AUME-800: INTRODUCTION TO HYBRID AND ELECTRIC VEHICLE TECHNOLOGY

Effective Term
Fall 2024

BOT Approval Date
01/11/2024

Discipline
AUME - Automotive/Transportation Tech
Course Number
800

Course Title
Introduction to Hybrid and Electric Vehicle Technology

Short Title
Hybrid/Electric Vehicles

Credit Status (CB 04)
D - Credit - Degree applicable

Units

Lecture Units
2.00

Lab Units
1.00

Total Units
3.00

Hours

Lecture Contact Hours
32-36
Out of Class Hours Lecture
64-72

Lab Contact Hours
48-54
Out of Class Hours Lab
0.00

Total Contact Hours
80 - 90

Total Out of Class Hours
64 - 72

Total Student Learning Hours
144 - 162

Is this an existing Extensive Lab?
No

Do you want to propose this for Extensive Lab?
Yes

Distance Education
No

Catalog Description
This course explores the technologies used in modern hybrid and electric vehicle propulsion systems. Topics discussed include high voltage service safety precautions, power invertor and battery technologies as well as hybrid/electric vehicle driveability and maintenance issues. Hybrid and electric vehicle integrated propulsion systems produced by various manufacturers will be compared and contrasted. This course is intended to assist the student in preparing to take the ASE L3 Hybrid and Electric Vehicle Specialist Certification Exam.

Attach Supporting Documents
ASE_L3_Study_Guide_2023.pdf

Requisites

Prerequisite(s)

Prerequisite(s) (must be taken before)
AUME-780 (with a grade of C or better) or Instructor Approval.

Requisite Course Attachment(s)
ASE PROGRAM STANDARDS ELECTRICAL.pdf

Codes

TOP Code (CB 03)
0948.40* - *Alternative Fuels and Advanced Transportation Technology

CIP Code
47.0614 - Alternative Fuel Vehicle Technology/Technician.

Student Accountability Model (SAM) Priority Code (CB 09)
C - Clearly Occupational

Noncredit Category (CB 22)
Y - Credit Course

Repeatability Code
No

Grading Option
Letter grade OR P/NP

Minimum Qualifications

Minimum Qualifications	And/Or
Automotive Technology	End

CSU Area(s)

IGETC Area(s)

Learning Objectives

Learning Objectives

Learning Objective
1. Analyze and select the precautions that must be employed in order to safely service high voltage propulsion systems.
2. Compare and contrast the different types of hybrid and electric vehicle propulsion and power management systems produced by various manufacturers.
3. Examine various types of wiring and protective conduits, discriminate between high and low voltage systems.
4. Inspect the brake, steering and air conditioning systems used on hybrid and electric vehicles.
5. Formulate diagnostic strategies intended to assess the operating characteristics of hybrid and electric vehicle propulsion systems.
6. Evaluate the condition of High-Voltage Propulsion components.
7. Investigate resources available from federal, state and local sources that will make it possible for people who are members of disadvantaged groups to be able to afford to purchase hybrid or electric vehicles.
8. Document the causes of faults that are discovered in hybrid and electric propulsion management systems.
9. Exhibit the ability to perform basic maintenance procedures on hybrid and electric vehicle propulsion systems.

Learning Outcome Information

Course Learning Outcomes

Learning Outcome
1. The student will apply personal and shop safety procedures associated with high voltage propulsion systems.
2. The student will describe the purpose and operation of the various components used on hybrid and electric vehicle propulsion systems.
3. The student will exhibit the ability to perform basic maintenance procedures related to hybrid and electric vehicle operating systems.
4. The student will demonstrate the ability to diagnose a basic fault on a hybrid or electric vehicle operating system using industry standard diagnostic equipment.

Program Learning Outcomes

Learning Outcome
Complete all NATEF (National Automotive Technician Education Foundation) task sheets.
Enter the workforce in the automotive industry.
Pass all eight areas in the ASE certification.

