



## COURSE OUTLINE

**Course Number**  
AUT 115

**Course Title**  
Automotive Brake Systems

**Credits**  
4

**Hours:**  
**lecture/Lab/Other**  
2 4

**Co- or Pre-requisite**  
AUT 110, AUT 111

**Implementation**  
**sem/year**  
Fall 2008

**Catalog description (2006-2009 Catalog):** The principles, theory, and servicing of both disc and drum brake systems used on automobiles. Emphasis is on diagnosis of malfunctions, using road testing techniques and visual brake inspection procedures, and on integrity of repair. Hydraulic theory fundamentals, component machining operations, and current anti-lock brake, stability control, and traction control systems will also be covered.

**Is course New, Revised, or Modified?** Revised

**Required texts/other materials:** Owen, Clifton E. **Automotive Brake Systems**, Thompson Delmar Learning, 2008

**Revision date:**  
December 2008

**Course coordinator:** Fred Bassini, Ext. 3776, bassinif@mccc.edu

**Information resources:** Chrysler DealerConnect web-site, Chrysler Academy Training Reference Books, Service Manuals, On-line and CD Disc Self-study Courses and the AllData Online Service Information Database.

**Other learning resources:** ASE Study Guides, Automotive Related Articles Obtained From Magazines and Journals

## **Course Competencies/Goals:**

### ***The student will be able to:***

- demonstrate his/her knowledge of principles, terminology, theories of operation, and service procedures regarding modern automotive brake systems.
- analyze automotive brake systems through inspection processes and road testing procedures.
- demonstrate proper component resurfacing procedures needed to comply with warranty requirements and ensure customer safety.
- explain the operation of anti-lock brake and stability control, and traction control systems.
- demonstrate his/her ability to accurately diagnose customer concerns relating to anti-lock brake, stability control, and traction control systems.
- explain differences between brake fluid types that are used in automobiles and explain consequences using the incorrect fluid type or brake fluid contamination.

## **Course-specific General Education Knowledge Goals and Core Skills.**

### **General Education Knowledge Goals**

**Goal 1. Communication.** Students will communicate effectively in both speech and writing.

**Goal 2. Mathematics.** Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.

**Goal 3. Science.** Students will use the scientific method of inquiry, through the acquisition of scientific knowledge.

**Goal 4. Technology.** Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.

**Goal 5. History.** Students will understand historical events and movements in World, Western, non-Western or American societies and assess their subsequent significance.

**Goal 6. Ethical Reasoning and Action.** Students will understand ethical issues and situations.

### **MCCC Core Skills**

**Goal A. Written and Oral Communication in English.** Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.

**Goal B. Critical Thinking and Problem-solving.** Students will use critical thinking and problem solving skills in analyzing information.

**Goal C. Ethical Decision-Making.** Students will recognize, analyze and assess ethical issues and situations.

**Goal D. Information Literacy.** Students will recognize when information is needed and have the knowledge and skills to locate, evaluate, and effectively use information for college level work.

**Goal E. Computer Literacy.** Students will use computers to access, analyze or present information, solve problems, and communicate with others.

**Goal F. Collaboration and Cooperation.** Students will develop the interpersonal skills required for effective performance in group situations.

**Goal G. Intra-Cultural and Inter-Cultural Responsibility.** Students will demonstrate an awareness of the responsibilities of intelligent citizenship in a diverse and pluralistic society, and will demonstrate cultural, global, and environmental awareness.

## **Unit I      **HISTORY OF AUTOMOTIVE BRAKE SYSTEMS****

### **Learning Objectives**

#### ***The student will be able to...***

- explain changes to the automotive brake system design since the invention of the automobile.
- demonstrate his/her ability to understand the reasons for changes to system design.
- analyze publications and determine the type of braking system installed on older vehicles.

