AE510/ME510

Advanced Gasdynamics

Fall 2013

Professor: Marco Panesi
Office: Talbot Lab 314
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Class Meets: Tu-Th 10-1150 am
Office Hours: just stop by anytime

Text: "*Modern Compressible Flow: With Historical Perspective*", Anderson, McGraw Hill.
Course Notes from Prof. D.S. Stewart

Recommended Texts:

- *"Linear and Nonlinear Waves"*, G. B. Whitham, Wiley-Interscience
- *"Computational Gasdynamics"*, C. Laney. Cambridge U Press
- *"The Dynamics and Thermodynamics of Compressible Fluid Flow"*, Shapiro, Wiley

Prerequisites: An introduction to undergraduate level thermodynamics and gas-dynamics

Course Evaluation: College of Engineering standard format at the end of the semester. I welcome feedback on all aspects of the course at any time, either in person or with a note. I appreciate helpful suggestions.

PLANNED SYLLABUS (as time permits)

Governing equation for a heat conduction viscous compressible fluid
- Mathematical preliminaries
  - Reynolds transport theorem, various divergence theorems
- Conservation equations in integral form
  - Mass, momentum, energy, specie (conserve scalars)
- Conservation equations in differential form
- Jump conditions and discontinuity analysis
- Simple constitutive theory for an ideal gas with heat conduction and viscosity
- Equations of a compressible heat conduction, viscous fluids

Dimensional analysis
- Effects of compressibility
- Regimes of the Mach number
- Nearly incompressible

Compressible flow
Transonic flow
Hypersonic flow

Equations of gas dynamics for both general and ideal equation of state

Basic thermodynamic review and needed results
Primitive form
Conservative form
Canonical form
Characteristic form (in one dimension)
Acoustic limit and the sound speed
Pressure field of a point disturbance and signaling

General Theorems of gas dynamics

Irrotational flow
Hometropic flow
Isentropic flow
Circulation theorem
Crocoo's theorem
Potential flow

One dimensional flow (Steady and Unsteady)

1D duct flow equations
Normal shock relations
Simple waves
Basic Riemann problem and the shock tube problem
Quasi-steady flow through nozzles
1D potential flow
Generalized 1D flow with losses (and gains)

Shock interactions

1D shock fitting
The shock change equation

Properties of High-Temperature Gases

Microscopic description of the gas
Boltzmann Distribution
Evaluation of the Thermodynamic Properties
Equilibrium Constant
Chemical Equilibrium
Introduction to Non-equilibrium Systems
Vibrational and Chemical Rate Equation

High-Temperature Flows: Basic Examples

Grading and Exams

Home Work: 70 %
Final Project: 30 %

100 - 90	A +:	100 - 97	A:	96 - 93	A :	92 - 90
89 - 80	B+:	89 - 87	B:	86 - 83	B-:	82 - 80
79 - 70	C+:	79 - 77	C:	76 - 73	C-:	72 - 70
69 - 60	D+:	69 - 67	D:	66 - 63	D-:	62 - 60
< 60 F						