ROWAN UNIVERSITY CURRICULUM PROPOSAL

PROPOSAL TITLE:
Introduction to Combustion

CHECK APPROPRIATE: _x_ UNDERGRADUATE ___ GRADUATE ____ SEMESTER HOURS

SPONSOR(S):
Dr. Anthony J. Marchese and the Department of Mechanical Engineering

DEPARTMENT/TELEPHONE # Mechanical Engineering, x4627

CHECK ONE: _x_COURSE __MINOR PROGRAM __CONCENTRATION __SPECIALIZATION

__ACHIEVEMENT CERTIFICATE __CERTIFICATION PROGRAM __MAJOR PROGRAM

Step #1 (Department)

✓ Approved (Date)

___ Not Approved (Date)

Dept. Curriculum Chr.

2/25/98
Reviewed (Date)

Dept. Chr.

Step #2 (Receipt)

SCC# 97-98-302

2-27-98
Date Received Senate

Senate Curriculum Chr.

Step #3 (School)

Reviewed Date: 2/25/98

X Recommend to Approved

___ Recommend NOT to Approve

Forward for Open Hearing:

___WITHOUT Reservations

___WITH Reservations:

Comments:

Robert P. Hesketh
School Committee Chr.

Step #4 (Academic Dean): ✓Recommended ____ NOT Recommended ____ Conditionally Recommended (See Comments)

Comments:

Dean Signature/Date 2/27/98

Step #5 (Senate Curriculum Committee): Open Hearing Date: 4/28 Approved by Curriculum Committee Date 4/28/98

Returned to Sponsor(s) for the following reason:

6 (Senate) Date announced/voted on at Senate 4/28 If voted on: ____Approved ___NOT Approved

Date forwarded to Executive Vice President/Provost 5/11/98

Senate Curriculum Committee chair Signature/Date: 5/8/98

#7 (Executive Vice President/Provost): Date Received [illegible]

___ Approved

___ NOT Approved If no, reasons are as follows:

Student Credit Hours _____

Faculty Load Hours _____

Equalized Credit Hours _____

Official Copy & Approval Sheet Filed (Date) 5/16/98

Executive Vice President/Provost Signature [signature]

[illegible]rar

Date Approved Course Description Received _____

Hegis Taxonomy and Course Number Assigned [illegible]

Date/Signature of Registrar [illegible]

Notification Forward:

_____ Senate Curriculum Committee Chairperson

_____ Department Chairpersons

_____ Academic Dean(s)

_____ Registrar

_____ Sponsor(s)

Course Proposal

1. Details:

a) Course Title:	Introduction to Combustion (0910-411)
b) Sponsor:	Dr. Anthony J. Marchese, Department of Mechanical Engineering, College of Engineering
c) Credit Hours:	3 credit hours
d) Course Level:	Senior
e) Curricular Effect:	A senior elective for Mechanical Engineering majors. May also be taken by Chemical Engineering and Civil Engineering majors with the Environmental Option.
f) Prerequisites:	Engineering Thermodynamics II or equivalent.
g) Suggested Time/ Scale of Implementation	Fall 1999 One section
h) Resources:	Faculty is in place to teach the course within the Dept. of Mechanical Engineering. A 1130 square foot thermo and engine laboratory will be available to support this course. A bomb calorimeter and flash point tester have already been purchased in support of this course. Library resources are in place. Computer hardware resources are available in the Engineering Building to support this course. A license for Chemkin III, the industry standard combustion modeling computer software has been purchased to support this course.

2. Rationale:

The proposed course is part of the Engineering Curriculum Proposal approved by the College Senate in December 1994. The proposed course is consistent with the establishment of the School of Engineering approved by the Board of Trustees in February 1995. The curriculum for the Department of Mechanical Engineering consists of two major focuses: Mechanical Systems and Thermal/Energy Systems. The Introduction to Combustion course is an important elective for those wishing to focus on the thermal/energy systems track.

