

MERCER COUNTY COMMUNITY COLLEGE

Division of Business and Technology

AUT 225

Automatic Transmission Service

I. COURSE DESCRIPTION:

Principles of operation and proper diagnostic and repair procedures for today's automatic transmissions and transaxles. Basic hydraulic theory will be covered with emphasis on the use of test equipment for diagnosis and in-car service. Each student will be required to disassemble, overhaul, and assemble an automatic transmission and transaxle.

Text (s): Reference Division Booklist

Prerequisites: AUT 224

Co-requisites:

Credits: 3 Lecture Hours: 2 Studio/Lab Hours: 3

Food and drink are strictly prohibited in classrooms as per health and safety laws. Students are not permitted to bring in any chemicals or cleaning fluids without the appropriate MSD sheets.

Course Coordinator: Fred Bassini

Latest Review: Summer 2003

GENERAL LEARNING OBJECTIVES

1. To acquaint the student/apprentice with the fundamentals of hydraulics and their importance to the operation of the automobile automatic transmission/transaxle.
2. To provide the student/apprentice with intermediate level skills in diagnosis and overhaul on both a rear-wheel drive and front-wheel drive automatic transmission.

TOPIC SUMMARY

- I. Transmission/Transaxle Identification
 - A. Transmission Types
 - B. Identification Areas

- II. Planetary Gears
 - A. Components
 - B. Principles of Operation
 - C. Operating Conditions

- III. Frictional Units
 - A. Components
 - B. Principles of Operation

- IV. The Flow of Power
 - A. Component Operation: Drive Positions

- V. Fundamentals of Fluid Compiling and Torque Converters
 - A. Principles of Operation
 - B. Torque Converter Construction
 - C. Torque Converter Theory of Operation

- VI. Hydraulic Fundamentals
 - A. System Basics
 - B. Transmission Hydraulic System
 - C. Control System
 - D. Hydraulic Circuit Pressure Charts

TOPIC SUMMARY (cont'd)

- VII. Testing and Diagnosis
 - A. Road Testing Procedures
 - B. Applying Fundamentals for Diagnosis
 - C. The Diagnosis Procedure

- VIII. Transmission Overhaul Procedures
 - A. Unit Disassembly
 - B. Component Inspection
 - C. Unit Reassembly

- IX. 41TE/42LE Ultra Drive Electronic Transaxle
 - A. Operating the Transaxle
 - B. Component Identification and Function
 - C. Transaxle Function of Operation
 - D. Transaxle Diagnosis and Service

Course Review/Final Exam

I. Transmission/Transaxles Identification

- A. *Transmission Types - RWD*
 - 1. 44RE
 - 2. 45RE
 - 3. 46RE
 - 4. Mitsubishi
- B. *Transaxle Types – FWD*
 - 1. 31TE
 - 2. 41TE
 - 3. 42LE
 - 4. Mitsubishi
- C. *Transmission Methods of Identification*
 - 1. Serial Number
 - 2. Vehicle Identification Number
 - 3. Torque Converter Number
 - 4. Transmission Oil Pans
 - 5. Transaxle Bell Housing Identification

II. Planetary Gears

- A. *Components: Planetary Gear Set*
 - 1. Sun Gear
 - 2. Planet Carrier
 - a) Pinion gears
 - 3. Annulus Gear or Ring Gear
- B. *Input and Output Torque Variations*
 - 1. Combinations
- C. *Simpson Gear Train*
 - 1. Two different simple gear sets with common sun gear
 - 2. Gear Ratios
 - 3. Combinations
 - a) #1: Sun Gear is held: Ratio = 0.7 to 1.0
 - b) #2: Sun Gear is held: Ratio = 1.45 to 1.0
 - c) #3: Annulus Gear is held: Ratio = 3.23 to 1.0
 - d) #4: Annulus Gear is held: Ratio = 0.32 to 1.0
 - e) #5: Planet Carrier is stationary: Ratio = 0.45 to 1.0
 - f) #6: Planet Carrier is stationary: Ratio = 2.20 to 1.0
 - (1) Reverse Range
 - (2) Additional Combination
 - (3) Direct Drive
 - (4) Loads on Gear Sets and Shafts
 - (5) Perpendicular Loads
 - (6) Parallel Loads
 - (7) Gear Noise and Wear
 - (8) Foundation and Power Flow

