Department of Mathematics and Statistics
620-342
Industrial and Applied Mathematics

Semester 2, 2008

CLASSES

Lectures:
- Monday 9 am – 10 am. Babel 305
- Wednesday 9 am – 10 am. Old Geology Theatre 1
- Friday 9 am – 10 am. Old Geology Theatre 1

Practice Class:
- Thursday 4:15 pm – 5:15 pm. Russell Love Theatre, Richard Berry Building

COURSE OBJECTIVES

As a result of this course, students should

- Comprehend:
  - the basic principles governing viscous fluid flow
  - the apparatus needed to formulate these principles mathematically (including vector and tensor methods)
  - the concept of a constitutive equation

- Have developed:
  - the ability to select a constitutive equation and correctly pose boundary-value problems
  - skills in solving flow problems in simple geometries
  - insight into the validity of approximate analyses
  - the ability to interpret solutions in physical terms

- Appreciate:
  - the potential for mathematical modelling of flow processes which arise in many areas of science and technology
  - the intimate connection between continuum mechanical problems and fundamental mathematical problems

PREREQUISITES

Stated prerequisites are 620-331. Students without the prerequisites will not be permitted to remain enrolled without permission. Students with a marginal performance in 620-231 are urged to revise vector analysis.

TEXTBOOKS

There is no prescribed textbook for this course. The following books have been placed on reserve in the Maths Library:

- Batchelor, An Introduction to Fluid dynamics, CUP, 1967
- Paterson, A First Course in Fluid Dynamics, CUP, 1983
- Acheson, Elementary Fluid Dynamics, Clarendon, 1990

Numerous suitable books are available in the library at call number 532.05.
Printed Lecture Notes are available for purchase at the Bookroom.

SCHEDULE

i. **Weeks 1-6 Fundamentals of fluid mechanics**
Overview of continuum mechanics and fluid mechanics; the continuum picture; streamlines and pathlines; Eulerian & Lagrangian view; conservation of mass in a fluid, equation of continuity; conservation of linear & angular momentum, Cauchy equation of motion, the stress tensor; Cartesian tensors; hydrostatics; the Euler fluid, Bernoulli's Theorem, d'Alembert's paradox; Newtonian fluids, Navier-Stokes equations, boundary conditions.

ii. **Weeks 7-8 Exact solutions and their lessons**
Solutions for unidirectional flows; dynamical similarity; the Rayleigh problem and the vorticity equation; circular Couette flow as an example of non-unidirectional flow.

iii. **Weeks 9-12 Approximate solutions**
Low Reynolds number flow - Stokes drag, Stokes paradox, Oseen equation. High Reynolds number flow laminar boundary layer theory, the Blasius solution, boundary layer separation.

ASSESSMENT

Two assignments 15% each, issued weeks 6,10, due in weeks 8, 12.
One three-hour end-of-semester exam 70%.

Problem sheets, this outline and assignments will also be available from the subject homepage (enter initially through the Department of Mathematics and Statistics homepage www.ms.unimelb.edu.au).

John Sader
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