#### **A. SERVICE BRAKES**

- a. Slow and Stop a Vehicle

#### **B. PARKING BRAKES**

- a. Hold a Vehicle Stationary
- b. Should Never Be Referred To As An Emergency Brake

#### **C. MECHANICAL BRAKE SYSTEMS (Early)**

- a. Pads or Blocks
- b. Application Using Levers

- c. Pad or Block On Wheel
- D. MECHANICAL BRAKE SYSTEMS (Updated)
  - a. External-Contracting Bands
  - b. Internal-Expanding Bands
  - c. Drum
- E. DISADVANTAGES OF EARLY BRAKING SYSTEMS
  - a. Ineffective For Increased Speed And Performance Vehicle Applications
  - b. Not Adequate For High Required High Braking Force (No Duo-Servo Action)
  - c. Dirt And Water Damage
  - d. Overheating
  - e. Wheel Lock-Up
- F. HYDRAULIC BRAKING SYSTEMS (Drum Braking Systems)
  - a. Hydraulic/Mechanical Systems
    - i. Began In the 1920's
    - ii. Non – Power Assist
  - b. Split-Band (Shoe)
    - i. Drum Brakes
    - ii. 4-Wheel Drum Braking System Standard Equipment
- G. FEDERAL MOTOR VEHICLE SAFETY STANDARDS
  - a. 1967 – FMVSS 105
  - b. Performance Standards To Meet Government Regulations
  - c. Production Of Faster And More Powerful Vehicles
- H. DISC BRAKES
  - a. Mid To Late 1960's
  - b. Designed From Aircraft Brakes Of World War II
  - c. Two Opposing Pad
  - d. Spinning Metal Disc
  - e. Caliper
  - f. Front-Wheel Disc Brakes
  - g. Four-Wheel Disc Brakes
  - h. Advantages
- I. POWER ASSISTED BRAKEING SYSTEMS
  - a. Vacuum Power Assist
  - b. Hydraulic Power Assist
- J. ANTI-LOCK BRAKING SYSTEMS
  - a. Prevent Wheel Lock-Up During Braking
- K. TRACTION CONTROL
  - a. Prevent Wheels From Loosing Traction During Acceleration
- L. STABILITY CONTROL
  - a. Computer Controlled Braking To Retain Vehicle Stability While Cornering
- M. BRAKE ASSIST
  - a. Computer-Controlled Brake Assist During Panic Stops

## **Unit II PRINCIPLES AND THEORIES OF BRAKE SYSTEM OPERATION**

### **Learning Objectives**

***The student will be able to...***

- explain how atmospheric pressure is used in the design of brake systems.
- describe changes in energy that occur during brake system operation.
- explain important brake system dynamics that accompany automotive brake system operation.
- determine what affect changes in brake system materials, surface finish, and brake system operating temperatures will have on brake system performance.

- A. BRAKE SYSTEM PRESSURE
  - a. Driver Input
    - i. Brake Pedal Design
    - ii. Master Cylinder Design
    - iii. Caliper/Wheel Cylinder Design
    - iv. Power Brake Booster Design
    - v. ABS System
- B. ACTUATION OF BRAKE CALIPERS AND WHEEL CYLINDERS
  - a. Mechanical Action (Driver Input)
  - b. Hydraulic Action (Motion Transfer Through Hydraulic Fluid)
  - c. Mechanical Action (Output Pistons Pushing Brake Linings Into Rotor/Drum)
- C. ENERGY TRANSFERS IN BRAKE SYSTEMS
  - a. Kinetic Energy
    - i. The Energy Of Mechanical Work Or Motion
    - ii. The Movement Of The Vehicle
    - iii. Mass, Weight, Speed, And Acceleration
  - b. Thermal Energy
    - i. Heat Energy
    - ii. Heat Generated By The Slowing Of The Vehicle
  - c. Inertia
    - i. Resistance To Change In Motion
    - ii. Newton's Law Of Motion
- D. WEIGHT TRANSFER
  - a. Unequal Weight Distribution
  - b. Front And Rear Braking Power Requirements
    - i. Front Wheel Drive
    - ii. Rear Wheel Drive
  - c. Vehicle Braking Stability
    - i. Preventing Wheel Lock-Up
- E. FRICTION PRINCIPLES
  - a. Kinetic Friction
    - i. Friction Used To Stop Or Slow Kinetic Energy
    - ii. Force
    - iii. Surface Area
  - b. Static Friction
    - i. Friction Between Two Stationary Objects
    - ii. Force
    - iii. Surface Area
  - c. Rolling Resistance
    - i. Resistance Between The Tires And The Road
  - d. Coefficient Of Friction
    - i. Measurement Of Frictional Characteristics
    - ii. One Object Contacting Another
  - e. Tensile Force
    - i. The Amount Of Force Required To Slide One Object Over Another
- F. WHAT AFFECTS COEFFICIENT OF FRICTION
  - a. Surface Finish
    - i. Rough
    - ii. Smooth
  - b. Friction Material
    - i. Composition Of Friction Material

1. Heat Dissipation
  2. Resistance To Fade
  3. Ability To Shed Water
- c. Operating Temperature
- i. Heat Dissipation
    1. Brake Fade
      - a. Lining Fade
      - b. Mechanical Fade
      - c. Gas Fade

### **Unit III BASIC HYDRAULIC THEORY AND MECHANICAL ADVANTAGE**

#### **Learning Objectives**

***The student will be able to...***

- explain theories behind the operation of hydraulic automotive braking systems.
- ,given a question on an exam, analyze hydraulic circuits and determine output piston force, movement, and system pressure.
- demonstrate his/her ability in diagnosing functionality concerns in hydraulic circuits.