- B. *Power Flow from Engine to Transmission Input Shaft*
 - 1. Crankshaft to transmission input shaft
 - 2. Converter drives front pump
 - 3. Impeller turns
 - 4. Input shaft splined to turbine
 - 5. Front clutch hub/rear clutch retainer
 - a) Input shaft, front clutch hub/rear clutch retainer
 - b) Two sets of multiple-disc clutch assemblies

III. Fictional Units

A. *Components*

- 1. Clutch Assemblies
- 2. Brands
- 3. Over-Running Clutch
 - a) Mechanical Unit
- 4. Function

B. *Clutch Assemblies*

- 1. Multiple Disc Clutch Assembly
 - a) Function
 - b) Clutch Assembly Construction
 - (1) Hub
 - (2) Driving Discs
 - (3) Driven Plates
 - (4) Apply Pistons
 - (5) Seals
 - (6) Pressure Plates
 - (7) Release Springs
 - (8) Clutch Assembly Retainer
 - c) Snap-Ring
 - (1) Selective Fit
 - d) Clutch Plate Clearance
 - e) Clutch Frictional Material
- 2. Rear Clutch Assembly
 - a) Drives Front Annulus Gear
- 3. Front Clutch Assembly
 - a) Drives Sun Gear
- 4. Multiple Disc Clutch Pressure Check
 - a) Pressure Check
 - (1) 70 P.S.I.
 - (2) Force of Clutch Application: Torque
 - b) Defective Seals
 - c) Glazing of Frictional Material
 - (1) Overheating

C. Bands

1. Function
 - a) Hold Drums or Retainers
2. Friction Material
 - a) Steel with lining
3. Band Anchors
 - a) Servo Piston
4. Applied Force/Torque
 - a) Torque Requirement
5. Kickdown Band
 - a) Holds Sun Gear
6. Low-Reverse Band
 - a) Holds rear planetary carrier
 - b) Manual low operation
 - (1) Engine Braking

D. Over-Running Clutch (Front-Wheel Drive)

1. Construction
 - a) Inner race
 - b) Outer race or cam
 - c) Rollers and springs (8, 10, or 12)
 - d) Spring retainer
2. Over-running Clutch Operation
 - a) Free-Wheeling Condition
 - b) Locked Condition
3. Over-running Clutches
 - a) Two Utilized
4. Front-Wheel Drive Operation
 - a) Drive Breakway
 - b) Manual Low

IV. The Flow of Power

A. Components Operation

1. Front Clutch Hub/Rear Clutch Retainer Assembly
 - a) Multiple-Disc Clutch Assemblies: Two Sets
 - b) Front Clutch/Rear Clutch
2. Output Shaft
 - a) Rear-Wheel Drive
 - (1) Construction
 - b) Front-Wheel Drive
 - (1) Construction
 - c) Lubrication and Cooling

B. Power Flow: Drive Positions

1. Neutral
 - a) Torque Converter Develops Torque (Power)
 - b) No Bands or Clutches Applied
 - c) Disc and Output Shaft are Stationary

C. Drive Breakway/Manual Low

1. Shift Lever in “D” position
2. Rear Clutch Applies
3. Planetary Carrier Rotation
4. Low/Reverse Drum
5. Over-Running Clutch Operation
6. Final Drive Gear Ratio: Engine to Output Shaft
 - a) RWD = 2.74:1
 - b) FWD = 2.69:1
 - c) Sum of Both Planetary Gear Sets

D. Second Gear (Drive)

1. Application of Kickdown Band
 - a) Holds Front Clutch retainer
 - b) Holds Sun Gear Stationary
2. Engine to Output Shaft
 - a) RWD = 1.54:1
 - b) FWD = 1.55:1
3. Over-Running Clutch – 1 to 2 Shift
 - a) Free-Wheeling

