ME 231 Thermo-Fluid Mechanics I (Section 1B)
Spring 2012: Mechanical & Aerospace Engineering Department

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Instructor:	**Dr.** Arindam **Banerjee** Assistant Professor, Mechanical & Aerospace Engineering Department **184 Toomey Hall**, Missouri University of Science & Technology Rolla, MO 65409. Phone: 573-341-4494; Email: **banerjeea@mst.edu**
Class schedule:	**Tuesday-Thursday: 9.30 a.m. – 10.45 a.m.**
Location:	**Toomey Hall 256**
Office hours :	**Tuesday – 2.00 - 4.00 PM.** Please note that meeting me at all other times by prior appointment (i.e. to ensure I am in my office).
Grading Outline	Bi-Weekly Quizzes (9): 25%, Mid-Term Exams (3): 75%
Grading Policy:	Final grades will be curved. Approximate cut-offs: **A:** 90 % , **B:** 80% , **C:** 70%, **D:** 60% **F:** below 50%. Class statistics and grades will be provided ONLY after each exam.
Catalog Description:	Principles of viscous and inviscid flow in ducts, nozzles, diffusers, blade passages and application to design; dimensional analysis and laws of similarity; external flows; compressible flows.
Prerequisites:	**A grade of "C" or better in ME 219** (no exceptions allowed)
Course Objectives:	Provide a one-semester treatment of the fluid mechanics topics, which are judged to be most useful to the average mechanical engineer.
Textbook:	White, Frank, Fluid Mechanics, 7th Ed., McGraw-Hill, Inc., 2010

Administrative Issues:

- All Quizzes & Mid-term Exams will be open text book (only). No notes/solutions are allowed.
- Home-work problems will be assigned each week. However, they will not be collected.
  a. A quiz will be administered every 2nd week and will be based on the assigned Home-Work problems. The Quizzes will be held towards the end of the class and will be no more than 15-20 minutes in duration.
  b. Quizzes will be announced in advance. There will be NO make-up Quiz.
  c. Solutions to all assigned HW problems (and Weekly Quizzes) will be posted on Blackboard.
  d. In addition, a study problem set (with solutions) will be posted on Blackboard to help students with problem solving.
  e. Students will have the option to drop their two lowest quiz score. However, if they decide to exercise this option, they would also need to agree to drop their highest quiz-score.
  f. There will be NO quiz during the week of the mid-term exams.
- There will be 3 mid-term exams.
  Tentative dates are: Mid-Term 1 – 2/14; Mid-Term 2 – 3/20; Mid-Term 3 – week of finals.
- There will NO make-up exam.
- A problem session will be scheduled before each Mid-Term Exam. Attendance to the problem session is voluntary. Old Exams will be posted on Blackboard prior to each exam.
- **Strategies for Success –**
  1. Come to class and participate (ask questions/be proactive);
  2. Read the book (reading assignments will be given) every class:
  3. Review study problem set & solutions,
  4. Work on HW sets (either individually or in groups) and prepare your own solutions:
  5. On completion of quiz, review your solutions with posted solutions immediately….not just before exam.

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Prof. A. Banerjee
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Chapter	Topic	Class Period #	Date
1	**INTRODUCTION (3 lectures)**		
	Course policy & description	1	
	Review of vector algebra/calculus (Handout)		
	Concept of a fluid, Dimensions & units, Dimensional homogeneity	2	
	Properties of fluid: thermodynamic properties (pressure, temperature, density, specific weight, and specific gravity)		
	Properties of fluid :specific gravity, secondary properties – viscosity, surface tension	3	
2	**PRESSURE DISTRIBUTION IN A FLUID (3 lectures)**		
	Pressure at a point	4	
	Pressure on a fluid element (Hydrostatics)		
	Measurement of Pressure: Manometers & Sample Problems		
	Hydrostatic force on Surfaces i. Plane Surface ii. Curved Surface	5	
	Buoyancy & Stability	6	
	Fluids in Rigid Body Motion Sample Problems		
3	**INTEGRAL RELATIONS FOR A CONTROL VOLUME (4 lectures)**		
	Systems vs. Control Volume	6	
	Reynolds Transport Theorem		
	Conservation of Mass		
	Conservation of Linear Momentum		
	Conservation of Energy (The first Law of Thermodynamics) – Steady Flow Energy Equation,	7	
	Frictional Head Loss – Pump vs. Turbine Frictionless Flow – Bernoulli's Equation		
	Bernoulli's Equation: Applications Concept of Stagnation Flow, Pitot Tubes.	8-9	
4	**DIFFERENTIAL RELATIONS FOR FLUID FLOW (5 lectures)**		
	Velocity & Acceleration Field Streamlines, Streaklines & Pathlines	10	
	Conservation of Mass (Continuity Equation)		
	Conservation of Linear Momentum (Navier Stokes Equations)	11	
	Basic Equations – Boundary Conditions		
	Solutions to incompressible viscous flow equations (Problems in Cartesian co-ordinates – Couette & Poiseulli Flow)	13	
	Solutions to incompressible viscous flow equations (Problems in radial co-ordinates – flow inside a pipe: Hagen-Poiseulli flow)	14	
5	**DIMENSIONAL ANALYSIS & SIMILITUDE (2 lectures)**		
	Introduction, Dimensional Homogeneity	16	
	Buckingham Pi Theorem		
	Dimensional Parameters		

	Similarity & Modeling, Non-dimensional numbers	17	
6 (11*)	**VISCOUS FLOWS IN DUCTS (3 lectures)**		
	Laminar & Turbulent Flow, Reynolds Number	18	
	Fully developed Laminar Flow in a Pipe : Entrance Region, Major & Minor Losses		
	Examples of Losses in Pipes, Measurement of flow, Bernoulli Obstruction Theory	19	
	***Pump Performance & System Matching, Cavitation and NPSH**	20	
7	**FLOW PAST IMMERSED BODIES (3 lectures)**		
	Geometry Effects/ MI estimates of Boundary Layers	**21**	
	Boundary layers on a flat plate – Exact Solution & comparison with MI estimates	**22**	
	Flow Separation, Concept of Drag and Lift on a body	**23**	
9	**COMPRESSIBLE FLOWS (4 lectures)**		
	Introduction & Review of Thermodynamics	**24**	
	Speed of Sound		
	Adiabatic & Isentropic Flow, Isentropic Flow with Area Change	**25**	
	Converging-Diverging Nozzles, Normal Shock Wave	**26**	