



Module Descriptor Form

Civil and Environmental Engineering

CL951 - Groundwater Flow Modelling

Module Code	CL951	Module Title	Groundwater Flow Modelling				
Module Registrar	Kremer, Dr Yannick						
Other Staff Involved							
Credit Weighting	10	Semester	2	Elective	Yes	Academic Level	5
Pre-requisites							
Required for							

Module Format and Delivery (hours):

Lectures	Tutorials	Assignments	Labs	Private Study	Total
9	27	40	0	24	100

Educational Aim

This module aims to:

This class aims to guide the student

- To gain an understanding of Groundwater Flow Modelling as a discipline and to understand the role of modelling in hydrological research, groundwater management and environmental protection.
- To understand the key equations required for modelling groundwater flow and solute transport.
- To understand how a finite difference approach can be used to solve partial differential equations such as the groundwater flow equation, in a spatiotemporal domain.
- To provide an introduction to MODFLOW, an industry standard numerical code for groundwater flow modelling.
- To provide an introduction to MT3D, an industry standard groundwater solute transport simulator.
- To provide an introduction to FloPy (a Python interface to MODFLOW) and demonstrate the use of Python notebooks for interactive modelling and reporting. The class includes a basic introduction to Python Programming. The student does not need to have any programming experience before starting the class.
- To develop groundwater flow modelling skills and understand how groundwater models can be used to refine and understand conceptual models, and to understand the limitations inherent to numerical modelling

Syllabus

This module will teach the following:

The course will be taught using a combination of online and on-campus lectures, computer tutorials, self study and independent project work. The following topics will be covered in the lectures and tutorials:

- Key equations for groundwater flow modelling and contaminant transport
- Case studies applied hydrology
- Numerical modelling
- Finite difference and finite element models
- Conceptual models
- Groundwater flow models
- MODFLOW and FloPy
- Model parameter calibration and sensitivity
- An introduction to Python and related tools. No prior knowledge of programming or Python is required.

N.B. the class runs over nine weeks. For on campus students, the class will be delivered via a flipped classroom. A typical week will consist of:

- 2 to 4 mini lecture videos (10 minutes each)
- Independent reading (1-2 hours)
- On campus introduction lecture (10-20 minutes)
- On campus tutorial (2-4 hours)
- MyPlace quiz 5-10 minutes

For distance learning students a recorded version of the on campus lecture will be made available, in addition to the online resources. A weekly Zoom session will be scheduled for the tutorial. This Zoom session will be planned at a time to allow as many students to attend.

Assessment is based on the MyPlace quizzes and two written assignments.

Learning Outcomes

On Completion of the module, the student is expected to be able to:

LO: 1	The role of groundwater flow modelling within hydrogeology and consequently water resources management.
LO: 2	The mathematical basis of groundwater flow models (Darcy's law, conservation of mass/energy, finite difference models)
LO: 3	The key components of groundwater flow models and the typical workflow of groundwater flow modelling, with emphasis on application using MODFLOW.
LO: 4	Interpretation of groundwater flow models in a water resource management context

(UK SPEC suggests no more than 4 learning outcomes per module. Statements must be broad and be syllabus free and link in with the intended learning outcomes on the programme specifications.)

CL951 - Groundwater Flow Modelling**Assessment of Learning Outcomes - Criteria**

Learning Outcome: 1

	Criteria
1	C1 Theory of groundwater flow modelling C2 Understanding and knowledge of the groundwater flow modelling discipline
2	Understanding and knowledge of the groundwater flow modelling discipline

Learning Outcome: 2

	Criteria
1	Implementation of finite difference scheme in spreadsheet software
2	Demonstrate understanding of model basis in written reports

Learning Outcome: 3

	Criteria
1	Document the functioning and implementation of groundwater flow models using MODFLOW in written reports
2	Successful completion of weekly assignments using MODFLOW, assessed using MyPlace quizzes

Learning Outcome: 4

	Criteria
1	Written reports on Groundwater Flow models, interpreting case studies.
2	MyPlace quizzes on theory and applications

Assessment Method(s) Including Percentage Breakdown and Duration of Exams

To Pass the module, students need to gain a summative mark of: 50%

Description	Semester	Start Week	Duration	Weight	Submission Week	Linked Criteria
Individual video presentation	2	2		40%	8	
Dumfries basin model report	2	4		40%	11	

Principles of Assessment Feedback

Principles of Assessment and Feedback

(within Assessment and Feedback Policy at:

<https://www.strath.ac.uk/staff/policies/academic/http://www.strath.ac.uk/learnteach/informationforstaff/staff/assessfeedback/12principles/>)

1. Assessment and feedback promote effective student learning . Learning is assessed by two assignments and weekly MyPlace quizzes. The first assignment focusses on the role of modelling in the science and practice of hydrogeology (LO1, LO2). Students will select a topic in hydrogeology and review it using multiple published modelling studies. The second assignment focusses on applied groundwater flow modelling. In the class tutorials students will develop a groundwater flow and transport model. For assignment 2 they document the model and asses it's implications on groundwater resource management (LO3 and LO4).
2. Assessment and feedback practices promote effective student learning . Each week includes a tutorial. MyPlace mini-quizzes are used to assess the tutorials (LO1, LO2, LO3, LO4).
3. Assessment criteria for the two written assignments are communicated clearly to the students in week 1.
4. Assessment and feedback procedures are reviewed annually.

Additional Information

Resit Procedure

Submission of coursework(s) prior to commencement of the August exam diet.

Recommended Reading

***Purchase recommended **Highly recommended reading *For reference

*** Anderson, Mary P., William W. Woessner, and Randall J. Hunt. Applied groundwater modeling: simulation of flow and advective transport. Academic press, 2015. (Available online via Strathclyde Library)

** Sundnes, Joakim. Introduction to scientific programming with Python. Springer Nature, 2020. (Open Access)

* Cohen, Andrew J.B., John A. Cherry, Conceptual and Visual Understanding of Hydraulic Head and Groundwater Flow . The Groundwater Project 2020. (Available for free from gw-project.org)

Module Timetable

Week	Semester 1	Semester 2
0		
1		
2		
3		
4		
5		
6		
7		
8		Submission 40%
9		
10		
11		Submission 40%
E		

Date of Last Modification

06-11-2025