E. Third Gear (Drive/Direct)

1. Kickdown Band Released/Front Clutch Applied
 - a) Rear Clutch Still Applied
2. Both Clutch Assemblies Locked Up
 - a) Rotate in same direction
3. Engine to Output Shaft Ratio = 1.0:1
4. Front and Rear Planet Pinions Not Rotating
5. All Connected Parts: One Common Unit

F. Reverse Gear

1. Front Clutch Applies With Low-Reverse Band
2. Sun Gear Rotation
 - a) Planet Pinions Rotation
 - (1) Opposite Engine Direction
3. Engine to Output Shaft Ratio
 - a) RWD = 2.22:1
 - b) FWD = 2.10:1

G. Manual Low = "1"

1. Rear Clutch Applied Along With Low-Reverse Band
2. Engine to Output Shaft Ration
 - a) RWF = 2.74:1
 - b) FWD = 2.69:1
3. Same as Drive Breakway
 - a) Application of Low-Reverse Band
 - b) Engine Braking
4. Engine Deceleration
 - a) Reverse of Power Flow
 - b) Torque Load and Gear Reduction

H. Manual Second/3-2 Kickdown

1. Same as Second Gear (Drive)

I. Clutch and Band Application Chart

V. Fundamentals of Fluid Couplings and Torque Converters

A. Principles of Operation

1. Fundamental Coupling Principle
2. Components
 - a) Impeller or Pump
 - b) Turbine
 - c) Shroud
3. Fluid Coupling Construction
 - a) Vane Placement
4. Operation of a Fluid Coupling
 - a) Driving Member (Impeller)
 - b) Driven Member (Turbine)
 - c) Fluid Coupling Filled With Oil
 - d) Oil Set in Motion
 - (1) Thrown by Centrifugal Force
 - (2) Strikes Vanes
 - (3) Greater Torque Imparted to Input Shaft
 - e) Greater difference in speed between members means more power developed
 - f) Engine Braking

5. Oil Flow in Fluid Coupling and Torque Converter
 - a) Types of Flow
 - (1) Vortex
 - (2) Rotary
 - (3) Turbulent
 - b) Rotary Flow
 - (1) Complete Path of Oil Flow
 - c) Vortex Flow
 - (1) Circular Path
 - d) Turbulence
 - (1) Violent Random Motion
6. Addition of the Guide Ring
 - a) Split Guide Ring
 - (1) Reduces Turbulence of Oil

B. Torque Converter Operation

1. Vane Construction
 - a) Curved
 - b) To Change Flow Direction of Oil
 - (1) More pushing force on turbine
2. Stator
 - a) The Stator Effect
 - (1) Torque Multiplication
 - (2) Oil Redirected by Vanes
3. Purpose of the Stator
 - a) To Redirect Oil Flow
 - b) Stall Speed
 - (1) Point of Maximum Torque Multiplication
 - c) Over-Running Clutch Assembly
 - (1) Hold Stator Stationary
4. Checking Stall Speed
 - a) Precautions
 - b) High Stall Speeds
 - c) Low Stall Speeds
 - d) Stall Test Oil Flow and Temperature
 - e) Diagnosis of Results

C. The Three Element Torque Converter

1. Elements
 - a) Turbine
 - b) Impeller
 - c) Stator
2. Turbine
 - a) Driven or Output Member of Converter
 - b) Splined to Input Shaft
 - c) Blades Curved in Opposite Direction of Impeller
3. Impeller
 - a) Integral Part of Converter Housing
 - b) Driving Member
 - c) Curved Vanes Placed Radially on Inside of Cover
 - d) Impeller Rotates – Throws Fluid Out
4. Stator Assembly and Over-Running Clutch
 - a) Third Set of Blades
 - b) Mounted on Stationary Shaft: Part of Oil Pump
 - c) Over-Running Clutch
 - (1) Permits Stator to Rotate Only in Same Director as Impeller
 - (2) Locks Stator to Shaft: Torque Multiplication
 - (3) Sealed Inside Converter
 - (4) Lubricated by Transmission Fluid
 - (5) Damage Due to Contamination
5. Stator Action Within the Torque Converter
 - a) Bounce-Back Effect
 - b) Stator Vanes Turn in “Helping” Direction
 - c) Torque Converter as a Mechanical Lever
 - (1) Stator: Fulcrum
 - (2) Impeller: Long Arm
 - (3) Turbine: Short Arm
 - (4) Fluid “Pivots”
 - (5) Torque Multiplication = 2.2:1
6. Fluid Flow at Coupling Stage
 - a) Limited Rotary and Vortex Flow
 - b) Cruising Speed: Approximately 30 mph and up
7. Converter Operating Characteristics
 - a) Acts as Automatic Clutch
 - b) Automatically Adjusts Torque Output
 - c) Acts as a Natural Shock Absorber
8. Converter Capacity or Size
 - a) Torque Capacity – Stall Speed
 - b) Converter and Engine Must Be Matched
 - c) Use of Small or Low Capacity Converter
 - d) Use of a Too Large Converter