- A. AIR IS COMPRESSABLE
- B. FLUID CANNOT BE COMPRESSED
- C. FLUIDS CAN TRANSMIT MOVEMENT AND FORCE
  - a. No Force – No Motion
  - b. Force Applied
  - c. Resulting Hydraulic output
- D. PASCAL'S LAW APPLIED TO HYDRAULIC BRAKE SYSTEMS
  - a. Pascal's Law
    - i. Definition
    - ii. Application To Hydraulic Braking Systems
  - b. Force
  - c. Pressure
  - d. Movement
- E. CALCULATING FORCE, PRESSURE, AND MOVEMENT
  - a. Force
    - i. Formula
      1.  $\text{Force} = \text{Pressure} \times \text{Area}$
  - b. Pressure
    - i. Formula
      1.  $\text{Pressure} = \text{Force} / \text{Area}$
  - c. Movement
    - i. Formula
      1.  $\text{Movement} = S \times (A1 / A2)$ 
        - a. S = Input Piston Stroke
        - b. A1 = Input Piston Area
        - c. A2 = Output Piston Area
  - d. CHANGING PISTON SIZE
    - i. Changes in Movement
      1. Input Movement
      2. Output Movement
    - ii. Changes in Force
      - 1.
  - e. BRAKE PEDAL MECHANICAL ADVANTAGE
    - i. Second Class Lever

1. Fulcrum Location (Top-End)
  2. Force Applied (Bottom-End)
  3. Central Load
  - ii. Changes in Lever Length
    1. Shorter – Less Mechanical Advantage
    2. Longer - Greater Mechanical Advantage
- f. CALCULATING BRAKE PEDAL MECHANICAL ADVANTAGE RATIO
- i. Ratio
    1. Formula
      - a. Mechanical Advantage Ratio =  $D1 / D2$ 
        - i.  $D1$  = Distance From Input Force to Load
        - ii.  $D2$  = Distance From Load to Fulcrum
    - ii. Application of Calculated Mechanical Advantage
      1. Calculated Value in Relation To An Input Unit Of 1(One)
        - a. Example(s)
          - i. Calculated Value : 1
          - ii. 5 : 1
          - iii. 8 : 1
- F. ADJUSTABLE PEDAL SYSTEMS (APS)
- a. Pedal Position Adjustment
    - i. Purpose
    - ii. Adjusting Mechanism

## Unit IV MASTER CYLINDERS, SERVICE, AND BRAKE FLUID

### Learning Objectives

#### ***The student will be able to...***

- explain the operation of a brake master cylinder.
- identify differences between multiple designs of brake master cylinders.
- demonstrate his/her ability in diagnosing functionality concerns in hydraulic circuits.
- explain the differences in characteristics of different types of hydraulic brake fluids.
- demonstrate his/her ability to overhaul a brake master cylinder.

### A. MASTER CYLINDER

- a. Types
  - i. Single Circuit
  - ii. Dual Circuit
- b. Components
  - i. Body
  - ii. Reservoir
- c. Body
  - i. One Piece
  - ii. Two Piece
- d. Reservoir
  - i. Design
    1. Fluid Level Inspection
    2. Translucent Reservoirs
      - a. Stains
  - ii. Cap and Diaphragm
    1. Purpose
    2. Function

