

Department, number, and title of course: Mechanical & Aerospace Engineering 449,
Combustion Engines

Designation as a 'Required' or 'Elective' course: Elective

Course (catalog) description: Spring. 3 credits.

Introduction to combustion engines, with emphasis on the application of thermo-dynamic and fluid-dynamic principles affecting their performance. Chemical equilibrium and kinetics, ideal-cycle analyses, deviations from ideal processes, engine breathing, combustion, knock. Formation and control of undesirable exhaust emissions.

Prerequisite(s): ENGRD 221 (Thermodynamics, also M&AE 221) and M&AE 323 (Introductory Fluid Mechanics).

Textbook(s) and/or other required material:

Internal Combustion Engines, C.R. Ferguson, A.T. Kirkpatrick, Wiley, 2001.

Course Reading Packet, available at Cornell Campus Store.

Course objectives:

Upon completion of this course, students should be:

1. familiar with types and operation of engines and fuel cells (ABET a);
2. familiar with air pollution, global warming, and fuelling issues for engines and fuel cells (ABET h);
3. able to calculate performance limits for engines and fuel cells (ABET a and e);
4. able to predict engine performance with two models (gas cycle, fuel-air cycle) (ABET a and e);
5. able to calculate properties, equilibrium composition, and adiabatic flame temperatures for ideal gas mixtures (ABET a);
6. able to describe why and how fuel cell output changes in response to operating conditions (ABET a and e);
7. able to calculate chemical reaction rates and describe their roles in engines and fuel cells (ABET a and e);
8. able to use spreadsheets and chemical equilibrium software (ABET k);

Topics covered:

- ♦ Description and Operation of Engines and Fuel Cells
- ♦ Thermo Review
- ♦ Gas Cycle Model
- ♦ Thermochemistry and Mixtures of Ideal Gases
- ♦ Adiabatic Flame Temperature

- ♦ Thermodynamic Performance Limits for Fuel Cells and Engines
- ♦ Nernst Equation
- ♦ Chemical Equilibrium
- ♦ Fuel-air Cycles
- ♦ Kinetics
- ♦ Losses in Fuel Cells
- ♦ Breathing and Combustion in Engines
- ♦ Air Pollution
- ♦ Fuelling Engines and Fuel Cells

Class/laboratory schedule, i.e., number of sessions each week and duration of each session:

Two 75-minute lectures each week.

Contribution of course to meeting the professional component: This course partially fulfills the requirement to complete three upper level M&AE courses as a Field Approved Elective. It can be used to partially fulfill the requirement to complete two upper level courses within the Thermo-fluids or Vehicle Engineering concentrations or it can be used to fulfill the Technical Elective requirement.

Relationship of course to program outcomes: This course meets ABET Outcomes a, e, h and k and Program Educational Objectives 1 and 2.

Outcome Assessment: Grades on individual parts of assignments and exams are tracked during the semester and reported in order to evaluate how well course objectives are met.

Person(s) who prepared this description and date of preparation:

Elizabeth Fisher

2/27/04