1 INSTRUCTOR

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Office hours: By appointment

2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*6740 CourseLink site. You are responsible for checking the site regularly.

2.2 Required Resources

Slides, hands-on activities and assignment instructions will be posted on CourseLink. Visual MODFLOW Flex software and HydroGeoSphere software (with ParaView for visualization) is available in School of Engineering computer laboratories.

2.3 Recommended Resources


2.4 Additional Resources

**Lecture Information:** Basic lecture notes (slides) and hands-on activities are posted on CourseLink.

**Assignments:** The assignment requirements are posted on CourseLink and discussed in class.

**Project:** The project requirements are posted on CourseLink and discussed in class.

3 ASSESSMENT

3.1 Dates and Distribution

**Assignments:** 60% (completed individually)
- 5 in total, distributed every 2 weeks starting on Tuesday, September 15.

**Term Project:** 40% (completed in groups of 2 or individually)
- This is a report (in the form of a journal article), due on Tuesday, December 8, 5:00 pm.

3.2 Course Grading Policies

**When You Cannot Meet a Course Requirement:** When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course in writing, with your name, id#, and e-mail contact. See the graduate calendar for information on regulations and procedures for Academic Consideration:

https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2082.shtml
Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2116.shtml

Passing grade: Students must obtain a final grade of 65% or higher in order to pass the course.

Late Assignments: Late submissions of assignments or the term project will be penalized by 20% per day late.

4 AIMS & OBJECTIVES

4.1 Calendar Description

Introduction to current groundwater issues, definition of terms, review of fundamental equations describing fluid and contaminant transport in saturated groundwater zones. Mathematical techniques (analytical, FE and FD) for the solution of the fundamental equations. Application of numerical groundwater models to a variety of situations. Case studies. Review of groundwater models used in industry.

4.2 Course Aims

The goal of this course is to introduce students to the basics of groundwater modelling as it is currently practised. Primary topics will include an introduction to groundwater issues, definition of pertinent terms as well as an introduction to the fundamental equations describing fluid flow and contaminant transport in the saturated zone. Before proceeding to the use of already existing (e.g., commercial) groundwater models, the various mathematical techniques for the solution of the fundamental equations will be introduced and their advantages and shortcomings covered. The course will finish with the application of the models to a variety of situations. Finally, groundwater models commonly used in industry are covered.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Know the basis for the fundamental equations for groundwater movement for steady and unsteady flow for fully saturated conditions.
2. Understand the basic parameters used in groundwater systems to describe the transport mechanisms of fluid and dissolved contaminants.
3. Be familiar with the transformation of the fundamental partial differential equations into approximate linear equations for the purposes of numerical modelling.
4. Understand the capabilities and limitations of numerical modelling for groundwater systems.
5. Develop and apply a commercial grade groundwater model to a variety of situations including those for which an analytical solution exists.

4.4 Instructor’s Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. Lecture notes (slides) will be made available to students on CourseLink but these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide information to supplement the posted notes. Scheduled classes will be the principal venue to provide information and feedback for assignments and the project.

4.5 Students’ Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

E-mail Communication: As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Recording of Materials: Presentations which are made in relation to course work—including lectures—cannot be recorded in any electronic media without the permission of the presenter, whether the instructor, a classmate or guest lecturer.

4.6 Relationships with other Courses

Previous Courses: It is expected that students taking this course will have an undergraduate degree in engineering or equivalent. Although an undergraduate course in groundwater would be advantageous, it is not a prerequisite (although self-directed supplemental learning will be required).

5 Teaching and Learning Activities

5.1 Timetable

Lectures:
   Tuesday: 9:30 am to 12:20 pm
   Thursday: 9:30 am to 12:20 pm

There will be 12 lectures in total, starting Thursday, September 10 until Thursday, October 22. No class will be held on Tuesday, October 13 (Fall Study Break). However, the assignments and term project will be completed throughout the entire semester.

RICH 2531
5.2 Course Topics and Schedule

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to course and basic groundwater principles</td>
</tr>
<tr>
<td>2</td>
<td>Groundwater flow (e.g., governing equations)</td>
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<tr>
<td>3</td>
<td>Analytical solutions (flow)</td>
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<tr>
<td>4</td>
<td>Numerical solutions (finite difference) and intro to groundwater modelling software (Visual MODFLOW Flex)</td>
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<tr>
<td>5</td>
<td>Finite difference method continued (space and time)</td>
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<tr>
<td>6</td>
<td>Solution methods</td>
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<tr>
<td>7</td>
<td>Modelling considerations (e.g., calibration)</td>
</tr>
<tr>
<td>8-9</td>
<td>Contaminant transport (e.g., governing equations)</td>
</tr>
<tr>
<td>10</td>
<td>Guest lecture (modelling applications using HydroGeoSphere and visualization with Paraview); Assignment work period</td>
</tr>
<tr>
<td>11</td>
<td>Simulating transport (MODFLOW); Term project work period</td>
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<tr>
<td>12</td>
<td>Term project work period</td>
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</tbody>
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5.3 Other Important Dates

**Drop Date:** The last date to drop one-semester courses, without academic penalty, is Friday, November 6, 2015. Two-semester courses must be dropped by the last day of the add period in the second semester. Refer to the Graduate Calendar for the schedule of dates: [https://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-f10.shtml](https://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-f10.shtml)

**Feedback:** By the 40th class day, some feedback (grade assessment) should be provided to students: [https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2072.shtml](https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2072.shtml)

6 LAB SAFETY

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible. There is to be no food or drink in the computer laboratory.
7 ACADEMIC MISCONDUCT

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University’s policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection. The Academic Misconduct Policy is detailed in the Graduate Calendar: https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2386.shtml

7.1 Resources

A tutorial on Academic Integrity produced by the Learning Commons can be found at: http://www.academicintegrity.uoguelph.ca/

The School of Engineering has adopted a Code of Ethics that can be found at: http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

The Graduate Calendar is the source of information about the University of Guelph’s procedures, policies and regulations which apply to graduate programs: http://www.uoguelph.ca/registrar/calendars/graduate/current/

8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community’s shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact Student Accessibility Services (SAS) as soon as possible

For more information, contact SAS at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/
9 RECORDING OF MATERIALS

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

10 RESOURCES

The Academic Calendars are the source of information about the University of Guelph’s procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:
http://www.uoguelph.ca/registrar/calendars/index.cfm?index