Learning Objectives (1 of 3)

1.1 Prepare for the ASE Manual Drive Train and Axles (A3) certification test content area “F” (Four-Wheel-Drive/All-Wheel-Drive Component Diagnosis and Service).

1.2 Explain the characteristics of four-wheel-drive (4WD) vehicles.

1.3 Differentiate between part-time and full-time four-wheel-drive vehicles.

Learning Objectives (2 of 3)

1.4 Explain the purpose and function of the central differential and transfer case in a four-wheel drive vehicle.

1.5 Explain the purpose and function of electronic transfer cases and the power transfer unit of a four-wheel-drive vehicle.

1.6 Explain the purpose and function of couplers and torque bias devices.
Learning Objectives (3 of 3)

1.7 Discuss the operation of front drive axles and drive axle/wheel disconnect systems.

Four-wheel Drive (1 of 2)

• Four-wheel drive (4WD) for cars, pickups, and light trucks has steadily evolved from the somewhat crude but rugged Jeep of World War II to sport cars and sport-utility vehicles.
• What are the issues of powering all four wheels?

Four-wheel Drive (2 of 2)

• 4WD can be based on any drivetrain configuration including:
  – Front engine–RWD—Most truck-based four-wheel systems use this arrangement.
  – Front engine–FWD—Many passenger vehicles and sport utility vehicles (SUV) use this arrangement.
  – Mid-engine–RWD—Some sport cars use this arrangement such as some Porsches.
  – Rear engine–RWD—Some sport cars use this arrangement such as some Porsches.
Figure 15–3 Four-wheel-drive vehicles can be achieved by using an existing rear-wheel-drive arrangement and adding a transfer case, or a front-wheel-drive arrangement with the addition of rear axle output shaft and center differential assembly.

Terminology

- Two-wheel drive
- Four-wheel drive
- Part-time four-wheel drive
- Full-time four-wheel drive
- On-demand four-wheel drive

Transfer cases

- Purpose and function
- Types of shifts
  - Mode
  - Range
Part-time Four-wheel drive

• Both front and rear axles are mechanically connected and locked together.

• Dry pavement can cause the drivetrain to bind unless the front wheels are disconnected usually using locking hubs.
  – If so, the vehicle should only be driven on dirt, mud, or snow to avoid damage caused by driveline windup.
Full-time Four-wheel Drive

- Uses a center (interaxle) differential, which allows for both the front and rear axles to rotate at different speeds.
- Can be safely driven in four-wheel drive on dry pavement and under all driving conditions.

Figure 15–8 A typical planetary set used in a transfer case
The terms and their meaning include the following:

The terms used for four-wheel-drive vehicles can be confusing.

- **Part-time four-wheel system**: Both front and rear axles are mechanically connected and locked together. Driving on dry pavement and under all driving conditions.
- **Full-time four-wheel system**: Allows for both the front and rear axles to rotate at different speeds. A vehicle equipped with a full-time four-wheel-drive system uses a center (interaxle) differential, which prevents driveline harshness and vibration, commonly referred to as “driveline windup.”
- **On-demand four-wheel system**: One axle is driven all the time and engine torque is only sent to the other axle when traction has been lost on the primary axle. This type four-wheel-drive system is commonly used in front-wheel-drive-based vehicles where the front axle is driven all the time and engine torque only applied to the rear when the front wheels are starting to slip.

Central Differentials

- **Purpose and Function**
  - Center differential, also called interaxle differential, prevent driveline harshness and vibration, commonly referred to as “driveline windup.”
- **Types**
  - Standard bevel gear
  - Planetary gear
  - Viscous coupling

Transfer Cases (1 of 2)

- The purpose and function of the transfer case is to control the power flow to both the front and rear axles.
- The gear ranges can be engaged in a number of ways, such as:
  - Manual lever (older vehicles)
  - Electrical motor (most commonly used)
  - Vacuum actuators (Usually used to connect and disconnect the front-drive axle when two-wheel drive is selected).
Transfer Cases (2 of 2)

- Two-wheel drive operation
- Four-wheel drive operation
- Oil pump
- Manual shift on-the-fly systems

FIGURE 15–19 The oil pump is driven by the rear output shaft and is removed with the rear part of the case.

Electronic Transfer Cases

- Purpose and Function
  - The transfer case motor/encoder assembly is an electric motor used to shift the transfer case from two-wheel high to four-wheel high
  - Can also make a range change between four-wheel high and four-wheel low.
- Motor/Encoder assembly
- Torque split
Power Transfer Unit

- 4WD/AWD vehicles that are based on FWD vehicles integrate a power transfer unit (PTU) into the transaxle. In its simplest form, a PTU is just a right angle gear set.
- Parts and operation

**FIGURE 15–20** Four-wheel-drive/hand range torque flow in a NV231 transfer case

**FIGURE 15–24** A PTU has an interaxle differential that drives the front axle differential and the transfer of torque to the rear driveshaft.
Couplers and Torque Bias Devices

• Purpose and Function
  – Couplers are connected in series with other drivetrain members and are used to transfer torque, much like a clutch. They are applied only when needed.

• Electromagnetic clutch coupler
  – Torque Management
  – Interactive Torque Management System
  – Intelligent AWD System
  – Active Torque Dynamics

• Electro-hydraulic coupler

FIGURE 15–30 The Haldex system uses hydraulic pressure to apply the clutch, which can be created as soon as there is a speed differential between the input and output shafts. Hydraulic pressure and speed at which the clutch will be applied are controlled by the ECU.

Front Drive

• Front Drive Axles
  – Some of the 4WD vehicles use a RWD drive axle that is rotated so the drive pinion points toward the rear.
  – Axles using reverse-cut gears can be identified by a high-mounted pinion shaft.
FIGURE 15–32 Constant velocity (CV) joints are used on the front axles of many four-wheel-drive vehicles like this Chevrolet Blazer.

Drive Axles/Wheel Disconnect Systems

- Purpose and function
- Drive Axles/Wheel Disconnect Systems
  - The engine intake manifold provides the vacuum, which is controlled by the vacuum control valve.
    - The control valve is controlled by the mode switch.
- Continuous vacuum locking hubs
- Pulse vacuum locking hubs

FIGURE 15–34 A General Motors sport utility vehicle front axle showing the electric axle disconnect actuator.
Summary (1 of 2)

• Many of today’s 4WD/AWD vehicles are based on front engine FWD vehicles.
• A transfer case or power transfer unit drives the second axle.
• AWD transfer cases/PTUs can include a differential, viscous coupler, or electromechanical clutch to control torque to the front and rear drive axles.

Summary (2 of 2)

• A front drive axle has outboard U-joints or CV joints to allow steering.
• Front wheel hubs can be disconnected using a mechanical, automatic, or vacuum operation.