



# ILLINOIS VALLEY COMMUNITY COLLEGE

## COURSE OUTLINE

**DIVISION: Workforce Development**

**COURSE: ATO 1240 Power Trans and Manual Transmissions**

Date: Spring 2022

Credit Hours: 3.5

*Complete all that apply or mark "None" where appropriate:*

Prerequisite(s): None

Enrollment by assessment or other measure?  Yes  No

If yes, please describe:

Corequisite(s): None

Pre- or Corequisite(s): None

Consent of Instructor:  Yes  No

Delivery Method:  **Lecture**                      **2 Contact Hours** (1 contact = 1 credit hour)  
 **Seminar**                              **0 Contact Hours** (1 contact = 1 credit hour)  
 **Lab**    **3 Contact Hours** (2-3 contact = 1 credit hour)  
 **Clinical**                                      **0 Contact Hours** (3 contact = 1 credit hour)  
 **Online**  
 **Blended**  
 **Virtual Class Meeting (VCM)**

Offered:  **Fall**     **Spring**     **Summer**

### **CATALOG DESCRIPTION and IAI NUMBER (if applicable):**

This course includes information relative to clutches, manual transmissions/transaxles, driveshafts/halfshafts and differentials on front wheel drive and rear wheel drive vehicles. The course will study the operation, service and rebuilding of constant mesh, fully synchronized manual transmissions and transaxles.

## **ACCREDITATION STATEMENTS AND COURSE NOTES:**

The Automotive Technology program at Illinois Valley Community College is a ASE Education Foundation Master Certified Automotive Technology Program.

The program goes through an on-site evaluation every five years and the ASE Education Foundation tasks that are taught in this course are also updated every five years to align with any changes made by the ASE Education Foundation national automotive advisory council.

## **COURSE TOPICS AND CONTENT REQUIREMENTS:**

### **I. Clutches**

#### **A. Clutch Assembly**

1. Flywheel
  - a) Stepped Flywheel
  - b) Machining
2. Pressure plate
  - a) Diaphragm type
  - b) Coil spring type
  - c) Semi-centrifugal type
3. Clutch disc
  - a) Construction
  - b) Cushion springs
  - c) Dampening springs (torsional)
4. Release bearing
  - a) Ball bearing type
  - b) Roller bearing type
5. Pilot bearing
  - a) Ball bearing type
  - b) Roller bearing type
  - c) Bronze bushing

#### **B. Clutch Operation**

1. Mechanical
  - a) Linkage and leverage action
  - b) Adjustment and maintenance
2. Hydraulic
  - a) Component operation
  - b) Bleeding and maintenance
3. Cable
  - a) Component operation
  - b) Adjustment and maintenance
  - c) Self-adjusting mechanism

#### **C. Operation of Clutch Components**

1. Flywheel function
2. Pressure plate
  - a) Release levers operation
  - b) Coil springs
3. Disc
  - a) Cushioning springs
  - b) Hub and torsional spring
4. Release bearing

- a) Types
      - b) Adjustment and maintenance
    - 5. Pilot bearing
      - a) Purpose
      - b) Inspection for wear
      - c) Removal and replacement
  - D. Clutch Problems and Diagnosis
    - 1. Test Drive
    - 2. Chatter
    - 3. Pedal pulsation
    - 4. Slippage
    - 5. Grinding
    - 6. Clutch will not release
    - 7. Chronic clutch disc wear
    - 8. Binding linkage
    - 9. Damaged release bearing
    - 10. Clutch grabs
    - 11. Pilot bearing noise
    - 12. Throw-out bearing noise
    - 13. Transmission input bearing noise
- II. Manual Transmission
- A. Gear Design
    - 1. Helical
    - 2. Spur
    - 3. Internal Gears
    - 4. External gears
    - 5. Thrust
  - B. Gear Ratios
    - 1. First through fifth and reverse gear ratios
    - 2. Calculation of gear ratios
    - 3. Speed and torque multiplication relationship
  - C. Synchronizers
    - 1. Operation
    - 2. Blocker ring type
    - 3. Inspection
    - 4. Reasons for replacement
  - D. Three, Four, and Five Speed Transmission
    - 1. Construction
    - 2. Power flow
    - 3. Disassembly / assembly procedures
    - 4. End-play adjustments
  - E. Overdrive
    - 1. Operation
    - 2. Planetary gear type
    - 3. Manually shift type
    - 4. Hydraulic shift type
    - 5. Electrical shift type
  - F. Manual Transaxle
    - 1. Transverse engine