Institutional Learning Outcomes

Communication: The student will effectively express and exchange ideas through listening, speaking, reading, writing, visual works, and other modes of interpersonal expression.
Critical Thinking: The student will analyze problems, gather and synthesize relevant information, evaluate ideas, information, and evaluate alternative points of view to create, innovate and implement effective solutions.
Information and Technology Literacy: The student will access, interpret, evaluate, and apply relevant information sources and digital media effectively, and in an ethical and legal manner.
Scientific Awareness: The student will apply the scientific method of inquiry to assess potential solutions for real-life challenges by employing science-based knowledge and methodologies in daily life.
Social Awareness: The student will recognize and analyze the interconnectedness of global, national, and local concerns, analyzing cultural, political, social, and environmental issues from multiple perspectives and appreciate similarities and differences among cultures.
Civic
Personal
and Professional Responsibility

Content

Course Lecture Content

1. S/P2 Automotive Safety and Hazardous Pollution Prevention Certification
    a. Automotive Service Safety Certification
    b. Automotive Service Hazardous Pollution Prevention Certification
    c. Automotive Lift Institute's "Lifting it Right" Certification
    d. S/P2 "Ethics and You in the Automotive Industry Certification
    e. S/P2 Electric Vehicle Safety Certification
2. Hybrid/Electric Propulsion System Types
    a. Series Hybrids
    b. Parallel Hybrids
    c. Series-Parallel Hybrids
    d. Plug-In Hybrids
    e. Fully Electric Vehicles
    f. Micro-Hybrids
    g. Fuel-Cell Vehicles
3. Hybrid/Electric Vehicle Safety
    a. Equipment
        i. Class 0 1000 Volt Lineman's Gloves
            1. Age Certification
            2. Roll-up Test
        ii. Category III Digital Multi-Meters
        iii. The Technician Removal Tool
        iv. The Lock-Box
    b. High-Voltage Circuit Identification
    c. Depowering High-Voltage Systems
        i. The Role of 12 Volt Batteries
        ii. The High-Voltage Disconnect
        iii. The Live-Dead-Live Test
        iv. Hybrid Vehicle Internal Combustion Engine (ICE) Service Precautions
4. Hybrid/Electric Preventive Maintenance
    a. Special Fluids
        i. Antifreeze Types
        ii. Transaxle Oil Types
        iii. Air Conditioning Compressor POE Oil
        iv. Hybrid/Electric Tires
5. Regenerative Braking
    a. Service Precautions
    b. Special Considerations
6. Electric Assist Power Steering
    a. Service Precautions
    b. Special Considerations
7. Hybrid/Electric Transmissions
    a. Continuously Variable Transmissions (CVT)
    b. Planetary Gear Based Units
    c. Service Considerations
    d. Special Precautions
8. Special Incentives for Purchasing Environmentally Friendly Vehicles
    a. Federal Subsidies
    b. State Subsidies and Tax Incentives
    c. Local Subsidies and Incentives
    d. How these Incentives Increase Ownership of Environmentally Friendly Vehicles by Members of Traditionally Underrepresented Populations
9. Investigate the Ethnic and Gender Composition of Automotive Specialty Technicians

a. Improvement in Opportunities for Women in the Past 30 Years
b. Ethnic Composition of Automotive Specialty Technicians in California
    i. Ethnic Composition is Nearly Equal to the Population as a Whole
    ii. Monetary Compensation Gap is Shrinking

Course Lab Content

1. Hybrid/Electric Propulsion System Types
    a. Identify the System Type
    b. Identify High-Voltage Wiring and Components
2. High-Voltage Service Precautions
    a. Identify Acceptable Test Equipment
    b. Identify Acceptable HV Protective Gloves
        i. The Roll-Up Test
        ii. Checking for Safety Certification and Age
    c. Emission and Chemical Identification
    d. Hybrid Vehicle Internal Combustion Engine (ICE) Service Precautions
3. The High-Voltage Disconnect
    a. Disconnect the 12 Volt System
    b. Locate and Remove the HV Service Plug
    c. The Live-Dead-Live Test
4. Hybrid/Electric Vehicle Preventive Maintenance
    a. Test and/or Replace Coolant
    b. Regenerative Braking System Service
        i. Recognize Service Precautions
        ii. Perform Regenerative Braking System Diagnosis
    c. Service the Electric Power Steering
        i. Identify the System Voltage
        ii. Electric Steering Service
    d. Hybrid/Electric Transmissions
        i. Transmission Oil Change and Fluid Level Check
        ii. Transmission Scan-Tool Diagnosis
5. Research Incentives for Purchasing Environmentally Friendly Vehicles
    a. Reflect About How Subsidies and Tax Incentives Would Contribute to Ownership of Environmentally Friendly Vehicles by Members of Disadvantaged Groups
        i. Tax Incentives
        ii. Direct Subsidies
        iii. Other Incentives
        iv. Cost Savings that Result from Electric Conversions

Methods of Instruction

Method

Group Projects

Integration

Students should be encouraged to plan and produce instructional aids such as a cutaway or disassembled system component display illustrating the operating principles of hybrid and electric vehicle subsystems, including the high-voltage drive system, the DC-to-DC converter and the hybrid drive power inverter while working together in small groups of 4-6 students.

