

I. Catalog description

A. Course description

This course introduces students to the role, function, and practical application of alternative fuels for the internal combustion engine. Alternative fuels explored in class and lab include compressed natural gas (CNG), liquefied natural gas (LNG), propane, alcohol (ethanol and methanol), hydrogen, and biodiesel. Fuel cell, hybrid, and electric vehicles will also be explored.

B. Class hours: 3.0 lecture / 1.5 laboratory (54 lecture / 27 laboratory)

Units: 3.5

C. Prerequisite: None

Corequisite: None

D. Recommendation: None

II. Texts and other instructional materials

A. Required texts:

1. Ramadhas, Arumugam. S. *Alternative Fuels for Transportation (Mechanical and Aerospace Engineering Series)*, Boca Raton, FL: CRC Press, 2010.
2. Ogden, Joan M., Robert H. Williams, and Eric D. Larson. *Societal lifecycle costs of cars with alternative fuels/engines*, Energy Policy, 32 (2004), 7-27. <http://libraryguides.cerritos.edu/databases>.
3. Pascoli, Stefano Di, Aldo Femia, and Tommaso Luzzati. *Natural gas, cars and the environment. A (relatively) 'clean' and cheap fuel looking for users*, Ecological Economics, 38 (2001), 179-189. <http://libraryguides.cerritos.edu/databases>.
4. Yeh, Sonia. *An empirical analysis on the adoption of alternative fuel vehicles: The case of natural gas vehicles*, Energy Policy, 35 (2007), 5865-5875. <http://libraryguides.cerritos.edu/databases>.
5. Das, L. M., Rohit Gulati, and P. K. Gupta. *A comparative evaluation of the performance characteristics of a spark ignition engine using hydrogen and compressed natural gas as alternative fuels*, International Journal of Hydrogen Energy, 25 (2000), 783-793. <http://libraryguides.cerritos.edu/databases>.
6. U.S Department of Energy, *Biodiesel Handling and Use Guide*, 5th ed., 2016, https://www.afdc.energy.gov/uploads/publication/biodiesel_handling_use_guide.pdf

B. References:

Lee, Sunggyu, James G. Speight, and Sudarshan K. Loyalka. *Handbook of Alternative Fuel Technologies*, Boca Raton, FL: CRC Press, 2007.

C. Required materials:

Safety glasses

III. Course content

Lecture

- A. General automotive safety
- B. Fuel safety procedures
- C. Design and operation of internal combustion engine
- D. Origin, properties, and chemical structure of natural gas and hydrogen
- E. Origin, properties, and chemical structure of alcohol, ethanol, and methanol
- F. Origin, properties, and chemical structure of propane and biodiesel
- G. Operation and function of high pressure fuels in vehicles
- H. Design and function of fuel storage systems
- I. Exhaust emissions produced by different fuels
- J. Fuel delivery systems
- K. Electrical systems used in fuel delivery systems
- L. Installation procedures
- M. Maintenance procedures
- N. Diagnosis of different fuel system faults
- O. Comparative analysis of different fuel system faults
- P. Fuel handling regulations
- Q. Refilling procedures
- R. Electric vehicle battery design
- S. Electric and hybrid vehicle charging stations
- T. Hybrid vehicle transaxle design and operation
- U. Renewal biodiesel

Lab

- A. General automotive safety
- B. Fuel safety procedures
- C. Design and operation of internal combustion engine
- D. Design and function of fuel storage systems
- E. Exhaust emissions produced by different fuels
- F. Fuel delivery systems
- G. Electrical systems used in fuel delivery systems
- H. Installation procedures
- I. Maintenance procedures
- J. Diagnosis of different fuel system faults
- K. Comparative analysis of different fuel system faults
- L. Fuel handling regulations: gasoline, ethanol, diesel, hydrogen, and compressed natural gas (CNG)
- M. Refilling procedures for CNG vehicles
- N. Electric and hybrid charging station
- O. Hybrid vehicle transaxle operation
- P. Electric vehicle inspection

