

# AUTO 282: ELECTRIFIED POWERTRAIN VEHICLES

## Citrus College Course Outline of Record

Heading	Value
Effective Term:	Fall 2024
Credits:	4
Total Contact Hours:	108
Lecture Hours :	54
Lab Hours:	54
Hours Arranged:	0
Outside of Class Hours:	108
Total Student Learning Hours:	216
Prerequisite:	AUTO 148 or AUTO 168 or MTRK 159, or one year of automotive or heavy-truck or heavy-equipment industry experience with department consent.
Strongly Recommended:	ENGL 101; MATH 144.
Transferable to CSU:	Yes
Transferable to UC:	No
Grading Method:	Standard Letter, Pass/No Pass

## Catalog Course Description

Intended for the incumbent worker, re-entry person or person seeking a career advancement in the automotive service industry. This course covers the service and diagnosis of hybrid and electric vehicle powertrains, including motor/generator, batteries, inverters and charging system. This course is also a requirement of the T-TEN program. 54 lecture hours, 54 lab hours.

## Course Objectives

- Observe safety precautions when working around high voltage and mechanical system.
- Proper selection of personal protective equipment and test equipment.
- Test, diagnose and repair hybrid Internal Combustion Engine control systems.
- Test, diagnose and repair high voltage battery pack internal components.
- Test, diagnose and repair, hybrid and electric vehicle motor/generator systems.
- Test, diagnose and repair hybrid and electric vehicle inverter units.
- Test, diagnose and repair plug-in hybrid and electric vehicle external charging systems.

## Major Course Content

1. Introduction to hybrid and electric vehicles
  - a. History of alternative energy
  - b. Basics of electric vehicles
  - c. Hybrid/Electric propulsion systems
    - i. Mild and assist hybrids
    - ii. Full hybrids

- iii. Series hybrid
  - iv. Parallel hybrid
  - v. Series -parallel hybrid
  - vi. Plug in hybrids
  - vii. Battery electric
2. Electrical Review
    - a. Electrical Terms
    - b. Conductors and Insulators
    - c. Circuit Components
    - d. Electromagnetism
    - e. Safety
      - i. Proper safety gloves selection.
      - ii. Select, qualify and use proper electrical testing equipment and leads.
  3. Battery System
    - a. Battery chemistry and characteristics.
    - b. High voltage disconnect procedure; reconnect/enable high voltage system.
    - c. Battery Diagnostic Trouble codes
    - d. Problems caused by damaged or failed harnesses, connectors, terminals and fuses.
    - e. High voltage (HV) battery pack malfunctions.
    - f. High voltage leaks/loss of isolation.
    - g. Battery pack heating and cooling systems.
    - h. High voltage battery pack internal components.
      - i. Charging problems when using electric vehicle supply equipment (EVSE).
  4. Internal Combustion Engine
    - a. Hybrid Engine Diagnostic Trouble Codes
    - b. Internal combustion engine (ICE) is in CRANK mode or RUN mode.
    - c. Driveability problems caused by the internal combustion engine and/or hybrid drive system.
    - d. Internal combustion engine testing
      - i. Internal combustion engine cranking compression test.
      - ii. Internal combustion engine running during service.
      - iii. Internal combustion engine no-crank condition.
      - iv. Internal combustion engine cranks/no-start condition.
      - v. Vacuum and compression readings on Atkinson cycle engines.
    - e. Engine start/stop strategy; diagnose malfunctions.
    - f. Engine cooling system.
  5. Drive Systems
    - a. Motor/Generator component and operation
    - b. Motor-rotor position sensor (Resolver or Encoder type).
    - c. High voltage disconnect procedure; reconnect/enable high voltage system.
    - d. Motor/Generator Diagnostic Trouble Codes
    - e. Problems caused by damaged or failed harnesses, connectors, and terminals.
    - f. High voltage leaks/loss of isolation.
    - g. Electrically actuated parking pawl operation; determine needed repair.
    - h. Transmission fluid and coolant fluid requirements; verify fluid levels.

## 6. Power Electronics

- a. Diagnose the cause of a hybrid system warning displayed on the instrument panel and/or a driveability complaint.
- b. Impact sensor problems
- c. AC/DC inverter overheating.
- d. AC/DC inverter failure
- e. AC/DC inverter cooling pump.
- f. Voltage level of capacitors.
- g. Safely disable/enable safety interlocks.
- h. DC/DC converter
- i. High voltage cable integrity and loss of isolation.
- j. 12-volt battery testing.
- k. System main relay (SMR)/contactor malfunctions;

## 7. Hybrid Supporting Systems

- a. Interpret driver indicators, power flow display and energy monitor; determine necessary action.
- b. High voltage air conditioning compressor
- c. High voltage air conditioning compressor; identify and select proper system oil.
- d. Cabin heating system performance problems;
- e. Electric/electronic steering systems.
- f. Brake system performance problems; differentiate between braking problems caused by hydraulic system and regenerative system malfunctions
- g. Deactivate brake system self-test prior to service.
- h. Service liquid cooling system(s).