- 3. Suspecting Brake Fluid Contamination
    - e. Internal Master Cylinder Construction
      - i. Ports
        - 1. Vent
        - 2. Replenishing
      - ii. Chambers
        - 1. Primary
        - 2. Secondary
      - iii. Pistons
      - iv. Piston Cups
        - 1. Design
        - 2. Operation
      - v. Return Springs
      - vi. Push Rod
      - vii. Piston Stops
      - viii. Seals and Grommets
      - ix. Retaining Ring(s), Pin(s), Threaded Retainer(s)
    - f. Operation and Function
      - i. Hydraulic Pump
        - 1. System Pressure
      - ii. Brakes Released
        - 1. Master Cylinder Component Functions
      - iii. Brakes Applied
        - 1. Master Cylinder Component Functions
    - g. ABS Requirements
      - i. Central-Valve Master Cylinder
- B. MASTER CYLINDER OVERHAUL AND SERVICE
  - a. Removal
  - b. Disassembly
  - c. Inspection
  - d. Replacement Components
  - e. Refinishing The Cylinder Bore
  - f. Repairs For Damaged Cylinder Walls
  - g. Assembly
  - h. Bench Bleeding
  - i. Installation
  - j. System Bleeding Requirements
- C. BRAKE FLUIDS
  - a. Function
  - b. Requirements By Law
  - c. Properties
  - d. Types
    - i. Polyalkylene-Glycol-Ether Based (Polyglycol)
    - ii. Silicone Based
    - iii. Mineral Based
  - e. Department of Transportation Ratings (DOT)
  - f. Fluid Color
  - g. Ability To Absorb Moisture
  - h. Boiling Points
  - i. Heavy Duty Fluids
  - j. System Contamination
  - k. Damage To Vehicle Paint Finishes
  - l. Fluid Compatibility

- m. Fluid Cost Differences
- n. Vehicle Manufacturer Requirements (Specifications)
- o. Fluid Storage and Handling
  - i. Non-Porous/Sealed Container
    - 1. Plastic vs Metal
  - ii. Always Use Fluid From A New Sealed Container
- p. Dealing With Brake Fluid Contamination
  - i. System Flushing
  - ii. Rubber Seal And Piston Cup Damage
  - iii. ABS Hydraulic Control Unit Damage Inspection

## **Unit V DRUM BRAKE THEORY, OPERATION, AND SERVICE**

### **Learning Objectives**

***The student will be able to...***

- explain the operation of drum brake systems.
- identify different types of drum brake system designs.
- demonstrate his/her ability to restore drum brake system function to factory specifications.
- explain advantages and disadvantages of drum brake systems.

#### **A. COMPONENTS AND FUNCTIONS**

- a. Brake Drum
- b. Brake Shoes
  - i. Primary
  - ii. Secondary
  - iii. Linings
    - 1. Requirements
- c. Brake Springs and Hardware
- d. Parking Brake Assembly
- e. Self-Adjusting Mechanism
- f. Drum Brake Designs
  - i. Duo-Servo
    - 1. Servo-Action (Self-Energizing)
    - 2. Non-Servo

#### **B. HYDRAULICS AND TROUBLESHOOTING**

- a. Wheel Cylinders
  - i. Purpose: Hydraulic Pressure Into Force
  - ii. Function: Apply The Brake Shoes
  - iii. Internal Components
    - 1. Pistons
    - 2. Piston Cups
    - 3. Cup Expanders
    - 4. Spring
- b. Inspection
  - i. External Fluid Leaks
  - ii. Moisture Found Behind Dust Boot
    - 1. Fluid Leak
    - 2. Moisture Accumulation
  - iii. Cylinder Bore
    - 1. Rust
    - 2. Scoring

#### **C. INSPECTION, MEASURING TOOLS, RESURFACING, AND TROUBLESHOOTING**

- a. Drum Brake Problems

- i. No Self-Adjust
      - ii. Brake Shoe Knock
      - iii. Surge or Chatter
      - iv. Brakes Fade At High Speeds
      - v. Wheel(s) Lock(s) During Braking
      - vi. Brake Pedal Feels “Hard”
      - vii. Brake Pedal Feels “Spongy”
      - viii. Brake Pedal Has Excessive Travel Before Brakes Start Working
      - ix. Brake Pedal Pushes To The Floor
      - x. Brake Squeal
      - xi. Vehicle Pulls To One Side During Braking
    - b. Brake Drum
      - i. Removal
      - ii. Size Identification
      - iii. Visual Inspection
        - 1. Cracks
        - 2. Friction Surface
          - a. Grooves
          - b. Glazing
          - c. Dark Spots
      - iv. Checking Drum Diameter
        - 1. Using A Brake Drum Micrometer
    - c. Brake Shoes
      - i. Construction
        - 1. Bonded
        - 2. Riveted
        - 3. Advantages And Disadvantages
      - ii. Lining Surface
        - 1. Grooves
        - 2. Signs Of Over-Heating
        - 3. Rivets
        - 4. Minimum Thickness
      - iii. Brake Shoe Adjustment
        - 1. Manual Adjustment
          - a. Tools
          - b. Star Wheel Adjuster
          - c. Cam-Type Adjuster
      - iv. Brake Service Safety
        - 1. Reducing Airborne Brake Dust (Possible Asbestos Dust)
        - 2. Proper Procedures
        - 3. Available Equipment
        - 4. Protecting Yourself/Protecting Others
    - d. Brake Drum Resurfacing
      - i. Brake Drum Removal
      - ii. Maximum Allowable Diameter
      - iii. When To Replace The Brake Drum
      - iv. Setting-Up The Brake Lathe
        - 1. Brake Lathe Operation
      - v. Brake Drum Installation
        - 1. Manual Brake Shoe Adjustment
- D. PARKING BRAKE (DRUM SYSTEM)
  - a. Mechanical – Not Hydraulic
  - b. Testing

