# MAE101B
# ADVANCED FLUID MECHANICS
# SPRING 2009

Prof. Sutanu Sarkar
Mechanical and Aerospace Engineering
Mail Code 0411
Office: 578 EBU II
Phone: 534-8243
Email: sarkar@ucsd.edu

- **Course description:** This is the second of a two-course series in Fluid Mechanics. The principles of Fluid Mechanics will be applied to viscous flows and to compressible flows. Examples from engineering and natural applications will be discussed.
- **Prerequisites:** MAE 101A, MAE 110A or equivalent are required.
- **Lectures:** Tuesday, Thursday 11:00 AM -12:20PM CENTR 214
  Wednesday, 10:00AM -10:50AM CENTR 113
  The Wednesday hour will be used mainly as a recitation period where the TA will work out problems, although it will also be occasionally used as a lecture period.
- **Text:** *Fluid Mechanics*, F. M. White, 6th edn., McGraw-Hill.
- **TA information:** The TA's are Javier Urzay and Hieu Pham
- **Homework:** There will be six homeworks worth 20% of the grade. NO late submissions.
- **Exams:** Two midterms will account for 40% and a final will account for 40% of the grade.
  Midterm 1 on Wednesday, April 22. Midterm 2 on Wednesday, May 13.
  Final on Tuesday, June 9, 11:30-2:30 PM.
- **Grading Policy:** HWs must be your OWN work. Do not copy off OTHER (friends, solution manuals, books, etc.) sources. Ditto for exams. Any copying as defined above will be grounds for a **F** grade. See http://www-senate.ucsd.edu/manual/Appendices/app2.htm
- **Professor office hours:** Tuesday, 1-2 PM, in office, EBU II-578.
- **TA office hours:**
  Monday:1:00-2:30 PM, EBU II-305
  Tuesday: 5:00-6:30 PM, EBU II-305
  Wednesday: 3:00-4:30 PM, EBU II-305

# MAE 101 B, Spring 2009
# Course Outline

| | |
|---|---|
| Week 1: March 31-April 2 | Chapter 6: subject is *Internal Viscous Flows*. Qualitative description of flow in a pipe: pressure drop and friction factor; turbulent versus laminar flow; entrance length; fully-developed regime. Review of Navier-Stokes equations. Analytical description: shear stress variation; laminar flow solution. |
| Week 2: April 7-9 | Chapter 6, continued. Turbulent flow: Reynolds averaging; wall, outer and overlap layers in turbulent wall-bounded flows; log law for the velocity profile. Friction factor: turbulent smooth wall solution; effect of rough walls; Colebrook formula, Moody chart and their use in pipe flow problems. HW1 collected on April 9. |
| Week 3: April 14-16 | Chapter 6, continued. Flow measurement devices. Overview of Chapter 6. HW 2 collected on April 16. |
| Week 4: April 21-23 | MIDTERM 1 on Wednesday, April 22. Chap. 7: subject is *External Viscous Flows.* Boundary layer (BL) on a flat plate: different measures of the BL thickness; skin friction coefficient & drag coefficient; laminar versus turbulent boundary layer; BL approximation of the Navier-Stokes equations. |
| Week 5: April 28-30 | Blasius solution of the BL equations. Von Karman momentum integral relationship and its application to a boundary layer. Turbulent BL: logarithmic overlap region, skin friction law. HW 3 collected on April 30 |
| Week 6: May 5-7 | Chapter 7, continued. BL under favorable pressure gradient; adverse pressure gradient. Drag in external flow: friction drag, pressure (form) drag, wave drag. Overview of Chap. 7. HW 4 collected on May 7. |
| Week 7: May 12-14 | MIDTERM 2 on Wednesday, May 13. Chapter 9: subject is *Compressible Flow*. Review of thermodynamics: first law, second law, equation of state, ideal gas relationships, isentropic process. Mach number. |
| Week 8: May 19-21 | Chapter 9, continued. One-dimensional adiabatic and isentropic steady flow in a duct, Mach number relationship. Flow in non-uniform duct: effect of convergence, effect of divergence, choking. HW 5 collected on May 21. |
| Week 9: May 26-28 | Chap. 9, continued. Normal shock: Rankine-Hugoniot relationship, Mach number relations. Converging-diverging nozzle. HW 6 collected on May 28. |
| Week 10: June 2-4 | Chapter 9, continued. Duct flow with friction (Fanno flow). Duct flow with heat loss (Rayleigh flow). Wrap up! |