

# AUTO-2310: MANUAL TRANSMISSION AND DRIVETRAIN

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## Cuyahoga Community College

**Viewing: AUTO-2310 : Manual Transmission and Drivetrain**

**Board of Trustees:**

January 2022

**Academic Term:**

Fall 2022

**Subject Code**

AUTO - Automotive Technology

**Course Number:**

2310

**Title:**

Manual Transmission and Drivetrain

**Catalog Description:**

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, 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. Laboratory skills emphasize diagnosis, troubleshooting, and repair.

**Credit Hour(s):**

3

**Lecture Hour(s):**

2

**Lab Hour(s):**

3

## Requisites

**Prerequisite and Corequisite**

AUTO-1300 Automotive Engines; or departmental approval.

## Outcomes

**Course Outcome(s):**

Diagnose and isolate problems with the vehicles drivetrain.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Identify and interpret drivetrain concern; determine necessary action.
2. Research vehicle service information including fluid type, vehicle service history, service precautions, and technical service bulletins.
3. Check fluid condition; check for leaks; determine necessary action.
4. Drain and refill manual transmission/transaxle and final drive unit; use proper fluid type per manufacturer specification.

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**Course Outcome(s):**

Diagnose, repair, and maintain drivetrain and clutch components and systems.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Measure flywheel runout and crankshaft endplay; determine necessary action.
2. Inspect and replace clutch pressure plate assembly, clutch disc, release (throw-out) bearing and linkage, and pilot bearing/bushing (as applicable).
3. Check and adjust clutch master cylinder fluid level; check for leaks; use proper fluid type per manufacturer specification.
4. Inspect, remove or replace pilot bearing or bushing (as applicable).
5. Diagnose clutch noise, binding, slippage, pulsation, and chatter; determine necessary action.
6. Inspect clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs; perform necessary action.
7. Bleed clutch hydraulic system.
8. Inspect flywheel and ring gear for wear, cracks, and discoloration; determine needed action.
9. Describe the operation and service of a system that uses a dual mass flywheel.

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**Course Outcome(s):**

Diagnose, repair, and maintain transmission and transaxle components, units, and systems.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Remove and reinstall transmission/transaxle.
2. Diagnose noise concerns through the application of transmission/transaxle powerflow principles.
3. Disassemble, clean, and reassemble transmission/transaxle components.
4. Inspect transmission/transaxle case, extension housing, case mating surfaces, bores, bushings, and vents; perform necessary action.
5. Diagnose noise, hard shifting, jumping out of gear, and fluid leakage concerns; determine necessary action.
6. Remove and replace transaxle final drive.
7. Inspect, adjust, and reinstall shift cover, forks, levers, grommets, shafts, sleeves, detent mechanism, interlocks, and springs.
8. Measure endplay or preload (shim or spacer selection procedure) on transmission/transaxle shafts; perform necessary action.
9. Inspect and reinstall synchronizer hub, sleeve, keys (inserts), springs, and blocking rings.
10. Remove, inspect, measure, adjust, and reinstall transaxle final drive pinion gears (spiders) shaft, side gears, side bearings, thrust washers, and case assembly.
11. Remove, inspect, measure, adjust, and reinstall transaxle final drive pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case assembly.
12. Inspect lubrication devices (oil pump or slingers); perform necessary action.
13. Describe the operational characteristics of an electronically-controlled manual transmission/transaxle.
14. Diagnose hard shifting and jumping out of gear concerns; determine necessary action.
15. Diagnose transaxle final drive assembly noise and vibration concerns; determine necessary action.
16. Disassemble, inspect clean, and reassemble internal transmission/transaxle components.
17. Inspect, adjust, and reinstall shift linkages, brackets, bushings, cables, pivots, and levers.

