

PROPOSAL NUMBER: 99-429

CURRICULUM PROPOSAL FORM

***DEADLINES:**

REGULAR COURSE PROPOSALS: OCTOBER 23, 1998 FOR FALL, 1999 AND FEBRUARY 19, 1999 FOR SPRING, 2000
 SHORT-TERM COURSE PROPOSALS: DECEMBER 11, 1998 FOR FALL, 1999 AND MARCH 26, 1998 FOR SPRING 2000

PROPOSAL TITLE: INTRODUCTION TO GAS DYNAMICS

SPONSOR/S: ANTHONY J. MARCHESE, ASSISTANT PROFESSOR

DEPARTMENT: Mechanical Engineering 0910.421

CHECK ALL THAT APPLY:

UNDERGRADUATE GRADUATE

COLLEGE: Engineering

If LAS: History/Humanities
 Math/Sciences
 Social/Behavioral Sciences

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TYPE OF PROPOSAL. (Check ALL that Apply)

<input type="checkbox"/> General Education	<input checked="" type="checkbox"/> New Course (NOT Gen. Ed.)
<input type="checkbox"/> New Course in _____ Bank	<input type="checkbox"/> Name Change (Dept., School, Major)
<input type="checkbox"/> Existing course, Add To _____ Bank	<input type="checkbox"/> Changes in Degree Requirements
<input type="checkbox"/> Multicultural/Global Designation	<input type="checkbox"/> Changes Involve Gen. Ed. requirements
<input type="checkbox"/> Writing Intensive Designation	<input type="checkbox"/> Minor Changes to Existing Courses
<input type="checkbox"/> New Minor/Concentration/Specialization	<input type="checkbox"/> Course is NOT General Education
<input type="checkbox"/> New Major/Degree Program	<input type="checkbox"/> Course IS General Education
<input type="checkbox"/> Short Term Course Proposal	

DEPARTMENT
 (SIGNATURE INDICATES APPROVAL)

[Signature] 10/22/98 TR Chandrasekhar 10/22/98

DEPT. CURRICULUM CHAIR / DATE DEPT. CHAIRPERSON / DATE

<p>COLLEGE CURRICULUM COMMITTEE DATE OF OPEN HEARING (if necessary) _____</p> <p><input checked="" type="checkbox"/> APPROVED <input type="checkbox"/> NOT APPROVED</p> <p>COMMENTS:</p> <p><u>[Signature]</u> 2/10/99 SIGNATURE DATE</p>	<p>ACADEMIC DEAN (& GRADUATE DEAN, for New Graduate Programs Only)</p> <p><input checked="" type="checkbox"/> APPROVED <input type="checkbox"/> NOT APPROVED</p> <p>COMMENTS:</p> <p><u>[Signature]</u> 10/23/98 SIGNATURE (Academic Dean) DATE</p> <p>_____ SIGNATURE (Graduate Dean) DATE</p>
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UNIVERSITY CURRICULUM COMMITTEE

DATE OF OPEN HEARING (if necessary) 2/10/99 (college level only)

APPROVED

NOT APPROVED

COMMENTS:

Janette Reeves 4/1/99
SIGNATURE DATE

SENATE

Date announced at Senate 2/23/99

Voted upon at Senate: Approved Not Approved Date:

EXECUTIVE VICE PRESIDENT/PROVOST

APPROVED

NOT APPROVED If no, reasons are as follows:

STUDENT CREDIT HOURS _____ FACULTY LOAD HOURS _____ EQUALIZED CREDIT HOURS _____

OFFICIAL COPY & APPROVAL SHEET FILED (DATE): _____

DATE/SIGNATURE EXECUTIVE VICE PRESIDENT/PROVOST [Signature]

REGISTRAR

DATE APPROVED COURSE DESCRIPTION RECEIVED _____

HEGIS TAXONOMY & COURSE NUMBER ASSIGNED C910.421

DATE/SIGNATURE OF REGISTRAR Robert G. Kubat 4/12/99

NOTIFICATION FORWARD:

SENATE CURRICULUM COMMITTEE CHAIRPERSON

DEPARTMENT CHAIRPERSONS

ACADEMIC DEAN(S)

REGISTRAR

SPONSOR(S)

T.M. 4/12/99

Course Proposal

1. Details:

- a) Course Title: Introduction to Gas Dynamics (0910-421)
- 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: Senior level thermal sciences elective for Mechanical Engineering majors.
- f) Prerequisites: Engineering Thermodynamics II (910.312) and Fluid Mechanics II (910.313), or equivalent courses.
- 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 supersonic nozzle flow apparatus has been purchased in support of this course. The supersonic nozzle apparatus has been installed in the 1130 square foot thermodynamics and engine laboratory, which will be used in support of this course. Library resources are in place. Computer hardware resources are available in the Henry M. Rowan Hall to support this course. No new software resources are required.

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.

