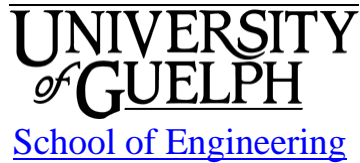


ENGG*3220 Groundwater Engineering Winter 2019



(Revision 1: January 3, 2019)

1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Miln Harvey, Ph.D., P.Eng., FEC
Office: Thorn 2361 (Ext. 53385)
Email: miln@uoguelph.ca
Office hours: Monday: 13:30 to 14:20
Wednesday: 13:30 to 14:20

1.2 Lab Technician

Technician: Ryan Smith
Office: 1114
Email: rsmith17@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Teresa Pilato	tpilato@uoguelph.ca	During lab
Oliver Conway-White	oliver.conway-white@g360group.org	During lab

2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*3220 CourseLink site. You are responsible for checking the site regularly.

2.2 Required Resources

1. C.W. Fetter, *Applied Hydrogeology*, 4th edition, Prentice Hall, 2001.
 - **You need to purchase this textbook.**
2. R.A. Freeze and J.A. Cherry, *Groundwater*, Prentice Hall, 1979. A pdf version of each chapter of this textbook is available here: <http://hydrogeologistswithoutborders.org/wordpress/1979-english/>

2.3 Recommended Resources

There are various groundwater textbooks and resources available at the library, should you wish to do additional reading. Another excellent resource is:

- F.W. Schwartz and H. Zhang, *Fundamentals of Ground Water*, John Wiley & Sons, Inc., 2003

2.4 Additional Resources

Lecture Information: The lecture slides are posted on CourseLink. Additional notes (handwritten) are provided in class.

Lab Information: The handouts for all the lab sessions are within the labs section of CourseLink.

Exams: Any pertinent resources will be posted on CourseLink.

Miscellaneous Information: Additional resources (e.g., links to pertinent web pages) can be found on CourseLink.

2.5 Communication and Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website (CourseLink). **It is your responsibility to check the course website regularly.** 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 student.

3 ASSESSMENT

3.1 Dates and Distribution

Labs: 30%

See section 5.3 below for due dates

Midterm exam: 30%

Wednesday, February 27, 2019, in class (14:30-15:50)

Final Exam: 40%

Wednesday, April 17, 2019 19:00-21:00, Room TBA on WebAdvisor

3.2 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on the regulations and procedures for Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.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 the regulations and procedures for Academic Accommodation of Religious Obligations:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

Passing grade: In order to pass the course, you must pass the final exam. Students must obtain a grade of 50% or higher on the final exam portion of the course in order for the laboratory assignment portion of the course to count towards the final grade.

Missed midterm exam: If you miss the midterm exam due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the final exam. There will be no makeup midterm exam.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab.

Late Lab Reports: Late submissions of lab reports will not be accepted.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

This course introduces water resources engineering and environmental engineering students to the fundamentals of groundwater systems. Emphasis is placed on quantitative analyses required for groundwater resource extraction and quality protection of the saturated zone. Laboratories emphasize problem solving, use of commercial software and practical groundwater engineering investigation.

Prerequisite(s): ENGG*2230

4.2 Course Aims

This is an introductory course in groundwater engineering, which is an important area of practice for water resources and environmental engineers. The main goals of the course are:

1. to teach students the fundamental concepts in applied quantitative hydrogeology; and
2. to provide an understanding of the practical engineering tools and approaches for analysis including field and lab work.

4.3 Learning Objectives

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

1. Understand the principals of, and apply, the equations governing groundwater flow.
2. Conduct and interpret parameter estimation tests and analyses.
3. Apply fundamental knowledge to the design of groundwater resource extraction systems.
4. Understand and apply contaminant transport principles for porous media subsurface systems.
5. Use common software tools to aid quantitative analysis (e.g., interpretation of aquifer tests).

4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

Graduate Attribute	Learning Objective	Assessment
1. Knowledge Base for Engineering	1, 2, 3, 4	Labs, Exams
2. Problem Analysis	2	Labs, Exams
3. Investigation		
4. Design		
5. Use of Engineering Tools	5	Labs
6. Communication		
7. Individual and Teamwork		
8. Professionalism		
9. Impact on Engineering and Society and the Environment	4	Labs
10. Ethics and Equity		
11. Environment, Society, Business and Project Management		
12. Life-Long Learning		

4.5 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 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 example problems that supplement posted notes. Scheduled classes and labs will be the principal venue to provide information and feedback for tests and assignments.

4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and laboratories. 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.

4.7 Relationships with other Courses & Labs

Previous Courses:

ENGG*2230: Fundamentals of gravity and pressure driven flow

Follow-on Courses:

ENGG*4240: Groundwater remediation technologies

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Monday	14:30 – 15:50	THRN 1307
Wednesday	14:30 – 15:50	THRN 1307

Laboratory:

Wednesday	Sec 01	8:30 – 10:20	<i>Soils lab:</i> THRN 1107 <i>Seminar room:</i> ROZH 108 <i>Computer lab:</i> THRN 2336
Monday	Sec 02	11:30 – 13:20	<i>Soils lab:</i> THRN 1107 <i>Seminar room:</i> MCKN 304 <i>Computer lab:</i> THRN 2336
Wednesday	Sec 03	10:30 – 12:20	<i>Soils Lab:</i> THRN 1107 <i>Seminar room:</i> CRSC 101 <i>Computer lab:</i> THRN 2336
Friday	Sec 04	10:30 – 12:20	<i>Soils Lab:</i> THRN 1107 <i>Seminar room:</i> MCKN 521 <i>Computer lab:</i> THRN 2336