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**Course Outcome(s):**

Diagnose, repair, and maintain constant velocity (CV) joints, and drive axles.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Diagnose constant-velocity (CV) joint noise and vibration concerns; determine necessary action.
  2. Diagnose universal joint noise and vibration concerns; perform necessary action.
  3. Check shaft balance and phasing; measure shaft runout; measure and adjust driveline angles.
  4. Inspect, service, and replace shafts, yokes, boots, and CV joints.
  5. Inspect, service, and replace shaft center support bearings.
  6. Measure and adjust side bearing preload and ring and pinion gear total backlash and backlash variation on a differential carrier assembly (threaded cup or shim types).
  7. Remove and replace drive axle shafts.
  8. Inspect, remove, and/or replace bearings, hubs, and seals.
  9. Inspect, service, and replace shafts, yokes, boots, and universal/CV joints.
  10. Inspect and replace wheel studs.
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**Course Outcome(s):**

Diagnose, repair, and maintain differential gears and drive axle assemblies.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Diagnose noise and vibration concerns; determine necessary action.
2. Diagnose fluid leakage concerns; determine necessary action.
3. Inspect ring gear and measure runout; determine necessary action.
4. Remove, inspect, reinstall and/or replace drive pinion and ring gear, spacers, sleeves, and bearings.
5. Measure and adjust drive pinion depth.
6. Measure and adjust drive pinion bearing preload.
7. Check ring and pinion tooth contact patterns; perform necessary action.
8. Disassemble, inspect, measure, and adjust or replace differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case.
9. Reassemble and reinstall differential case assembly; measure runout; determine necessary action.
10. Diagnose noise, slippage, and chatter concerns; determine necessary action.
11. Clean and inspect differential case; check for leaks; inspect housing vent.
12. Inspect and reinstall clutch (cone or plate) components.
13. Measure rotating torque; determine necessary action.
14. Inspect, adjust, and repair shifting controls (mechanical, electrical, and vacuum), bushings, mounts, levers, and brackets.
15. Diagnose drive axle shafts, bearings, and seals for noise, vibration, and fluid leakage concerns; determine necessary action.
16. Remove and replace drive axle shafts.
17. Inspect and replace drive axle shaft seals, bearings, and retainers.
18. Disassemble, service, and reassemble transfer case and components.
19. Check drive assembly seals and vents; check lube level.
20. Diagnose, test, adjust, and/or replace electrical/electronic components of four-wheel drive/all-wheel drive systems.
21. Check and adjust differential case fluid level; use proper fluid type per manufacturer specification.
22. Drain and refill differential case; use proper fluid type per manufacturer specification.
23. Check shaft balance and phasing; measure shaft runout; measure and adjust driveline angles.
24. Drain and refill differential housing.
25. Inspect and replace companion flange and pinion seal; measure companion flange runout.
26. Inspect and replace drive axle wheel studs.
27. Measure drive axle flange runout and shaft end play; determine necessary action.
28. Measure and adjust drive pinion bearing preload.
29. Disassemble, inspect, measure, and adjust or replace differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case.
30. Reassemble and reinstall differential case assembly; measure runout; determine necessary action.

**Course Outcome(s):**

Diagnose, repair, and maintain an electronic transfer case control system on a part-time four-wheel drive (4WD) vehicle.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Distinguish between different types of transfer case controls and controllers used in modern vehicles and their proper operation.
2. Recall the correct operation of an electronically controlled 4WD vehicle and identify correct methods for troubleshooting and diagnosing.
3. Check for leaks at drive assembly and transfer case seals; check vents; check fluid level; use proper fluid type per manufacturer specification.
4. Identify concerns related to variations in tire circumference and/or final drive ratios.
5. Diagnose noise, vibration, and unusual steering concerns; determine necessary action.

**Course Outcome(s):**

Diagnose, repair, and maintain an electronic transfer case on an all-wheel drive (AWD) vehicle.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Recall correct operation of an electronically controlled AWD vehicle and identify correct methods for troubleshooting and diagnosing.
2. Distinguish between different types of transfer case controls and controllers used in modern vehicles and their proper operation.
3. Check for leaks at drive assembly seals; check vents; check lube level.
4. Identify concerns related to variations in tire circumference and/or final drive ratios.
5. Diagnose noise, vibration, and unusual steering concerns; determine necessary action.

