

4-Unit Course – Advanced Electric Vehicle Diagnosis and Repair

INTRODUCTION

Battery electric vehicle (BEV) training has become an absolute necessity into today's automotive world. With the rapid proliferation of electric vehicles in use today, automotive dealerships have sounded an alarm stating there is a shortage of qualified BEV technicians. To that end, this course has been designed to provide basic BEV training for students desiring to advance their career opportunities. Although this course includes most of the basic concepts, additional dealership training will fine-tune the technician's expertise in the specific manufacturer's platforms.

Moreover, to accommodate workforce development programs, this 4-unit course has been created using stackable 1-unit courses to provide flexibility for working technicians and college campuses that plan to teach this technology. Each unit requires 36 hours of instruction consisting of 9 hours of lecture and 27 hours of laboratory training and testing.

PREREQUISITE

This 4-unit course requires students to access, test, and diagnose high-voltage battery systems which pose a safety hazard without the proper training. Therefore, a pre-requisite for this course has been created which is the 40-hour introduction to battery electric vehicles. The introductory course reviews a variety of topics but focuses on ohms law and high-voltage safety procedures to ensure a safe working environment. Unlike today's 12-volt electrical systems which cannot electrocute a technician, the high voltage systems can be lethal if improperly handled. A detailed list of the prerequisite is as follows:

- ◆ Introduction and History
- ◆ Safety and Tools
- ◆ Electrical Overview
- ◆ Electrical Trainer Labs
- ◆ Batteries
- ◆ Voltage Conversion
- ◆ Motors
- ◆ Motors Quiz
- ◆ Maintenance

- ◆ Milli-ohmmeter Lab
- ◆ Transmission and Braking
- ◆ Final Exam

COURSE GOAL

Completion of this course provides students with the skill sets required to test, diagnose, and repair battery electric vehicles systems and obtain employment at a new car dealership that services electric vehicles. Students will also become competent in the use of new equipment required for BEV technology and will gain confidence to safely diagnose and repair electrical and drivability problems with these highly evolved electric vehicles.

COURSE CONTENT AND DEVELOPMENT

The 4-unit course content was developed in cooperation with Valley CAN and 8 automotive instructors from California Community Colleges. The goal was to identify the most important areas of BEV service and repair required for students to obtain employment as BEV technicians. Although other content areas are available in BEVs, we focused on the most important and common areas of BEV service and repair. The course content is in the early stages of development and Bakersfield College staff has been charged with its development. The course provides basic instruction for the electric vehicle technicians in four primary areas which are categorized follows:

- ◆ Electric vehicle powerplants and generators.
- ◆ High and low voltage battery systems.
- ◆ Inverters, converters and charging systems.
- ◆ Isolation and temperature controls systems.

CONTENT DETAILS

The following provides additional detail for each of the content areas:

Module 1 - Diagnose and repair a powerplants/generators.

- Theory and operation of DC motors.
- Theory and operation of AC motors.
- Pros and cons of AC vs DC current.
- Theory and operation of generators.
- Regeneration theory.
- Theory and operation.
- Use of insulation testers to diagnose motor insulation deterioration.
- Use of milli-ohmmeter resistance faults in motors/generators.
- Diagnose and repair regeneration faults.

Module 2 - Diagnose and repair high-voltage battery and low-voltage faults.

- Theory and diagnosis of high and low voltage battery systems.
- Testing high and low-voltage batteries.
- Use of scan data to assess high-voltage battery state.
- Removal and installation of high-voltage batteries.

Module 3 - Diagnose and repair inverter/converter faults and EV charging faults.

- Theory and operation of inverters.
- Theory and operation of converters.
- Proper discharging techniques for converters.
- Diagnosis of converter/inverter safety circuits.
- Diagnosis and repair/replacement of inverters and converters.
- Theory and diagnosis of high and low-voltage battery charging systems.
- Repair/replacement of high and low-voltage battery charging systems.

Module 4 - Diagnose and repair isolation faults and temperature control faults – both liquid and air-cooling systems.

- Theory of circuit isolation systems which isolates the high-voltage system from the low-voltage system.
- Diagnosis techniques for locating the source of isolation faults.

- Importance of battery temperature control using both air conditioning and coolant system.
- Impact of heat and cold on batteries.
- Diagnosis and repair of air conditioning and coolant systems required for battery temperature control.

COMPETENCY

Although competency is important for any automotive course, the introduction of high-voltage systems amplify the need since a lack of competency with these systems can cause severe injury or death. Students will demonstrate competency through the successful completion of both written exams and labs exercises for each module. Any student failing to pass the competency tests will receive additional instruction and the opportunity to retest.