

# Copper Mountain College - All Fields Course Report

## Cover

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**Course Number** 028

**Discipline(s)**

Automotive Technology

**Subject** AUTO

**Title** Introduction to Hybrid and Electric Vehicle Technology

**Description**

This course explores the use of Hybrid and Electric battery power for vehicle transportation. Topics will include safety when using high voltage, maintenance, drivability, inverter, DC/DC power transfer, and battery technology. Physics of battery storage, Hybrid generation systems, electric vehicle applications and their integrated systems from many manufacturers will be discussed. Hybrid and high voltage maintenance procedures will be covered. This course could be a preparation for the student to successfully complete the L3 ASE certification exam. The Light Duty Hybrid/Electric Vehicle Specialist (L3) is a new, advanced level certification geared toward technicians who perform diagnoses and repairs on hybrid/electric vehicles.

Students are advised that the Automobile Electrical/Electronic Systems (A6) and Engine Performance (A8) certifications are required to registered for the (L3) certification.

Has Enrollment Limitation

**Limitation Text**

**Is this a replacement course?** No

**Effective Semester** Fall

**Effective Year** 2017

## Hours/Units

### Units

**Total Units** 3.000

**Lecture Units** 2.000

**Lab Units** 1.000

### Weekly Hours

<b>Total Weekly Hours</b> 5.000
<b>Weekly Lecture Hours</b> 2.000
<b>Weekly Lab Hours</b> 3.000
<b>Semester Hours</b>
<b>SIUs</b> 4.000
<b>Grading Method</b>
<b>Grading Method</b> Letter Grade
<input checked="" type="checkbox"/> Recommend course for credit by examination?

### Student Learning Outcomes

**Enter one outcome at a time**

<b>Outcome Text</b> Demonstrate the precautions for personal and shop safety procedures needed to safely work on high voltage systems.
<b>Outcome Text</b> Demonstrate acquired knowledge related to the components used on modern Hybrid/Electric vehicles.
<b>Outcome Text</b> Demonstrate familiarity with reference materials such as wiring schematics, flow charts, logic trees, and workshop manuals to aid in battery system troubleshooting.
<b>Outcome Text</b> Demonstrate how to diagnose a basic hybrid or electric vehicle fault using standard diagnostic equipment.

### Requisites

**A minimum grade of "C" is implied.**

<b>Requisite Type</b> Prerequisite
<b>Subject</b> AUTO - Automotive Technology
<b>Requisite Course</b> AUTO 004 - Principles of Automotive Technology (Active)

**Requisite Comment**

The following student learning outcomes are necessary for students to be successful in this course: A) Understand the basic construction, function, operation, theory, and process for servicing, diagnosing, and/or repairing automobile components and/or systems: engine, lubricating and cooling, electrical, batteries, starting and charging, lighting, electrical instrumentation, electronic and computer systems, and electrical accessories, supplemental restraint systems (SRS), ignition, intake and exhaust, fuel delivery, emission control, clutches, transmissions and transaxles, drive axles and differentials, tires and wheels, suspension, steering, and brakes. B) Identify and properly use basic automotive tools and equipment. C) Apply appropriate shop safety practices.

**Condition**

**Requisite Type** Corequisite

**Subject** AUTO - Automotive Technology

**Requisite Course** AUTO 020 - Automotive Electrical Systems I (Active)

**Requisite Comment**

This course is required on the ALTF 100 C-ID course descriptor.

**Condition**

## Course Content

**Course Content****Specific Objectives (Formerly Known as Course Objectives)**

- a. Demonstrate the precautions for personal and shop safety procedures needed to safely work on high voltage systems.
- b. Demonstrate acquired knowledge related to the components used on modern Hybrid/Electric vehicles.
- c. Demonstrate familiarity with reference materials such as wiring schematics, flow charts, logic trees, and workshop manuals to aid in battery system troubleshooting.
- d. Demonstrate how to diagnose a basic hybrid or electric vehicle fault using standard diagnostic equipment.