Method

Homework

Integration

Reading assignments of 1-3 chapters per week from the required texts and the completion of multiple choice and essay questions taken from the end of the chapters. Topic include the five different types of hybrid and fully electric vehicle drivetrain layouts, the role of the Internal Combustion Engine (ICE) in the hybrid vehicle and the design and operational function of Nickel-Metal Hydride and Lithium Ion Batteries as well as emerging technologies such as Aluminum Oxide batteries.

Method

Lab Activities

Integration

Students should be guided and coached through basic maintenance and diagnostic procedures in a lab setting as members of small groups of 4-6 students. Activities include the procedures employed to safely disconnect the high-voltage battery packs when servicing the hybrid and electric vehicle and how to use a diagnostic scan tool to perform diagnostics on the hybrid electric and fully electric drive systems.

Method

Lecture

Integration

Present materials supported by accessible power-point and other forms of accessible audio-visual aids in order to compare and contrast different hybrid/electric vehicle operating systems and explain their component parts and theory of operation. For example, students will be asked to differentiate between mild hybrids, parallel hybrids, series hybrids, series-parallel hybrids and fully electric drivetrain layouts.

Method

Observation and Demonstration

Integration

Demonstrate the methods used to power down high voltage systems and verify that they are safe to service. Students will then be required to demonstrate the ability to properly perform these procedures themselves while under instructor observation.

Method

Online Activity/Discussion

Integration

Students will participate in the completion of online manufacturer training modules covering such topics as wiring conduit color identification and the differentiation between acceptable and unacceptable types of Personal Protective Equipment (PPE) and test equipment types that are suitable for high-voltage applications and those that are not.

Method

Directed Study

Integration

Students will be asked to research the resources available from federal, state and local sources that will make it possible for people who are members of disadvantaged groups to be able to afford to purchase hybrid or electric vehicles. These incentives include tax rebates, direct subsidies and financial incentives designed to allow everyone to participate in the utilization of environmentally friendly vehicles.

Methods of Evaluation

Method

Class Participation

Integration

Evaluation of student understanding of the concepts presented in class is based on an individual student's ability to correctly identify component parts and/or explain their purpose and theory of operation when questioned by the instructor; for example, students will be asked to differentiate between the low-voltage and high-voltage electrical systems and discuss the safety precautions to be taken with each of them. Responses will be evaluated according to their adherence to accepted manufacturer safety standards.

Method

Class Performance

Integration

Evaluation of student performance during lab activities is based on the individual student's ability to perform the task assigned on the lab worksheet according to industry standard and within the time allotted. For example, students will be asked to perform a live-dead-live test procedure to verify that the propulsion system is safe to service; this should be performed according to the procedures outlined in the published service information and completed within the period described by the published labor and time guide. Student performance will be evaluated according to their adherence to those standards.

Method

Exams/Tests

Integration

Midterm and final exams will be used to measure the student's understanding of the concepts covered during the lecture and lab sessions. For example, a question might ask the student to identify the method used to determine the presence of high voltage in an individual system and how much voltage is present. Student evaluation is based on a correct and complete response to the question.

Method

Final Performance

Integration

Students will be asked to diagnose a problem on a bugged vehicle using industry standard equipment. Evaluation will be based on the student's ability to make a correct diagnosis using a logical method in a reasonable period of time as compared to the procedure and time period allotted in the published service information for the vehicle being serviced.

Method

Oral Presentation

Integration

Five to ten minute oral presentations based on 1-3 page research papers will be given describing the types of incentives that are available to economically disadvantaged people who wish to own or utilize vehicles with environmentally friendly propulsion systems.

Method

Quizzes

Integration

Quizzes will be used to evaluate the student's understanding of the concepts presented in the textbook. The questions used in these quizzes are usually multiple-choice, short answer, or completion style questions.

