



CHEE 884 / CIVL 889 – BIOREMEDIATION

Course Syllabus – Winter 2022

This is your course syllabus. Please download the file and keep it for future reference.

Land Acknowledgement

Queen's University is situated on traditional Anishinaabe and Haudenosaunee Territory.

See: <http://www.queensu.ca/encyclopedia/t/traditional-territories>

Inclusivity Statement

Queen's students, faculty, and staff come from every imaginable background – small towns and suburbs, urban high rises, Indigenous communities, and from more than 100 countries around the world. You belong here: <https://www.queensu.ca/inclusive/>.

COURSE INSTRUCTOR

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COURSE INFORMATION

COURSE DESCRIPTION¹

Bioremediation as an option to treat contaminated soils, ground water, fresh water, and marine environments. In this course, advantages and disadvantages of bioremediation are compared with nonbiological processes. Factors affecting choice of in-situ or ex-situ processes. Assessment of biodegradability; biostimulation vs. bioaugmentation; mineralization vs. partial degradation; factors affecting microbial activity (choice of electron acceptor, toxicity of pollutant, C/N/P ratio, co-substrates, soil humidity, pH, and temperature); bioavailability of pollutant. Biodegradation of specific contaminants (e.g., diesel fuel, polychlorinated biphenyls, dyestuffs, aromatic and polyaromatic hydrocarbons) will be studied in detail.

COURSE LEARNING OUTCOMES (CLO)

The objective of this course is to develop an understanding of the science and engineering concepts underpinning bioremediation, including:

- Pollutants of interest.
- Remediation trends, market, and practices.
- Fundamental theory.
- Physical and chemical interactions involved in biodegradation at the microbial level.
- Microbial ecology and organic pollutant biodegradation.
- Physical, chemical, and biological processes in naturalized systems.
- Biodegradation in naturalized systems.
- Application of theory to case studies.

RELEVANCE TO THE PROGRAM

CHEE 884 / CIVL 889 is a graduate-level course offered to students in Chemical and Civil Engineering and open to other students (with permission). The knowledge gained from this course is applicable in a wide range of applications, including environmental sciences and engineering.

COURSE STRUCTURE AND ACTIVITIES

36 lecture hours per term. Lecture times and locations will be scheduled in consultation with the class at the beginning of the term. Course delivery is flexible and will likely be presented in a blended format, through which students will have access to all course materials and recordings ahead of time. Before each weekly lecture, students will be invited to review the applicable material. During lecture, a summary of this material will be presented and discussed informally.

EXPECTATIONS FOR LECTURES AND ASSIGNMENTS

Lecture slides and relevant handouts are posted in advance on Queen's Learning Management System (LMS, online). Lecture materials include examples, video clips, and problem solutions. Students are expected to review the material ahead of scheduled lecture time to promote discussions and a more in-depth understanding of the concepts. Maximum benefits can be gained only if students come prepared in advance.

COURSE MATERIALS

All course material is accessible through the course LMS.

¹ Course Author: L. Meunier: Bioremediation, Winter 2022; Queen's University holds a license for the use of the Course Author's Intellectual Property for CHEE 221.

LEARNING SUPPORT

- Instructor is available by appointment (through e-mail).
- Additional review and help sessions may be scheduled as required during the term.

COURSE EVALUATION

Deliverable	Week or Date	Weight%
Assignment <ul style="list-style-type: none"> • Seminar (oral presentation) • Written report • Peer evaluation 	Presentation scheduled during lectures Draft Report due in Week 9 Final report due in Week 11 Peers will contribute to assessment of oral presentations and written reports	15% 30% 10%
Exam <ul style="list-style-type: none"> • Part 1 • Part 2 	Week 6 Week 12	20% 20%
Literature Review and Participation	Informal review of 2 publications (during lectures)	5%

Assessment Descriptions

Each student will present a seminar and prepare a detailed written report on a selected topic (approved by instructor). Students will review and assess selected oral presentations and written reports and provide feedback. Peer evaluation will also be marked.

During the term, each student will deliver 2 informal literature reviews of selected publications related to lecture topics, but on topics other than the one selected for their term assignment. Each 1-minute presentation must include a summary of the content of the publication, and a comment on how the content relate to the course content.