**Lecture Content**

## Lecture.

- i. Working safely with High-Voltage.
  1. National Fire Protection Association (NFPA), and SAE high voltage standards.
  2. High-voltage safety.
  3. High-voltage safety equipment.
  4. De-powering the high-voltage system.
  5. Moving and towing a HEV.
  6. Removing high-voltage batteries.
- ii. Main service plug disconnects.
- iii. Drive Systems.
  1. Hybrid/EV drive systems.
  2. Design.
  3. Operation.
- iv. Regenerative Braking (electrical energy recovery).
  1. Principles of operation.
  2. Types of regenerative braking.
  3. Regenerative braking systems.
- v. Hybrid batteries and battery service.
  1. Lead-acid batteries.
  2. Nickel-cadmium.
  3. Nickel-metal hydride.
  4. Lithium-ion.
  5. Lithium-polymer.
  6. Sodium-metal-chloride.
  7. Battery ratings.
  8. HV battery construction, cooling, and service.
  9. SAE J1772 electric vehicle plug.
  10. Level 1, 2 and 3 charging stations.
- vi. Power Management Systems.
  1. Boost converters.
- vii. System monitoring sensors.
  1. Resolvers.
  2. Encoders.
  3. Proximity commutation.
  4. Current sensors.
  5. Accelerator pedal position.
  6. Throttle position.
  7. Other miscellaneous inputs.
- viii. Wiring.
- ix. Cables and harnesses.
- x. Hybrid controllers and inverters.
  1. Power inverters.
  2. Motor control.
- xi. High-voltage air conditioning compressors.
  1. Hybrid cooling system components.
  2. Cabin heating systems.
  3. Hybrid air-conditioning systems.

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**Lab Content**

**Lab.**

- i. High-voltage safety demonstration.
- ii. Properly powering down system and verification with meter. (Hybrid vehicle high-voltage circuit disconnect).
- iii. HEV engine features.
- iv. Hybrid vehicle ICE service precautions.
- v. Service procedures associated with hybrid/high-voltage technology.
- vi. Connect and observe hybrid/electric vehicle scan tool data.
- vii. Inverter operation.
- viii. DC/DC operation.
- ix. AC to DC charging conversions.
- x. Electric power steering.
- xi. Electric braking.
- xii. Regenerative energy collection.
- xiii. Hybrid battery identification.
- xiv. Hybrid vehicle auxiliary battery.
- xv. Hybrid traction motor identification.
- xvi. Regenerative braking system component ID.
- xvii. Hybrid transmission identification.
- xviii. Hybrid vehicle A/C system precautions.
- xix. High-voltage circuits identification.
- xx. Identify high-voltage of HEVs.
- xxi. High-voltage circuits identification.

## Methods of Instruction

### Instruction Method

**Instruction Type** Integrated lecture/lab

### Method Of Instruction to SLO Map

Demonstrate the precautions for personal and shop safety procedures needed to safely work on high voltage systems. Demonstrate acquired knowledge related to the components used on modern Hybrid/Electric vehicles. Demonstrate familiarity with reference materials such as wiring schematics, flow charts, logic trees, and workshop manuals to aid in battery system troubleshooting. Demonstrate how to diagnose a basic hybrid or electric vehicle fault using standard diagnostic equipment.

## Assignments

### Assignments

**List samples of activities students are expected to complete outside of class/lab time.**

- a. Assigned reading materials.
- b. Workbook assignments.
- c. Completion of hands-on laboratory worksheets.
- d. Course notebook as defined in syllabus.
- e. Assigned student project.

## Methods of Evaluation

Describe how you will evaluate students, the basis for grading and how this is tied to the student learning outcomes. You must show that the grade is partially based on either proficiency in the form of writing or problem solving ability.

**Evaluation Method**

**Evaluation Method** Exams

**If you selected "Other", please provide details.**

Quizzes and exams.

**Evaluation Method** Skills Demonstration

**If you selected "Other", please provide details.**

Students' demonstrations and completion of assigned lab tasks to assess practical application of knowledge and skills.