Method

Research Projects

Integration

A research project will be assigned in which the students will have to clearly identify one of the many incentives available from government agencies at the federal, state and local level that allow people belonging to disadvantaged groups to benefit from the advantages of utilizing a vehicle with a clean-energy powertrain. The project will be assessed on how clearly the student can identify the steps required of individuals to participate in these programs.

Assignments

Assignment Type

Reading

In-class and/or outside of class

Outside of class

Formative or Summative

Formative

Assignment

Read a textbook chapter designed to advance your knowledge about the components and theory of operation of various sub-systems of a hybrid or fully electric drivetrain; these chapters will include information about the AC/DC Inverter System, the DC/DC Converter and describe how Electric Drive Motors are incorporated into the transmission or transaxle construction. You should be prepared to complete a quiz about the material in order to verify completion of the assignment and provide you with feedback about your understanding of the material.

Assignment Type

Other

In-class and/or outside of class

In-class

Formative or Summative

Summative

Assignment

Perform what is known in the automotive repair industry as a live-dead-live test to assure that the high-voltage system has indeed been powered down and the various high-voltage components on the vehicle are safe to service once the high=voltage system has been depowered. The live-dead-live test consists of these three parts: (1) you will measure the voltage present on one of the low-power test points on the vehicle to test the integrity of the meter you are using, and (2) you will locate and measure the amount of high-voltage potential present at the manufacturer's specified test point. Finally, (3) you will measure the low-power voltage with the same meter to make certain that the meter has not been damaged by unrecognized high-voltage--this verifies the trustworthiness of you high-voltage measurement.

Assignment Type

Writing

In-class and/or outside of class

In-class

Formative or Summative

Formative

Assignment

Prepare a repair order according the the standards demanded by the State of California's Bureau of Automotive Repair (BAR). The repair order will display required items of information about both the customer and the vehicle being inspected or repaired. The repair order will also include an information section in which the customer complaint or complaints will be summarized in a form

referred to in our industry as the "3Cs"--a brief summary of the customer complaint, a description of the cause of that complaint, and an explanation of the correction of that complaint. The assignment is intended to encourage students to utilize a logical process when performing diagnosis and repair of the hybrid drivetrain; is source of the customer complaint the result of a failure in the internal combustion engine or in the electric drive motor or motors? The assignment will be evaluated by how well it meets the BAR standards.

Assignment Type
Writing

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
Research and clearly describe how individuals or families who represent disadvantaged groups can take advantage of the financial incentives available from government agencies which are intended to allow everyone to utilize a vehicle with a clean-energy propulsion system.

Course Materials

Textbooks
Bennett, Sean (2024) Electric Vehicles: A Systems Approach, 1st Edition. Goodheart-Willcox. ISBN: 978-1-68584-267-3

Halderman, J. D. (2023) Hybrid and Electric Vehicles, 1st. Edition. Pearson. ISBN: 9780137532124

Class Size Information

Class Size
32

Class Size Category
G - Large lab 32

Diversity and Inclusion

Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.
The Department has made every effort to make the tools and equipment used to teach this course as user-friendly as possible; for example, a high-voltage trainer unit is used for the initial instruction on high-voltage safety procedures; while this unit actually does utilize circuitry with power levels of up to 400 volts for the sake of realism, the electrical current produced by these circuits is limited so that work performed on the trainer is as safe as possible. This precaution is intended to ease the difficulties and the level of intimidation that students without any previous experience with high voltage circuits might otherwise experience. Our intent is to make the course as accessible as possible to both traditional and non-traditional students alike

In addition, the Department has included assignments in which our students will have to identify the financial incentives that are available from government and other sources that are designed to make clean-energy vehicle ownership available to people who represent disadvantaged groups or groups who have traditionally been excluded from owning or operating electric or plug-in hybrid vehicles because of the expense that is involved in doing so.
Finally, the employment opportunities available to individuals trained to diagnose and repair hybrid or electric vehicles is presented as a regular part of the curriculum; the representation of different groups in this sector of the automotive repair industry is stressed; for example, the participation of individuals of color as automotive specialty technicians such as the ones being trained to repair clean-energy vehicles should mirror the ethnic composition of the general population.

Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.