D. Lock-Up Converters

1. Benefits of System
 - a) Better Fuel Economy
 - b) Lower Transmission Operating Temperature During Highway Operation
 - c) Less Engine speed During Highway Operation
2. Fluid Coupling Slippage
 - a) All Fluid Drives Slip
3. Torque Converter Lock-Up Clutch
 - a) Introduced in 1978: Rear Wheel Drive Cars
 - b) Eliminates Torque Converter Slip
 - c) Locks Turbine and Impeller Together at Predetermined Speed in Drive
4. Operation
 - a) Movable Piston Added to Turbine
 - b) Friction Material Added to Inside of Impeller Housing
 - c) Piston Applied by Means of Oil Pressure
 - (1) Applied Force of Approximately 800 Pounds
 - d) Straight-through 1:1 Mechanical Connection
 - e) Torsional Vibration Load
 - (1) Damping Springs
 - f) Lock-Up and Fail-Safe Valves
 - (1) Lock-Up and Disengagement Points
 - (a) 24-50 mph
 - (b) Engine Size and Axle Ratio
 - (2) Torque Converter Control Valve
 - (a) Spool Valve
 - (3) Switch Valve
 - (a) On and Off Oil Pressures for Piston
 - (4) Lock-Up Valve
 - (a) Reacts to Prop Shaft Speed
 - (5) Fail-Safe Valve
 - (a) Direct Gear Only
 - (b) Provides Fast Lock-Up Release: Kickdown
5. Input Shaft Lock-Up Oil Passages

VI. Hydraulic Fundamentals

A. System Basics

1. The Hydraulic Lever: Pascal's Law
 - a) "Pressure on a confined fluid is transmitted equally in all directions and acts with equal force on equal areas."
2. Force and Pressure Relationships
 - a) Force of Gravity
 - b) Frictional Force
 - c) Spring Force
 - d) Pressure
 - (1) Force (lbs.) divided by area (IN² or FT.²)
3. Pressure on a Confined Fluid
 - a) Resistance to Flow
 - b) Pressure in Fluid Same Everywhere
4. Force Multiplication
 - a) Difference of Area to Create Difference in Pressure to Move Object
5. Piston Travel
 - a) Mechanical Lever: Weight-to-Distance Output
6. Basic Hydraulic System
 - a) Components
 - (1) Reservoir
 - (2) Pump
 - (3) Valving
 - (4) Pressure Lines
 - (5) Actuating Mechanisms
 - b) Fluid Reservoir
 - (1) Storehouse for Fluid
 - (2) Cooling Through Heat Transfer
 - (3) Vent Line, Pressure Line, Return Line
 - c) The Pump
 - (1) Splined to the Converter Impeller Hub
 - (2) Gerotor (Internal/External) Pump (RWD)
 - (3) Gear Pump (FWD)
 - (4) Regulator Valve: Pressure
 - d) Valving
 - (1) Directs and Regulates Fluid
 - (2) Balanced Valve System
 - (3) Relay Valve
 - e) The Actuating Mechanism
 - (1) Servo

