steel belt can be changed by applying hydraulic pressure to move the pulleys.
6. A/an _____ transmission shifts gears by either applying or releasing either of the clutches.
7. The three holding devices include _____, multiple-plate clutches, and one-way clutches.
8. The powertrain or transmission control module controls the application of the _____ by applying power or ground to the correct control solenoid at the right time.
9. Electronically controlled automatic transmissions and transaxles use _____ to allow passages to be opened or closed so that shift valves can be used to send hydraulic fluid pressure to the clutches or bands.

Click [here](#) to check your answers.



KEY POINTS AND RESOURCES

KEY POINTS

- The torque converter is located between the engine and the transmission/transaxle, and transmits engine torque, acts as a clutch, and allows slippage so the vehicle can remain in gear even when stopped.
- A torque converter consists of an impeller, turbine, and stator. The impeller is the driving member, and drives the turbine through the action of transmission fluid. The stator is located between the impeller and turbine, and multiplies the torque from the impeller.
- The torque converter also drives the transmission oil pump.
- Stall speed is the engine speed at which the impeller is driven at the maximum speed possible without moving the turbine.
- Eliminating torque converter slippage can improve fuel economy by approximately 4–5 percent during highway cruising.
- Most automatic transmissions and transaxles include park, neutral, reverse, overdrive, drive, third, second and low shift modes.
- Most automatic transmissions use a planetary gear set system that doesn't require an interruption of torque flow to change gear ratios.
- Compound planetary gear set systems include the Simpson, Ravigneaux, and Lapelletier gear sets.
- Automatic transaxles include a differential assembly as well as planetary gear sets; this connects the output from the gear sets to the drive axle shafts.
- A continuously variable transmission, usually found in front-wheel-drive vehicles, uses variable-width pulleys to change the gear ratio.
- A dual clutch automatic transmission uses a manual-type transmission and two clutches instead of a torque converter and planetary gear sets. This allows shifts to occur without interrupting engine torque, resulting in rapid shifts.
- A dual clutch automatic transmission uses two clutches mounted concentrically—the smaller one drives the even number gears and the larger one drives the odd number gears.
- There are three types of automatic transmission fluid: non-friction modified,

friction modified, and highly friction modified (used by all current OEMs).
Automatic transmission fluid is formulated to work in specific transmissions.

- ATF flows through a cooler, which is a separate section of the radiator tank.
- Apply (or holding) devices are mechanical or hydraulic assemblies that hold or drive members of a planetary gear set. Transmission bands and multiple-plate or one-way clutches are used for this purpose.
- Valve bodies have many fluid passages for multiple transmission hydraulic circuits. One-way valves and check balls are used to direct fluid flow.
- Hydraulically controlled transmissions use valves to control when to shift.
- Electronically controlled transmissions use the powertrain or transmission control module to control shifting, resulting in smoother operation than hydraulically controlled systems.

RESOURCES

James Halderman

(<http://www.jameshalderman.com>)

Chapter 127 Videos

(http://www.jameshalderman.com/links/book_master/vid/ch127/video_frame.html)

Torque Converter Fluid Flows

(http://www.jameshalderman.com/links/a2/flash/tc_fluid_flows.swf)

Torque Converter Power Flows

(http://www.jameshalderman.com/links/a2/html5/tc_power_flow.html)

Clutch TCC Operation

(http://www.jameshalderman.com/links/a2/html5/tcc_op.html)

PGS 1, Reduction

(http://www.jameshalderman.com/links/a2/html5/pgs_1.html)

PGS 2, Rev Reduction

(http://www.jameshalderman.com/links/a2/flash/pgs_2.swf)

PGS 3, Reduction

(http://www.jameshalderman.com/links/a2/html5/pgs_3.html)

PGS 4, Rev OD

(http://www.jameshalderman.com/links/a2/html5/pgs_4.html)

Clutch PGS 5

(http://www.jameshalderman.com/links/a2/html5/pgs_5.html)

PGS 6, OD

(http://www.jameshalderman.com/links/a2/html5/pgs_6.html)

PGS 7, Direct Drive

(http://www.jameshalderman.com/links/a2/html5/pgs_7.html)

Power Flow, Simpson Geartrain

(http://www.jameshalderman.com/links/a2/html5/pf_1_simpson.html)

Power Flow, Simpson Geartrain and Overdrive

(http://www.jameshalderman.com/links/a2/html5/pf_2_simpson_plus_od.html)

