Engineering Tripos Part IIA, 3D5: Water Engineering, 2019-20

Module Leader

Dr D Liang [1]

Lecturers

Dr D Liang and Prof A McRobie [1]

Lab Leader

Dr D Liang [1]

Timing and Structure

Michaelmas term. 16 lectures and coursework.

Aims

The aims of the course are to:

- Explain some fundamental principles necessary for understanding the common water issues in the world.
- Cover the basic topics in practical hydrology, civil engineering hydraulics, turbulent mixing, and water/waste water treatments.
- Allow students to grasp essential concepts and procedures for analysing hydro-environmental processes and develop skills to solve practical water engineering problems.
- Highlight some of the most pressing water-related global challenges, such as freshwater scarcity, soil erosion, water quality deterioration and flooding, and stress the need for sustainable and integrated management of water resources.

Objectives

As specific objectives, by the end of the course students should be able to:

- Comprehend the scope of water-related topics in civil and environmental engineering
- Appreciate the environmental, social, political and economical implications of water engineering
- Understand the hydrologic cycle and the Earth’s water budget
- Understand simple models of infiltration
- Undertake simple rainfall-runoff calculations over small catchments
- Understand river hydraulics.
- Be aware of a wide range of hydro-environmental issues
- Understand the advective, diffusive, dispersive and reactive processes related to pollutant transports in uniform flows
- Evaluate the impact of large hydraulic engineering projects
- Solve steady flows using the equations of mass, energy and momentum conservations
- Analyse unsteady flows using the method of characteristics.
- Explain the cause of soil erosion and mitigation measures.
- Understand the mechanism of sand particle motion.
- Calculate the sediment transport rate and determine the bed regime.

- Select pipeline systems for water conveyance
- Make appropriate pump selections and design simple pumping systems
- Be aware of the principles and elements of water/wastewater treatments and the key engineering variables for their design
- Notice the limitations of the traditional water supply and sewage treatment systems in a sustainability context

Content

Hydrology (3L) 2 lectures/week, weeks 1-2 (Prof F. A. McRobie)

- Global water issues
- Hydrologic cycle
- Unit hydrographs

Open Channel Flows, Pollutant and Sediment Transports (12L) 2 lectures/week, weeks 2-8 (Dr D. Liang)

- Boundary layer and turbulence
- Flow resistance
- Steady flow in pipelines
- Water pollution
- Steady flow in open channels
- Pollutant advection,diffusion,dispersion and reaction
- Unsteady flow,flood routing and method of characteristics
- Sediment transport and bed form
- Pipeline systems
- Pumping systems

Water/Waste Treatments (1L) 2 lectures/week,week 8 (Prof F. A. McRobie)

- Water treatment
- Wastewater treatment

Coursework

Sign-up sheets will be posted on the Inglis Building Mezzanine Floor by 9am on Wednesday of Week 0.

Sediment transport

Learning objectives:

- To gain first-hand experience of open channel flow and sediment transport phenomena.
- To study the threshold condition under which sediments are moved. This condition separates the state of the clear-water flow over an immobile bed from the state where sediment transport and bed deformation take place.
- To investigate the relationship between the bed forms and the flow conditions. This is important because the bed forms have a significant impact on the bed roughness and thus the channel conveyance.
- To appreciate the local scour phenomena around underwater structures.

Practical information:

- Sessions will take place in Room ISG-86 (Inglis Building Ground Floor, Centre for Smart Infrastructure & Construction).
- This activity doesn't involve preliminary work, but it will be beneficial to read the handouts beforehand.

Full Technical Report:

Students will have the option to submit a Full Technical Report.

Booklists

Please see the Booklist for Part IIA Courses [2] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [4] standard:

Toggle display of UK-SPEC areas.

GT1

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

D1

Wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations.

S1

The ability to make general evaluations of commercial risks through some understanding of the basis of such risks.

S3

Understanding of the requirement for engineering activities to promote sustainable development.

S4

Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues.

E1

Ability to use fundamental knowledge to investigate new and emerging technologies.

E2

Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate.

E3

Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.

P1

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

P3

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US3

An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.

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Links
[1] mailto:dl359@cam.ac.uk
[2] https://www.vle.cam.ac.uk/mod/book/view.php?id=364091&chapterid=46611
[3] https://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[4] https://teaching.eng.cam.ac.uk/content/uk-spec