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**Course Outcome(s):**

Comply with personal and environmental safety practices associated with clothing, eye protection, hand tools; power equipment, proper ventilation, and the handling, storage, and disposal of chemical/materials in accordance with local/state, and federal safety environmental regulations.

**Essential Learning Outcome Mapping:**

Civic Responsibility: Analyze the results of actions and inactions with the likely effects on the larger local and/or global communities.

**Objective(s):**

1. Identify general shop safety rules and procedures.
2. Utilize safe procedures for handling of tools and equipment.
3. Identify and use proper placement of floor jacks and jack stands.
4. Identify and use proper procedures for safe lift operation.
5. Utilize proper ventilation procedures for working within the lab/shop area.
6. Identify marked safety areas.
7. Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment.
8. Identify the location and use of eye wash stations.
9. Identify the location of the posted evacuation routes.
10. Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities.
11. Identify and wear appropriate clothing for lab/shop activities.
12. Secure hair and jewelry for lab/shop activities.
13. Demonstrate awareness of the safety aspects of supplemental restraint systems (SRS), electronic brake control systems, and hybrid vehicle high voltage circuits.
14. Demonstrate awareness of the safety aspects of high voltage circuits (such as high intensity discharge (HID) lamps, ignition systems, injection systems, etc.).
15. Locate and demonstrate knowledge of material safety data sheets (MSDS).

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**Methods of Evaluation:**

1. Participation and discussion
2. Observation
3. Written assignments
4. Exams
5. Quizzes
6. Lab tasks
7. Classroom recitations

**Course Content Outline:**

1. Drive train componentry
  - a. Engine
    - i. engine torque
    - ii. torque multiplication
  - b. Basic gear theory
  - c. Transmission
  - d. Transmission gears
  - e. Clutch
  - f. Drive line
  - g. Rear axle assembly
  - h. Differential design
    - i. Driving axles
  - j. Types of gears

- i. spur
  - ii. helical
  - iii. herringbone
  - iv. bevel
  - v. hypoid
  - vi. worm
  - vii. rack and pinion
  - viii. planetary
- k. Gear wear
  - i. peening
  - ii. scoring
  - iii. pitting
  - iv. spalling
- l. Bearings
  - i. bushing
  - ii. ball or roller
  - iii. radial
  - iv. thrust
- 2. Clutches
  - a. Clutch location
  - b. Clutch design
    - i. flywheel
    - ii. dual mass flywheel
    - iii. flexplate
  - c. Clutch shaft
  - d. Clutch disc
    - i. rigid clutch disc
    - ii. flexible clutch disc
  - e. Pressure plate assembly
    - i. coil spring
    - ii. diaphragm
    - iii. semicentrifugal
  - f. Release bearing
  - g. Clutch linkages
    - i. mechanical
    - ii. hydraulic
      - 1. master cylinder
      - 2. slave cylinder
  - h. Clutch operation
    - i. engage
    - ii. disengage
- 3. Manual transmissions and transaxles
  - a. Types of manual transmissions and transaxles
    - i. sliding gear
    - ii. collar shift
    - iii. synchromesh
  - b. Synchronizers
    - i. synchronizer design
    - ii. synchronizer operation
  - c. Transmission designs
    - i. five speed transmissions
    - ii. six speed transmissions
  - d. Basic operation of manual transmissions
    - i. operation of a five speed transmission
    - ii. power flow in neutral
    - iii. power flow in first gear
    - iv. power flow in second gear
    - v. power flow in third gear
    - vi. power flow in fourth gear