2. Operation
  3. Overhaul
  4. Removal and installation
- G. Manual Transmission Problems and Diagnosis
1. Worn detent parts
  2. Synchronizer failure
  3. Damage pilot bearing
  4. Bent shift fork
  5. Gears clash during shifting
  6. Transmission oil leaks
  7. Hard shifting into gear
  8. Transmission jumps out of gear
  9. Linkage adjustments
  10. Front wheel drive shaft noises
- III. Drive Line and Axles
- A. Drive Shafts
1. Design
    - a) Torque tube drive
    - b) Hotchkiss drive
  2. Slip yoke
  3. Universal joint
    - a) Cross and roller
    - b) Constant velocity
  4. Tube construction
  5. Phasing
  6. Balancing
  7. Law of canceling angles
- B. Axles
1. Design
    - a) Semi-floating
    - b) Full-floating
    - c) Front wheel drive
- C. Bearings
1. Types
  2. Service
- IV. Differentials
- A. Operation
1. Driving wheels turn at different speeds
  2. Straight ahead operation
  3. Torque multiplication
  4. One wheel held stationary
- B. Differential Parts
1. Side gears
  2. Differential pinions
  3. Ring gear
  4. Pinion gear
  5. Bearings
  6. Shims
  7. Oil Seal Case

- 8. Thrust washers
- C. Gear Design
  - 1. Hypoid
  - 2. Spur bevel
- D. Gear Ratios
  - 1. Calculations
  - 2. Hunting, non hunting, and partial non hunting
- E. Limited-Slip Differential
  - 1. Types
    - a) Clutch plates
    - b) Clutch cones
  - 2. Operation
  - 3. Testing
  - 4. Service
- F. Disassembly/Assembly Procedures
  - 1. Ring gear backlash
  - 2. Ring gear run-out
  - 3. Carrier bearing pre-load
  - 4. Drive pinion bearing pre-load
  - 5. Drive pinion depth
  - 6. Gear tooth patterns
    - a) Interpretation
    - b) Adjustment
  - 7. Lubrication
- G. Differential Problems and Diagnosis
  - 1. Noise on turns
  - 2. Vibration
  - 3. Noise produced with car in neutral
  - 4. Noise is the same in drive or coast
  - 5. Clunk on acceleration or deceleration
  - 6. Chatter on turns
- V. Transfer Case
  - A. Purpose
  - B. Types
    - 1. Part-time transfer case
    - 2. Full-time transfer case
  - C. Four Wheel Drive Front Hubs
    - 1. Locked hub
    - 2. Free-running clutch hub
  - D. Adjustments and Maintenance

### **INSTRUCTIONAL METHODS:**

- 1. Lecture
- 2. Demonstration
- 3. Videos
- 4. Quizzes
- 5. Exams
- 6. Handouts

## **EVALUATION OF STUDENT ACHIEVEMENT:**

1. Complete all lab objectives (NATEF Tasks)
2. Pass written exams and quizzes.
3. Safety Practices
4. Attitude
5. Attendance.
6. Class participation

## **INSTRUCTIONAL MATERIALS:**

### **Textbooks**

Chris Johanson and James E. Duffy. **Manual Drive Trains and Axles**. 4th Edition, Goodheart-Wilcox Company, Inc., 2021.

### **Resources**

1. Pro-Demand – Information System
2. All Data Pro - Information System

## **LEARNING OUTCOMES AND GOALS:**

### **Institutional Learning Outcomes**

- 1) Communication – to communicate effectively;
- 2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion;
- 3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally;
- 4) Responsibility – to recognize how personal choices affect self and society.

### **Course Outcomes and Competencies**

## **III. MANUAL DRIVE TRAIN AND AXLES**

### **A. General**

2. Identify manual drive train and axles components and configurations.
4. Check fluid condition; check for leaks; determine needed action.
4. Drain and refill manual transmission/transaxle; use proper fluid type per manufacturer specification.
5. Diagnose drive train concerns; determine needed action.

## **III. MANUAL DRIVE TRAIN AND AXLES**

### **B. Clutch**

1. Check and adjust clutch master cylinder fluid level; check for leaks; use proper fluid type per manufacturer specification.
2. Diagnose clutch noise, binding, slippage, pulsation, and chatter; determine needed action.
3. Inspect clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs; determine needed action.
4. Inspect and/or replace clutch pressure plate assembly, clutch disc, release (throw-out) bearing, linkage, and pilot bearing/bushing (as applicable).
5. Bleed clutch hydraulic system.
6. Inspect flywheel and ring gear for wear, cracks, and discoloration; determine needed action.

7. Measure flywheel runout and crankshaft end play; determine needed action.
8. Describe the operation and service of a system that uses a dual mass flywheel.

### **III. MANUAL DRIVE TRAIN AND AXLES**

#### **C. Transmission/Transaxle**

1. Describe the operational characteristics of an electronically controlled manual transmission/transaxle.
2. Inspect, adjust, lubricate, and/or replace shift linkages, brackets, bushings, cables, pivots, and levers.
3. Diagnose noise concerns through the application of transmission/transaxle powerflow principles; determine needed action.
4. Diagnose hard shifting and jumping out of gear concerns; determine needed action.
5. Diagnose transaxle final drive assembly noise and vibration concerns; determine needed action.
6. Disassemble, inspect clean, and reassemble internal transmission/transaxle components.