Mechanical Engineering is broadly split between the study of mechanical systems and thermal/energy systems. At Rowan, Mechanical Engineering majors must take at least 2 electives in each of the above broad areas. The proposed course satisfies a Senior level elective in the thermal/energy systems area. Introduction to Gas Dynamics introduces Mechanical Engineering students to the important area of compressible fluid mechanics. Knowledge of compressible fluid mechanics is vital for many career paths in the aerospace industry or energy services industry.

3. Essence of the Course:

a) Objectives:

Engineering Thermodynamics II and Fluid Mechanics II briefly introduce Mechanical Engineering Students to the concept of compressible gas dynamics. The main objective of the

course Introduction to Gas Dynamics, is to provide students with insight into many applications of one-dimensional compressible flow and to introduce students to solution techniques for two-dimensional compressible flow.

The following are the specific objectives of this course:

Solve problems in one -dimensional steady compressible flow including: isentropic nozzle flow, constant area flow with friction (Fanno flow) and constant area flow with heat transfer (Rayleigh flow).

Derive the conditions for the change in pressure, density and temperature for flow through a normal shock.

Determine the strength of oblique shock waves on wedge shaped bodies and concave corners.

Determine the change in flow conditions through a Prandtl-Meyer expansion wave.

Use the Method of Characteristics to solve problems in two-dimensional compressible flow.

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:

1. Review of Fundamental Principles
 - 1.1 Compressibility
 - 1.2 Fundamental Assumptions
 - 1.3 Conservation Laws
2. Equations of Steady One-Dimensional Compressible Fluid Flow
 - 2.1 Continuity Equation
 - 2.2 Momentum Equation
 - 2.3 Energy Equation
 - 2.4 Equation of State
 - 2.5 Entropy Considerations
 - 2.6 Use of One-Dimensional Flow Equations
3. Fundamental Aspect of Gas Dynamics
 - 3.1 Isentropic Flow in a Stream Tube
 - 3.2 Speed of Sound
 - 3.3 Mach Waves
4. One-Dimensional Isentropic Flow
 - 4.1 Stagnation Conditions
 - 4.2 Critical Conditions
 - 4.3 Maximum Discharge Velocity
 - 4.4 Isentropic Relations
5. Normal Shock Waves
 - 5.1 Shock Waves
 - 5.2 Stationary Normal Shock Waves

- 5.3 Normal Shock Wave Relations
- 5.4 Moving Normal Shock Waves
- 6. Variable Area Flow
 - 6.1 Effects of Area Changes on Flow
 - 6.2 Equations for Variable Area Flow
 - 6.3 Operating Characteristics of Nozzles
 - 6.4 Convergent-Divergent Supersonic Diffusers
- 7. Adiabatic Flow with Friction
 - 7.1 Flow in a Constant Area Duct
 - 7.2 Friction Factor Variations
 - 7.3 The Fanno Line
 - 7.4 The Effects of Friction on Variable Area Flow
- 8. Flow with Heat Addition or Removal
 - 8.1 One-Dimensional Flow in a Constant Area Duct
 - 8.2 Entropy-Temperature Relations
 - 8.3 Variable Area Flow with Heat Addition
 - 8.4 One-Dimensional Constant Area Flow with Heat Exchange and Friction
 - 8.5 Combustion Waves
 - 8.6 Condensation Shocks
- 9. Oblique Shock Waves
 - 9.1 Oblique Shock Wave Relations
 - 9.2 Reflection of Oblique Shock Waves
 - 9.3 Interaction of Oblique Shock Waves
 - 9.4 Conical Shock Waves
- 10. Expansion Waves
 - 10.1 Prandtl-Meyer Flow
 - 10.2 Reflection and Interaction of Expansion Waves
 - 10.3 Boundary Layer Effects on Expansion Waves
 - 10.4 Flow over Bodies Involving Shock and Expansion Waves
 - 10.5 Boundary Layers
- 11. Numerical Analysis of One-Dimensional Flow
 - 11.1 Discretization
 - 11.2 Stability and Accuracy
 - 11.3 Steady Isentropic Subsonic Flow
 - 11.4 Steady Isentropic Supersonic Flow
 - 11.5 Unsteady One-Dimensional Flow
- 12. Two-Dimensional Compressible Flow
 - 12.1 Governing Equations
 - 12.2 Vorticity Considerations
 - 12.3 Linearized Solutions
 - 12.4 Linearized Subsonic and Supersonic Flow
 - 12.5 Method of Characteristics
 - 12.6 Numerical Solutions

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 Gas Dynamics (0910-421)

Prerequisites: Engineering Thermodynamics II (910.312) and Fluid Mechanics II (910.313), or equivalent.

This course emphasizes application of the conservation equations of mass, momentum and energy to solve problems in one-dimensional and two-dimensional compressible flow. Specific applications of one-dimensional compressible flow include one-dimensional isentropic flow, flow with area change, adiabatic flow with friction, normal shock waves and flow with heat addition. The method of characteristics is introduced to solve two-dimensional compressible flow problems.