

# SYLLABUS FOR MECH539 – ADVANCED FLUID MECHANICS

## 1. Contact Information

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## 2. Schedules

The course duration is from Jan. 19 to May 8. The class is offered on Tuesdays and Thursdays from 12:30 pm to 1:45pm in Engineering B105. Office hours are provided upon appointment.

## 3. Course Description and Objectives

Development of the three-dimensional, non-steady, field equations for describing the motion of a viscous, compressible fluid; differential and integral forms of the equations; constitutive equations for a compressible fluid; the entropy equation; compressible boundary layers; area-averaged equations for one-dimensional steady flow; shock waves; channel flow with heat addition and friction; flow in nozzles and inlets; oblique shock waves; Prandtl-Meyer expansion; unsteady one-dimensional flow; the shock tube; acoustics in one-dimension; steady flow in two-dimensions; potential flow; linearized potential flow; lift and drag of thin airfoils.

Upon completion of this course, students will be equipped with theories and analytical methods for furthering studies on compressible flow with more general flow geometry and real gas effects.

## 4. Text and References

- (1) Required Text: *Fundamentals of Compressible Flow* (available on line)
- (2) Recommended Reference: Van Dyke, *An Album of Fluid Motion*, Parabolic Press
- (3) Reference Book List:
  - Liepmann and Roshko, *Elements of Gasdynamics*, Dover
  - Anderson, *Modern Compressible Flow*, McGraw Hill
  - Thompson, *Compressible Fluid Dynamics*, Rensselaer Polytechnic Institute Press
  - Shapiro, *The Dynamics and Thermodynamics of Compressible Fluid Flow*, Ronald Press
  - Aris, *Vectors, Tensors, and the Basic Equations of Fluid Mechanics*, Prentice-Hall
  - Schlichting and Gersten, *Boundary Layer Theory*, Springer

## 5. Course Grading Scheme and Policies

There will be a number of assignments given throughout the course. There is a course project. There are no exams. The final grade will be based on marks obtained for the assignments and the course project. The composition of the grade: (1) 50% for the assignments and (2) 50% for the course project where 20% midterm project report and 30% for the final project report and discussions.

The grades are **A, B, C, D, F**; the low boundary value for each grade is **90, 75, 60, 45, and less than 45**, correspondingly.

Late assignments will not be graded. They will be assigned up to 3/5 credit depending on effort and returned without examination. This applies to the course project.

## 6. Course Outline

- (1) Fluid flow patterns
- (2) Thermodynamics of gases
- (3) Control volumes, vector calculus
- (4) Kinematics of fluid flow
- (5) Conservation equations in integral and differential form, the Navier-Stokes equations

- (6) Alternate forms of the equations of motion, rotational and irrotational flow
- (7) Entropy generation and transport
- (8) Viscous flow along a wall
- (9) Quasi-one-dimensional flow, shock waves
- (10) Gasdynamics of nozzles
- (11) Channel flow with area change, friction and heat addition
- (12) Steady waves, oblique shocks, Prandtl-Meyer expansion
- (13) Unsteady wave motion, acoustics, centered expansions, the shock tube
- (14) Linearized potential flow, thin airfoil theory

## 7. Acknowledgment

We thank Prof. Brian Cantwell from Stanford University for giving his permission to Xinfeng Gao for using the course materials developed by Prof. Cantwell for “Fundamentals of Compressible Flow”.

## 8. Department of Mechanical Engineering: Student Academic Integrity Policy

For student academic integrity policy, please refer to  
[www.engr.colostate.edu/me/pages/undergraduate/programs-requirements/AcademicIntegrity.pdf](http://www.engr.colostate.edu/me/pages/undergraduate/programs-requirements/AcademicIntegrity.pdf).