MODULE DESCRIPTOR 2019/20

CL989 Isotope Hydrology

Registrar: Prof Robert M Kalin	**Taught To (Programme): MSc**	
Other Lecturers Involved:	**Credit Weighting: 10**	**Semester: 1/2/3**
Assumed Pre-requisites:	**Compulsory/ optional/ elective class**	**Academic Level: 5**

Class Format and Delivery (hours):

Lecture	Tutorial	Laboratory	Coursework	Project	Private Study	**Total**
35	5		30		30	100

Class Aim(s)

This class aims to:

- Explore the evaluation of the water environment using the natural abundance of stable and radio isotopes
- Develop application of Isotope Hydrology Principals including:
  - Evaluation of Precipitation Sources with Isotopes
  - Evaluation of Surface Water with Isotopes
  - Evaluation of Groundwater with Isotopes
- Develop skills examining water resources management using natural stable and radio isotopes, including:
  - Analysing relationships between precipitation, runoff and storage
  - Analysing hydrographs
  - Examining the influence of contaminants in the environment
  - Using Isotope Hydrology within an Earth Science System analysis
- Develop skills examining water resources management using atmospheric gases
  - Use stable and inert atmospheric gases (Ne, Kr, Ar and Xe) to understand the physical conditions under which groundwater recharge occurred (recharge temperature, excess air and degassing)
  - Relate dissolved concentrations of trace atmospheric gases to atmospheric mixing ratios using Henry's Law (groundwater age)
  - Develop an understanding of groundwater age in relation to groundwater resource management (groundwater flow velocity, recharge rates and mixing)
  - Examine the susceptibility of a groundwater resource to contamination
  - Constrain groundwater flow models using groundwater age estimates

Learning Outcomes

On completion of the class the student is expected to be able to

LO1

LO2

LO3

LO4

Syllabus

The class will teach the following:

Hydrological cycle and Stable / Radio Isotopes
Isotopes in Atmospheric water; Water vapour, Precipitation, Evapotranspiration
Isotopes in Hydrologic Measurement of atmospheric water and surface water; rain gauges,
Calculation of catchment inflow from multiple sources
Catchment water balance using Isotope Hydrology
Isotopes within Earth Science Systems
Age dating of groundwater with Isotopes
Age dating of groundwater with atmospheric gases
Calculation of the physical conditions under which groundwater was recharged using atmospheric gases

Assessment Criteria

For each of the Course Learning Outcomes the following criteria will be used to make judgements on student learning:

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LO1 Outline the significance of using Isotope Hydrology and atmospheric gases (collectively referred to as "environmental tracers") to evaluate the water cycle in the environment, developing appropriate models for the hydrological process and applying environmental tracers as a tool for analysing surface water and groundwater catchments.

C1 Detail the underlying principles and individual components of the hydrological cycle
C2 Use environmental tracers to determine contributions of hydrological cycle components
C3 Ability to perform catchment water balance analysis using environmental tracer techniques
C4 Detail various possible sources of uncertainty in Integrated Water Resources Management and the use of environmental tracers in reducing uncertainty

LO2 Evaluate key management strategies for Integrated Water Resources Management based on environmental tracer principles

C1 Ability to calculate catchment water balances using environmental tracer data
C2 The ability to determine the temporal controls on water movement in the environment using environmental tracer data
C3 The ability to solve complex hydrological analyses using environmental tracers
C4 The ability to identify natural biogeochemical reactions using environmental tracers

The standards set for each criterion per Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessments.

Principles of Assessment and Feedback (*https://www.strath.ac.uk/staff/policies/academic/*)

(on Learning & Teaching web pages: http://www.strath.ac.uk/learnteach/informationforstaff/staff/assessfeedback/12principles/)

Please state briefly how these are incorporated in this class.

1. All assignments and assessments combine straightforward and challenging tasks. Assessment criteria are set clearly in advance, as are marking rubrics and resources.
2. All assessed coursework assignments are returned to students with feedback including annotations and comments. Model solutions are provided for some coursework assignments.
3. Opportunity for one-to-one interaction between instructors and students and timely feedback will be made at least every two weeks but is planned on a weekly basis. Online forums and

discussion environments will be used and participation encouraged for peer learning on problems

Recommended Reading

Various environmental tracer papers and materials on MyPlace

PLEASE NOTE:
Students need to gain a summative mark of 50% to pass the module. Students who fail the module at the first attempt will be re-examined during the August diet. This re-examination will consist entirely of exam / coursework.

Resit Arrangements

Will be made on a case by case basis

Approved

Programme Director Signature:
Date of Last Modifications: 14/09/19

Assessment and Feedback Schedule

Class Code	CL989	Class Title	Isotope Hydrology

Brief Description of Assessment

Online Exam (50%)
Online Quizzes (10%)
Assignment 1 (10%)
Assignment 2 (15%)
Assignment 3 (15%)

Indicate in the tables below the Hand-Out (H), Submission (S) and Feedback (F) dates for each lab report/coursework/project and the timing of each Exam/Class Test (E), (T). Include duration of exam in brackets (e.g. E (2)).

Term 1/2/3

Assessment type (& title)	LOs	Weight (%)	Individual / Group	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
Weekly Quizzes	LO1 LO2		Individual	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
Assignment 1	LO1 LO2		Individual	H					S			F			
Assignment 2	LO1 LO2		Individual	H							S			F	
Assignment 3	LO1 LO2		Individual	H									S		F
Class Exam	LO1 LO2		Individual											H	SF