ENGG*4240 Site Remediation

Fall 2018
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 05, 2018

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1 Course Details

1.1 Calendar Description

Remediation of contaminated sites is done to mitigate impacts to the environment and public health. The course will: review the applicable legislation; identify the important soil, water, air and chemical interactions; review the steps of an environmental risk assessment so that contaminated sites can be identified and evaluated to see if remediation is required; and evaluate and appraise various remediation technologies to complete the soil and groundwater remediation.

Co-Requisite(s): ENGG*3590, ENGG*3670

1.2 Course Description

Completion of this course will provide students with: (i) an understanding on what classifies a site as being contaminated and the governing legislation; (ii) an appreciation of cross-media issues for a contaminant in the groundwater, non-aqueous phase liquids, soil, and soil-air matrices; (iii) an appreciation of human health and ecological risk assessment in context of a contaminated site; (iv) insight on how to select and apply appropriate soil and groundwater remediation technologies; and (v) insight on how to design a remediation action plan. Students will also become familiar with the technical literature dealing with contaminated sites, and with select analytical and computational modeling methods used to characterize contaminated sites. The following specific activities will be required:

i. **Submit a Literature Review**: Students will complete a comprehensive literature that will identify and evaluate the resources available to them, and will critique a site remediation theme.
ii. **Submit Phase I and Phase II ESA Projects**: Students will complete a Phase I and a Phase II Environmental Site Assessment (ESA) of a specific property, and justify the need for site remediation.
iii. **Submit a Phase III Remediation Project**: Based on a specific site, students will design a remediation plan to address the contamination present.

1.3 Timetable

Lectures: Tuesdays and Thursdays from 04:00PM to 05:20PM in MCKN 238

Tutorial: Mondays from 03:30PM to 05:20PM in MCKN 234

1.4 Final Exam

No Final Exam is scheduled for this course. The Remediation Project Report due date is during the Exam Week.

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2 Instructional Support

2.1 Instructor(s)

Rafael Santos
Email: santosr@uoguelph.ca
Telephone: +1-519-824-4120 x52902
Office: THRN 2342

2.2 Teaching Assistant(s)

Teaching Assistant: Abu Taher Jamal Uddin
Email: ajamalud@uoguelph.ca
Office Hours: Has no scheduled office hours. Regular contact time is in tutorials on Mondays from 03:30PM to 5:20PM in MCKN 234.

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3 Learning Resources

3.1 Required Resource(s)

Course Website (Website)
https://www.courselink.uoguelph.ca
Course materials, news, announcements, and grades will be regularly posted to the ENGG*4240 Courselink site. You are responsible for checking the site regularly. **As per University regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly;** e-mail is the official route of communication between the University and students.

Practical Design Calculations for Groundwater and Soil Remediation (Textbook)
https://subzero.lib.uoguelph.ca/login?url=https://www.taylorfrancis.com/books/9781466585249
Kuo, J. (2014), CRC Press, Second Edition, ISBN 9781466585249.

eBook is available for download through the University of Guelph Library: search for book on Primo, and follow link to "Online resources".

3.2 Additional Resource(s)

Lecture (Notes)
Lecture notes will be posted on Courselink prior to the respective lectures. Some supporting information will also be ocasionally posted on the Courselink site.

Projects (Other)
Project assignments will be posted on Courselink at an appropriate time according to the due

date schedule given in this handout.

In Situ Remediation of Chlorinated Solvent Plumes (Textbook)
https://link-springer-com.subzero.lib.uoguelph.ca/book/10.1007%2F978-1-4419-1401-9
Stroo, H.F., Ward, C.H. (2010), Springer Science+Business Media, ISBN 978-1-4419-1400-2.

eBook is available for download through the University of Guelph Library: search for book on Primo, and follow link to "Online resources".

Remediation Engineering: Design Concepts (Textbook)
https://www.crcpress.com/Remediation-Engineering-Design-Concepts-Second-Edition/Suthersan-Horst-Schnobrich-Welty-McDonough/p/book/9781498773270
Suthersan, S.S., Horst, J., Schnobrich, M., Welty, N. (2016), CRC Press, Second Edition, ISBN 9781498773270.

3.3 Announcements

Information related to ENGG*4240 will be posted on Courselink. In addition, per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly. This e-mail is the official route of communication between the University and students.

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4 Learning Outcomes

The goal is to prepare students to deal with open-ended site remediation problems that consist of contaminated groundwater and soil, similar to situations that they will encounter as working professionals. To that end, students will learn and experience how to:

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Selectively search and critically review scientific literature on a site remediation topic of their choice;
2. Collect and analyze relevant information for a target site to complete Phase I and II Environmental Site Assessments;
3. Complete a risk assessment on the target site to evaluate whether site remediation is needed; and
4. Knowledgably select an appropriate remediation technology, and design an effective, feasible and safe remediation plan for the target site.