- c. Cable Replacement
  - i. Front
  - ii. Rear
  - iii. Adjustments
  - iv. Vacuum Valve (Automatic Brake Release)
    - 1. Application
    - 2. Removal
    - 3. Installation
    - 4. Adjustments
- E. WHEEL CYLINDER OVERHAUL AND SERVICE
  - a. Removal
  - b. Disassembly
  - c. Inspection
  - d. Cylinder Wall Resurfacing
  - e. Assembly
  - f. Installation
  - g. System Bleeding Requirements

## **Unit VI      DISC BRAKE THEORY, OPERATION, AND SERVICE**

### **Learning Objectives**

#### ***The student will be able to...***

- explain the operation of disc brake systems.
- identify differences in brake caliper design and explain reason for those differences.
- demonstrate his/her ability to restore disc brake system function to factory specifications.
- explain advantages and disadvantages of disc brake systems.

### **A. COMPONENTS AND FUNCTIONS**

- a. Components
  - i. Brake Rotor
  - ii. Brake Caliper Assembly
  - iii. Splash Shields
  - iv. Brake Pads
  - v. Bleeder Screw (Location)
  - vi. Parking Brake Mechanism (If Equipped)
- b. Caliper Assembly
  - i. Fixed
  - ii. Floating/Sliding
  - iii. Differences In Design And Operation
- c. Pads And Linings
  - i. Bonded Or Riveted
    - 1. Organic
    - 2. Semi-Metallic
    - 3. Metallic
    - 4. Ceramic
    - 5. Other
  - ii. Wear Sensing Indicator
  - iii. Advantages And Disadvantages
  - iv. Reasons For Being Standard Equipment For Front Wheel Applications
    - 1. More Stopping Power
    - 2. Better Heat Dissipation
    - 3. Less Brake Fade
    - 4. Greater Friction Surface Area

- 5. Self-Adjusting
    - 6. Reduced Wheel Lock-Up (Better Braking Control)
  - d. Disc Brake Inspection
    - i. Things To Look For
    - ii. Repairs
    - iii. Component Replacement Requirements
- B. HYDRAULICS AND TROUBLESHOOTING
  - a. Fixed-Caliper Operation
    - i. Components
      - 1. Caliper Body
      - 2. Hydraulic Pistons (Each Side Of Caliper)
      - 3. Brake Pads (2)
      - 4. Piston Seals (One Per Piston)
      - 5. Dust Boot (One Per Piston)
    - ii. Function
      - 1. Squeezing Or Clamping Of Pads To Rotor
      - 2. Self-Adjusting
      - 3. No Self-Energizing Action (Caliper Remains Stationary)
    - iii. Hydraulics
      - 1. More Brake Fluid Required
      - 2. Higher Braking Force For A Given Hydraulic Pressure
    - iv. Caliper Mounting
      - 1. Bolted/Fixed
  - b. Floating-Caliper Operation
    - i. Components
      - 1. Caliper Body
      - 2. Hydraulic Piston(s) (One Side Of Caliper Only)
      - 3. Brake Pads (2)
      - 4. Piston Seal(s) (One Per Piston)
      - 5. Dust Boot(s) (One Per Piston)
    - ii. Function
      - 1. Squeezing Or Clamping Of Pads To Rotor
      - 2. Self-Adjusting
      - 3. Self-Energizing (Reaction Occurs When Caliper Piston(s) Moves)
    - iii. Caliper Mounting
      - 1. Two Locating Bolts Or Guide Pins (Allows The Caliper To Move)
  - c. Sliding-Caliper Operation
    - i. Components
      - 1. Caliper Body
      - 2. Hydraulic Piston(s) (One Side Of Caliper Only)
      - 3. Brake Pads (2)
      - 4. Piston Seal(s) (One Per Piston)
      - 5. Dust Boot(s) (One Per Piston)
    - ii. Function
      - 1. Squeezing Or Clamping Of Pads To Rotor
      - 2. Self-Adjusting
      - 3. Self-Energizing (Reaction Occurs When Caliper Piston(s) Moves)
    - iii. Caliper Mounting
      - 1. Supported By Two Abutments Or Ways
      - 2. Held In Place By Retaining Hardware (Allows Caliper To Move)
- C. BRAKE ROTOR
  - a. Construction
    - i. Fixed Rotor