B. Transmission Hydraulic System

1. Components
 - a) Fluid: Dextron II
 - b) Oil Pan or Sump
 - c) Oil Pump
 - d) Bands and Clutches
 - e) Valve Body
2. Fluid
 - a) Performance Tasks
 - b) Properties
 - c) Operating Temperatures
 - d) Methods of Fluid Cooling
 - e) Contamination
3. Fluid Source: Oil Pan
 - a) Filter Locations
 - b) Fluid Level Over Full
4. Oil Pump Assembly
 - a) Parts and Construction
 - b) Failure Diagnosis
5. Hydraulic Operating Units
 - a) Front Clutch Assembly
 - b) Rear Clutch Assembly
 - c) Low-Reverse Servo
 - d) Kickdown Servo
 - e) Unit Components
 - f) Lube Oil Loss
6. Clutch Pack Assembly
 - a) Driving Discs/Driven Plates
 - b) Steel Plates
 - c) Clutch Frictional Material
7. Clutch Assembly Operation
 - a) Compressing Clutch Pack
 - b) Clutch Application
 - c) Results of Slippage
 - d) Vent and Ball Check Valve – Eliminates Possibility of Plate Drag
8. Rear Clutch Assembly
 - a) Belleville Spring Washer – Multiplies Hydraulic Apply Force
 - b) Fiber Thrust Washer
9. Low-Reverse Servo
 - a) Piston/Piston Plug Movement
 - b) Reduced Band Loading-Cushions Shift

10. Kickdown Servo
 - a) Components
 - b) Operation
 - (1) Applies Kickdown Band
 - (2) Release of Servo
 - (3) Line Pressure and Return Spring Force
 - (4) Release Timing

C. Control System

1. Pressure Regulation and Flow Control Valves
 - a) Ball Check Valves
 - b) Circuits
 - c) Orifices
2. Pressure Relief: Ball Check Valve
 - a) Operation
 - b) Adjustment
3. Transmission Ball Check Valves
 - a) Eight Check Balls (FWD)
 - b) Seven Check Balls (RWD)
 - c) Two Ball Check Valves (RWD)
4. The Spool Valve
 - a) Self-Cleaning
 - b) Operation
 - c) Spring Forces
 - d) Compensating or Regulating Valve
 - e) Relay Valve
5. Manual Valve
 - a) Relay-Type Valve
 - b) Directs Fluid to Different Circuits
 - c) Differences Between Front and Rear-Wheel Drive
6. Pressure Regulator Valve Train
 - a) Front-Wheel Drive
 - (1) Throttle Pressure Plug
 - b) Rear-Wheel Drive
 - (1) Line Pressure Plug
7. Pressure Regulation: Operation
 - a) In Park Position
 - b) In Drive Position
 - (1) Torque Converter and Switch Valve Circuit
 - (2) Range: 50-90 PSI
 - (3) Throttle Pressure-Line pressure
 - (4) RWD
 - (5) FWD
 - (6) Throttle Pressure Linkage Adjustment
 - c) In Reverse Position
 - (1) Line Pressure
 - (2) Causes of High Pressure
 - (3) FWD: Metered Orifice – Throttle Valve
 - (4) RWD: Modulated Line Pressure

8. Throttle Valve and Kickdown Valve Operation (FWD)
 - a) Delays Upshift
 - (1) Engine and Vehicle Speeds
 - b) Meters Line Pressure
 - c) Wide Open Throttle (WOT) Condition
 - d) Throttle Pressure Equal Line Pressure
9. Governor Assembly
 - a) Signals for Shift
 - (1) Governor Pressure
 - (a) *Vehicle Speed*
 - (2) Throttle Pressure
 - (a) *Engine Torque Load*
 - (b) *Governor Symptoms*
 - (i) Sticking
 - (c) *Governor Operation (FWD)*
 - (i) Primary Valve
 - (ii) Secondary Valve
 - (iii) Operates in Two Stages
 - (d) *Governor Operation (RWD)*
 - (i) Centrifugal Force
 - (ii) Governor Pressure Corresponds to Vehicle Speed
 - (iii) Governor Pressure Checks
 - (a) *0 to 90-100 PSI*
 10. Shift Valve Operation
 - a) Before Shift
 - b) After Shift
 - c) FWD and RWD
 11. Front Servo Operation (Controlled Load)
 - a) Kickdown Band Application
 - b) Two-Diameter Main Piston
 - c) Hydraulic Cushioning in Stages
 - d) Orifice and Seal Condition: Diagnosis
 12. Accumulator Operation
 - a) FWD
 - (1) Cushions Application of Kickdown Band
 - (2) Two-Diameter with Spring
 - b) RWD
 - (1) Line Pressure
 - (2) Application of Rear Clutch
 - (3) 1-2 Shift Control Pressure
 13. Limit Valve Operation (RWD)
 - a) Low Road Speeds
 - b) High Road Speeds
 14. Shuttle Valve Operation
 - a) Opens By-Pass Circuit
 - b) Controls Kickdown Shift Quality
 - c) Allows Quick Release of Band on Upshift