Exam Part 1 is focused on the first half of the course, and Part 2 on the second half of the course, which requires an understanding of material presented during the entire course. Assignments and exams must be completed individually.

Deliverables include a full copy of seminar presentation slides and presenter's notes (e.g., PowerPoint); a written report prepared according to an appropriate scientific journal article format (MS Word preferred); completed oral presentation rubrics and completed written report rubrics with edits and comments. Exams will be administered through the course LMS. Students will have a 24-hour window during which to complete each exam. Once initiated, students will have 120 minutes (which includes 100 minutes for the test and 20 minutes to upload written solutions) and one attempt to complete the exam.

This course makes use of **Turnitin**, a third-party application that helps maintain standards of excellence in academic integrity. Normally, students will be required to submit their course assignments to through the course LMS to Turnitin. In doing so, students' work will be included as source documents in the Turnitin reference database, where they will be used solely for the purpose of detecting plagiarism.

Turnitin is a suite of tools that provide instructors with information about the authenticity of submitted work and facilitates the process of grading. Turnitin compares submitted files against its extensive database of content and produces a similarity report and a similarity score for each assignment. A similarity score is the percentage of a document that resembles content held within the database. Turnitin does not determine if an instance of plagiarism has occurred. Instead, it gives instructors the information they need to determine the authenticity of work as a part of a larger process.

Please read Turnitin's Privacy Pledge, Privacy Policy, and Terms of Service, which governs users' relationship with Turnitin. Also, please note that Turnitin uses cookies and other tracking technologies; however, in its service contract with Queen's Turnitin has agreed that neither Turnitin nor its third-party partners will use data collected through cookies or other tracking technologies for marketing or advertising purposes. For further information about how you can exercise control over cookies, see Turnitin's Privacy Policy.

Turnitin may provide other services that are not connected to the purpose for which Queen's University has engaged Turnitin. Your independent use of Turnitin's other services is subject solely to Turnitin's Terms of Service and Privacy Policy, and Queen's University has no liability for any independent interaction you choose to have with Turnitin.

GRADING

All assessments in this course will receive numerical percentage marks. The final grade a student receives for the course will be derived by converting the numerical course average to a letter grade according to the established [Grade Point Index](#).

Feedback on Assessments

The instructor will provide feedback on graded activities. Marking will be performed with care and the instructor will take the time necessary to provide detailed feedback on assessed tasks and tests; the goal is to return marked activities within a reasonable time following submission. However, students must bear in mind that detailed marking of written reports and long exam solutions takes time.

To be eligible for mark reassessment (of assignments or tests), a request must be submitted within one weeks of the initial return date along with a mark reassessment form (available on the course LMS) and the complete original submission. Please note that marked assignments and exams will be archived.

Accessing Final Grade

Final grades will be posted on SOLUS. Official transcripts showing final grades will be available on the Official Grade Release Date. Please note that, in official transcripts, a mark of IN (incomplete) is considered a grade, and your transcript is released with this grade.

HOW TO DO WELL IN THIS COURSE

This course introduces important concepts in bioremediation that range from simple to complex. Students are expected to apply the concepts and to implement the methods taught in class and presented in the various references offered in support of the material presented in class. These concepts will be tested in assignments and exams, and students must be capable of extrapolating the applications to a variety of problems in the context of this course. As such, significant depth of knowledge is required to frame and solve problems efficiently and correctly. Students should plan on attending lectures having prepared for the session as detailed on the course LMS. Students are expected to read through and assimilate concepts, applications, and methodologies presented, to practice by answering suggested questions, and to seek help from the instructor when they do not understand the concepts. Students are expected to remember and apply concepts taught in previous courses.

To obtain full marks, problem solutions must include the complete and correct methodology, as well as clearly labeled diagrams where appropriate. For questions involving multiple parts, partial credit may be given for correct methodology, but the final answer must also be correct. If the answer does not reflect the expected outcome, or if it is not physically representative, then the student is encouraged to provide comments, using critical analysis skills, to point out any outstanding issue. All relevant assumptions must be stated, and proper units must be included.

Suggested Time Commitment

This course is offered through a study period of one semester spanning 12 weeks. Learners can expect to invest on average 4-6 hours per lecture hour in this course. Learners who adhere to a pre-determined study schedule are more likely to successfully complete the course.

