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 and AUT 111

Implementation
sem/year
Spring 2019

Catalog description (2018-2019 Catalog): The principles and servicing of both disc and drum brake systems used on today's automobiles, including computer-controlled anti-lock braking systems. Emphasis on malfunction diagnosis, use of road-testing techniques and visual brake inspection procedures, repair integrity, plus hydraulic theory and component machining operations.

Is course New, Revised, or Modified? Revised


Revision date: January 2019

Course coordinator: Jason Evans, ext. 3776, evansj@mccc.edu

Information resources: DealerConnect web-site, Learning Center Reference Books, Subaru of America resources, 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.

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 BRAKING 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. Force = Pressure x Area
   b. Pressure
      i. Formula
         1. Pressure = Force / Area
   c. Movement
      i. Formula
         1. Movement = S x (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
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 CONTOL, AND REGENERATIVE BRAKING SYSTEMS

Learning Objectives
The student will be able to...
• explain the operation anti-lock, traction control, and satiability 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 actually 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 ensuring the full participation of all students in all activities, programs and services. If you have a documented differing ability or think that you may have a
differing ability that is protected under the ADA and Section 504 of the Rehabilitation Act, please contact Arlene Stinson in LB 216 stinsona@mccc.edu for information regarding support services. If you do not have a documented differing ability, remember that other resources are available to all students on campus including academic support through our Academic Learning Center located in LB 214.