



**MERCER**  
COUNTY COMMUNITY COLLEGE

## COURSE OUTLINE

<b>Course Number</b> <b>AUT 226</b>	<b>Course Title</b> <b>Electrified Vehicles</b>	<b>Credits</b> <b>3</b>
<b>Hours:</b> <b>Lecture/Lab/Other</b> <b>2/2</b>	<b>Pre-requisite</b> <b>AUT 114 and AUT 122</b>	<b>Implementation</b> <b>Semester &amp; Year</b> <b>Fall 2022</b>

**Catalog description:** Examination of high-voltage, electrified vehicles and special service techniques necessary to diagnose and repair electrical and mechanical faults. Course includes hybrid, plug-in hybrid, and fully electric vehicle design and operation. Includes use of special tools and equipment. Strong emphasis placed on personal and workplace safety.

**General Education Category:** **Not GenEd** | **Course coordinator:** Jason Evans, [evansj@mccc.edu](mailto:evansj@mccc.edu), 609-570-3776

**Required texts & Other materials:**

Denton, T. (2020). *Electric and Hybrid Vehicles* (Edition 2). Routledge. (ISBN 13: 978-0367273231).

Electude, Electric Drive online content voucher (ISBN: 978-94-92580-88-7)

A basic calculator capable of adding, subtracting, multiplying, and dividing numbers. Cell phone calculators are not allowed during quizzes and exams.

Access to a personal laptop computer, tablet, or Chromebook is strongly recommended during class and lab.

Students must purchase safety glasses, work boots, and appropriate clothing to work in the automotive lab. This requirement is reviewed with the students on the first day of class. These items are not needed for the first class meeting of the term.

The following is provided at no charge to the students:

Vehicle service information provided through Stellantis, Subaru of America, Audi of America, or ALLDATA.

**Accreditation Statement:**

The Automotive Technology, Mopar CAP, Program is Master Automotive Service Technology (MAST) accredited by Automotive Service Excellence Education Foundation.

<https://www.aseeducationfoundation.org/>

## **Course Student Learning Outcomes (SLO):**

### ***Upon successful completion of this course, the student will be able to:***

1. Compare the advantages and disadvantages of high-voltage vehicles. [Supports ILG #10,11; PLO #4]
2. Explain the differences between propulsion systems found in hybrid, plug-in hybrid, and electric vehicles. [Supports ILG #1,11 ; PLO #4]
3. Identify safety hazards associated with service, repair, and maintenance of high-voltage vehicle systems. [Supports ILG #10,11 ; PLO #2,3]
4. Explain how to properly quarantine a high-voltage vehicle during service and prevent electrocution during vehicle diagnosis, repair, and maintenance procedures. [Supports ILG # 4,10,11 ; PLO #2, 3]
5. Explain the power flow through the drivetrain of a high-voltage vehicle. [Supports ILG #1,11 ; PLO #3,4]
6. Explain electrical power management in a high-voltage vehicle. [Supports ILG #1,11 ; PLO #3, 4]
7. Locate service information related to vehicle systems needing diagnosis, repair, and maintenance. [Supports ILG #4,10 ; PLO #3]
8. Analyze high-voltage vehicle systems to locate the cause of system malfunctions. [Supports ILG #2,4,10 ; PLO #1,3]
9. Select the proper special service tools to diagnose, repair, and maintain high-voltage vehicle systems, to minimize the risk of personal injury and damage to the vehicle. [Supports ILG #4, 10, 11 ; PLO # 1, 2, 3]
10. Demonstrate industry recognized safety techniques necessary during diagnosis, repair, and maintenance of high-voltage vehicle systems. [Supports ILG #10 ; PLO # 1, 2, 3]

## **Course-specific Institutional Learning Goals (ILG):**

**Institutional Learning Goal 1. Written and Oral Communication in English.** Students will communicate effectively in both speech and writing.

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

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

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

**Institutional Learning Goal 10. 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.

**Institutional Learning Goal 11. Critical Thinking:** Students will use critical thinking skills understand, analyze, or apply information or solve problems.

