ENGG*3220 Groundwater Engineering
Winter 2018

School of Engineering

(Revision 0: December 29, 2017)

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1 Instructional Support

1.1 Instructor

Instructor: Jana Levison, PhD, EIT
Office: RICH 3505, ext. 58327
Email: jlevison@uoguelph.ca
Office hours: Thursdays from 15:00 to 16:00

1.2 Lab Technician

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

1.3 Teaching Assistants

GTA	Email	Office Hours
George (Duncan) McTaggart	gmctagga@uoguelph.ca	During lab sections
Brett Snider	bsnide01@uoguelph.ca	During lab sections

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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

1. There are various groundwater textbooks and resources available at the library, should you wish to do additional reading.

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.

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3 ASSESSMENT

3.1 Dates and Distribution

Labs: 30%
See section 5.3 below for due dates

Midterm exam: 30%
Tuesday, February 27, 2018, in class (8:30-9:50)

Final Exam: 40%
Friday, April 20, 2018 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 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 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.

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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, an important area of practice for water resources and environmental engineers. The main goals of the course are: (1) to teach students fundamental concepts in applied quantitative hydrogeology; and (2) to provide understanding of 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 principals of and apply 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 Objectives	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 of Engineering on Society and the Environment	4	Labs
10. Ethics and Equity		
11. Environment, Society, Business, & 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

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5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Tuesday		8:30 – 9:50	MCKN 029
Thursday		8:30 – 9:50	MCKN 029
Laboratory:			
Monday	Sec 03	11:30 – 13:20	*Soils lab:* THRN 1107 *Seminar room:* MCKN 261 *Computer lab:* THRN 2336
Monday	Sec 06	14:30 – 16:20	*Soils lab:* THRN 1107 *Seminar room:* MCKN 261 *Computer lab:* THRN 2336
Friday	Sec 01	14:30 – 16:20	*Soils Lab:* THRN 1107 *Seminar room:* CRSC 101 *Computer lab:* THRN 2336

5.2 Lecture Schedule

Week	Lecture Topics	References	Learning Objectives
1-3	Principles of and equations governing groundwater flow • Review of: aquifers, aquitards, hydraulic conductivity, intrinsic permeability, transmissivity, porosity, specific yield, storativity, hydraulic head, hydraulic gradient, recharge • Homogeneity/heterogeneity and isotropy/anisotropy	Fetter: Ch. 2, 3, 4	1

	• Darcy's law and its applicability • Determining groundwater recharge from baseflow • Derivation of 3D flow equations for confined and unconfined porous media aquifers • Solutions of 3D flow equations for confined and unconfined porous media aquifers • Boundary conditions • Dupuit assumptions • Review of flow nets		
4-6	Flow to wells, parameter estimation tests and aquifer properties • Radial flow • Drawdown caused by a pumping well • Determining aquifer parameters from time-drawdown data (pumping tests) • Scale and representative elementary volume • Slug tests • Software for aquifer test analysis • Unsaturated zone properties in a recharge context	Fetter: Ch. 5, 6	2, 5
6-8	Groundwater resource extraction (for water supply and site dewatering) • Aquifer-test design (timing, wells/piezometer design) • Well interference • Well drilling, construction, maintenance and related legislation • Sustainable yield • Introduction to considerations for fractured bedrock systems • Regional flow systems and geology of groundwater occurrence	Fetter: Ch. 5, 11, 7, 8	3
--	Winter break		
7	Midterm exam		
8-9	Introduction to subsurface contaminant transport	Fetter: Ch. 10	4

	• 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, multilevel installations) • Introduction to tracer experiments and environmental tracers (e.g., isotopes) • Case histories: contaminated sites (e.g., Love Canal; Hinkley)		
10	Source water protection in a groundwater context • Delineating wellhead protection areas and related policy • Groundwater under the direction influence of surface water (GUDI) • Recharge and discharge areas • Water budgets (from a groundwater perspective) • Case history: Walkerton Tragedy • Case histories/research examples: e.g. development of the City of Guelph water supply system	Fetter: Ch. 11	1, 4
11-12	Introduction to groundwater modelling • Review of finite difference method • Applying boundary conditions to numerical models • Excel models • Case histories: application of commercial groundwater models for flow and contaminant transport	Fetter: Ch. 13	5

5.3 Lab Schedule

Week	Topic	Location	Due
1	Introduction to Lab Equipment and Safety Training *GTA: Brett and Duncan*	Soils lab	
2	**Calculation lab**: baseflow, Darcy's law, groundwater flow *GTA: Brett*	Seminar room	Week 3
3	**Water lab**: investigation of flow, pumping and contaminant	Soils lab	Week 4

	transport using a physical aquifer model (porous media) *GTA: Brett*		
4	**Calculation lab:** groundwater flow equations and flow nets, pumping test analysis *GTA: Brett*	Seminar room	Week 5
5	**Calculation lab:** pumping test and slug test analysis *GTA: Brett*	Seminar room	Week 6
6	**Computer lab**: software for interpreting common aquifer tests (AquiferTest) *GTA: Duncan*	Computer lab	Week 7
7	**Calculation lab**: groundwater resource extraction/understanding regional flow systems *GTA: Duncan*	Seminar room	Week 8
8	**Water lab**: 1) investigation of flow, pumping and contaminant transport using a physical aquifer model (fractured bedrock) and 2) intro to core logging *GTA: Duncan*	Soils lab	Week 9
9	**Calculation lab:** solute transport in porous media *GTA: Duncan*	Seminar room	Week 10
10	**Field lab**: measuring groundwater levels and conducting slug tests at the Bedrock Aquifer Field Facility (BAFF), 360 College Ave. E *GTA: Duncan*	Outside	Week 11
11	**Field lab**: conducting pumping tests at the Guelph Centre for Urban Organic Farming (GCUOF) *GTA: Duncan*	Outside	Week 12
12	**Computer lab**: constructing a simple finite difference model to examine flow system properties (investigate effect of changing aquifer parameters and boundary conditions) *GTA: Duncan*	Computer lab	End of lab period

5.4 Other Important Dates

Tuesday, January 9, 2017: first class

Monday, February 19, 2017: Winter Break begins (NO CLASSES SCHEDULED THIS WEEK)

Friday, March 9, 2017: Fortieth class day (Last day to drop one semester courses)

Thursday, April 5, 2017: last class

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

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. 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