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome Set Name	Course Learning Outcome
1	Knowledge Base	1, 2, 3, 4
1.1	Recall, describe and apply fundamental mathematical principles and concepts	2, 3, 4

#	Outcome Set Name	Course Learning Outcome
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1, 2, 3, 4
1.3	Recall, describe and apply fundamental engineering principles and concepts	1, 2, 3, 4
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2, 3, 4
2	Problem Analysis	2, 3, 4
2.1	Formulate a problem statement in engineering and non-engineering terminology	2, 3, 4
2.2	Identify, organize and justify appropriate information, including assumptions	2, 3, 4
2.3	Construct a conceptual framework and select an appropriate solution approach	4
3	Investigation	2, 3, 4
3.1	Propose a working hypothesis	3, 4
3.3	Analyze and interpret experimental data	2, 3, 4
3.4	Assess validity of conclusions within limitations of data and methodologies	2, 3, 4
4	Design	4
4.1	Describe design process used to develop design solution	4
4.2	Construct design-specific problem statements including the definition of criteria and constraints	4
4.3	Create a variety of engineering design solutions	4
4.4	Evaluate alternative design solutions based on problem definition	4
5	Use of Engineering Tools	4
5.1	Select appropriate engineering tools from various alternatives	4
5.3	Recognize limitations of selected engineering tools	4
6	Individual & Teamwork	2, 3, 4
6.1	Describe principles of team dynamics and leadership	2, 3, 4
6.2	Understand all members’ roles and responsibilities within a team	2, 3, 4
6.3	Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude	2, 3, 4

#	Outcome Set Name	Course Learning Outcome
6.4	Apply strategies to mitigate and/or resolve conflicts	2, 3, 4
6.5	Demonstrate leadership through, for example, influencing team vision and process, promoting a positive team culture, and inspiring team members to excel	2, 3, 4
7	Communication Skills	1, 2, 3, 4
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	1, 2, 3, 4
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	2, 3, 4
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	1, 2, 3, 4
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	1, 2, 3, 4
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	1, 2, 3, 4
8	Professionalism	2, 3, 4
8.1	Demonstrate an understanding of what it means to be a professional engineer and distinguish between legislated and non-legislated professions	2, 3, 4
8.3	Demonstrate professional behaviour	2, 3, 4
9	Impact of Engineering on Society and the Environment	2, 3, 4
9.1	Analyze the safety, social, environmental, and legal aspects of engineering activity	2, 3, 4
9.2	Evaluate the uncertainties and risks associated with engineering activities	2, 3, 4
9.3	Anticipate the positive and negative impacts of introducing innovative technologies to solve engineering problems	3, 4
10	Ethics & Equity	3, 4
10.3	Demonstrate values consistent with good ethical practice, including equity, diversity, and inclusivity	3, 4
11	Economics and Project Management	4
11.3	Estimate economic impact and feasibility of an engineering project or	4

#	Outcome Set Name	Course Learning Outcome
	design using techniques such as cost benefit analysis over the life of the project or design	
12	Life Long Learning	1, 2, 3, 4
12.1	Identify personal career goals and opportunities for professional development	2, 3, 4
12.2	Self-assess skills relative to career goals and SOE defined learning outcomes	2, 3, 4
12.3	Demonstrate capability for continuous knowledge and skill development in a changing world	1, 4

4.3 Relationships with other Courses & Labs

ENGG*4240 is a senior Environmental Engineering elective. As such, students are required to build on the knowledge gained in all the preceding courses, applying engineering analysis and design principles to the design problem at hand.

Subject areas discussed and applied in this course predominantly include: transport phenomena (fluid mechanics, mass transfer); physical, inorganic and organic chemistry; soil mechanics; groundwater hydrology; environmental sciences; regulatory law; economics; sociology; health and safety. Proficiency in some of these subjects, and familiarity with most, is expected.

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5 Teaching and Learning Activities

5.1 Lecture

Lecture Notes 1

Topic(s): Regulations and Brownfields Overview - definitions, remediation issues, brownfields

Lecture Notes 2

Topic(s): Remediation Technologies Overview - ex-situ, in-situ, green processes

Lecture Notes 3

Topic(s): Contaminant Interactions with Soil Components - soil composition, physical chemistry of soil contaminants, geochemistry

Lecture Notes 4

Topic(s): Contaminant Chemistry - inorganic, organic, chemical partitioning

Lecture Notes 5

Topic(s): Environmental Site Assessment Phase I

Lecture Notes 6

Topic(s): Contaminant Transport Mechanisms and Principles

Lecture Notes 7

Topic(s): Geochemical Modeling - introduction, Visual MINTEQ practice examples

Lecture Notes 8

Topic(s): Plume Migration in Aquifer and Soil - NAPL movement, Darcy's Law, transport in saturated zone