- vii. power flow in fifth gear (overdrive)
      - viii. power flow in reverse gear
    - e. Gearshift linkages
      - i. internal
      - ii. external
    - f. Basic transaxle operation
      - i. power flow in neutral
      - ii. power flow through forward gears
      - iii. power flow in reverse
      - iv. differential action
    - g. Transmission and transaxle maintenance
  - 4. Drive shafts and universal joints
    - a. Drive shaft construction
      - i. damper rings
      - ii. balance weights
    - b. Types of drive shafts
      - i. Hotchkiss
      - ii. torque tube
      - iii. flexible type
    - c. Center support bearings
    - d. Universal joints
      - i. speed variations
      - ii. phasing
      - iii. canceling angles
    - e. Types of universal joints
      - i. single
      - ii. double cardan
      - iii. constant velocity (CV)
      - iv. slip joints
    - f. Maintenance of universal joints
  - 5. Differentials and drive axles
    - a. Function and components
    - b. Differential operation
    - c. Axle housings
    - d. Differential gears
      - i. gear ratios
      - ii. determining final drive ratio
      - iii. hunting and nonhunting gears
        - 1. nonhunting
        - 2. partial nonhunting
        - 3. hunting
    - e. Differential bearings
      - i. pinion mountings
      - ii. drive pinion bearing preload
      - iii. differential case
    - f. Transaxle final drive gears and differential
      - i. helical final drive assembly
      - ii. planetary final drive assembly
      - iii. hypoid final drive assembly
    - g. Limited slip differentials
      - i. types of limited slip differentials
        - 1. clutch pack
        - 2. cone clutches
        - 3. viscous clutch
      - ii. locked differentials
      - iii. operation
    - h. Drive axle shafts and bearings
      - i. Types of drive axle shafts

- i. full-floating
    - ii. semi-floating
    - iii. Independent Rear Suspension (IRS)
  - j. Types of axle bearings
    - i. ball-type
    - ii. straight-roller
    - iii. tapered-roller
  - k. Maintenance
- 6. Front drive axles
  - a. Drive axle construction
  - b. Drive axles
    - i. equal length shafts
    - ii. vibration dampers
    - iii. unequal length half-shafts
    - iv. drive axle supports
  - c. CV joints
    - i. CV boots
    - ii. types of CV joints
    - iii. inboard and outboard joints
      - 1. fixed
      - 2. plunging
    - iv. inboard types
      - 1. ball
      - 2. tripod
    - v. outboard types
      - 1. ball
      - 2. tripod
  - d. CV joint wear and maintenance
- 7. Four-wheel drive systems
  - a. Four-wheel drive design variations
  - b. Types of four-wheel drive systems
    - i. full-time
    - ii. part-time
    - iii. all wheel drive
  - c. Transfer cases
    - i. modes of operation
    - ii. transfer case designs
      - 1. drive chains
      - 2. planetary gear drives
      - 3. electronically controlled planetary gearsets
      - 4. locking hubs
      - 5. center differentials
  - d. Viscous couplings
    - i. operation of a viscous coupling
- 8. Drive train electrical and electronic systems
  - a. Clutch safety switch
  - b. Reverse lamp switch
  - c. High gear switch
  - d. Upshift lamp circuit
  - e. ABS speed sensor circuits
  - f. Shift blocking
  - g. Electrical clutches
  - h. Other electronic systems
- 9. Safety
  - a. Safe work practices
    - i. carbon monoxide
    - ii. automotive refrigerant
    - iii. lifting heavy objects
  - b. Safe work areas

