



# **ILLINOIS VALLEY COMMUNITY COLLEGE**

## **COURSE OUTLINE**

**DIVISION: Workforce Development**

**COURSE: ATO 2200 Brake Systems**

Date: Spring 2022

Credit Hours: 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**    **6 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 of study is for the design and operation of automotive brake systems used on cars and light trucks. It will focus on the theory of operation for disc and drum brake designs, hydraulics, master cylinder and power assist units, valves, and anti-lock brakes. The service of these systems will be practiced during lab sessions.

## **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. Safety
  - A. Brake Safety Regulations
  - B. Asbestos Health Hazards
  - C. Material Safety Data Sheets
  - D. Hazardous Waste Disposal
  - E. Personal Safety
  - F. Hoist Safety
  - G. Air Bag Safety
  - H. Tool Safety
  - I. Floor Jacks and Safety Stands
- II. Brake Tools and Equipment
  - A. Fasteners
  - B. Measuring Systems
    - a. Metric and English
    - b. Disc and Drum Specification Manual and Brake Bleeding Sequence Guide
  - C. Brake Tools
    - a. Disc Brake Micrometer
    - b. Drum Brake Digital Measuring Tool
    - c. Torque Wrenches
    - d. Common Brake Service Tools
    - e. Dial Indicator
  - D. Brake Bleeding Equipment
  - E. Brake Cleaning Equipment
- III. Brake Fluid
  - A. Characteristics and Characteristics
  - B. Types
  - C. Electronic Tester
  - D. Service
  - E. Bleeding Brakes
    - a. Conventional
    - b. ABS
  - F. Using A Scanner to Bleed Brakes
- IV. Master Cylinders
  - A. Dual-Piston Construction and Operation
  - B. Front-to-Rear and Diagonally Split Systems
  - C. Fast-Fill and Quick Take-up Master Cylinders
  - D. Central-Valve Master Cylinder
  - E. Free Pedal Inspection
  - F. Bench Bleeding Procedure

- G. Remove and Replace Procedure
- H. Checking Teves High Pressure ABS Fluid Level
- I. Final System Bleeding
- V. Hydraulic Lines, Valves, and Switches
  - A. Brake Lines
    - a. Steel
    - b. Rubber
    - c. Proper Service
  - B. Brake Fittings
    - a. Banjo and Other Designs
  - C. Flare Fittings
    - a. ISO Flare
    - b. SAE Flare
  - D. Brake System Valves
    - a. Metering Valve
    - b. Proportioning Valve
    - c. Height-Sensing Proportioning Valve
    - d. Pressure Differential Valve
    - e. Combination Valve
  - E. Brake Pad Indicators
  - F. Master Cylinder Fluid Level Switch
  - G. Stoplamp Switch Service and Adjustment
  - H. Brake Bleeding
    - a. Manual, Vacuum, Gravity, and Pressure
  - I. Wheel Brake Bleeding Sequence
  - J. Recentering the Pressure Differential Valve
  - K. Using Flare Wrenches for Brake Lines and Bleeder Screws
  - L. Brake Switch Adjustment
- VII. Power Brake Service
  - A. Design and Operation
  - B. Types of Vacuum Boosters
  - C. Reaction-Disc Booster
  - D. Tandem Boosters
  - E. Hydro-Boost Design
  - F. Power Master Operation
  - G. Vacuum Booster Testing
  - H. Pedal Height Adjustment
  - I. Pushrod Gauge Adjustment
  - J. Vacuum Pump
- VIII. Disc Brakes
  - A. Design and Operation
  - B. Construction
  - C. Fixed and Floating Rotors
  - D. Solid and Vented Rotors
  - E. Friction Materials for Disc and Drum Brakes
  - F. Friction Material Selection
    - a. Coefficient of Friction
    - b. Edge Coding
  - G. Brake Pad Wear Indicators

