Module Code	CEU44A02 / CEP55E06
Module Name	4A2 Groundwater and Pollution Control / 5A2 Groundwater and Pollution Control
ECTS Weighting[1]	5 ECTS
Semester taught	Semester 2
Module Coordinator/s	Lecturer(s): Asst. Prof. David O'Connell (david.oconnell@tcd.ie) Co-ordinator
Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline	On successful completion of this module, students should be able to: LO1. Solve mathematical problems concerned with groundwater flow, geophysical surveys, rock discontinuities and slope stability. LO2. Question the assumptions underlying common methods of groundwater analysis, particularly in the context of the heterogeneous nature of the bedrock aquifers found in Ireland. LO3. Develop a conceptual model of an aquifer system and plan a groundwater investigation programme, including identification of suitable drilling, geophysical and other investigation techniques. LO4. Appraise organic groundwater pollution in a variety of contexts, such as how to identify and then manage and remediate the groundwater system contaminated **Graduate Attributes: levels of attainment** To act responsibly - Enhanced To think independently - Enhanced To develop continuously - Enhanced To communicate effectively - Enhanced

[1] TEP Glossary

Module Content

This is an applied geology module aimed at civil engineers, geologists and environmental scientists. The hydrogeology component covers the analysis of groundwater flow, both regional flow and radial flow to wells, with an emphasis on teaching the student to compare and evaluate different methods of analysis, and to critically examine the underlying assumptions. Students are introduced to various techniques in groundwater investigation, borehole drilling, geophysical logging methods, well design, profile sampling. Students are also taught how to plan groundwater investigations in a systematic manner, with the aid of case studies. The groundwater pollution component deals with the analysis of organic pollutant properties and their application to groundwater contamination problems (as such, this module component is complementary to compulsory modules in the students third and fourth years which focus on water flow and quality issues).

Module content

- Groundwater concepts [Asst. Prof. David O'Connell]
    - Aquifers, aquitards and aquicludes
    - Confined and unconfined aquifers
    - Aquifer properties
- Groundwater flow [Asst. Prof. David O'Connell]
    - General flow equations
    - Methods of solution: flow nets, analytical solutions, numerical methods
    - Analytical solutions for regional flow in confined and unconfined aquifers
    - Radial flow to wells under steady state and transient conditions
    - Multiple wells: principle of superposition
    - Hydraulic boundary effects
    - Introduction to the use of distributed groundwater models
- Groundwater exploration and development [Asst. Prof. David O'Connell]
    - Hydrogeological surveys
    - Geophysical techniques: resistivity, EM, seismic refraction
    - Exploratory drilling methods
    - Formation sampling and geophysical logging
    - Introduction to well design
- Groundwater Organic Chemical Pollution [Asst. Prof David O'Connell]
    - Basic principles of organic chemistry, properties and phase transition
    - Vadose zone contaminant processes
    - Dissolution of NAPL source zones
    - Groundwater Organic Contaminant monitoring and pollution
    - Abiotic Organic Chemical Reactions
    - In-situ Groundwater Remediation Techniques
    - Civil engineering based remediation

	The module outcomes are targeted at analysis and evaluation, and the implications of this evaluation for engineering design and practice. It aims to motivate students to develop an interest in the subject matter, but also to enhance their skills in critical thinking within an engineering context. The applications to engineering practice consider the social and business context.
Teaching and Learning Methods	Lectures, tutorials, demonstrations and in-class labs.

Assessment Details[2]
Please include the following:

- **Assessment Component**
- **Assessment description**
- **Learning Outcome(s) addressed**
- **% of total**
- **Assessment due date**

Assessment Component	Assessment Description	LO Addressed	% of total	Week due
Examination	2 hour written examination [Online exam – covid-19 contingency]	LO1-4	100%	

Reassessment Requirements	100% written examination

Contact Hours and Indicative Student Workload[2]	
	Contact hours: 32 hours lectures including lectures, tutorials, labs.
	Independent Study (preparation for course and review of materials): 40 hours; Researching journals; reading text books recommended in module booklist; reviewing lecture material and class notes; practice calculations.
	Independent Study (preparation for assessment, incl. completion of assessment): 30 hours; literature review, review of lectures and tutorial questions.

[2] TEP Guidelines on Workload and Assessment

Recommended Reading List	***Groundwater and Pollution*** Fetter, CW (2001). *Applied Hydrogeology*. Fourth edition. Macmillan. Hiscock, KM & Bense, V (2014). *Hydrogeology: Principles and Practice*. Second edition. Wiley-Blackwell. Misstear, BDR, Banks, D & Clark, L. (2006) *Water Wells and Boreholes*. Wiley Reynolds, JM (2011). *An introduction to Applied and Environmental* *Geophysics*. Second edition. Wiley. C. W. Fetter, Thomas Boving, David Kreame. Contaminant Hydrogeology, Third Edition.
Module Pre-requisite	
Module Co-requisite	No co-requisite
Module Website	https://www.tcd.ie/Engineering/undergraduate/baiyear4/modules/4A2.pdf
Are other Schools/Departments involved in the delivery of this module? If yes, please provide details.	No
Module Approval Date	
Approved by	
Academic Start Year	January 2024
Academic Year of Date	2023-24

COVID-19 contingency statement:

While the intention is to deliver lectures, tutorials and labs face-to-face, there is uncertainty due to the Covid-19 situation and the entire module delivery may need to change to an online delivery if required by government restrictions. In the case of a possible new lockdown scenario during teaching term:

- All lectures, tutorials and labs will be delivered online using Blackboard. Some of these sessions will be ***live*** sessions and your attendance at live sessions is required.
- Assignments and examinations will be conducted and submitted online.