The University of Sydney

School of Mathematics and Statistics

MATH 3974: FLUID DYNAMICS (Advanced)

2011

LECTURER: Dr David Galloway (Carslaw 712, dave@maths.usyd.edu.au) Lectures will be held on Mondays and Wednesdays at 10-11am in Carslaw 350, and Thursdays at 10-11am in Merewether Lecture Room 4 (which is room 275).

There is one tutorial per week on Wednesdays at 12-1pm in Carslaw 351, starting in week 2. The tutorials are run as examples classes; most problems are solved interactively between the students and the lecturer.

COURSE DESCRIPTION A description of the course is to be found in the Third Year Maths Handbook (see the Mathematics web-pages www.maths.usyd.edu.au/u/UG/SM).

AIMS AND OBJECTIVES By the end of the course, students should have received a basic introduction to the following:

• The basic variables used to describe flows; the need for continuity, momentum and energy equations; simple forms of these equations; geometric and physical simplifying assumptions; streamlines and stream funtions; incompressibilty and irrotationality; simple examples of irrotational flows

• Bernoulli's equation and some applications thereof; the importance of vorticity, Kelvin's circulation theorem and Helmholtz's theorem that vortex lines move with the fluid

• Cartesian tensors; the role of viscosity and the derivation of the Navier-Stokes equation; the significance of the Reynolds number; pipe flow and unidirectional viscous flows; flow between concentric cylinders; thin film flows

• Irrotational flows with added circulation; Laplace's equation and the use of complex variable methods for its solution in two dimensions; airfoil theory and the derivation of the formula for lift; basic understanding of how aircraft fly

• The fundamental importance of boundary layers and the subtleties of the change of order when viscosity is omitted; the Blasius and Falkner-Skan boundary layer solutions

• The ideas of hydrodynamic stability together with examples of calculations; transitions to turbulence via a sequence of bifurcations; the turbulent closure problem and other difficulties; Kolmogorov's theory for the spectrum of turbulent eddies

COURSE MATERIALS: A set of handwritten notes is available from Kopystop, Mountain Street (off Broadway). The lectures will mostly follow the notes, though the presentation will vary somewhat for the sake of variety.

ASSESSMENT: Assessment will be by three assignments worth 10% each (due at the ends of weeks 5, 9 and 13), and a two hour examination worth 70%. The assignments are an integral part of the course and are mostly based on material which can be researched in books

or discovered on the Web. Past experience has shown that there is an excellent correlation between those who do (or don't do) the assignments and those who pass (or fail) the course. The lecturer is willing to provide help to anyone struggling.

CONSULTATIONS: There are no formal consulting hours but I will normally be happy to see students at any time where I am not otherwise occupied with something specific. Students are therefore encouraged to drop in, or to book a specific time by e-mail if preferred.

REFERENCE BOOKS: A list of books appears in the back of the notes.

WEB PAGE: This can be accessed from outside the School via the School's web pages **www.usyd.edu.au/u/UG/SM**. The web pages will include exercise sheets (which are also in the notes), and solutions (which are not). There are four sheets which are treated in sequence in the tutorials, but with no week-by-week assignation of particular problems.