**Evaluation Method** Research Paper/Project

**If you selected "Other", please provide details.**

Project completion.

**Evaluation Method** Lab Reports

**If you selected "Other", please provide details.**

Class participation; individual and group work assignments.

**Textbooks/Learning Materials**

List in APA or MLA format. (Please list more than one, if possible, in each applicable section. Materials should be current, i.e., published not more than seven years. However, some disciplines may require text content currency, e.g. Computer Science, Criminal Justice, Fire, etc. If a textbook is not within the currency guidelines, a brief explanation should be included.)

a. Specify the material/s (reading level must be 13 or above, except for basic skills courses).

b. Required for Science courses: Specify the lab manual (reading level must be 13 or above, except for basic skills courses).

**Textbook**

Author	Title	Publisher	Publication Location	Publication Date	Rational
Halderman, J.	Hybrid and alternative fuel vehicles	Prentice Hall	NY, NY	2016	relevant content
Automotive research and design	Hybrid electric vehicle technology	American Technical Publishers, Inc.	Orland Park, IL.	2003	relevant content
Erjavec, J.	Hybrid, electric & fuel cell vehicles	Delmar	Clifton Park, NY	2013	relevant content
Lowry, J.	Electric vehicle technology explained	John Wiley & Sons Ltd,	The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England	2001	relevant content

**Software**

Title	Edition	Publisher	Description
If student is required to purchase materials additional to the text, list the materials and their respective fee here. This information must also be included in the course syllabus.			
<b>Additional Materials</b>			
Required	Material	Cost	

## Distance Education

<input type="checkbox"/> Has DE Modality
<b>B-Both, H-Hybrid Only</b>
<input checked="" type="checkbox"/> Proposed For Distance Education
<b>Distance Education</b>
<b>Request Online Modality</b> Hybrid
<b>Comments</b> The lab portion of the course will be offered face-to-face while the lecture part of the course may be offered in a distance education format.
<b>Special instructions for faculty</b>
<b>Special instructions for students to be printed in the schedule</b> The lab portion of the course will be offered face-to-face while the lecture part of the course may be offered in a distance education format.
Special Instructions to Academic Affairs Office:
<input checked="" type="checkbox"/> Contact faculty initiator regarding meeting dates to be printed (for hybrid).
<input checked="" type="checkbox"/> Create the course shell in the Learning Management System.
<input type="checkbox"/> Other:
<b>Other Explain:</b>
Indicate additional instructional materials and resources necessary for distance education.
<input type="checkbox"/> Virtual textbook or instructional materials:
<b>Explain:</b>
<input type="checkbox"/> Other:
<b>Other Explain:</b>

What is the intent in offering the course as distance education?
<input checked="" type="checkbox"/> To provide flexible opportunities for our students to reach their education goals.
<input type="checkbox"/> Other
<b>Other Explain:</b>
How will student learning outcomes be consistent with the F2F course? Please explain and provide examples.
<input checked="" type="checkbox"/> The student learning outcomes will be the same.
<input type="checkbox"/> Other:
<b>Other Explain:</b>
<input checked="" type="checkbox"/> Will this Distance Education class comply with federal laws regarding accommodation for students with disabilities?
**If not selected then this course cannot be approved for Distance Education**

## DE Contact Types

Specify how the design of this course will meet the requirements of CMC's Regular and Effective Contact Policy, State requirements, and accreditation requirements. The CMC policy is available on our website at:
<a href="http://www.cmccd.edu/Faculty-Resources-Documents">http://www.cmccd.edu/Faculty-Resources-Documents</a>
<b>Distance Education Regular and Effective Contact</b>
<b>Contact Type</b> Instructor will provide a clearly identified open discussion forum for students to ask the instructor content related questions. Instructions will include expected response time from the instructor.
<b>Percentage</b>
<b>Description</b>
<b>Contact Type</b> Instructor must provide specific discussion forum activities which solicit the level of student understanding. The instructor will participate with comments and/or summary of student comments.
<b>Percentage</b>
<b>Description</b>
<b>Contact Type</b> Instructor will post regular announcements.
<b>Percentage</b>