IV. Course objectives

- A. Identify hazardous materials in the automotive shop and their proper handling

- B. Identify fuel handling and safety procedures
 - C. Locate the material safety data sheets (MSDS) for common automotive chemicals
 - D. Identify and properly use personal equipment
 - E. Identify the proper fire extinguisher for the type of fire
 - F. Define automotive fuel systems and components
 - G. Define CNG and liquid natural gas (LNG) systems and components
 - H. Define hydrogen fuel system and components
 - I. Define alcohol, ethanol, and methanol systems and components
 - J. Define propane and biodiesel systems and components
 - K. Describe the operating principles of different fuel systems
 - L. Understand the safety protocol as applicable to different fuel systems
 - M. Provide the generally accepted dangers of alternative fuels
 - N. Develop skills in recognizing which OSHA standards apply to fuel delivery systems
 - O. Explain the operating principles of each alternative fuel
 - P. Examine natural gas pressures at various stages in CNG/LNG system
 - Q. Examine biodiesel pressures at various stages in the system
 - R. Determine accurate and appropriate fuel system pressures
 - S. Identify and select the appropriate alternative fuel system components
 - T. Define potential problems and their solutions when trouble-shooting alternative fuel systems
 - U. Relate how atmospheric pressure and temperature affect performance
 - V. Comprehend the difference between dedicated bi-fuel and dual fuel systems
 - W. Define renewable biodiesel
 - X. Identify principles of regulators and mixers
 - Y. Define closed and open loop systems
 - Z. Explain basic ignition and timing systems
 - AA. Interpret emission testing and decipher test data
 - BB. Read and decipher general trouble-shooting flowcharts
 - CC. Explain general maintenance procedures
 - DD. Find service information in automotive databases
 - EE. Comprehend fitting and tube bending techniques
 - FF. Identify fuel tank damage and determine necessary action
 - GG. Explain proper electric and hybrid vehicle charging procedures
 - HH. Locate the emergency cutoff switch for electric and hybrid vehicles
 - II. Locate the emergency cutoff switch for CNG vehicles
- V. Assignments
- A. Reading
 - 1. Weekly readings from required textbooks
 - 2. Magazine and journal articles
 - 3. Reference books
 - 4. Handouts
 - B. Writing or problem solving or skill attainment

5. Create accurate sketches of systems and sub systems
 6. Compare different fuel systems and write about differences found
 7. Qualify different fuel systems installation procedures
 8. Create written automotive fuel system schematics
 9. Determine start-up, shutdown, and storage procedures of alternative fuel systems
- C. Critical thinking
1. Utilize proper documentation to determine schematic accuracy
 2. Analyze installation directions to determine appropriate procedures
 3. Determine the steps in utilizing equipment for proper testing procedures
 4. Select proper testing equipment and tools to monitor fuel system circuits
- VI. Methods of instruction may include
- A. Lecture
 - B. Demonstration
 - C. Overhead projections
 - D. Written assignments and reports
 - E. Instruction utilizing Electronic Information technology (EIT) (i.e. video, audio, websites, web services and software) must comply with Cerritos College BP & AP 3720, Cerritos College BP & AP 3411 and Section 508 standards (law). When course materials are not compatible with a person's disability, the Instructor will develop an Equally Effective Alternative Access Plan (EEAAP).
- VII. Methods of evaluation may include
- A. Identification of alternative fuel systems components
 - B. Design projects
 - C. Written quizzes on lecture topics
 - D. Mid-term examination
 - E. Outside assignments
 - F. Evaluation of virtual safe use of equipment
 - G. Graded written assignments
 - H. Final examination
- VIII. Student learning outcomes
- A. Identify the principal components of natural gas and hydrogen fuel systems
 - B. Identify the chemical composition of different types of fuels
 - C. Identify the principal components of alcohol based fuel systems
 - D. Determine appropriate pressures required to operate natural gas, hydrogen, and alcohol based fuel systems
 - E. Compare and contrast alternative fuel system applications
 - F. Identify proper placement and location of fuel system components