CE 416 ENVIRONMENTAL FLUID MECHANICS

Co-ordinator: Prof R.J. Sobey, (Room 330), r.j.sobey@imperial.ac.uk

Status: Environmental Elective

Lecturers:	Prof R.J. Sobey (RJS) (Room 330) Dr G.R. Hunt (GRH) (Room 331) gary.hunt@imperial.ac.uk
Structure:	55 contact hours (lectures, tutorials, coursework, case studies)
Links:	see below

Introduction

The environmental topics of river and estuarine flows and contaminant transport, as well as the 'dry land' topic of the ventilation of buildings in an environment and people friendly way are currently 'hot', and it is certain that they will remain so in the future. The module addresses the above topics by complementing and extending material currently taught in Years II and III Hydraulics/Environmental core and elective modules.

Aims

The focus is on exposing the students to the available analytical, experimental and computational techniques for the analysis of river and estuarine flows, contaminant transport and ventilation of buildings. Particular attention is paid to demonstrating the practical application of the analysis techniques through the presentation of a significant number of relevant case studies. The case studies are presented by practicing engineers.

Links with other course modules

The module requires good analytical skills, it has a strong practical flavour, and the theoretical aspects involve mathematical techniques taught during the first two years (CE102, CE201). It also relies on knowledge from the core classes in Fluid Mechanics (CE105, CE202 and CE302).

SYLLABUS

1. Unsteady flow in rivers and tidal channels [RJS 15 hours]: Follows on from material currently taught in the Year II 'Hydraulics' module. Covers physical processes, analytical solutions, and numerical solutions.
2. Unsteady flow in stratified channels [RJS 3 hours]: Introduces barotropic and baroclinic modes (internal waves) and interfacial stability.
3. Longitudinal dispersion [RJS 3 hours]: Introduces the concept of longitudinal dispersion in natural channels, as an extension of the turbulent diffusion process covered in the Year III module 'Hydraulic Engineering'
4. Buoyancy−driven flows and ventilation of modern low−energy buildings [GRH 20 hours]: Fluid flows driven by density differences occur widely in nature and industry and in this course a description of these flows will be developed primarily in the context of air flows in modern buildings that are driven by temperature differences − natural ventilation. This is a modern topic that should be attractive not only to students with an interest in Fluid Mechanics, but also to those who are interested in structures and their interaction with the natural environment. The analytical framework developed to model these flows leads to an understanding of how air and heat moves through buildings, and a set of design guidelines and rules−of−thumb for achieving low−energy designs. It is demonstrated that the framework developed also applicable to other problems involving stratification and exchanges between fluid bodies. In parallel with material taught in class, demonstrations will be provided in the Fluid Mechanics Laboratory that allows these flows to be visualised and quantified.
5. Stratified flow in estuaries and ocean outfalls (GRH 4 hours).

6. Case studies (Various external contributors from industry; 9 hours): Illustration of the practical application of the analytical and computational tools that deal with above topics.

Coursework

For topics 1−3, there will be four coursework assignments in the Autumn Term. For topics 4 and 5, the coursework will take the form of a problem−based learning session in the context of building ventilation.

Assessment

The coursework assignments will be assessed for a coursework mark. The written examination at the end of Part IV session will consist of six questions covering all topics, from which five are to be chosen.

Recommended Textbooks

FISCHER et al. Mixing in Inland and Coastal Waters
WOOD et al., Ocean Disposal of Wastewater
GILL, Atmosphere−Ocean Dynamics
SIMPSON, Gravity Currents in the Environment and the Laboratory
TURNER, Buoyancy effects in fluids
Material developed in topic 4 will draw from the results of research papers published in International Journals. Details will be given in class.

Learning Outcomes

Appreciate the multi−faceted nature of flow and transport problems and the techniques available to the engineer. Appreciate the importance of environment and people−friendly ventilation of modern buildings and the way in which the solution techniques may be applied to other problems involving stratification or mixing of fluids. Familiarity with numerical prediction of unsteady flow in rivers and estuaries. Rational evaluation of alternative analytical, experimental or computational methods for analysis of specific environmental flow and transport problems.