Engineering Tripos Part IIA, 3D8: Geo-Environmental Engineering, 2021-22

Module Leader

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Lecturers

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Lab Leader

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Timing and Structure

Lent term. 16 lectures and Lab.

Aims

The aims of the course are to:

- The aim of the course is to introduce the transport processes of fluids, water and pollutants, in the porous media that constitute the geo-environment.
- The module aims to address the factors that influence groundwater, heat and pollutant transport, practical and design applications and problems that might arise.
- This course aims to introduce the students to the flow regimes that occur in porous media and ways to estimate the flow quantities using flownets.
- Similarly heat flow through porous media is introduced drawing parallels with the groundwater flow.
- Contaminant transport through porous media is another important aspect in geo-environmental engineering that is addressed in this module.
- Practical ways to dispose waste into the ground, the effects the contaminants have on the host soil and necessary aspects of remediation of contaminated land will also considered.

Objectives

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

- Understand the geotechnical environment.
- Determine flow patterns in steady state groundwater seepage.
- Evaluate potentials, pore water pressures, and flow quantities in the ground by constructing flow nets.
- Anisotropic soils and flow nets
- Seepage below concrete dams
- Seepage through embankment & earth dams
- Excavations and seepage, Cofferdams and stability
- Draw parallels between groundwater flow and heat flow in porous media
- Develop necessary skills to estimate heat storage and extraction from ground
- Introduction to contaminated soil and its remediation
- Understand the soil properties that affect the geo-environment and vice versa
- Develop an understanding of the interactions between soils and contaminants

- Understand the effect of soil contamination on geotechnical properties
- Develop an understanding of the fate and transport mechanisms of contaminants in the ground
- Solving of Advection-Dispersion equation using error functions
- Develop appreciation of the contaminated land/landfills environment
- Understand disposal of waste into well-engineered systems
- Be able to design a solution relevant to land remediation or a landfill

Content

The following topics will be covered:

Flow of Water through Porous Media, is an important aspect in the design of many civil engineering structures such as retaining walls, caissons, excavation for foundations, etc. As it will be shown in the second part of the module, the same physical principles and mathematical concepts can be used to understand flow of heat in porous media, for example, in the design of energy piles or ground source heat pumps.

Contaminant Transport through Porous Media, is important to understand the presence of contaminants in the ground and how they are transported through various mechanisms and how they affect the properties of the soil. Equally disposal of waste of waste safely into well-engineered facilities is critical to minimise the environmental impact of the waste.

Groundwater, Seepage and Heat Flow in Granular media (8L)

- Introduction
- Concept of porous media and bulk properties.
- Definitions of potential head, pressure head and pore pressure.
- Groundwater flow and seepage
- Theory of flownets
- Anisotropic soils and flownets
- Darcy's law and Hydraulic conductivity
- Laboratory and in situ measurements
- Seepage below concrete dams
- Seepage through embankments and earth dams
- Stability and seepage around excavations
- Coffer dams and their stability
- Fourier’s law and heat flow in porous media
- Parallels between ground water flow and heat flow
- Ground source heat pumps
- Storage and extraction of heat from ground

Contaminated Land and transport of contaminants through ground (8L)

- Introduction to contaminated land and contaminants in the geo-environment
- Introduction to waste containment structures – landfills
- The structure of clays
- The clay-water interactions
- The clay-water-contaminant interactions
- The effect of contaminants on the geotechnical properties of soils
- Mechanisms of contaminant transport
- Fick’s law for diffusion in porous media, dispersion and sorption, Peclet’s number
- Solving advection-dispersion equation, Error functions
- Land remediation and waste containment design applications
- Relevant case studies and project examples.

Coursework

Environmental Geotechnical Engineering

Learning objectives:

- Axi-Symmetric flow of ground water into a well boring
- Axi-Symmetric heat flow in saturated soil

Practical information:

- Sessions will take place in [ISG-88], during week(s) [2-6].
- This activity [doesn't involve] preliminary work but read the lab handout prior to the lab session ([1 hr]).

Full Technical Report:

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

Booklists

Please refer to the Booklist for Part IIA Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

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

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links
[1] mailto:mspg1@cam.ac.uk
[2] mailto:aa22@cam.ac.uk
[3] http://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[4] http://www.engc.org.uk/ukspec.aspx
[5] http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/
[6] http://teaching.eng.cam.ac.uk/content/output-standards-matrices