1. Bearing Hub And Rotor Cast As An Assembly
  - ii. Floating Rotor (Two-Piece Rotor)
    1. Rotor And Bearing Hub Separate
  - iii. Composite Rotor
    1. Manufactured With Two Different Metals
      - a. Web – Steel
      - b. Friction Surface – Cast Iron
        - i. Lighter
        - ii. More Difficult To Resurface
  - iv. Vented Rotor
    1. Larger Heat-Transfer Surface
      - a. Typically Found On A Front Brake System
  - v. Cross-Drilled/Slotted Rotor
    1. Performance Applications
  - vi. Solid Rotor
    1. Lacks Cooling Fins For Heat Dissipation
      - a. Typically Found On A Rear Brake System
- b. Brake Rotor Resurfacing
- i. Brake Rotor Removal
  - ii. Minimum Allowable Thickness
  - iii. When To Replace The Brake Rotor
  - iv. Setting-Up The Brake Lathe
    1. Brake Lathe Operation
  - v. Brake Rotor Installation
  - vi. Checking Lateral Run-Out
- D. BRAKE CALIPER OVERHAUL AND SERVICE
- a. Removal
  - b. Disassembly
  - c. Inspection
  - d. Cylinder Wall Resurfacing
  - e. Assembly
  - f. Installation
  - g. System Bleeding Requirements

## **Unit VII BRAKE SAFETY SWITCHES, VALVES, BRAKE TUBING, HOSES, AND FITTINGS**

### **Learning Objectives**

#### ***The student will be able to...***

- explain the operation of all valves and switches used for the operation of modern brake systems.
- identify the proper type of brake tubing that should be used to complete a hydraulic repair.
- demonstrate his/her ability to form inverted double and ISO brake tubing flares.
- explain procedures necessary to purge air from a hydraulic brake system.

### **A. BRAKE SAFETY SWITCHES AND VALVES**

- a. Brake Warning Light Switch
- b. Metering Valve
  - i. Purpose
  - ii. Operation
- c. Proportioning Valve
  - i. Purpose
  - ii. Operation
- d. Load Sensing Proportioning Valve

- i. Purpose
    - ii. Operation
  - e. Residual Valve
    - i. Purpose
    - ii. Operation
  - f. Combination Valve
    - i. Purpose
    - ii. Operation
  - g. Brake Warning Lamp Switch
    - i. Purpose
    - ii. Operation
  - h. Stop Lamp Switch
    - i. Purpose
    - ii. Operation
    - iii. Adjustment
- B. BRAKE TUBING AND HOSES
  - a. Brake Tubing
    - i. Types
    - ii. Purpose
    - iii. Precautions
    - iv. Forming
    - v. Flaring
      - 1. Inverted Double Flare
      - 2. ISO Flare
    - vi. Fittings And Tools
    - vii. Replacement
    - viii. Bleeding Requirements
  - b. Brake Hoses
    - i. Types
    - ii. Purpose
    - iii. Precautions
    - iv. Replacement
      - 1. Fittings
        - a. Conventional
        - b. Banjo Fittings
          - i. Copper Sealing Washers

## **Unit VIII      POWER ASSISTED BRAKE SYSTEMS**

### **Learning Objectives**

#### ***The student will be able to...***

- explain the operation of power assist brake units.
- explain the advantages and necessities of different types of power assist units.
- analyze and repair customer concerns in this area of automotive technology.
- explain to customers the safety features designed into each power assisted brake system.