- H. Caliper Design and Operation
  - a. Steel and Phenolic Pistons
  - b. Low-Drag Calipers
- I. Fixed, Floating, and Sliding Calipers
- J. Rear Wheel Disc Brakes
  - a. Design and Service
  - b. Parking Brake Design
- K. Proper Inspection Procedures
- L. Loaded versus Unloaded Calipers
- M. Brake Pad Replacement
- N. Anti-Rattle Clips
- O. Caliper Overhaul
- P. Brake Rotor Service
  - a. Measurements – Minimum and Discard Thickness
  - b. Parallelism and Rotor Run-out
- Q. On and Off Brake Lathe Operation and Procedures
- R. Proper Torque Procedures for Calipers and Wheels
- IX. Drum Brake Service
  - A. Design and Operation
  - B. Servo and Self-Engerizing Action
  - C. Self-Adjustment Designs and Service
  - D. Fade Resistance
  - E. Construction
  - F. Brake Drum Design and Service
  - G. Backing Plate
  - H. Wheel Cylinders
    - a. Overhaul and Replacement
    - b. Residual pressure
  - I. Hold-Down Springs Types and Replacement
  - J. Self-Adjusters
    - a. Manual and Automatic
  - K. Leading/Trailing Design
  - L. Parking Brake Adjustment
  - M. Brake Drum Machining and Service
  - N. Final Brake Adjustment
  - O. Brake Drum Common Failures
- X. Parking Brakes
  - A. Design and Operation
  - B. Warning Lamps
  - C. Adjustments
  - D. Cable Replacement
  - E. Rear Disc Parking Brake Design and Service
    - a. Special tools
  - F. Automatic Vacuum Release System
- XI. Antilock Brake System
  - A. Design and Operation -- One, Three, or Four Channel Systems
  - B. System Components
  - C. Hold, Release, and Build Modes
  - D. Network Sharing

- E. Inputs
- F. Outputs
- G. Wheel Speed Sensors Design, Operation, Troubleshooting, and Known Good Oscilloscope Patterns
- H. Brake Switch
- I. Solenoid Valve Design, Operation, and Troubleshooting
- J. Relays
- K. Warning Lamps Operation and Troubleshooting
- L. Rear Wheel Anti-Lock Brake Design and Service
- M. Traction Control System
  - a. Six Different Ways to Control Wheel Spin
- N. Data Link Connector, Scan Tool Usage and Code Retrieval
- O. Pinpoint Charts for Codes
- P. Depressurizing the System if Needed for Service
- Q. Hard and Soft Codes
- R. Voltage Drop Testing Procedures and Specifications
- S. Clearing ABS Codes
- XII. Tire, Wheel, and Bearing Service
  - A. Tire and Wheel Inspection
  - B. Proper Tire Inflation
  - C. Tire Placard
  - D. ABS and the Need for the Same Tire Size on Each Wheel
  - E. Tire Effects on Braking
  - F. Tire Inflation Monitoring Operation
    - a. Inspection
  - G. Wheel Bearing Design and Operation
  - H. Wheel Bearing Service, Repacking, and Proper Adjustments
    - a. Bearing Cup/Cone Replacement
  - I. Wheel Alignment Effects on Braking
  - J. Proper Tire Rotation
  - K. Proper Wheel Lug Nut Torque Procedures
    - a. Torque Stick

#### **INSTRUCTIONAL METHODS:**

1. Lecture
2. Demonstrations
3. Practical (Lab)
4. Power Point
5. Class Discussion
6. Handouts
7. Quizzes and Tests

#### **EVALUATION OF STUDENT ACHIEVEMENT:**

1. Complete all lab objectives (ASE Education Foundation Tasks)
2. Practical Application
3. Attendance
4. Work Habits
5. Attitude
6. Safety Practices

7. Student Notebook and Log Book
8. Ability to Work with Others
9. Written Exams and Quizzes
10. Class Participation

## **INSTRUCTIONAL MATERIALS:**

### **Textbooks**

1. Electude Online software

### **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**

#### **ASE Education Foundation 2022 Tasks**

#### **V. BRAKES**

##### **A. General**

1. Research vehicle service information such as fluid type, vehicle service history, service precautions, technical service bulletins, and recalls including vehicles equipped with advanced driver assistance systems (ADAS).
2. Identify brake system components and configurations.
3. Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed.
4. Describe procedure for performing a road test to check brake system operation, including an anti-lock brake system (ABS).
5. Install wheel and torque lug nuts.
6. Identify and interpret brake system concerns; determine needed action.

#### **V. BRAKES**

##### **B. Hydraulic System**

1. Diagnose pressure concerns in the brake system using hydraulic principles (Pascal's Law).
2. Measure brake pedal height, travel, and free play (as applicable); determine needed action.
3. Check master cylinder for internal/external leaks and proper operation; determine needed action.
4. Inspect brake lines, flexible hoses, and fittings for leaks, dents, kinks, rust, cracks, bulging, wear, and loose fittings/supports; determine needed action.
5. Select, handle, store, and fill brake fluids to proper level; use proper fluid type per manufacturer specification.

6. Identify components of hydraulic brake warning light system.
7. Bleed and/or replace fluid in the brake system.
8. Test brake fluid for contamination.
9. Remove, bench bleed, and reinstall master cylinder.
10. Diagnose poor stopping, pulling, or dragging concerns caused by malfunctions in the hydraulic system; determine needed action.
11. Replace brake lines, hoses, fittings, and supports.
12. Fabricate brake lines using proper material and flaring procedures.
13. Inspect, test, and/or replace components of brake warning light system.