<b>Description</b>	
<b>Contact Type</b>	Instructor will provide regular feedback on student performance commensurate to the length of time required for a f2f course.
<b>Percentage</b>	
<b>Description</b>	
<b>Contact Type</b>	Instructor will regularly initiate interaction with students to determine that they are accessing and comprehending course material.
<b>Percentage</b>	
<b>Description</b>	
<b>Contact Type</b>	Instructor will use available technologies/resources to initiate course related user interactions.
<b>Percentage</b>	
<b>Description</b>	

### Cross Listed

**Related**

**Equivalent Course**

### General Education Status

Course has been approved for CSU GE

**Area/#**

Request that the CMC Articulation Officer submit the course for:

**CSU Area/#**

**If Yes, List 3 Similar Courses in this CSU area- Documentation attached.**

Course has been approved for IGETC:

**IGETC Area/#**

<input type="checkbox"/> Request that the CMC Articulation Officer submit the course for:
<b>IGETC Area/#</b>
<b>If Yes, List 3 Similar Courses from this IGETC Area- Documentation attached.</b>
<input type="checkbox"/> Course Approved for CMC GE:
<b>Area/#</b>
<input type="checkbox"/> Request that Course be Approved for CMC GE:
<b>Area/#</b>

<b>Course Transfer Status</b>
<b>Course Transfer Info</b>
<input type="checkbox"/> Request that course be designated as transferable to CSU
<input type="checkbox"/> Request that CMC Articulation Officer submit the course for UC transfer
<b>Request C-ID Submission</b>
<b>List 3 Similar Courses from UC Area</b>
<b>Transferable prior to separation from College of the Desert</b>
<input type="checkbox"/> Transferable to CSU prior to the separation from College of the Desert
<b>Or Approval Date</b>
<input type="checkbox"/> Transferable to UC prior to the separation from College of the Desert
<b>Or Approval Date</b>

<b>Program Impact</b>
<input checked="" type="checkbox"/> Are you requesting this course be added to an existing Program (major)?
If Yes, then see Program assistant for Curriculum to revise Program Documents.

If No, then answer the question below.

Does this course revision require that the changes are made to the program(s) in which it is part?

If Yes, then see Program Assistant for Curriculum to revise Program Documents.

### Stand-Alone Course Approval

**Is the course part of a Chancellor's Office approved program, recommended for inclusion in any general education pattern, or part of a program pending submission to the Chancellor's Office?** Yes

**What is the program name/GE pattern?**  
Associate in Science Degree in Automotive Technology.

If the answer is yes, the course is not a stand-alone and does not require any special approval.

**If no, are there more than 18 units in the same 4 digit TOP code linked together by prerequisites or co-requisites?**  
(If yes, this course cannot be approved.)

### Codes/Dates

**Special Dates**

**CSU GE Approval**

**Approved for CSU GE:**

**CSU GE Area Applied On:**

**Approved for IGETC:**

**IGETC Area Applied On:**

**Approved for CMC GE:**

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**[G101] College ID** - 971

**[CB00] CCCCCO Control ID**

**[CB01] Course ID** AUTO XX

**[CB02] Course Title** Introduction to Hybrid and Electric Vehicle Technology

**[CB03] T.O.P. Code** 094840 - Alternative Fuels and Advanced Transportation Technology

**[CB04] Credit Status** Degree Credit

**[CB05] Transfer Status** C - Not transferable

**[CB06] Max Credit** 3.000

<b>[CB07] Min Credit</b> 3.000
<b>[CB08] Basic Skills Status</b> N - Course is not a basic skills course.
<b>[CB09] Vocational Status</b> Clearly Occupational
<b>[CB10] Co-op Ed</b> N - Is not part of a cooperative work experience education program.
<b>[CB11] Course Classification</b> Y - Credit Course.
<b>[CB12] Repeatability</b> 0 - May be repeated zero times.
<b>[CB13] Course Special Status</b> N - Course is not a special class.
<b>[CB21] Course Prior to College Level</b> Y - Not applicable
<b>[CB22] Course Noncredit Category</b> Y - Not Applicable, Credit course
<b>[CB23] Funding Agency Category</b> Y - Not Applicable
<b>[CB24] Program Status</b> PA - 1 - Program Applicable