### **III. MANUAL DRIVE TRAIN AND AXLES**

#### **D. Drive Shaft and Half Shaft, Universal and Constant-Velocity (CV) Joints (Front, Rear, All-wheel, and Four-wheel Drive)**

1. Inspect and/or remove/replace bearings, hubs, and seals.
2. Inspect and/or service/replace shafts, yokes, boots, and universal/CV joints.
3. Check for leaks at drive assembly and transfer case seals; check vents; check fluid level; use proper fluid type per manufacturer specification.
4. Diagnose constant-velocity (CV) joint noise and vibration concerns; determine needed action.
5. Diagnose universal joint noise and vibration concerns; determine needed action.
6. Check shaft balance and phasing; measure shaft runout; measure and adjust driveline angles; determine needed action.

### **III. MANUAL DRIVE TRAIN AND AXLES**

#### **E. Differential and Drive Axles**

##### **E.1 Ring and Pinion Gears and Differential Case Assembly**

1. Inspect differential housing; check for leaks; inspect housing vent.
2. Check and adjust differential housing fluid level; use proper fluid type per manufacturer specification.
3. Drain and refill differential housing; use proper fluid type per manufacturer specification.
4. Inspect and replace companion flange and/or pinion seal; measure companion flange runout.
5. Inspect ring gear and measure runout; determine needed action.
6. Diagnose noise and vibration concerns; determine needed action.
7. Remove, inspect, reinstall or replace drive pinion and ring gear, spacers, sleeves, and bearings.
8. Measure and adjust drive pinion depth.
9. Measure and adjust drive pinion bearing preload.
10. 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).

11. Check ring and pinion tooth contact patterns; determine needed action.
12. Disassemble, inspect, measure, adjust, and/or replace differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case.
13. Reassemble and reinstall differential case assembly; measure runout; determine needed action.

## **E.2 Drive Axles**

1. Inspect and replace drive axle wheel studs.
2. Remove and replace drive axle shafts.
3. Inspect and replace drive axle shaft seals, bearings, and retainers.
4. Measure drive axle flange runout and shaft end play; determine needed action.
5. Diagnose drive axle shafts, bearings, and seals for noise, vibration, and fluid leakage concerns; determine needed action.

## **E.3 Limited Slip Differential**

1. Diagnose noise, slippage, and chatter concerns including electronically controlled systems; determine needed action.
2. Measure rotating torque; determine needed action.

## **FOUNDATIONAL TASKS – 2022**

### **Shop and Personal Safety**

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. Identify vehicle systems which pose a safety hazard during service such as: supplemental restraint systems (SRS), electronic brake control systems, stop/start systems, and remote start systems.
14. Identify vehicle systems which pose a safety hazard during service due to high voltage such as: hybrid/electric drivetrain, lighting systems, ignition systems, A/C systems, injection systems, etc.
15. Locate and demonstrate knowledge of safety data sheets (SDS).

### **Tools and Equipment**

1. Identify tools and their usage in automotive applications.
2. Identify standard and metric designation.

3. Demonstrate safe handling and use of appropriate tools.
4. Demonstrate proper cleaning, storage, and maintenance of tools and equipment.
5. Demonstrate proper use of precision measuring tools (e.g., micrometer, dial-indicator, dial-caliper).

### **Personal Standards**

1. Reports to work daily on time; able to take directions and motivated to accomplish the task at hand.
2. Dresses appropriately and uses language and manners suitable for the workplace.
3. Maintains personal hygiene appropriate for the workplace.
4. Meets and maintains employment eligibility criteria, such as drug/alcohol-free status, clean driving record, etc.
5. Demonstrates honesty, integrity, and reliability.

### **Work Habits / Ethic**

1. Complies with workplace policies/laws.
2. Contributes to the success of the team, assists others and requests help when needed.
3. Works well with all customers and coworkers.
4. Negotiates solutions to interpersonal and workplace conflicts.
5. Contributes ideas and initiative.
6. Follows directions.
7. Communicates effectively, both in writing and verbally, with customers and coworkers.
8. Reads and interprets workplace documents; writes clearly and concisely.
9. Analyzes and resolves problems that arise in completing assigned tasks.
10. Organizes and implements a productive plan of work.
11. Uses scientific, technical, engineering and mathematics (STEM) principles and reasoning to accomplish assigned tasks.
12. Identifies and addresses the needs of all customers, providing helpful, courteous, and knowledgeable service and advice as needed.
13. Respectful of tools and property used in school and workplace environment.
14. Contributes to an inclusive environment where every coworker and customer feels welcomed, heard, and valued.