- a. Retrieve and diagnose DTCs; determine needed repairs

- b. Determine if the internal combustion engine (ICE) is in CRANK mode or RUN mode.
- c. Differentiate between driveability problems caused by the internal combustion engine and/or hybrid drive system.
- d. Perform internal combustion engine cranking compression test.
- e. Keep the internal combustion engine running during service.
- f. Diagnose internal combustion engine no-crank condition.
- g. Diagnose internal combustion engine cranks/no-start condition.
- h. Interpret vacuum and compression readings on Atkinson cycle engines.
- i. Identify engine start/stop strategy; diagnose malfunctions.
- j. Service engine cooling system.

## 5. Drive Systems

- a. Retrieve and diagnose driveline DTCs; determine needed repairs.
- b. Diagnose problems caused by damaged or failed harnesses, connectors, and terminals.
- c. Test, diagnose and repair high voltage leaks/loss of isolation.
- d. Remove and install rotor from stator.
- e. Diagnose motor-rotor position sensor (Resolver or Encoder type).
- f. Diagnose drive/traction motor-generator assembly for improper operation (such as an inoperative condition, noise, shudder, overheating, etc.).
- g. Diagnose improper electrically actuated parking pawl operation; determine needed repair.
- h. Identify transmission fluid and coolant fluid requirements; verify fluid levels.

## 6. Power Electronics

- a. Retrieve and diagnose DTCs; determine needed repairs.
- b. Diagnose problems caused by damaged or failed harnesses, connectors, and terminals.
- c. Identify procedures necessary to establish the proper vehicle operational power mode during service (OFF, ACCESSORY, POWER ON, READY TO DRIVE).
- d. Diagnose the cause of a hybrid system warning displayed on the instrument panel and/or a driveability complaint.
- e. Diagnose impact sensor problems; determine needed repair.
- f. Diagnose AC/DC inverter overheating; determine needed repair.
- g. Diagnose AC/DC inverter failure; determine needed repair.
- h. Replace AC/DC inverter cooling pump.
- i. Remove and install AC/DC inverter.
- j. Diagnose failures in the data communications bus network; determine needed repair.
- k. Locate and test the voltage level of capacitors.
- l. Diagnose, locate and safely disable/enable safety interlocks.
- m. Diagnose failed DC/DC converter; determine needed repair.
- n. Remove and install DC/DC converter.
- o. Test high voltage cable integrity and loss of isolation.
- p. Perform 12-volt battery testing.
- q. Diagnose system main relay (SMR)/contactor malfunctions; determine needed repairs.

## 7. Hybrid Supporting Systems

- a. Diagnose problems caused by damaged or failed harnesses, connectors, and terminals.
- b. Retrieve and diagnose DTCs; determine needed repairs.

## Lab Content

## 1. Safety

- a. Perform high voltage disconnect procedure; reconnect/enable high voltage system.
- b. Select, test and use proper safety gloves.
- c. Select, qualify and use proper electrical testing equipment and leads.

## 2. Electrical Review

- a. Electrical Terms
- b. Conductors and Insulators
- c. Circuit Components
- d. Electromagnetism

## 3. Battery System

- a. Retrieve and diagnose DTCs; determine needed repairs.
- b. Diagnose problems caused by damaged or failed harnesses, connectors, terminals and fuses.
- c. Diagnose high voltage (HV) battery pack malfunctions.
- d. Remove and install high voltage battery pack.
- e. Test, diagnose and repair high voltage leaks/loss of isolation.
- f. Test, diagnose and repair high voltage battery pack heating and cooling systems.
- g. Test, diagnose, repair or replace high voltage battery pack internal components.
- h. Test and diagnose charging problems when using electric vehicle supply equipment (EVSE).

## 4. Internal Combustion Engine

- c. Observe and interpret driver indicators, power flow display and energy monitor; determine necessary action.
- d. Test and diagnose high voltage air conditioning compressor malfunctions; diagnose system problems; determine needed repairs.
- e. Remove and install high voltage air conditioning compressor; identify and select proper system oil.
- f. Diagnose cabin heating system performance problems; determine needed repairs.
- g. Diagnose and repair electric/electronic steering systems.
- h. Diagnose brake system performance problems; differentiate between braking problems caused by hydraulic system and regenerative system malfunctions; determine needed repairs.
- i. Deactivate brake system self-test prior to service.
- j. Service liquid cooling system(s).

## **Suggested Reading Other Than Required Textbook**

Vehicle Manufacturer's Technician Handbook and on-line repair manuals.

## **Examples of Required Writing Assignments**

Summary of Society of Automobile Engineers (SAE ) white papers.

## **Examples of Outside Assignments**

Technical journal articles covering advances in vehicle electrification and hybrid technology.

## **Instruction Type(s)**

Lab, Lecture