CE406 Applied Hydrodynamics

Co-ordinator: Professor C. Swan (Room 328), c.swan@imperial.ac.uk

Status: Environmental elective

Lecturers:	Professor C. Swan (CS) Room (328) Dr R. MacIver (RM) (Room 334)
Format:	22 Lectures, 22 tutorials, 10 hours laboratory/design projects
Links:	CE105, CE202, CE302, CE314

Introduction

Hydrodynamics, or the study of water flows, represents one of the core disciplines within Civil Engineering. This module provides students with an advanced understanding of such flows, with a particular emphasis on practical applications. It examines the fundamental relations governing the motion of all fluids and provides an insight into how complex flow patterns in many Civil Engineering applications can be successfully approximated by relatively simple modelling techniques. The emphasis of the module is on the solution of practically important problems with wide-ranging examples drawn from across Civil Engineering practice.

Aims

- To provide an advanced understanding of fluid flows
- To stress the multi-disciplinary nature of the subject
- To cultivate a high-level design capability involving the solution of practically important problems
- To emphasize the success (and limitations) of simple modelling procedures
- To introduce wide-ranging examples from:
  - Hydraulic Structures
  - Offshore Engineering
  - Coastal Engineering
  - Marine Energy Devices/Renewable energy

Links with other course modules

This module builds naturally on the earlier core courses in Fluid Mechanics (CE105, CE202 and CE302) and also the third year elective in Coastal Engineering, CE314. However, the latter is not a pre-requisite for attendance on this course.

SYLLABUS
The Autumn term lectures (CS) will cover the following topics:

1.0 General description of fluid motion
2.0 Fluid Loading on Static Bodies – Slender Body Theory
3.0 Fluid Loading on Static Bodies - Large volume structures

4.0 Extreme Loading – Slamming and impacts
5.0 Dynamic response

The Spring term lectures (RM) will cover the following topics:

1.0 Steady flow boundary layers
2.0 Oscillatory boundary layers
3.0 Turbulence modelling
4.0 Implications for sediment transport
5.0 Marine Energy

Coursework
In the Autumn term the coursework will involve design calculations concerning the description of the wave loads applied to a large volume structure. This is introduced in several stages, with students given several weeks to complete the overall task. In the Spring term the coursework takes the form of a laboratory session investigating boundary layers and turbulence modelling within the practical context of sediment transport.

Assessment
The mark award split between examinations and coursework is 60%:40% respectively. The end of session written examinations carries the rubric: “Answer five questions”, (out of a total of 6 questions).

Recommended Textbooks/Reading
BRADWSHAW, P., An introduction to turbulence and its measurements, *Pergamon*.
DEAN, R. G., & DALRYMPLE, R.A., 1992. Water wave mechanics for Engineers and Scientists. *World Scientific*.
DOUGLAS, J.F., GASIOREK, J.M. & SWAFFEILD, J.A., 2001 Fluid Mechanics. *Prentice* Hall.
DUNCAN, W.J., THOM, A.S. & YOUNG, A.D., Mechanics of Fluids. *Arnold*.
FALTINSEN, O.M., Sea loads on ships and offshore structures, *C.U.P*.
GODA, Y. 1985. Random Seas and Design of Maritime Structures, *University of Tokyo Press*.
NEWMAN, J.N. Marine Hydrodynamics*, MIT* Press.
PATEL, M.H, Dynamics of Offshore Structures, *Butterworth*.
SCHLICHTING, H., 1979. Boundary Layer Theory. *McGraw-Hill, New York*.

Learning Objectives
The students are expected to gain a physical insight into a wide range of practically relevant fluid flows. Approximate solutions are considered and their applicability assessed from a fundamental perspective. The key objective is for students to understand the limitations inherent in most engineering solutions and to appreciate when they can be confidently applied in engineering practice.