15. By-Pass Valve Operation (FWD)
 - a) During 2-3 Upshift
 - b) During 3-2 Downshift
16. 1-2 Shift Control Valve Operation (RWD)
 - a) Aids in Controlling Quality of 1-2 Upshift
 - b) Aids in Timing and Quality of 3-2 Kickdown
 - c) Operation

D. Hydraulic Circuit Pressure Charts

1. Park and Neutral (FWD)
2. Drive Breakaway (FWD)
3. Drive Second (FWD)
4. Direct Drive (FWD)
5. Drive Part Throttle Kickdown
6. Drive Full Throttle Kickdown
7. Manual Second (FWD)
8. Manual Low (FWD)
9. Reverse (FWD)
10. Park and Neutral (RWD)
11. Drive Breakaway (RWD)
12. Drive Second (RWD)
13. Direct Drive (RWD)
14. Drive Part Throttle Kickdown (RWD)
15. Drive Full Throttle Kickdown (RWD)
16. Manual Second (RWD)
17. Manual Low (RWD)
18. Reverse (RWD)
19. Direct Drive Lock-up Torque Flite (RWD)

VII. Testing and Diagnosis

A. Road Testing Procedures

1. Verify Customer Complaint
2. Have Customer Drive Car
3. Record Information of Transmission Operation

B. Problem Diagnosis-Symptoms

1. Slipping in Breakway Low
 - a) Rear Clutch Assembly
 - b) Over-Running Clutch Assembly
2. Slipping Kickdown Band
 - a) Faulty Kickdown Band
3. Slipping in Direct Drive
 - a) Front Clutch Assembly

4. Slippage in Reverse
 - a) Loose Low-Reverse Band
 - b) Causes of Burned Clutches and Bands

C. Hydraulic Pressure Testing

1. Gauge Locations (FWD)
 - a) Seven Circuits
 - b) Pressure Valves
2. Gauge Locations (RWD)
 - a) Five Circuits
3. Performing Pressure Checks
 - a) Test #1 (Selector in “1”)
 - b) Test #2 (Selector in “2”)
 - c) Test #3 (Selector in “D”)
 - d) Test #4 (Selector in “Reverse”)
 - e) Testing Governor Pressure
 - f) Front (Kickdown) Servo Apply Pressure (FWD) Tests #6 and #7
4. Indications from Test Results

VIII. Transmission Overhaul Procedures

A. Unit Disassembly

1. Component Cleaning and Inspection
 - a) Wear Patterns
2. Components
 - a) Valve Body
 - b) Input Shaft Endplay Measurement
 - c) Snap Rings
 - d) Thrust Washers
 - e) Oil Pump
 - f) Clutch Packs
 - g) Front Planetary and Annulus Gear
 - h) Low-Reverse Servo
 - i) Accumulator
 - j) Kickdown Servo (Controlled Load)
 - k) Governor Assembly
3. Special Tools