## **Program Learning Outcomes for Automotive Technology (PLO)**

1. Diagnose, repair, and service current automotive technologies
2. Demonstrate desirable attitudes and work habits while working individually or with others
3. Obtain service repair information and procedures from online websites and electronic databases
4. Communicate effectively and professionally with customers and fellow technicians

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## **Units of study in detail – Unit Student Learning Outcomes:**

### **Unit I      **Review of Workplace Safety** [Supports Course SLO # 3, 4]**

#### **Learning Objectives**

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

- Explain the basic personal protective equipment (PPE) required to work in an automotive repair facility.
- Explain general precautions necessary when servicing and repairing various automobile systems.
- Distinguish a high-voltage vehicle from a vehicle that does not use high-voltage systems.
- Explain the specific personal protective equipment (PPE) necessary to diagnose, service, and repair high-voltage vehicle systems.
- Criticize the integrity of required PPE before working on a high-voltage vehicle system.
- Explain the general procedures necessary to isolate (depower/disconnect/disable) the high-voltage system of a high-voltage vehicle prior to performing service work.

### **Unit II      **Review of Electrical Fundamentals** [Supports Course SLOs # 6, 9]**

#### **Learning Objectives**

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

- Demonstrate the difference between voltage, current, and electrical resistance.
- Explain Ohm's Law and describe how it applies to the operation of automotive electrical circuits.
- Apply Ohm's Law to calculate automotive electrical circuit voltage, current, and resistance figures in series, parallel, and series-parallel circuits.
- Use electrical measurement tools, such as a digital volt ohmmeter (DVOM) and test light to test and evaluate low-voltage automotive electrical circuits.
- Demonstrate techniques necessary for locating low-voltage circuit faults, including opens circuits and short circuits.

### **Unit III      **Introduction to High-voltage Vehicles** [Supports Course SLOs # 1, 2, 3, 4]**

#### **Learning Objectives**

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

- Explain the history and evolution of vehicles equipped with high-voltage propulsion systems.
- Explain the environmental impact of production, operation, and disposal of high-voltage vehicles and high-voltage vehicle components.
- Explain the difference between hybrid, plug-in hybrid, and electric vehicles.
- Explain the laws, regulations, and standards for high-voltage vehicles and their individual systems.
- Explain the location and purpose of safety devices found on a high-voltage vehicle that are used to protect vehicle occupants, service technicians, and first responders from electric shock.
- Describe common exterior vehicle body features and badges that may be used to identify a high-voltage vehicle.
- Identify common access points on a high-voltage vehicle that may be use by first responders to disable the high-voltage electrical system during an emergency.

### **Unit IV      **High-Voltage and Low-Voltage Electrical Systems** [Supports Course SLOs # 3, 4, 5, 6, 7, 9, 10]**

#### **Learning Objectives**

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

- Explain how low-voltage and high-voltage electrical system work together to operate a high-voltage vehicle.
- Demonstrate correct procedures to depower the low-voltage and high-voltage electrical systems, by following procedures published by the vehicle manufacturer.
- Explain the operation of the low-voltage battery charging system.
- Explain the operation of the high-voltage battery charging system.
- Use published vehicle service information to inspect, test, and replace low-voltage and high-voltage batteries.
- Use the appropriate electrical testing tools, equipment, and vehicle service information to take electrical measurements on low-voltage and high-voltage electrical systems.

**Unit V      Inverters, Converters, and Drivetrains [Supports Course SLOs # 3, 4, 5, 6, 7, 9, 10]**

**Learning Objectives**

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

- Describe the purpose and operation of inverters found in high-voltage vehicles.
- Describe the purpose and operation of converters found in high-voltage vehicles.
- Explain the operation of a high-voltage drive motor.
- Describe drivetrain operation, including propulsion of the vehicle and their role in recharging the high-voltage battery.
- Explain current flow through high-voltage inverters, converters, and electric drive motors.
- Identify high-voltage components and cabling, and know when it is necessary to isolate the high-voltage battery prior to diagnosis, repair, and vehicle maintenance.