## **V. BRAKES**

### **C. Drum Brakes**

1. Remove, clean, and inspect brake drum; measure brake drum diameter; determine serviceability.
2. Refinish brake drum and measure final drum diameter; compare with specification.
3. Remove, clean, inspect, and/or replace brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubricate and reassemble.
4. Inspect wheel cylinders for leaks and proper operation; remove and replace as needed.
5. Pre-adjust brake shoes and parking brake; install brake drums or drum/hub assemblies and wheel bearings; perform final checks and adjustments.
6. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pedal pulsation concerns; determine needed action.

## **V. BRAKES**

### **D. Disc Brakes**

1. Remove and clean caliper assembly; inspect for leaks, damage, and wear; determine needed action.
2. Inspect caliper mounting and slides/pins for proper operation, wear, and damage; determine needed action.
3. Remove, inspect, and/or replace brake pads and retaining hardware; determine needed action.
4. Lubricate and reinstall caliper, brake pads, and related hardware; seat brake pads against rotor; inspect for leaks.
5. Clean and inspect rotor and mounting surface; measure rotor thickness, thickness variation, and lateral runout; determine needed action.
6. Remove and reinstall/replace rotor.
7. Refinish rotor on vehicle; measure final rotor thickness and compare with specification.
8. Refinish rotor off vehicle; measure final rotor thickness and compare with specification.
9. Retract and re-adjust caliper piston on an integrated parking brake system.
10. Describe importance of operating vehicle to burnish/break-in replacement brake pads according to manufacturer's recommendation.
11. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pulsation concerns; determine needed action.

## **V. BRAKES**

### **E. Power-Assist Units**

1. Check brake pedal travel with and without engine running to verify proper power booster operation.
2. Identify components of the brake power assist system (vacuum/ hydraulic/electric).
3. Inspect vacuum-type power booster unit for leaks; inspect the check-valve for proper operation; check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster determine needed action.
4. Inspect and test hydraulically assisted power brake system for leaks and proper operation; determine needed action.
5. Inspect electric power booster unit; determine needed action.

## **V. BRAKES**

### **F. Related Systems (i.e., Wheel Bearings, Parking Brakes, Electrical)**

1. Remove, clean, inspect, repack/replace, and install wheel bearings; remove and install bearing races; replace seals; install hub and adjust bearings.
2. Check parking brake system components for wear, binding, and corrosion; clean, lubricate, adjust and/or replace as needed.
3. Check parking brake operation (including electric parking brakes); check parking brake indicator light system operation; determine needed action.
4. Check operation of brake stop light system.
5. Inspect and replace wheel studs.
6. Remove, reinstall, and/or replace sealed wheel bearing assembly.
7. Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; determine needed action.

## **V. BRAKES**

### **G. Electronic Brake Control Systems: Antilock Brake (ABS), Traction Control (TCS), and Electronic Stability Control (ESC) Systems**

1. Identify and inspect electronic brake control system components and describe function (ABS, TCS, ESC); determine needed action.
2. Describe the operation of a regenerative braking system.
3. Bleed the electronic brake control system hydraulic circuits.
4. Diagnose poor stopping, wheel lock-up, abnormal pedal feel, unwanted application, and noise concerns associated with the electronic brake control system; determine needed action.
5. Diagnose electronic brake control system electronic control(s) and components by retrieving diagnostic trouble codes, and/or using recommended test equipment; determine needed action.
6. Depressurize high-pressure components of an electronic brake control system.
7. Test, diagnose, and service electronic brake control system speed sensors (digital and analog), toothed ring (tone wheel), and circuits using a graphing multimeter (GMM)/digital storage oscilloscope (DSO) (includes output signal, resistance, shorts to voltage/ground, and frequency data).
8. Diagnose electronic brake control system braking concerns caused by vehicle modifications (tire size, curb height, final drive ratio, etc.).



## **ASE Education Foundation - 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.

### **Preparing for Vehicle Service**

1. Identify information needed and the service requested on a repair order.
2. Identify purpose and demonstrate proper use of vehicle protection such as: fender covers, mats, seat, and steering wheel covers.
3. Perform a vehicle walk-around inspection; identify and document existing vehicle conditions such as body damage, paint damage, windshield damage.
4. Perform a vehicle multi-point inspection and complete a vehicle inspection report.
5. Demonstrate use of the three C's (concern, cause, and correction).
6. Create a plan of action for each specific service or diagnostic situation.
7. Review vehicle service history.
8. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.

### **Preparing Vehicle for Customer**

1. Ensure vehicle is prepared to return to customer per school/company policy (floor mats, steering wheel cover, etc.).

### **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.