- A. POWER BRAKE SYSTEMS
  - a. Purpose
  - b. General Overview
  - c. Requirements
- B. VACUUM POWER BRAKE BOOSTERS
  - a. Operation
    - i. Atmospheric Pressure

- ii. Pressure Differential
- b. Components
  - i. Vacuum Supply Connections
  - ii. Vacuum Check valves
  - iii. Housing
  - iv. Control Valves
    - 1. Vacuum Valve
    - 2. Atmospheric Valve
  - v. Diaphragm(s)
  - vi. Power Piston(s)
  - vii. Return Spring
  - viii. Rods
    - 1. Input
    - 2. Output
  - ix. Reaction
    - 1. Reaction Disc
    - 2. Reaction Plate
- c. Functions
  - i. Brake Released
  - ii. Moderate Brake Application
  - iii. Brakes Holding
  - iv. Full Brake Application
  - v. Brakes Being Released
  - vi. Vacuum Reserve (Back-Up)
- d. Brake Pedal Feel
- e. Vacuum Booster Types
  - i. Single Diaphragm
  - ii. Dual Diaphragm (Tandem)
    - 1. Advantages
- f. Vacuum Supply To Booster
  - i. Auxiliary Vacuum Pumps
  - ii. Manifold Vacuum
  - iii. Vacuum Reservoir(s)
- g. Electronic Brake System (EBS)
  - i. Purpose
  - ii. Function

### C. HYDRAULIC POWER ASSIST BOOSTERS

- a. Operation
  - i. Hydraulic Pressure Differential
- b. Components
  - i. Hydraulic Fluid Connections
  - ii. Housing
  - iii. Control valve
    - 1. Spool Valve
  - iv. Power Piston
  - v. Return Spring
  
  - vi. Rods
    - 1. Input
    - 2. Output
  - vii. Reaction
    - 1. Reaction Rod

2. Accumulator
- c. Functions
  - i. Brake Released
  - ii. Moderate Brake Application
  - iii. Brakes Holding
  - iv. Full Brake Application
  - v. Brakes Being Released
  - vi. Hydraulic Pressure Reserve (Back-Up)
- d. Brake Pedal Feel
- e. Hydro-Boost
- f. Hydraulic Pressure Supply To Booster
  - i. Power Steering Pump
  - ii. Other
- D. POWER MASTER® BRAKE SYSTEM
  - a. Self-Contained System
    - i. Self-Produced Operating Pressure
      1. No Connection To Outside Pump

## **Unit IX      ANTI-LOCK, TRACTION CONTROL, STABILITY CONTROL, AND REGENERATIVE BRAKING SYSTEMS**

### **Learning Objectives**

#### ***The student will be able to...***

- explain the operation anti-lock, traction control, and stability control systems.
- explain to customer, the safety-added benefits of each system.
- analyze and repair customer concerns with these systems.
- distinguish between normal operation and actual system malfunctions.

- A. ANTI-LOCK BRAKE CONTROL
  - a. Theory Of Operation
    - i. Wheel Lock-Up/Maintain Directional Stability
    - ii. Normal And Anti-Lock Braking
    - iii. Self-Diagnostics Capability
  - b. Common Components
    - i. Wheel Speed Sensors (WSS)
    - ii. Vehicle Speed Sensor (VSS)
    - iii. Throttle Position Sensor (TPS)
    - iv. Steering Angle Sensor (SAS)
    - v. YAW Sensor
    - vi. Circuitry
    - vii. Computer Control Module
    - viii. Hydraulic Control Module
    - ix. Electric Hydraulic Fluid Pump
    - x. Accumulator
    - xi. Brake Pedal Position Sensor (BPP), (BOO)
    - xii. Warning Lamps
  - c. Systems Variations
    - i. Integrated
    - ii. Non-Integrated
  - d. Types Of Systems
    - i. One-Channel (RWAL, RABS, Other)
      1. Controls Rear Wheels Only, Via One Hydraulic Circuit

