

AUT 231 (A3)
MANUAL TRANSMISSION/TRANSAXLE AND DRIVETRAIN

COURSE DESCRIPTION:

Prerequisites: TRN 120

Corequisites: None

This course covers the operation, diagnosis, and repair of manual transmissions/transaxles, clutches, driveshafts, axles, and final drives. Topics include theory of torque, power flow, gear theory, and manual drive train servicing and repair using appropriate service information, tools, and equipment. Upon completion, students should be able to explain operational theory, diagnose and repair manual drive trains. Course Hours Per Week: Class Hours, 2; Lab, 3. Semester Credit Hours, 3.

SAFETY DISCLAIMER:

Automotive work presents many hazards. A moment's carelessness can cause injury to oneself or to others. Such mishaps can occur quickly due, in part, to the nature of the industrial tools used in automotive work. The weight of automobiles and the equipment used to fix them can even cause fatal injuries. Therefore, great care must always be taken in checking out equipment before use, and in using that equipment to work on automobiles.

As we work to insure the safety of everyone in the Durham Tech automotive lab, it is the instructor's responsibility to introduce students to equipment and to advise them on its safe operation. Those health and safety procedures are also presented in each textbook for each course in the automotive program. **Students are responsible for mastery of that safety information.** Durham Tech holds each student in every class responsible for reading and applying all of the information regarding personal and public safety and personal and public health in the required text.

While working in the Durham Tech automotive lab, safety glasses must be worn by everyone. However, safety glasses are only one small requirement so that students remain injury free. All safety recommendations in the text book and from the instructor must be followed. A student with any questions about a safety procedure should immediately ask an instructor for clarification.

Any student using equipment in the automotive lab must be responsible for using that equipment in a safe manner. Durham Tech holds each student in automotive classes responsible for acting to ensure a safe environment and to ensure both the student's own safety and the safety of his classmates.

LEARNING OUTCOMES:

Upon completion, students should be able to:

- a. Identify vehicle information and observe proper safety procedures.
- b. Complete repair orders and use service information systems.
- c. Inspect, diagnose, and repair automotive clutches.
- d. Service, inspect, diagnose, and repair manual transmissions and transaxles.
- e. Inspect, diagnose, and repair drivelines including; driveshafts and universal joints, half shafts, and constant velocity joints, and carrier bearings.

- f. Service, inspect, diagnose, and repair differentials and final drives, including drive axles.
- g. Service, inspect diagnose, and repair four wheel and all wheel drive systems.
- h. Diagnose and repair manual drive train control systems.

OUTLINE OF INSTRUCTION:

I. Clutch Assembly

A. Components

- 1) Flywheel-purpose
- 2) Pilot bushing (bearing)
- 3) Friction disc-construction
- 4) Ring gear for starter (removal and replacement)
 - a. Torsional springs or rubber inserts
 - b. Cushion springs
 - c. Hub
- 5) Pressure plate (diaphragm and coil-spring type)
- 6) Clutch cover
- 7) Throwout bearing (include self-centering type)
- 8) Release levers (include adjustable type)

B. Adjustments

- 1) Free-play clearance
- 2) Over-center spring
- 3) Automatic adjuster mechanisms
- 4) Align mounts

C. Measurements

- 1) Flywheel-to-block runout
- 2) Bell housing bore-to-crankshaft runout
- 3) Crankshaft end play
- 4) Flywheel runout
- 5) Friction disc runout
- 6) Crankshaft flange runout

D. Problem/Diagnosis

- 1) Does not engage
- 2) Does not release
- 3) Noises
 - a. Pedal depressed
 - b. Pedal released
- 4) Pulsating pedal
- 5) Chatter
- 6) Slipping
- 7) Binding
- 8) Shudder in reverse
- 9) Grab

E. Replacement Procedures/Tools

- 1) Aligning mandrels
- 2) Guide pins
- 3) Hydraulic clutch slave and master cylinder (bleeding)/lines/hoses
- 4) Pilot bearing pullers
- 5) Pedal linkage, brackets, bushings, and pivots

II. Manual Transmission/Transaxle

A. Power Flow (3-speed, 4-speed, 5-speed, and 6-speed)

B. Components (Identification and Replacement)

- 1) Shafts and retainers
- 2) Gears-nomenclature
- 3) Bearings, bores, and bushings
- 4) Thrust washers and thrust bearings
- 5) Synchromesh devices-operation
- 6) Shift levers, cables, and guides
- 7) Interlock mechanisms/detents
- 8) Speedometer drive gear and driven gear
- 9) Extension housing and/or case
- 10) Gaskets and seals (include sealants)
- 11) Mounts/dampers
- 12) Shifter mechanisms
- 13) Vents
- 14) Shift cover, grommets, and linkage (hard rods)
15. Lubrication devices

C. Rebuilding Procedures/Clearance/Checks/Adjustments/Cleaning

- 1) Shim/spacer selection
- 2) End play/preload
- 3) Shrink fit gear and bearing race installation

D. Problem/Diagnosis

- 1) Noises
- 2) Jumping out of gear
- 3) Gears do not engage
- 4) Backlash or end-play
- 5) Stays locked in gear
- 6) Leaks
- 7) Hard shifting
- 8) Premature bearing failure