B. Component Inspection and Measurement

1. Measuring Pump Clearance
2. Measuring Front Clutch Plate Clearance

C. Unit Assembly

1. Component Installation Procedures
 - a) Proper Torque
 - b) Lubrication
 - c) Clearances/End Play

IX. 41TE/42LE Ultradrive Electronic Transaxle

A. Operating the Transaxle

1. Neutral and Park
2. Overdrive “OD”
3. Drive “D”
4. Low “L”
5. Reverse “R”

B. Component Identification and Function

1. Transaxle Controller
2. Relays
 - a) Solenoid Shutdown Relay
 - b) Reverse Lamp Relay
3. Solenoid Assembly
4. Case
5. Valve Body
 - a) Elimination of Shift Valves
6. Torque Converter
7. Oil Pump
8. Input Clutch Retainer Assembly
 - a) Input Shaft, Hub, Pistons and Retainer
 - b) Input Clutches
9. 2-4 Low/Reverse Clutch Assemblies
 - a) 2-4 Clutch
 - b) Low/Reverse Clutch
10. Planetary Geartrain
 - a) Rear Carrier Assemblies
 - b) Rear Sun Gear
 - c) Front Carrier and Rear Annulus Assembly
 - d) Front Sun Gear Assembly
11. Transfer Gears
 - a) Transfer Shaft and Ring Gear
 - b) Differential Case Assembly

C. Transaxle Function of Operation

1. Transaxle Controller and Sensors
 - a) Adaptive Memory
 - b) Self-Diagnostics
2. Information Input to Transaxle Controller
 - a) Direct Battery Voltage
 - b) Ignition Voltage
 - c) Throttle Position Sensor
 - d) Engine Speed Signal
 - e) Turbine Input Speed Sensor
 - f) Output Speed Sensor
 - g) Neutral Safety Switch or “PRNDL” Switch
 - h) Low-Reverse Clutch Pressure Switch/2-4 Clutch Pressure Switch/Overdrive Pressure Switch

- i) Engineer Coolant Temperature Sensor
- j) Ambient Temperature Sensor
- k) Brake Switch Signal
- l) Solenoid Shutdown Relay
- m) Solenoid Assembly
- 3. Solenoid Assembly and Valve Body
 - a) Regulator Valve
 - b) Torque Converter Control Valve
 - c) Lock-Up Switch Valve
 - d) Solenoid Switch Valve
 - e) Manual Valve
 - f) Low Reverse/Lock-up and Overdrive Solenoids
 - g) 2-4/Low Reverse and Underwire Solenoids
 - h) Dribbler Circuits
 - i) Thermal Valve
 - j) Pressure Switches
 - k) Transaxle Operation Hydraulic Charts
- 4. Torque Converter
 - a) Lock-Up Clutch Operation
- 5. Clutches
 - a) Underdrive Clutch
 - b) Overdrive clutch
 - c) Reverse Clutch
 - d) 2-4 Clutch
 - e) Low/Reverse Clutch
- 6. Planetary Geartrain
 - a) First Gear
 - b) Second Gear
 - c) Third Gear
 - d) Fourth Gear
 - e) Reverse Gear
- 7. Transfer Gears
- 8. Final Drive Gears and Differential

D. Transaxle Diagnosis and Service

- 1. Diagnosis – General
 - a) Fault Codes/DRF-II
- 2. Shift Quality Quick-Learn Procedure
 - a) Upshift Learn Procedure
 - b) Kickdown Learn Procedures
- 3. Hydraulic Pressure Tests
- 4. Torque Converter Stall Test
- 5. Clutch Air Pressure Tests
- 6. Fluid Leakage
- 7. Component Service
 - a) Speed Sensors
 - b) Valve Body

- c) Accumulators
- d) Oil Pump Seal
- 8. Transaxle Overhaul Procedures
 - a) Disassembly and Component Inspection
 - b) Reassembly and Adjustments

LAB ACTIVITY: 41TE/42LE TRANSAXLE OVERHAUL

X. Course Review/Final Exam

- A. *Transmission/Transaxle Identification*
- B. *Planetary Gears*
- C. *Frictional Units*
- D. *The Flow of Power*
- E. *Fundamentals of Fluid Couplings and Torque Converters*
- F. *Hydraulic Fundamentals*
 - 1. System Basics
 - 2. Transmission Hydraulic System
 - 3. Control System
 - 4. Hydraulic Circuit Pressure Charts
- G. *Testing and Diagnosis*
- H. *Transmission Overhaul Procedures*
- I. *A-604 Ultradrive Electronic Transaxle*
- J. *Final Exam*

XI. Evaluation

- 1. 50% - Direct Evaluation of Shop Work
- 2. 40% - Six quizzes, midterm and final exams
- 3. 10% - Class participation