UNIVERSITY OF WARWICK
School of Engineering

ES30D Fundamental Fluid Mechanics II - Syllabus

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1 Preliminaries

1.1 Lecture Programme

Timetabled sessions in Term 2 are

- Monday (15:05:00-15:55, Room L5),
- Tuesday (14:05-14:55, Room PLT),
- Friday (12:05-12:55, Room L4).
  - Set Exercises, Case Studies & Revision.

1.2 Office Hours

- Thursday 17:00-18:00
- Friday 17:00-18:00

2 Academic Rationale

- The material most relevant to Civil Engineers is covered in ES30A Fundamental Fluid Dynamics I. Which is then immediately followed by this module, which will cover the remaining topics of interest to Mechanical Engineers.

3 Aims & Objectives

- The motion of a fluid around bodies and internal flows are of fundamental importance for Civil and Mechanical Engineers. This course is designed to follow on from the second-year ES252 Fluid Mechanics course, although it will be self-standing and therefore suitable for 3/4 Year students in Mathematics and some other degree programmes. The course will introduce students to the fundamental governing equations of fluid flow and their properties. The various approaches that engineers take to obtain approximate solutions to the equations will be covered on the course.
- At the end of the course students should have a sound understanding of the flow physics involved in a wide range of engineering and scientific applications. In particular they should be familiar with the interpretation, derivation and application of the Navier-Stokes equations and with the various approaches engineers use to obtain practical solutions for flow fields. They should also be familiar with a wide range of engineering applications including design calculations.

4 Assessment

100% Examination

- Three-hour written examination, which carries 100% of the course credit.
- Three questions each for **ES30A** and **ES30D**.
- **Two** questions out of **Three** will be required in the June examination.
- The questions will be based either on the lecture notes, the set exercises or the case studies.

5 Study Schedule

- Introduction.
  - Revision.
  - The Navier-Stokes equations.
  - Non-dimensional numbers: Reynolds number
- Chap. 8 - Flow at very low Reynolds number. (Stokes flow)
- Chap. 9 - Lubrication theory.

  - Reynolds lubrication equations.
  - Lubrication of gears and bearings.
    * Hydrostatic bearings.

- Chap. 10 - Flow at high Reynolds number.
  - Boundary-layer theory and its applications.
  - Turbulent flow.

- Chap. 11 - Computational fluid dynamics.
  - ODE/PDE
  - FDM/FVM/FEM/Spectral
  - Commercial CFD codes: **STAR-CD**

- Chap. 12 - Flow control.

6 Prerequisites

Modules required:

- ES252 Fluid Mechanics or equivalent and
- ES30A Fundamental Fluid Mechanics I

7 Textbook

The main textbooks are

- Houghton, E. L. & Carpenter, P. W. 2003 *Aerodynamics for Engineering Students*. 5th Edition, Oxford: Elsevier Science.
- White, F. M. 2003 *Fluid Mechanics*. 5th Edition, McGraw-Hill.
- Ferziger, J. H. & Perić, M. 2002 *Computational Methods for Fluid Dynamics*, 3rd Edition, Springer-Verlag.

Other Fluid Mechanics books that are referenced are:

- White, F. M. 1991 *Viscous Fluid Flow*. 2nd Edition, McGraw-Hill.
- Fox, R. W., McDonald, A. T. & Pritchard, P. J. 2003 *Introduction to Fluid Mechanics*. 6th Edition, John Wiley & Sons, Inc.

- Schlichting, H. & Gersten, K. 2000 *Boundary Layer Theory*. 8th Edition, Springer-Verlag.

References for CFD:

- Fletcher, C. A. J. 1991 *Computational Techniques for Fluid Dynamics 1*: Fundamental and General Techniques (Springer Series in Computational Physics). 2nd Edition, Springer-Verlag.
- Fletcher, C. A. J. 1991 *Computational Techniques for Fluid Dynamics 2*: Specific Techniques for Different Flow Categories (Springer Series in Computational Physics). 2nd Edition, Springer-Verlag.
- Tannehill, J. C. Anderson, D. A. & Pletcher, R. H. 1997 *Computational Fluid Mechanics and Heat Transfer*. 2nd Edition, Taylor & Francis.
- Anderson, J. D. Jr. 1995 *Computational Fluid Dynamics*. McGraw-Hill.
- Ferziger, J. H. 1998 *Numerical Methods for Engineering Application*. 2nd Edition, Wiley & Sons, Inc.
- Moin, P. 2001 *Fundamentals of Engineering Numerical Analysis*. Cambridge University Press.