COURSE COMMUNICATION

In this course, you may be expected to communicate with your peers and with the teaching team through electronic communication. You are expected to use the utmost respect in your dealings with your colleagues and instructors, or when participating in activities, discussions, and online communication. Following is a list of *netiquette* guidelines that the teaching team and Queen's personnel has adopted. Please read them carefully and use them to guide online communication in this course and beyond.

1. Make a personal commitment to learn about, understand, and support your peers.
2. Assume the best of others and expect the best of them.
3. Acknowledge the impact of oppression on the lives of other people and make sure your writing is respectful and inclusive.
4. Recognize and value the experiences, abilities, and knowledge each person brings.
5. Pay close attention to what your peers write before you respond. Think through and re-read your writings before you post or send them to others.
6. Disagreeing on ideas is acceptable, but do not make personal attacks.
7. Be open to be challenged or confronted on your ideas and challenge others with the intent of facilitating growth. Do not demean or embarrass others.
8. Encourage others to develop and share their ideas.

Course Announcements

The teaching team will routinely post course news in the Announcements section on the course LMS. Please sign up to be automatically notified by email of these posts. Instructions on how to modify your notifications are available on the LMS platform.

Office Hours

In addition to interactions through lectures and Q&A sessions, students can interact in a synchronous fashion with the instructor through office hours. A schedule for office hours will be determined in consultation with the class at the beginning of the term. Students may also contact the instructor by e-mail to ask questions and/or to request an appointment. Points of contact are available on the course LMS home page.

Confidential Matters

Students who wish to discuss a confidential matter can reach the instructor by e-mail to make an appointment. The instructor will normally reply within 48 hours during workdays.

COURSE POLICIES

Please review the following policies concerning copyright, academic integrity, absences, and academic accommodations:

COPYRIGHT

Course materials created by the course instructor, including all slides, presentations, synchronous and asynchronous course recordings, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell, or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution, posting, sale, or other means of dissemination, without the instructor's express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights and, with respect to recordings, potentially privacy violations of other students.

ACADEMIC INTEGRITY

This course is offered to engineering and science students. Nevertheless, all students are expected to abide by the code of ethics expected of engineers. Engineers are members of a long-respected profession with high standards of behaviour. As engineers and scientists, graduate students are expected to behave with integrity always. Please note that Engineers have a duty to:

- Act at all times with devotion to the high ideals of personal honour and professional integrity.
- Give proper credit for engineering work.

The standard of behaviour expected of professional engineers is explained in the [Professional Engineers Ontario Code of Ethics](#). Information on policies concerning academic integrity is available in the [Queen's University Code of Conduct](#), in the [Senate Academic Integrity Policy Statement](#), on the [Faculty of Engineering and Applied Science website](#), and from the course instructor.

If any aspect of the academic integrity policy is unclear, it is the student's responsibility to consult with the instructor to understand and clarify the applications of these policies in the context of this graduate-level course.

Late Policy

Students are expected to complete their work on time. The course instructor will provide notification (during lectures and/or on the course LMS) of due dates and any revisions thereof.

Submissions after the due date will not be accepted without prior arrangement and may be penalized at up to 20% per day (24-hour period following due date/time) unless a suitable justification is provided.

Extenuating Circumstances

In the event of extenuating circumstances, A student may request an extension to an assignment due date without penalty. Requests must be made to the instructor prior to the original due date of the assignment, and some substantiating documentation may be required (see information below on absences). Note that unacceptable reasons include extra-curricular activities, travel plans, generally behind on schoolwork, etc. In the absence of substantiating documentation, the normal late penalty will apply as described above and according to departmental policies.

Invalid Exams

An exam may be declared invalid in case of a significant interruption in an in-person examination; if the instructions in a remote or online exam were not followed; if the student uploads wrong materials; or if a situation arises where the integrity of the exam cannot be verified. If an exam is declared invalid, the student may be granted a re-write, subject to review and in accordance with academic integrity.

ABSENCES (ACADEMIC CONSIDERATION) AND ACADEMIC ACCOMMODATIONS

For absences and academic accommodations please review the information on the [FEAS website](#).