- i. housekeeping
  - c. Fire hazards and prevention
    - i. fire extinguisher types
      - 1. class A
      - 2. class B
      - 3. class C
      - 4. class D
  - d. Hand tool safety
  - e. Equipment safety
  - f. Battery safety
    - i. jump starting
    - ii. battery charging
  - g. First aid measures
  - h. Hazardous materials
    - i. handling
    - ii. disposal
- 10. Servicing clutches
  - a. Clutch problem diagnosis
    - i. grab
    - ii. noises
    - iii. binding
    - iv. slipping
    - v. clutch pulsation
    - vi. clutch chatter
    - vii. clutch vibrates
    - viii. pulsating clutch pedal
    - ix. does not engage
    - x. does not disengage
  - b. Mechanical clutch controls
    - i. free-play adjustments
    - ii. over-center spring
    - iii. automatic adjuster mechanisms
  - c. Hydraulic clutch controls
    - i. bleeding
    - ii. adjusting
  - d. Clutch pedal and release assemblies
  - e. Pressure plate inspection
  - f. Clutch disc inspection
  - g. Flywheel
    - i. crankshaft endplay
    - ii. flywheel to block runout
    - iii. flywheel runout check
    - iv. machining
  - h. Clutch removal and reinstallation
    - i. clutch disc aligning
      - 1. mandrel
      - 2. guide pins
  - i. Input shaft pilot bearing removal
    - i. grease
    - ii. pullers
  - j. Clutch release bearing inspection
  - k. Guidelines for servicing clutch systems
- 11. Servicing transmissions and transaxles
  - a. Diagnostics
    - i. visual inspection
      - 1. shift linkage
      - 2. transaxle mounts
      - 3. leaks
  - b. Troubleshooting methods



- i. unit shifts hard
  - ii. gears clash
  - iii. unit will not shift into a certain gear
  - iv. unit jumps out of gear
  - v. unit locked in one gear
  - vi. unit leaks
  - vii. unit has excessive vibration
  - viii. unit is noisy
- c. In-car service
  - i. fluid changes
  - ii. fluid flushed
  - iii. rear oil seal replacement
  - iv. rear bushing replacement
  - v. linkage adjustment
  - vi. speedometer reluctor service
- d. Removing transmission or transaxle
- e. Disassembly of transmission or transaxle
- f. Inspection of parts
  - i. transmission case
  - ii. extension housing
  - iii. center support plate
  - iv. front bearing retainer
  - v. bearings
  - vi. gears
  - vii. input shaft
  - viii. counter gear
  - ix. main shaft
  - x. synchronizer assemblies
  - xi. shift fork
  - xii. shift rails
  - xiii. interlock plates
- g. Reassembly of the transmission or transaxle
  - i. shim/spacer selection
  - ii. end play/preload
  - iii. shrink fit gear installation
- h. Installing the transmission or transaxle
- 12. Servicing drive shafts and universal joints
  - a. Diagnosing drive shaft problems
    - i. road test
      - 1. vibrations
    - ii. noises
      - 1. launch shudder
      - 2. deceleration clunk
      - 3. drone
      - 4. backlash clunk
    - iii. causes of failure
    - iv. lubricating universal joints
  - b. Drive shaft inspection
  - c. Removing and installing a drive shaft
  - d. Disassembling and assembling universal joints
    - i. single universal joint
    - ii. double cardan u-joints
  - e. Drive shaft balance
    - i. checking shaft balance
    - ii. correcting shaft balance
  - f. Drive shaft runout
    - i. measuring runout
    - ii. companion flange runout

- g. Universal joint and shaft angles
  - i. measuring the angles
  - ii. adjusting the angles
- 13. Servicing differentials and drive axles
  - a. Diagnosis of differential and drive axles
    - i. talking to the customer
    - ii. road test
  - b. Types of noises
    - i. chuckle
    - ii. knocking
    - iii. clunk
    - iv. gear noise
    - v. rumble
    - vi. bearing whine
    - vii. chatter
    - viii. on turns (limited slip)
  - c. Sources of leaks
    - i. pinion seal
      - 1. crush sleeve
    - ii. vent tube
  - d. Limited-slip diagnostics
  - e. In-vehicle service
    - i. checking the fluid level
    - ii. b. replacing pinion seals
  - f. Out-of-vehicle services
    - i. a. check ring gear runout
  - g. Removing final drive assemblies
  - h. Disassembling an integral carrier differential
    - i. Inspection of parts
    - j. Reassembling an integral carrier differential
  - k. Ring and pinion gear adjustments
    - i. pinion gear depth
      - 1. crush sleeve
      - 2. shims
    - ii. pinion bearing preload
    - iii. pinion seal service
    - iv. backlash and side bearing preload
      - 1. guidelines for setting backlash and side bearing preload
      - 2. threaded adjusters
      - 3. shims
    - v. gear tooth patterns
      - 1. drive side
      - 2. coast side
      - 3. heel
      - 4. toe
      - 5. face
      - 6. flank
  - l. Servicing FWD final drives
  - m. Servicing limited slip differentials
  - n. Servicing axle shafts and bearings
    - i. bearing inspection
    - ii. axle bearing replacement
    - iii. axle shaft seals
    - iv. installing axles
- 14. Servicing front drive axles
  - a. Diagnosing FWD axle problems
    - i. talk to the customer
    - ii. road test
    - iii. visual inspection