The topics covered in this course are extremely relevant for practicing mechanical, chemical and environmental engineers. While computers and electronics have revolutionized the way we live and access information, we still generate our electricity, heat our homes and power our vehicles using the same power source utilized by the cavemen: *fire!* In fact, despite efforts to develop and utilize renewable energy sources, 85% of all energy consumed in the United States is derived from the combustion of fossil fuels. Moreover, the combustion of *liquid* petroleum-based fossil fuels accounts for 39% of all energy consumption, and an astounding 97% of energy consumption in the transportation sector. Fossil fuels not only have a finite supply, but the combustion of these fuels is the major source of air pollutants such as soot, NO_x, and SO_x. In short, combustion impacts a wide variety of areas relevant to practicing engineers. Unfortunately, very few practicing engineers have had the opportunity to learn about combustion.

3. Essence of the Course:

a) Objectives:

Combustion refers to the study of chemically reacting fluid systems. Thus, this course utilizes all of the fundamental tools acquired during the study of Chemistry, Thermodynamics, Heat Transfer, and Fluid Mechanics. In this course, the fundamental concepts of chemically reacting systems (flames) will be studied along with many practical applications. Upon completion of this course, the undergraduate student will be able to

1. Calculate adiabatic flame temperatures using the concepts of chemical equilibrium.
2. Explain the explosion limits of the hydrogen/oxygen system using chemical kinetic arguments.
3. Qualitatively explain the chemical oxidation mechanism of alcohols, alkanes and aromatics.
4. Assemble detailed chemical kinetic mechanisms and model zero and one-dimensional chemically reacting systems.
5. Calculate premixed laminar flame speed using phenomenological arguments and the Frank-Kamenetskii solution.
6. Calculate detonation velocity and explain the structure of detonation waves.
7. Determine the burning rate of a liquid fuel droplet.
8. Explain the formation mechanisms of NO_x and soot.

b) Topical Outline:

The topical outline of the course may vary to some extent depending on the interests of the instructor and the students, and the advances in engineering technology. The topics to be covered will include the following:

Chemical Thermodynamics and Flame Temperatures
- Heats of Formation
- Free Energy and Equilibrium Constants
- Flame Temperature Calculations

Chemical Kinetics
- Rates of Reaction and Temperature Dependency
- Chain Reactions
- "Fall-Off" Reactions

Explosion Limits
- Chain Branching Reactions and Criteria for Explosion
- Explosion Limits of Hydrogen
- Explosion Limits of Hydrocarbons and Negative Temperature Coefficients

Hydrocarbon Oxidation and Pyrolysis Mechanisms
- Aldehydes
- Methane
- Alkanes
- Olefins
- Alcohols
- Aromatics

Premixed Flames
- Laminar Flame Structure
- Theory of Mallard and Le Chatlier
- Theory of Frank-Kamenetskii
- Flame Speed Measurements
- Stability Limits

Detonations
- Hugoniot Relations and the Hydrodynamic Theory of Detonation
- ZND Structure of Detonations
- Calculation of Detonation Velocity

Diffusion Flames
- The Burke-Schumann Flame
- Droplet Combustion

Environmental Considerations
- The Nature of Photochemical Smog
- NOx Formation and Reduction
- Particulate Formation

c) Evaluation and Grading Procedure of Students:
Student grades will be determined on the basis of examinations, homework and/or projects, laboratory projects and reports.

d) Course Evaluation:
The proposed course will be evaluated on the basis of student evaluations and curriculum review by appropriate faculty.

4. Results of Consultations:
The proposed course is part of the Engineering Curriculum Proposal approved by the Faculty Senate in December 1994. Consultations were submitted with original proposal as specified by the Curriculum Committee. Additional curriculum consultations were performed with outside consultants including, Professor Skip Fletcher of Texas, A&M. Professor Fletcher is a fellow of the American Society of Mechanical Engineers.

Catalog Description:

Introduction to Combustion (0910-411)
(Prerequisites: *Engineering Thermodynamics II or equivalent.*)

This course serves as an introduction to combustion, chemically reacting flow systems and flames. It covers the fundamental concepts of chemically reacting systems along with many practical applications. Specific topics include chemical equilibrium, chemical kinetics, premixed laminar flames, detonations, diffusion flames and environmental issues.