ME/AE 423 Viscous Fluid Flows
Mechanical & Aerospace Engineering Department, Missouri S&T

Instructor: Dr. Arindam Banerjee
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Class schedule: **Tu-Th: 12.30 pm – 1.45 pm**
Class Location: **Toomey Hall 249**
Office hours : **Wed: 2.00 pm – 4.00 pm**
Grading Outline: Homework – 30%, 2 mid-term exams: 20% each; Project – 30%
Catalog Description: Fundamentals of viscous fluids for incompressible and compressible flows governed by Navier-Stokes equations; exact, approximate, and numerical solutions for steady and unsteady laminar flows; stability, transition, and turbulence, CFD simulations of internal and external flows.
Prerequisites: ME/AE 331 or ME/AE 339 or any graduate level fluids class
Textbook: **White, F. Viscous Flows. Third Revised Ed., Mc-Graw Hill, Inc, 2005 (ISBN-10: 0072402318)**
Software: Occasional home-works will involve using Matlab, Fluent, Fortran and other softwares. You are expected to have a working knowledge of these softwares.

Topics Covered:

Preliminary concepts of Fluid Flow – Fluid properties: Kinematic (flow) and transport (fluid), Boundary conditions, Fundamental Equations for compressible viscous flows, Mathematical Nature of Basic Equations, dimensional parameters and non-dimensionalizing of basic equations, Reynolds Transport Theorem & Control Volume formulation – Chapter 1 & 2 (White)

Exact solutions of the Newtonian Viscous Flow Equations - Couette Flow, Poiseuille Flows, Combined Couette and Poiseuille Flows, Unsteady Duct Flows, Flows with Suction and Injection, Wind Driven Flows, Similarity Solutions, Micro-flows - Chapter 3 (White)

Boundary Layer Theory - Laminar Boundary Layer Theory, Integral analysis of energy equation & Nusselt number, Similarity Solution for steady 2D flow, Flat Plate Heat Transfer, Falker Skan Potential Flow, Free Shear Flows, Plain shear layers, Thermal Boundary Layers, 3D Boundary Layers - Chapter 4 (White)

Compressible Boundary Layer Theory -Compressible BL equations, isentropic flow, steady viscous flow, Similarity solutions of compressible laminar BL, Solutions of laminar flat plate and stagnation flow, Special Topics in compressible laminar flow - Chapter 7 (White)

Stability of Laminar Flows and Transition to Turbulence - Theory of steady flows, bifurcations and instability, Linear Stability Analysis (Kelvin-Helmholtz Instability, Rayleigh-Taylor Instability), Weakly non-linear theory (Rayleigh-Bénard convection, Instability of Couette Flow), Transition to turbulence. - Chapter 5 (White)

Things to Note:

1. **Attendance:** A sign-up sheet will be provided in class. Students will be dropped from course if they miss more than 4 classes. An academic alert will be issued before the class drop request is sent to the registrar's office.
2. **Homework problems** will be assigned every 1-2 weeks and will depend on progress/coverage
3. **Mid-term tests** will be a take home – will be assigned on a Friday and will be due by on Monday.
4. The **project** should based on a viscous flow problem to result in a report in the format/style of a journal paper. You can define you own project but you would need to discuss it with me (submit an abstract and plan of work). The project is due on 12/3/10.

Administrative Information:

Academic Alert System: The Academic Alert System is a web-based application that supports communication among instructors, advisors, and students. The purpose of the Academic Alert System is to improve the overall academic success of students by improving communication among students, instructors and advisors; reducing the time required for students to be informed of their academic status; and informing students of actions necessary by them in order to meet the academic requirements in their courses. To access the Academic Alert System (on-campus), visit:
http://academicalert.mst.edu/

***Academic Dishonesty*:** Page 30 of University's Student Academic Regulations defines academic dishonesty (including cheating, plagiarism and sabotage) and describes the student standard of conduct relative to the University System's Collected Rules and Regulations.
(http://registrar.mst.edu/academicregs/index.html).
In cases of academic dishonesty, the following procedure is carried out. This procedure follows the collected rules and regulations referenced below.

- Student Conduct (Collected Rules and Regulations: 200.010)
  (http://www.umsystem.edu/ums/departments/gc/rules/programs/200/010.shtml).
- Rules of Procedures and Student Conduct Matters (Collected Rules & Regulations: 200.020)
  (http://www.umsystem.edu/ums/departments/gc/rules/programs/200/020.shtml).

Classroom Exit Procedures: Please familiarize yourself with emergency exit procedures. Adjacent to each classroom entrance is a floor plan that shows students how to exit the building in the event of an emergency. If you have any further questions, please contact the University Police Department.

Disability Support Services: http://dss.mst.edu Any student inquiring about academic accommodations because of a disability should contact the instructor who will refer the student to Disability Support Services so that appropriate and reasonable accommodative services can be determined and recommended. Disability Support Services is located in 204 Norwood Hall. Their phone number is 341-4211 and their email is dss@mst.edu. Instructors may consider including the following statement on their course syllabus as a means of informing students about the services offered: *"If you have a documented disability and anticipate needing accommodations in this course, you are strongly encouraged to meet with me early in the semester. You will need to request that the Disability Services staff send a letter to me verifying your disability and specifying the accommodation you will need before I can arrange your accommodation."*