Module Code	CEU44A02
Module Name	4A2 Hydrogeology and Engineering Geology
ECTS Weighting[1]	5 ECTS
Semester taught	Semester 2
Module Coordinator/s	Lecturer(s): Asst. Prof. David O'Connell (oconnedw@tcd.ie) ; Dr. Rosanne Walker (WALKERRO@tcd.ie)
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 rock behaviour in a variety of contexts, such as how to identify and then deal with the occurrence of karst features when designing a road. **Graduate Attributes: levels of attainment** To act responsibly - Enhanced To think independently - Enhanced To develop continuously - Enhanced To communicate effectively - Introduced
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

engineering geology component deals with the analysis of rock properties and their application to geotechnical problems (as such, this module component is complementary to compulsory modules in the students third and fourth years which focus on geotechnical issues in soils).

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
- Properties of rock and rock mass [Prof Rosanne Walker]
  - Engineering geology terminology
  - Standard laboratory tests
  - Logging and discontinuity analysis
  - Stereographic projection
  - Behaviour of rock samples: strength and deformation
  - Behaviour of rock mass
  - Slope failures in rock
  - Analysis of slope stability
  - Hazardous rock conditions, such as karst and pyrite, and their implications for design.

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, 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	LO1-4	100%	

Reassessment Requirements

100% Written Examination

Contact Hours and Indicative Student Workload[2]

Contact hours: 39 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
Independent Study (preparation for assessment, incl. completion of assessment): 30 hours; literature review, review of lectures and tutorial questions.

Recommended Reading List

Hydrogeology

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.

Engineering geology

	Waltham, T (2009) *Foundations of Engineering geology*, Third edition, Spon Press Hoek, E & Bray, JW (1981). *Rock slope engineering*. E & FN Spon.
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 2022
Academic Year of Date	2021-22

COVID-19 contingency statement:

While the intention is to deliver some 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.