The Automotive Department makes extensive use of training video presentations in delivering the content of all of our courses; there is a video module that discusses the types of hybrid and electric drivetrain arrangements used as a part of this course, for example, that is presented by an African-American engineer from the General Motors Company and several modules on safe hybrid lifting and servicing procedures that are presented by female technicians. Our intent is to incorporate this content into the presentation of the course so that every student will feel welcome and have a more comfortable learning experience.
In addition, the department utilizes a number of different types of instructional tools, including the aforementioned videos, PowerPoint presentations, and physical demonstrations performed in both the classroom and the laboratory setting; this combination is intended to accommodate students who possess different learning styles. Finally, the evaluation of the student's performance in the course is based on a diverse set of competency measurements ranging from online quizzes that usually allow students multiple attempts, to daily or weekly evaluation of student performance during laboratory exercises and a final performance evaluation wherever possible. A written final that is presented in the same style as the certification exams used by our industry is also administered, and the final grade for the course is based on a combination of all of these inputs; our intention is to be able to evaluate our student's abilities in the most equitable way possible while making accommodation for their ability to perform differently on a diverse group of evaluation methods.

Interactions

Explain how the course will incorporate student-to-student interaction.

Students are generally encouraged to work in teams of four or five individuals. The tasks that are required in order to successfully complete the course require a considerable amount of teamwork on the part of the students; the lab exercises required by the course can be performed on an actual vehicle or a specialized trainer, but either of these options requires the Automotive Department to provide some very expensive equipment. It is necessary to ask the students to work in teams as a result. We also need to keep in mind that this is a technology that is undergoing rapid change; often, one part of a team will have to be responsible for performing research about one of the hybrid or electric sub-systems while the other members of the team depend on them to supply vital information. For example, some of the team members may have to perform a high-voltage system disconnect; each vehicle manufacturer publishes its own procedure for doing this, and the proper procedure must be followed exactly in order to assure personal safety and avoid damaging the vehicle.

Explain how the course will incorporate instructor-to-student interaction.

The instructor will interact with the students in a number of different ways. The Instructor's primary responsibility is to explain the theory of operation governing the various hybrid and electric vehicle drive and other systems and identifying their components. The Automotive Department utilizes a combination of visual presentations, instruction using specialized automotive trainer units and actual demonstration of procedures including the high-voltage disconnect and the live-dead-live verification that the vehicle is safe to work on is carefully supervised from beginning to end since the health and safety of our students is our paramount concern. In addition, the instructor will act as a coach to either encourage the students when they are performing their work correctly or suggest that they use better methods when they are not; in this course, for example, one of the most valuable skills that students can possess is the ability to differentiate between equipment and personal protective equipment (PPE) that appears to be safe to use and PPE and equipment that is actually safe to use. Finally, the instructor will provide feedback about the cumulative value of student performance on lab exercises and final performance functions, such as the ability to differentiate between a customer complaint that is caused by a fault with the internal combustion engine versus one that has its source in the electric drive propulsion system.

Explain how the course will incorporate student-to-content interaction.

The course content is delivered in a progressive fashion--first, students are instructed to identify the component parts of a specific hybrid or electric drive system and asked to identify those components on a worksheet. After this is completed successfully, the theory of operation of that system will be discussed; the students will generally be asked to perform an experiment and complete a worksheet on one of our specialized automotive systems trainer units. That experiment will allow the students to practice and to improve their skills in applying the course content. Finally, students are generally asked to demonstrate their ability to perform system diagnosis and repair on an actual vehicle, which requires that they be able to apply the content of the course to an actual situation.

Explain how the course will incorporate student-to-self interaction (metacognitive).

One of the concepts that our students are introduced to is an eight-step process that is generally accepted as the industry standard for performing diagnosis and repair on modern vehicles. The eight steps include verification of a problem or complaint, performing a thorough visual inspection, using a diagnostic scan tool to retrieve any available diagnostic information and checking for any Technical Service Bulletins that the vehicle manufacturer might have issued concerning the fault in question. The student will then use the scan tool to look at specific data that would assist in the diagnosis or repair; that will help to narrow the problem down to a specific system or defective component. The last two steps are to repair the problem and verify that it has indeed been repaired. Periodically, students will be asked to reflect on how the procedures that they have employed align with the flow of that diagnostic process, and that will provide the metacognitive interaction.

Key: 400