- b. Drive axle removal
  - c. Bench inspection
  - d. General service procedures
    - i. replacing joint boots
      - 1. "burping" the boot
      - 2. preventing binding
    - ii. replacing CV-joints
  - e. Drive axle reassembly
  - f. FWD front wheel bearings
    - i. wheel bearing inspection
    - ii. replacing front wheel bearings
  - g. Guidelines for servicing CV-joints and drive axles
15. Servicing four-wheel drive systems
- a. Diagnosis
    - i. customer comments
      - 1. noise
      - 2. hard shifting
    - ii. road test
    - iii. inspect for leaks
    - iv. inspect suspension
    - v. inspect steering
    - vi. inspect drive shaft
  - b. Axle housings and differentials
  - c. Shift controls
  - d. Transfer cases
    - i. removal of a transfer case
    - ii. disassembly of a transfer case
    - iii. assembly of a transfer case
  - e. Viscous coupling
  - f. Front axles and hubs
    - i. inspection
    - ii. removal
      - 1. manual locking hub
      - 2. automatic locking hub
    - iii. repair
  - g. Maintenance
16. Servicing drive train electrical systems
- a. Switches
    - i. clutch start
    - ii. clutch interlock
  - b. Backup lights
  - c. Speed sensors
  - d. Solenoids
    - i. shift blocking
    - ii. reverse lockout
  - e. Electromagnetic clutches
  - f. Code diagnosis
    - i. scan tool use
    - ii. schematic interpretation

## Resources

Halderman, James. *Automotive Technology: Principles, Diagnosis, and Service*. 6th ed. New York, NY: Pearson, 2020.

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Erjavec, Jack and Rob Thompson. *Automotive Technology: A Systems Approach*. 7th ed. Boston, MA: Cengage Learning, 2019.

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Halderman, James D. *Manual Drivetrains and Axles*. 8th ed. New York, NY: Pearson, 2018.

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Duffy, James E. *Modern Automotive Technology*. 9th ed. Tinley Park, IL: Goodheart-Willcox Publisher, 2017.

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### Resources Other

1. <http://www.autorepairmanuals.biz/page/267592> (<http://www.autorepairmanuals.biz/page/267592/>) - Transmission Repair Manuals & Rebuild Parts (<http://www.autorepairmanuals.biz/page/267592/>)
2. <http://auto.howstuffworks.com/transmission.htm> - How Manual Transmissions Work
3. [http://www.samarins.com/glossary/cv\\_joint.html](http://www.samarins.com/glossary/cv_joint.html) - CV Joint, How it Works, Symptoms, Problems
4. GearBoxVideo - YouTube (<https://www.youtube.com/channel/UCxP2351joupD-Re3KFpDTNQ/?app=desktop>) - Manual Transmission Rebuilding Tips
5. Automotive Repair Help (aa1car.com) (<https://www.aa1car.com/>) - Auto Repair Topics & Articles
6. Tom Broxholm's Skyline Automotive page (smccd.edu) (<http://accounts.smccd.edu/broxholm/Demos.htm>)

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