3A8 – Geology for Engineers [5 credits]

Lecturer(s): Prof. Sean McClenaghan, TBN

Module organisation
This module consists of 33 lectures over 11 weeks, together with 4 practical exercises and a fieldtrip to a local site of geological interest. All practicals, the fieldtrip and 9 weeks of lectures (geology) are given by Sean McClenaghan, the remaining lectures (hydrogeology) are given by Bruce Misstear.

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<th>Engineering Semester or Term</th>
<th>Start Week</th>
<th>Hours of Associated Practical Sessions</th>
<th>End Week</th>
<th>Lectures</th>
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Total Contact Hours: 41

Module description, aims and contribution to programme
Geology for Engineers provides an introduction to several areas of Earth Sciences that impact the engineer, including geological materials, earth surface processes, hydrocarbon exploration and production, natural disasters and climate change. Engineers often need to work with geologists. This module will enable the student to operate effectively in such a team by explaining terminology and concepts in the fields stated above. The module also provides the engineer with a natural, regional-scale context in which to place site-specific questions. Financial and time pressures on the engineer necessarily force him/her to concentrate on the site-specific aspects of geology, such as the mechanical properties of the ground and the local risk of natural hazards like flooding, subsidence or earthquakes. This module provides examples of how such local-scale phenomena can be better predicted using knowledge of regional-scale geological processes. The student will learn the kind of questions that geologists can answer, allowing him/her to better assess how much time/money to spend on geological investigations for any given project.

Learning outcomes
On completion of this module the student will be able to:
1. Recognise standard terminology, including basic classification systems for geological materials, and terminology applied to important plate tectonic, surface and climatic processes.
2. Describe the formation and internal structure of planet Earth and describe plate tectonic theory.
3. Explain how natural hazards such as earthquakes, tsunamis and volcanoes relate to plate tectonic processes, and explain difficulties in predicting natural disasters.

4. Explain the generation of hydrocarbons within sedimentary basins, use simple exploration techniques, and compare technologies for hydrocarbon exploration and extraction.

5. Describe the roles of glacial, fluvial, hill slope, coastal and submarine processes in forming the natural environment, and appraise whether engineering solutions are appropriate in managing surface processes.

6. Explain the major controls on global climate, describe evidence for natural climate change in the geological record, and assess the engineer’s role in managing anthropogenic climate change.

7. Explain the sources and distribution of radon in Ireland, describe engineering solutions to alleviate high indoor radon levels.

8. Explain the occurrence of groundwater, apply equations of groundwater flow to simple engineering problems, and give examples of the application of hydrogeology to environmental engineering.

Module content

- **Planet Earth [Dr. Sean McClenaghan]**
  - Earth’s internal structure: core, mantle, crust
  - Plate tectonics – Deformation of the plates: faulting and folding
  - Earthquake seismology
  - Describing and classifying rocks and minerals
  - Measuring geological time

- **Volcanic Processes [Dr. Sean McClenaghan]**
  - Controls on physical properties of magma
  - Principles of multi-phase geophysical flows
  - Eruption dynamics
  - Important mineral deposits produced by volcanic processes

- **Sedimentary basins and Hydrocarbons [Dr. Sean McClenaghan]**
  - Imaging sedimentary basins using reflection seismology
  - Types of sedimentary basin
  - Generation of hydrocarbons within sedimentary basins
  - Hydrocarbon exploration techniques

- **Geology of Ireland [Dr. Sean McClenaghan]**
  - Tectonic overview
  - Basement structure
  - Examples of igneous rock
  - Main occurrences of metamorphic rock
  - Clastic and carbonate sediments

- **Earth surface processes [Dr. Sean McClenaghan]**
  - Glacial landforms and sediments
  - Weathering, slope and river processes
  - Coastal processes
  - Role of society in controlling surface processes

- **Natural hazards [Dr. Sean McClenaghan]**
Updated 27th June 2018

- Earthquakes
- Tsunamis
- Volcanic hazards
- Radon and other radiological hazards

- **Climate [Dr. Sean McClenaghan]**
  - Role of atmosphere, oceans and the solid Earth in controlling climate
  - The Greenhouse Effect
  - Milankovitch cycles
  - Role of society in moderating climate change

- **Geology of Mineral Deposits [Dr. Sean McClenaghan]**
  - Natural Resources and their extraction
  - Mine Engineering
  - Acid Rock Generation

- **Hydrogeology [TBN]**
  - Hydrogeological terms
  - Occurrence of groundwater
  - Groundwater head and groundwater flow
  - Application of hydrogeology to landfill site selection and design
  - Groundwater protection

**Teaching strategies**

**Assessment**
Assessment is by one two hour exam at the end of the second semester. All of the material taught in the module (including practicals and field trip) is examinable.

**Required textbook**
This module focuses on areas of earth sciences of interest to the engineer. The module website contains illustrated sets of notes that relate directly to each group of geology lectures. These notes are designed to explain the important geological and geophysical processes in language understandable by physical scientists. The notes contain references to specific sections of a number of textbooks and websites in order to encourage students to further improve their knowledge. Recommended texts include:

- *Understanding Earth* (second edition), Press & Siever
- *The Solid Earth* (second edition), Fowler
- *Geology Basics for Engineers, Parriaux*
- *Introducing Groundwater* (second edition), Price
- *Water wells and boreholes* (second edition), Misstear, Banks & Clark

**Further information**
Module material, including geology handout notes and practical exercises will be made available in Blackboard on a week by week basis during the module.