Lecture Notes 9

Topic(s): Plume Migration - Solutions to Advection Dispersion Equation

Lecture Notes 10

Topic(s): Phase II Environmental Site Assessment - regulations and guidelines

Lecture Notes 11

Topic(s): Risk Assessment Toxicology - exposure pathways and models, ecological risk, human health risk

Lecture Notes 12

Topic(s): Risk Assessment Methodologies - Human Health Risk Assesment, Ecological Risk Assessment, risk-based remediation

Lecture Notes 13

Topic(s): Health and Safety Issues at Contaminated Sites - personnel, training, personal protective equipment, site controls

Lecture Notes 14

Topic(s): Phase III Remediation - Remedial Action Plan, remediation guidelines, site closure

Lecture Notes 15

Topic(s): Soil Remediation - technology section, in-situ and ex-situ treatments, radius of influence, estimation of removal

Lecture Notes 16

Topic(s): Soil Bioremediation and Groundwater Stripping

Lecture Notes 18

Topic(s): Permeable Reactive Barriers (PBR)

Lecture Notes 18

Topic(s): Brownfields Redevelopment - environmental site registry, social, economic and environmental benefits, funding

5.2 Other Important Dates

i) Classes begin: Thursday 6th Sept. 2018
ii) Thanksgiving holiday: Monday 8th Oct. 2018
iii) Fall Study Break Day: Tuesday 9th Oct. 2018
iv) Last date to drop course (fourtieth class day): Friday, 2nd Nov. 2018
v) Re-scheduled Tuesday class: Thursday, 29th Nov. 2018
vi) Re-scheduled Monday class (and Last class): Friday, 30th Nov. 2018

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6 Assessments

6.1 Marking Schemes & Distributions

Additional assignments will be given throughout the term but they will not be graded. Consider them as formative.

Name	Scheme A (%)
Individual Literature Review	10
Phase I ESA Report	15
Term Test 1	15
Phase II ESA Report	20
Term Test 2	15
Phase III Remediation Project (Part 1) Presentation	10
Phase III Remediation Project (Part 2) Report	15
Total	100

6.2 Assessment Details

Individual Literature Review (10%)

Due: Wed, Sep 26, 5:00 PM, CourseLink Dropbox

Phase I ESA Report (15%)
Due: Wed, Oct 10, 5:00 PM, CourseLink Dropbox

Term Test 1 (15%)
Date: Tue, Oct 23, 4:00 PM - 5:20 PM, MCKN 238

Phase II ESA Report (20%)
Due: Wed, Nov 7, 5:00 PM, CourseLink Dropbox

Term Test 2 (15%)
Date: Thu, Nov 22, 4:00 PM - 5:20 PM, MCKN 238

Phase III Remediation Project (Part 1) Presentation (10%)
Date: Week 12, Tutorial and/or Lecture classroom, as scheduled for each group
Presentations will be scheduled in the Tutorial and/or Lecture sessions between Monday Nov 26th and Friday Nov 30th.

Phase III Remediation Project (Part 2) Report (15%)
Due: Mon, Dec 3, 5:00 PM, CourseLink Dropbox

6.3 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 at 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, students must obtain an overall grade of 50% or higher on the aggregate of all the course work outlined in Section 6.1.

Late Reports: There will be no extension of the deadlines for submissions, except for serious health or compassionate reasons, with the appropriate documentation. Just like the consulting world where projects are not awarded if the proposals are late, a grade of zero will be given for late submissions.

Certification: Students must write their PEO SMP (Student Membership Program) number on all submitted work. This signifies that the SOE Code of Ethics was adhered to. For group projects, students must also state that they contributed to the group effort in an equitable manner.

6.4 Course Format

Classes are scheduled twice a week on Tuesdays and Thursdays. There is also a tutorial on Mondays. The format of the course is problem-based learning, where students will learn by doing. It is expected that each team member will spend an average of 10 to 12 h per week on the course. The active learning component will require group discussions and presentations on material related to the lecture material.

Students will work in teams of three or four persons. Course instructor will assist with the formation of the groups as required. Students will have the option of changing groups after the first project.

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7 School of Engineering Statements

7.1 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. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

7.2 Students' Learning Responsibilities

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

7.3 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 project-based course you are responsible for taking all reasonable safety precautions and following the campus safety rules. In addition, you are responsible for reporting all safety issues to the GTA, Course Instructor, or Campus Police.

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8 University Statements

8.1 Email Communication

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

8.2 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 instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The regulations and procedures for Academic Consideration are detailed in the Undergraduate Calendar.

8.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar.

8.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: www.uoguelph.ca/sas

8.6 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 or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

8.7 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, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

8.8 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.