5.2 Lecture Schedule

Week	Lecture Topics	Fetter Chapter	Learning Objectives
1	<ul style="list-style-type: none"> Principles of, and equations governing, groundwater flow Groundwater as a component of the hydrologic cycle Review of aquifers, aquitards, hydraulic conductivity, intrinsic permeability, transmissivity 	1, 2, 3	1
2	<ul style="list-style-type: none"> Review of porosity, specific yield, storativity Hydraulic head, gradient, recharge Homogeneity/heterogeneity and isotropy/anisotropy Darcy's law and its applicability Scale and representative elementary volume 	3, 4	1
3	<ul style="list-style-type: none"> Piezometers and monitoring wells Water table mapping Surface water-groundwater interaction Determining groundwater recharge from baseflow 	3, 4	1
4	<ul style="list-style-type: none"> Estimating baseflow using seepage meters Derivation of, and solutions to, the 3D flow equations for confined and unconfined porous media aquifers Boundary conditions and the Dupuit assumptions Flow nets and discharge calculations 	4, 5	1

5	<ul style="list-style-type: none"> • Radial flow to a pumping well • Determining aquifer parameters from time-drawdown data 	5	2, 5
6	<ul style="list-style-type: none"> • Boundary impacts on the radial flow solution • Software for pumping test analysis • Slug tests (single well response tests) 	5	2, 5
7	Winter break		
8	<ul style="list-style-type: none"> • Slug tests analysis • Software for slug test analysis <p>Midterm exam</p>	5	2, 5
9	<ul style="list-style-type: none"> • Vadose zone properties in a recharge context • Vadose zone flow equation • Aquifer test design (timing, wells/piezometer design) • Well drilling, construction, maintenance and related legislation • Regional flow systems and geology of groundwater occurrence 	6, 7	1
10	<ul style="list-style-type: none"> • Mass transport in porous media systems (advection, diffusion, mechanical dispersion, hydrodynamic dispersion, retardation, degradation) • Point and non-point sources of groundwater contamination • Groundwater monitoring (sampling, multi-level installations) • Introduction to tracer experiments and environmental tracers (e.g. isotopes) 	10	1, 4
11	<p>Source water protection in a groundwater context:</p> <ul style="list-style-type: none"> • Delineation of wellhead protection areas (WHPAs) and related policies • Groundwater under the direct influence of surface water (GUDI) • Recharge and discharge areas • Water budgets (from a groundwater perspective) • Case History: Source water protection for the City of Guelph 	11	1, 4
12	<ul style="list-style-type: none"> • Introduction to groundwater modeling • Review of finite difference method • Applying groundwater conditions to numerical models • Case History: application of commercial software (Visual MODFLOW) for flow and transport modeling 	13	3, 5
13	<ul style="list-style-type: none"> • Using Visual MODFLOW for flow and transport modeling 	13	3, 5

5.3 Lab Schedule

Week	Topic	Location	Due
1	Introduction to Lab Equipment and Safety Training	Soils Lab	
2	Calculation Lab: Baseflow, Darcy's Law, Groundwater Flow	Seminar Room	Week 3
3	Water Lab: Investigation of flow, pumping and contaminant transport using a physical aquifer (porous media) model	Soils Lab	Week 4
4	Calculation Lab: Groundwater flow equations and flow nets, pumping test analysis	Seminar Room	Week 5
5	Calculation Lab: Pumping test and slug test analysis	Seminar Room	Week 6
6	Computer Lab: Software for interpreting aquifer tests (AquiferTest)	Computer Lab	Week 7
7	Calculation Lab: Groundwater resource extraction/understanding regional flow systems	Seminar Room	Week 8
8	Water Lab: 1) Investigation of flow, pumping and contaminant transport using a physical aquifer (fractured bedrock) model, and 2) introduction to core logging	Soils Lab	Week 9
9	Calculation Lab: Solute transport in porous media	Seminar Room	Week 10
10	Field Lab: Measuring groundwater levels and conducting slug tests at the Bedrock Aquifer Field Facility (BAFF)	Outside at BAFF	Week 11
11	Field Lab: Conducting a pumping test at the Guelph Centre for Urban Organic Farming (GCUOF)	Outside at GCUOF	Week 12
12	Computer Lab: Constructing a simple finite difference model to examine flow system properties (investigate the effects of changing aquifer parameters and boundary conditions)	Computer Lab	End of Lab Period

5.4 Other Important Dates

Monday, January 7, 2019: first class

Monday, February 18, 2019: Winter Break begins (NO CLASSES SCHEDULED THIS WEEK)

Friday, February 22, 2019: Winter Break End

Friday, March 8, 2019: Fortieth class day (Last day to drop one semester courses)

Wednesday, April 3, 2017: last class

Please refer to the undergraduate calendar for the semester scheduled dates.

6 LAB SAFETY

Safety is critically important to the School of Engineering 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.

Students must wear clothing appropriate for the season for outdoor labs.

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.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:

<http://www.academicintegrity.uoguelph.ca/>

Please also review the section on Academic Misconduct in your [Engineering Program Guide](#).

The School of Engineering has adopted a Code of Ethics that can be found at:

<https://www.uoguelph.ca/engineering/content/resources/code>