University Of California, Berkeley
Department of Mechanical Engineering

ME 140: Combustion Processes (3 units)

Elective Course

Syllabus

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): Comb Processes
TIE CODE: LECS
GRADING: Letter
SEMESTER OFFERED: Fall, Spring
COURSES THAT WILL RESTRICT CREDIT: None
INSTRUCTORS: Professor Chen and Fernandez-Pello
DURATION OF COURSE: 15 weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 12
IS COURSE REPEATABLE FOR CREDIT? No
CROSSLIST: None

CATALOG DESCRIPTION

Fundamentals of combustion, flame structure, flame speed, flammability, ignition, stirred reaction, kinetics and nonequilibrium processes, pollutant formation. Application to engines, energy production and fire safety.

COURSE PREREQUISITES

ME 105 or ME 40, ME 106, and ME 109. ME 106 and ME 109 may be taken concurrently.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Required text: "Combustion Engineering", G.L. Borman and K. W. Ragland, 1998 McGraw-Hill. Prior knowledge of Thermodynamic principles covered in ME 105 or a similar course.

COURSE OBJECTIVES

The course provides an introduction to the subject of combustion, covering a broad range of topics important to the fields of energy conversion, engines, pollution and fires. It consists of classroom lectures and laboratory demonstration. It treats the fundamental processes occurring in combustion systems and emphasizes on technological-problem solving skills. The laboratory demonstrations provide practical experience with real combustion systems. The course also uses computer programs to aid the students in the calculations and analysis, especially in thermodynamics and chemical kinetics.

DESIRED COURSE OUTCOMES

Upon completion of the course, students shall be able to:

Understand and calculate the stoichiometry, adiabatic flame temperature and heat of combustion of a fuel and oxidizer mixture. Understand the role of elementary and global reactions. Calculate reaction rates. Know how to use computer codes (e.g. Cantera, STANJAN) to solve combustion problems. Understand and calculate the ignition characteristics of a fuel and oxidizer mixture: flammability limits, self-ignition. Understand and calculate the structure and properties of a premixed flame: propagation speed, thickness, quenching distance, and minimum ignition energy. Understand and calculate the structure and properties of a diffusion flame: height, lift-off distance and blow-off limit. Understand the formation of pollutants from hydrocarbon combustion. Understand the operation of practical systems, specifically, furnaces and boilers, spark ignition and diesel internal combustion engines, and gas turbines.

TOPICS COVERED

Nature of combustion. Types and characteristics of fuels. Thermodynamics: Heat of reaction and adiabatic flame temperature. Chemical Kinetics: Chemistry of combustion. Elementary and global reactions. Premixed flames: Laminar flame propagation. Flame speed and flammability. Ignition, extinction and quenching. Laboratory experiments with the ignition and propagation of premixed flames. Diffusion flames: Gaseous diffusion jets and flames flame heights. Turbulent flames. Environmental impacts: Pollutants and its generation paths. Laboratory experiments with a Droplet Combustion: Droplet sprays. Evaporation and burning of droplets. Real combustion systems: Gas-fired furnace, burners. Premixed charge engines. Diesel engines. Gas turbines. Alternative engines. About ten laboratory demonstrations covering: Computer-aided analysis with Cantera, bomb calorimeter, ignition of premixed mixtures, premixed flames propagation, flash and fire points, diffusion flames, Burke-Schumann flames, pool fires, internal combustion engine, spray combustion, gas turbine combustor.

CLASS/LABORATORY SCHEDULE

Three hours of lecture and one hour of demonstration lab per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

This course provides experience with real combustion systems (measurement devices, flames, engines, turbines) and hands on experience with computer-aided analysis of combustion problems including thermodynamics and chemical kinetics.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

An ability to apply knowledge of mathematics, science, and engineering. An ability to identify, formulate, and solve engineering problems. An understanding of professional and ethical responsibility. and the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. A knowledge of contemporary issues. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

Homework/laboratory and class-participation 20%, mid-terms 40%, final exam 40%. Participation in class and discussion sessions is strongly encouraged.

PERSON(S) WHO PREPARED THIS DESCRIPTION

Carlos Fernandez-Pello
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