**Unit VI      High-Voltage Thermal Management Systems, Braking Systems, and Heating and Air Condition (HVAC) Systems [Supports Course SLOs # 3, 4, 6, 7, 9, 10]**

**Learning Objectives**

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

- Compare high-voltage thermal management systems to thermal management systems found in mainstream vehicles equipped only with an internal combustion engine.
- Explain the need for and operation of thermal management systems for high-voltage components.
- Identify components used in the construction of high-voltage thermal management systems.
- Explain the design, operation, and purpose of regenerative braking systems.
- Explain the differences between cabin HVAC systems found in conventional, mainstream vehicles and those found in high-voltage vehicles.
- Identify HVAC components unique to high-voltage vehicles.
- Explain the hazards involved with the diagnosis, repair, and maintenance of high voltage thermal management systems, braking systems, and HVAC systems.

**Unit VII      High-voltage Vehicle Systems Diagnosis, Repair, and Maintenance [Supports Course SLOs # 3, 4, 5, 6, 7, 8, 9, 10]**

**Learning Objectives**

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

- Recite common maintenances required for hybrid, plug-in hybrid, and fully electric vehicles.
- Locate vehicle service information necessary to diagnose and repair operational concerns for a high-voltage vehicle.
- Use published diagnosis and service procedures to locate and repair operational faults in a high-voltage vehicle.
- Identify when the use of insulated personal protective equipment (PPE) is necessary during diagnosis, repair, and maintenance of a high-voltage vehicle systems.

- Evaluate insulated PPE prior to use, including checking inspection date codes and checking the PPE for functional defects prior to use.
- Identify when it is necessary to depower the high-voltage electrical system prior to working on a high-voltage vehicle.
- Use special tools and test equipment during diagnosis, repair, and maintenance of high-voltage vehicle systems.
- Compose an action plan to resolve malfunctions in high-voltage vehicle systems, noting any necessary replacement parts and labor time.

### **Evaluation of student learning:**

Students are evaluated using weekly quizzes, a mid-term exam, a final exam, graded homework assignments, and hands-on work assignments in the automotive laboratory. Students are expected to read the assigned textbook chapters, handouts, and complete vehicle manufacturers' training material (if applicable) outside of class and at appropriate times throughout the course.

Please note that:

- Any student who scores below a 60% (D) on the final exam must repeat the course
- Students enrolled in the any automotive program option sponsored by a vehicle manufacturer (Mopar CAP, Subaru University, or Audi AEP) must complete all vehicle manufacturer web courses, post-tests, and proctored assessments assigned at the start of the semester. The assigned web courses, post-test, and proctored assessments are in addition to the standard course assignments shown below. Due dates for each assigned web course, post-test, and proctored assessment is discussed in class, but all of them must be finished and passed before the beginning of the last week of the term.

Below is a list of the tools used for assessing student learning outcomes in this course. The percentages shown after each assessment tool refers to the weight each assessment has on a student's final course grade. Percentages shown are approximate.

Exams 40%

Quizzes 15%

Hands-On Lab Assignments 40%

Homework 5%

### **Policy Statement for Missed Lab Demonstrations:**

Due to the concerns for student and staff safety, a student who does not attend tool, equipment, and procedure demonstrations performed by the course instructor, prior to a hands-on learning activity, may be excluded from participating in the hands-on activity. This occurs because the tools, equipment, chemicals, and procedures necessary to complete automotive diagnosis and service often present safety hazards for users and observers if the correct handling procedures are not followed.

Reasons for not attending demonstrations may include full or partial absence during the demonstration, or if a student does not give his or her full attention during the demonstration. Enforcement of this classroom policy is at the discretion of the course instructor, and is based largely on the dangers involved with the use of the necessary tools, equipment, chemicals, and procedures required to complete the hands-on activity, and the time necessary to complete a make-up demonstration.