III. Drive Line

A. Type of Drive

- 1) Hotchkiss
- 2) Four wheel
- 3) Front wheel drive half shafts
 - a. Diagnose noise and vibration
 - b. Replace shaft, boots, and universal joints

B. Types of Universal Joints

- 1) Cross/yoke
- 2) Constant velocity
 - a. No speed fluctuation
- 3) Half shaft inboard and outboard joints
- 4) Service procedures
 - a. Grease fitting direction
 - b. Relieving in order to prevent bind
 - c. "Burping" the boot

C. Shaft Design

- 1) Tube
- 2) Solid
- 3) Two-piece/three-piece
 - a. Phasing

- b. Checking stub shaft runout
 - c. Working angle limits
 - d. "Odd" joint assemblies
- 4) Damper rings
- 5) Balance weights
- D. Drive Shaft
 - 1) Lateral runout
 - 2) Companion flange runout
 - 3) Bend
- E. Problem/Diagnosis
 - 1) Noise
 - a. Acceleration rumble (launch shudder)
 - b. Deceleration clunk or rattle
 - c. Squeaking/drone
 - d. Steer torque
 - e. Correction procedures
 - 2) Vibrations
 - a. Drive line angle (measure and adjust)
 - b. Checking balance with hose clamps
 - c. First and second order
 - d. Pressure in ears
 - e. Correction procedures
 - 3) Backlash clunk (excessive play)
- F. U-Joint Wear Patterns
 - 1) Brinelling
 - 2) Trunion end-galling
- G. Inspect/Service/Replace Center Support Bearings

IV. Differential and Axle Assembly

- A. Types
 - 1) Full floating axles
 - 2) Semi-floating axles
 - 3) Hypoid gear design
 - 4) Timed gear sets
 - 5) Transaxle
 - 6) Gear ratio calculation
- B. Construction and Components (Be Able to Identify Visually)
 - 1) Carrier and bearings
 - 2) Axle (side) gears
 - 3) Thrust washers
 - 4) Shafts and retainers
 - 5) Ring gear/case
 - 6) Drive pinion gear
 - 7) Drive pinion bearings
 - 8) Pinion (differential or "spider") gears
 - 9) Axle shaft and bearings
 - a. End-play
 - b. Removal
 - c. Inspection
 - 10) Seals (direction of lip faces grease)
 - 11) Vents (remote)
 - 12) Gear housing

V. Differential Service/Adjustments

A. Terms

- 1) Preload (how measured)
- 2) Backlash (how measured)
- 3) Depth
- 4) Pattern

B. Drive Pinion Preload Adjustment

- 1) Crush sleeve (purpose)
- 2) Shims (location)
- 3) New bearings versus used bearings

C. Drive Pinion Depth Setting

- 1) Shims (location)
- 2) Thickness and effect of change
- 3) Depth markings
- 4) Depth setting tools
- 5) Gear marking compound

D. Carrier Bearing Preload

- 1) Shims
- 2) Threaded adjusters

E. Ring Gear Backlash

- 1) Effected by movement of carrier
- 2) Shims
- 3) Threaded adjusters
- 4) Specifications

F. Ring Gear Runout

G. Differential Case Runout

H. Tooth Contact Patterns

- 1) Coast side
- 2) Drive side
- 3) Toe contact heavy
- 4) Heel contact heavy
- 5) Face contact high
- 6) Flank contact low
- 7) Determine correction needed

I. Rebuilding Procedures

- 1) Visual checks
- 2) Housing spreader (using in conjunction with dial indicator)
- 3) Clutch (cone/plate) pack replacement and adjustment

J. Replacement

- 1) Companion flange (mayor may not have attached weight)
- 2) Ring and pinion (as a matched set)
- 3) Case assembly
 - a. "Spiders"
 - b. Shaft
 - c. Side gears
 - d. Thrust washers
 - e. Case
- 4) Pinion seal

K. Problem/Diagnosis

- 1) Noises
 - a. Coast
 - b. Drive
 - c. Float
 - d. On turns
 - e. Chatter
 - f. Seal fit
 - g. Clunks
 - h. Improper lubricant (limited slip differential)
 - i. Limited slip differential operational test
 - j. Vibration
 - k. Fluid leaks
 - l. Axle shaft/flange runout
 - m. Bearing wear
 - n. Whine/howl
- 2) “Spewing” out lubricant

VI. Four-Wheel Drive Component Diagnosis and Repair

- A. Diagnose
 - 1) Noise
 - 2) Vibration
 - 3) Hard shifting
 - 4) Steering problems
- B. Inspect, Adjust, and/or Repair
 - 1) Transfer case shifting mechanisms
 - 2) Front wheel bearings and locking hubs
 - 3) Seals and remote vents
 - 4) Axle knuckles and driving shafts
 - 5) Front-drive propeller shafts and universal joints
 - 6) Lube level (synthetic)

VII. New Manual Driveline Technologies

REQUIRED TEXTBOOKS AND MATERIALS:

To be announced by the instructor.

NATEF:

This class fulfills 80 hours of the 125 hours required by **NATEF** for A3. See COE 111.