

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).
5. Drive Systems
 - 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.

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
 - 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.
5. Power Electronics
 - a. Retrieve and diagnose 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.

- 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 Manufacture'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