- a. Both Rear Wheels Respond The Same
    - ii. Two-Channel (4-Wheel ABS)
      - 1. Controls Rear Wheels Via One Hydraulic Circuit And Controls Front Wheels Via Two Hydraulic Circuits, One Per Wheel
        - a. Both Rear Wheels Respond The Same, Front Wheels Can Be Controlled Independently
    - iii. Four-Channel (True 4-Wheel ABS)
      - 1. Each Wheel Is Controlled Via A Separate Hydraulic Circuit
        - a. Each Wheel Can Be Controlled Independently
  - e. Diagnostics And Service
    - i. Retrieving DTC's
      - 1. Flash-Out-Codes
      - 2. Scan Tool Access
        - a. Scan Tool Connections
    - ii. Service Manual Diagnostic Procedure
    - iii. TSB's/SSM's
- B. TRACTION CONTROL**
- a. Theory Of Operation
  - b. Purpose
  - c. Self-Diagnostic Capability
  - d. Identifying Normal Operation
  - e. Common Components
    - i. Wheel Speed Sensors (WSS)
    - ii. Vehicle Speed Sensor (VSS)
    - iii. Throttle Position Sensor (TPS)
    - iv. Steering Angle Sensor (SAS)
    - v. YAW Sensor
    - vi. Circuitry
    - vii. Computer Control Module
    - viii. Hydraulic Control Module
    - ix. Electric Hydraulic Fluid Pump
    - x. Accumulator
    - xi. Brake Pedal Position Sensor (BPP), (BOO)
    - xii. Warning Lamps
    - xiii. Traction Control ON/OFF Switch
  - f. System Requirements
    - i. 4-Channel ABS System
  - g. Diagnostics And Service
    - i. Retrieving DTC's
      - 1. Scan Tool Access
        - a. Scan Tool Connections
    - ii. Service Manual Diagnostic Procedures
    - iii. TSB's/SSM's
- C. STABILITY CONTROL**
- a. Theory Of Operation
  - b. Purpose
  - c. Self-Diagnostic Capability
  - d. Common Components
    - i. Wheel Speed Sensors (WSS)
    - ii. Vehicle Speed Sensor (VSS)
    - iii. Throttle Position Sensor (TPS)
    - iv. Steering Angle Sensor (SAS)
    - v. YAW Sensor

- vi. Circuitry
  - vii. Computer Control Module
  - viii. Hydraulic Control Module
  - ix. Electric Hydraulic Fluid Pump
  - x. Accumulator
  - xi. Brake Pedal Position Sensor (BPP), (BOO)
  - e. Diagnostics And Service
    - i. Retrieving DTC's
      - 1. Flash-Out-Codes
      - 2. Scan Tool Access
        - a. Scan Tool Connections
    - ii. Service Manual Diagnostic Procedure
    - iii. TSB's/SSM's
- D. REGENERATIVE BRAKING SYSTEMS
- a. Purpose
  - b. Function
  - c. Application
    - i. Some Hybrid Vehicle Application
    - ii. Not All Hybrids Are Equipped
  - d. Service Manual Diagnostics
    - i. See Service Procedure
    - ii. TSB's/SSM's

**Unit X COURSE REVIEW/FINAL EXAM**

- A. HISTORY OF AUTOMOTIVE BRAKE SYSTEMS
- B. PRINCIPLES AND THEORIES OF BRAKE SYSTEM OPERATION
- C. BASIC HYDRAULIC THEORY AND MECHANICAL ADVANTAGE
- D. MASTER CYLINDERS, SERVICE, AND BRAKE FLUID
- E. DRUM BRAKE THEORY, OPERATION, AND SERVICE
- F. DISC BRAKE THEORY, OPERATION, AND SERVICE
- G. BRAKE SAFETY SWITCHES, VALVES, BRAKE TUBING, HOSES, AND FITTINGS
- H. POWER ASSISTED BRAKE SYSTEMS
- I. ANTI-LOCK, TRACTION CONTROL, STABILITY CONTROL, AND REGENERATIVE BRAKING SYSTEMS

**Evaluation of student learning:**

- A. Lab Work 50%
- B. Test/Quizzes/Homework Assignments/Final Exam 50%

**Academic Integrity Statement:**

Mercer County Community College is committed to Academic Integrity-- the honest, fair and continuing pursuit of knowledge, free from fraud or deception. This implies that students are expected to be responsible for their own work, and that faculty and academic support services staff members will take reasonable precautions to prevent the opportunity for academic dishonesty.

**Reasonable Accommodations for Students with Documented Disabilities**

Mercer County Community College is committed to supporting all students in their academic and co-curricular endeavors. Each semester, a significant number of students document disabilities, which may require learning, sight, hearing, manual, speech, or mobility accommodations to ensure access to academic and co-curricular activities. The college provides services and reasonable accommodations to all students who need and have a legal entitlement to such accommodations.

For more information regarding accommodations, you may visit the Office of Academic Support Services in FA129 or contact them at 609.570.3422 or [urbanb@mccc.edu](mailto:urbanb@mccc.edu).