## ASSIST

<input type="checkbox"/> Queue for Assist
<b>Last Request From Queue</b>
<b>Last Direct Request</b>

## ASSIST Preview

<b>Prefix</b> AUTO
<b>Course Number</b> 028
<b>Objectives</b> <ul style="list-style-type: none"> <li>a. Demonstrate the precautions for personal and shop safety procedures needed to safely work on high voltage systems.</li> <li>b. Demonstrate acquired knowledge related to the components used on modern Hybrid/Electric vehicles.</li> <li>c. Demonstrate familiarity with reference materials such as wiring schematics, flow charts, logic trees, and workshop manuals to aid in battery system troubleshooting.</li> <li>d. Demonstrate how to diagnose a basic hybrid or electric vehicle fault using standard diagnostic equipment.</li> </ul>
<b>Content</b>

## Lecture.

- i. Working safely with High-Voltage.
  - 1. National Fire Protection Association (NFPA), and SAE high voltage standards.
  - 2. High-voltage safety.
  - 3. High-voltage safety equipment.
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  - 5. Moving and towing a HEV.
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  - 1. Hybrid/EV drive systems.
  - 2. Design.
  - 3. Operation.
- iv. Regenerative Braking (electrical energy recovery).
  - 1. Principles of operation.
  - 2. Types of regenerative braking.
  - 3. Regenerative braking systems.
- v. Hybrid batteries and battery service.
  - 1. Lead-acid batteries.
  - 2. Nickel-cadmium.
  - 3. Nickel-metal hydride.
  - 4. Lithium-ion.
  - 5. Lithium-polymer.
  - 6. Sodium-metal-chloride.
  - 7. Battery ratings.
  - 8. HV battery construction, cooling, and service.
  - 9. SAE J1772 electric vehicle plug.
  - 10. Level 1, 2 and 3 charging stations.
- vi. Power Management Systems.
  - 1. Boost converters.
- vii. System monitoring sensors.
  - 1. Resolvers.
  - 2. Encoders.
  - 3. Proximity commutation.
  - 4. Current sensors.
  - 5. Accelerator pedal position.
  - 6. Throttle position.
  - 7. Other miscellaneous inputs.
- viii. Wiring.
- ix. Cables and harnesses.
- x. Hybrid controllers and inverters.
  - 1. Power inverters.
  - 2. Motor control.
- xi. High-voltage air conditioning compressors.
  - 1. Hybrid cooling system components.
  - 2. Cabin heating systems.
  - 3. Hybrid air-conditioning systems.

**Lab Content**

**Lab.**

- i. High-voltage safety demonstration.
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- xv. Hybrid traction motor identification.
- xvi. Regenerative braking system component ID.
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- xix. High-voltage circuits identification.
- xx. Identify high-voltage of HEVs.
- xxi. High-voltage circuits identification.

**Assignments**

- a. Assigned reading materials.
- b. Workbook assignments.
- c. Completion of hands-on laboratory worksheets.
- d. Course notebook as defined in syllabus.
- e. Assigned student project.

**Course Description**

This course explores the use of Hybrid and Electric battery power for vehicle transportation. Topics will include safety when using high voltage, maintenance, drivability, inverter, DC/DC power transfer, and battery technology. Physics of battery storage, Hybrid generation systems, electric vehicle applications and their integrated systems from many manufacturers will be discussed. Hybrid and high voltage maintenance procedures will be covered. This course could be a preparation for the student to successfully complete the L3 ASE certification exam. The Light Duty Hybrid/Electric Vehicle Specialist (L3) is a new, advanced level certification geared toward technicians who perform diagnoses and repairs on hybrid/electric vehicles. Students are advised that the Automobile Electrical/Electronic Systems (A6) and Engine Performance (A8) certifications are required to registered for the (L3) certification.

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