ENG ME 425 Compressible Flow and Propulsion

2008-2009 Catalog Data:

ENG ME 425 Compressible Flow and Propulsion
Prereq: ENG ME 303 and ME 304. Fluid mechanics and thermodynamics of compressible fluid flow with application to external and internal flows as found in propulsion systems. Fluid/thermal related topics include: normal and oblique shocks, Prandtl-Meyer expansion waves, variable area duct flow, and wave drag. Propulsion applications include rocket nozzles, rocket engine staging, supersonic inlets, and exhaust nozzles for airbreathing propulsion systems. Parametric cycle analysis for ramjet, turbojet, turbofan, and turboprop engines. 4 cr.

Class/Lab Schedule: 4 lecture hours per week, 3 hour lab per semester

Status in the Curriculum: Required for Aerospace Program

Textbook(s) and/or Other Required Material: *Modern Compressible Flow* 3rd ed., J. Anderson Jr.
Fundamentals of Jet Propulsion with Applications R. D. Flack

Coordinator: Sheryl Grace, Associate Professor, Mechanical Engineering

Prerequisites by topic:
1. Intro to fluid mechanics
2. Intro to thermodynamics

Goals:
The goal of this course is to introduce the students to concepts in compressible flow and propulsion. The students will learn analytical methods for modeling inviscid internal and external compressible flows. Duct flows both isentropic and nonisentropic will be discussed in the context of wind tunnels and propulsion system nozzles and diffusers. The students will also become familiar with parametric cycle analysis for air breathing propulsion systems.

Course Learning Outcomes:

As an outcome of completing this course, students will:
i. Develop the ability to model and analyze compressible fluid flow systems utilizing natural laws and methods of analysis which include vector field theory and partial differential equations, including application to practical problems such as supersonic external flows and isentropic and nonisentropic internal flows. (A, E, L)

ii. Become proficient in the application of fundamental thermodynamics and fluid mechanics to the analysis of propulsion systems and their components including: airbreathing engines such as ramjets, turbojets, turbofans and turbopropos as well as non-airbreathing enges such as solid and liquid fueld rockets. (A, E, L).

iii. Gain experience in generation of computer solutions to fluid thermal problems and in assessing results from a CFD (RANS) code by writing MATLAB programs to solve for the aerodynamic properties double wedge airfoils in supersonic flows and to analyze a turbojet cycle as well as complete the computational lab which utilizes the CFD code OVERFLOW. (K,L,M)

Course Learning Outcomes mapped to Program Outcomes:

Program:	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Course:	I,ii				I,ii						iii	I,ii,iii	iii	
Emphasis:	5	1	1	1	5	1	1	1	1	1	4	4	4	1

Topics (time spent in weeks):

1. Governing Equations of Fluid Motion (0.5)
2. 1-D flows, normal shocks (1)
3. 1-D with heat and friction (1)
4. Oblique shocks (0.5)
5. Expansion waves (0.5)
6. Quasi 1-D flows, nozzles (1)
7. Rockets (0.5)
8. Supersonic inlets and wind tunnels (1)
9. Transonic flows, numerical methods (1.5)
10. Thermodynamic cycles (0.5 wk)
11. Engine component thermodynamic behavior (1)
12. Ideal parametric cycle analysis (1.5)
13. Non-ideal parametric cycle analysis (1)
14. Off-design air-breathing engines (1)
15. Exam (0.5)

Contribution of Course to Meeting the Professional Component:

Engineering topics: 100%

Status of Continuous Improvement Review of this Course:

Date Last Reviewed: 2007 **Reviewed by**: Fluids/Thermal Subcommittee

Prepared by: Sheryl Grace **Date**: April 1, 2009