Module Code	CEU44A04
Module Name	4A4 Hydraulics
ECTS Weighting[1]	5 ECTS
Semester taught	Semester 1
Module Coordinator/s	Aonghus McNabola
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: 1. To predict the performance of hydraulic prototypes from simple hydraulic models. 2. To demonstrate an understanding of open channel flow in relation to natural channels. 3. To categorise turbines and to design the hydraulic aspects of a small scale hydro electric scheme. 4. To calculate the forces on sediment on the bed of a river and to design river bank slope protection measures. 5. To analyse river hydrographs and to relate the river response to rainfall data. 6. To interpret the results from a network of rain gauges and synthesise the data for use in a hydrological study of a river catchment. 7. To evaluate the translation and attenuation of a flood hydrograph down a river channel using hydrologic flood routing techniques. 8. To demonstrate an understanding of and formulate design solutions for problems involving unsteady flows. 9. To predict the transformation of waves using linear wave theory **Graduate Attributes: levels of attainment** To act responsibly - Enhanced To think independently - Enhanced To develop continuously - Enhanced To communicate effectively - Enhanced

Module Content

This is a one semester module. It explains the use of dimensional analysis in predicting the performance of prototypes from model studies and in the analysis of significant variables in hydraulic experiments. The module reviews the important relationship of open channel flow in natural channels and uses these relationships to study the water profiles to be expected in various design situations. The module explains the concepts behind hydraulic turbines and categorises turbines in relation to the specific head and usage. The design of small scale hydro schemes is also formulated. The module develops design methods for river protection measures by analysing the stability of sediment on the river bed. The hydrology section of the course begins by describing how to quantify the water mass balance on a catchment by rainfall and evaporation measurement and analysis. The measurement of flow in rivers is then explained by various gauging methods before the concept of a hydrograph is detailed. The design technique of the Unit Hydrograph is then developed before finally explaining different methods which can be used to route a flood down through a river channel. The module also examines the behaviour of sea-water waves using linear wave theory, predicting their speed, power and energy among other factors. Students will be able to apply this theory to the design of coastal structures or wave energy devices. Finally, the module examines analysis of engineering problems involving unsteady flow, such as pressure transient in pipelines and quasi-steady flow problems.

Module content

- **Dimensional analysis and similarity**
  Indicial method and Buckingham's theory

  Prediction of the performance of prototypes from models

  Simplification of experimental studies.

- **Open channel flow in Natural Channels**
  Velocity Distributions in Natural Channels

  Flow in Compound Channels

  Conveyance

- **Turbines and hydro schemes**
  Engineering characteristics of turbines

  Analytical methods of predicting the performance of turbines

- **River protection**
  Analysis of forces on sediment in rivers

	Analytical methods of designing river protection systems ○ **Hydrology** Precipitation measurement and analysis Evaporation measurement and calculation River gauging and flow measurement Hydrograph analysis Unit Hydrograph Flood routing. ○ **Unsteady Flow** Types of unsteady flow Pressure Transients Surge Towers Quasi-steady flow ○ **Linear Wave Theory** Wave transformation processes Wave Energy Coastal Protection
Teaching and Learning Methods	This module is taught by a combination of online and face to face lectures, laboratory classes and tutorials.

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	LO1-9	75%	
Coursework	3 laboratories & 1 assignment	LO1-9	25%	

Reassessment Requirements

100% written examination

Contact Hours and Indicative Student Workload[2]

Contact hours: 27 lectures, 3 lab sessions
Independent Study (preparation for course and review of materials): 30 hrs
Independent Study (preparation for assessment, incl. completion of assessment): 60 hrs

Recommended Reading List

Hydraulics in civil and environmental engineering - Chadwick & Morfett (E & FN Spon)

Hydrology in practice – Shaw (Chapman & Hall)

Engineering Hydrology – Wilson (Scholium International)

Mechanics of Fluids – Massey (Taylor & Francis)

Module Pre-requisite

Module Co-requisite

Module Website

https://www.tcd.ie/Engineering/undergraduate/baiyear4/modules/4A4.pdf

Are other Schools/Departments involved in the delivery of this module? If yes, please provide details.

Module Approval Date

Approved by

Academic Start Year	September 2020
Academic Year of Date	2020-21

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:

- Lectures and tutorials will be delivered online using Blackboard. Sessions will be ***live*** sessions and your attendance at live sessions is required. Labs will be conducted in person unless government guidelines prevent this in future.
- Assignments and examinations will be conducted and submitted online.