ACADEMIC AND STUDENT SUPPORT

Queen's has a robust set of supports available to you including the [Library](#), [Student Academic Success Services \(Learning Strategies and Writing Centre\)](#), and [Career Services](#). Learners are encouraged to visit the Faculty of Engineering and Applied Science [Current Students](#) web portal for information about various other policies such as academic advisors, registration, student exchanges, awards and scholarships, etc.

Individual Needs and Support

If you have a disability or health-related condition that may require academic accommodations, please approach the [Queen's Accessibility Services](#). The staff at Accessibility Services are available by appointment to develop individualized accommodation plans, provide referrals, and assist with advocacy. The sooner you let us know your needs, the better we can assist you in achieving your learning goals. For questions or assistance with requesting Academic Consideration or Accommodation, contact the FEAS Academic Accommodation Coordinator at engineering.aac@queensu.ca.

Every effort has been made to provide course materials that are accessible. For further information on accessibility compliance of the educational technologies used in this course, please consult the links below.

Accommodations requests must be made as soon as an issue arises, and normally well before each affected due date. Although every effort will be made to accommodate students, retroactive applications after an exam has been attempted, or past an assignment due date may not be possible.

Educational Technology	Accessibility Compliance Information
onQ (Brightspace Learning Management System by D2L)	https://www.d2l.com/accessibility/standards/
RocScience	https://www.rocscience.com/
Google Spreadsheets	https://www.google.com/accessibility/products-features/
MS-Teams	https://support.microsoft.com/en-us/office/accessibility-support-for-microsoft-teams-d12ee53f-d15f-445e-be8d-f0ba2c5ee68f
Zoom	https://zoom.us/accessibility

If you find any element of this course difficult to access, please discuss with your instructor how you can obtain an accommodation.

Religious Observance

Students in need of accommodation for religious observance are asked to speak to their professor within a week of receiving their syllabus. Note that alternative assignments are considered a "reasonable accommodation" under the Ontario Human Rights Code. Students with questions about their rights and responsibilities regarding religious accommodation should contact Chaplain Kate Johnson via Chaplain@queensu.ca.

Technical Support

Basic hardware and software skills and online access are required for this course. If you require technical assistance, please contact [Technical Support](#).

Supportive Personal Counselling

If at any time you find yourself feeling overwhelmed, anxious, sad, lonely, or distressed, consider confidential supportive counselling offered by the [embedded counselors](#) at the Student Wellness Service Faculty of Engineering and Applied Science.

COURSE OVERVIEW

CHEE 884 / CIVL 889 Course contents		
Week/Hours	Modules*	Notes/Comments
Week 1 2 lectures	1: Overview	<i>Students register seminar topic (presentations in weeks 5-9)</i>
Week 1/2 4 lectures	2: Pollutants of interest, remediation market, trends	Priority pollutants, overview of applications
Week 2/3/4 5 lectures	3: Bioremediation fundamentals	Theory and main concepts
Week 4/5 3 lectures	4: Physical and chemical interactions	Soil classification and characterization Factors affecting degradation and bioavailability
Week 5/6 5 lectures	5: Microbial metabolism and nutrient requirements; student presentations	Electron tower, energy, reaction stoichiometry Biodegradation of petroleum hydrocarbons and chlorinated solvents
Week 6 2 lectures	Review, exam preparation, student presentations	Presentation schedule to be determined in week 1
Exam Part 1** (2 hours)	Modules 1 – 5	Administered online through course LMS
Week 7/8 4 lectures	6: Naturalized treatment processes; student presentations	Water chemistry; environmental processes Redox zone
Week 9 3 lectures	7: Processes and constituent cycles; student presentations	Physical, chemical, biological (including phyto-) processes Preliminary assignment written report due
Week 10 3 lectures	8: Wetland systems	Biosorption systems; Bioretention ponds; integrated systems
Week 11 3 lectures	9: Sulfate-reducing bacteria	Mechanisms; bioremediation of metals; acid mine drainage Assignment written report due
Week 12 3 lectures	10: Permeable reactive walls	Plume treatment; landfill leachate
Exam period Exam Part 2** (2 hours)	Focused on Modules 6-10, with support from previous modules	Administered online through course LMS

* Lecture content delivery through lecture materials available in presentation slide format, including examples and case studies.

** Exam may include short and long answers, definitions, descriptions of concepts and applications, and full procedural solutions.