Clutch Power Flow, Ravigneaux Four-Speed

(http://www.jameshalderman.com/links/a2/html5/pf_8_rav_4_spd.html)

Power Flow, Allison 1000, Five-Speed

(http://www.jameshalderman.com/links/a2/html5/pf_12_allison_1000.html)

Power Flow, 6T70/6F50

(http://www.jameshalderman.com/links/a2/html5/pf_10_jnt_vntr_6_speed.html)

Honda 4-Speed Automatic Transaxle

(http://www.jameshalderman.com/links/a2/flash/Honda_4_Spd_automatic_transaxle.swf)

Clutch CVT Forward and Reverse

(http://jameshalderman.com/links/a3/html5/cvt_forward_and_rev.html)

CVT Operation

(http://jameshalderman.com/links/a3/html5/cvt_operation.html)

CVT Ratio Control

(http://jameshalderman.com/links/a3/html5/cvt_ratio_control.html)

Dual Clutch Transaxle

(http://www.jameshalderman.com/links/a2/html5/dual_clutch_transaxle.html)

Clutch Dual Clutch Transmission Hydraulic and Electronic Control

(http://www.jameshalderman.com/links/a2/html5/Dual_Clutch_Trans_hyd_elecronic_control.html)

7-Speed Dual Clutch Transmission

(http://www.jameshalderman.com/links/a2/html5/7_speed_dual_clutch_transmission.html)

Chapter 127 Key Terms

(http://www.jameshalderman.com/links/book_master/cw/crossword_ch_127.pdf)

Chapter 128 Videos

(http://www.jameshalderman.com/links/book_master/vid/ch128/video_frame.html)

Basic Hydraulic System

(http://www.jameshalderman.com/links/a2/html5/basic_hyd_sys.html)

Pressure Regulator Valve

(http://www.jameshalderman.com/links/a2/html5/pr_valve.html)

EPC Solenoid

(http://www.jameshalderman.com/links/a2/flash/epc_force_motor.swf)

Auto Transmission Band and Servo Operation

(http://www.jameshalderman.com/links/a2/html5/at_band_and_servo.html)

Accumulator

(<http://www.jameshalderman.com/links/a2/flash/accumulator.swf>)

Electronic Clutch Control

(http://www.jameshalderman.com/links/a2/html5/clutch_apply_elec_cntrl.html)

Electronic/Hydraulic Shift Control

(http://www.jameshalderman.com/links/a2/html5/Elec_Hyd_Shift_Contrl.html)

One-Way Roller Clutch

(http://www.jameshalderman.com/links/a2/html5/roller_clutch.html)

Sprag Clutch

(http://www.jameshalderman.com/links/a2/flash/sprag_clutch.swf)

Simple Hydraulic Shifts

(http://www.jameshalderman.com/links/a2/html5/smpl_trans_hyd.html)

Simple Electronic Controlled Shifts

(http://www.jameshalderman.com/links/a2/flash/smpl_elec_trans.swf)

Orifice with Check Valve

(http://www.jameshalderman.com/links/a2/html5/orifice_w_chk_vlv.html)

Orifice

(<http://www.jameshalderman.com/links/a2/flash/orifice.swf>)

Mechanical Diode

(http://www.jameshalderman.com/links/a2/html5/mechanical_diode.html)

Manual Valve

(http://www.jameshalderman.com/links/a2/flash/manual_valve_w_rc.swf)

Manual Lever Position Switch

(<http://www.jameshalderman.com/links/a2/html5/mlps.html>)

Vacuum Modulator Valve

(http://www.jameshalderman.com/links/a2/html5/tv_vac_mod.html)

Governor Operation

(<http://www.jameshalderman.com/links/a2/html5/governor.html>)

Shift Valve Forces

(http://www.jameshalderman.com/links/a2/html5/shift_valve_forces.html)

Shift Valve

(http://www.jameshalderman.com/links/a2/flash/shift_valve.swf)

Shuttle Valve

(http://www.jameshalderman.com/links/a2/html5/shuttle_valve.html)

Simple Electronic Controlled Shifts

(http://www.jameshalderman.com/links/a2/html5/smpl_elec_trans.html)

Simple Hydraulic Shifts

(http://www.jameshalderman.com/links/a2/html5/smpl_trans_hyd.html)

Electronic Transmission Control

(http://www.jameshalderman.com/links/a2/html5/elec_trans_cntrl_components.html)

Chapter 128 Key Terms

(http://www.jameshalderman.com/links/book_master/cw/crossword_ch_128.pdf)