McMaster University | Civil Engineering

2025-26 COURSE OUTLINE

COURSE INFORMATION

Course Name: Biological Aspects of Wastewater Treatment Course Code: CIV ENG 4V04 (6V04)

Session Offered: Winter 2026

Calendar Description: 4 units. Microbial kinetics and cell yield in biological wastewater treatment; conventional activated sludge systems; models of activated sludge systems; aeration systems; sedimentation; membrane bioreactors; biological nutrient removal; sequential batch reactors; biosolids treatment, including sludge thickening, anaerobic digestion and dewatering; attached growth reactors, including trickling filters, rotation disk contactors and fluidized bed reactors. (Prerequisite(s): CIVENG 3L03 or CHEMENG 2D04 or permission of the department)

Instructor: Younggy Kim (younggy@mcmaster.ca)

Class Schedule:
Lecture: Tu 12:30-2:20pm; Th 12:30-1:20pm Office hr: Th 1:30-2:20pm (or by appointment)
Lab: Mo Fr 2:30-5:20pm; We 8:30-11:20am
Tutorial: We 12:30-2:20pm; Fr 12:30-2:20pm

Lab instructor: Monica Han (hanm7@mcmaster.ca; available by appointment)

Teaching Assistants: Sara Hemmati (hemmatis@mcmaster.ca), Shuangyu Gao (gaos39@mcmaster.ca), Ijaj Chowdhury (chowdi11@mcmaster.ca)

1. COURSE OBJECTIVES

At the end of the course, students will have solid understanding of fundamentals of biological reactions in various wastewater treatment processes. Students will also practice and obtain relevant skills and techniques in evaluating and designing wastewater treatment processes.

2. COURSE SPECIFIC POLICIES

Attendance: Lecture attendance is expected but will not be reflected in grading. It is strongly recommended that every student should not miss any lectures. Instructor's written notes will not be shared while power point presentations and handouts will be posted on A2L.

Textbook and course materials: There are no designated textbooks in this course. In case you are interested in biological wastewater treatment, you can read: Grady et al., Biological wastewater treatment; Metcalf & Eddy, Wastewater engineering; and Rittmann & McCarty, Environmental biotechnology. Course materials will be posted on A2L.

Examinations: The McMaster Standard Calculator may be used during examinations. You may bring 1 crib sheet (letter size; double sided) in mid-term exam; and 2 sheets for the final examination.
- Crib sheets must be prepared only by hands (hand-written or hand-drawn contents only).
- Photocopied or printed information of any size is NOT allowed.
- Photocopies of your own handwriting (e.g., homework assignments and note) are NOT allowed.

Assignments: 4 homework assignments will be posted on A2L. Late assignments will be assessed a penalty of 20% per academic day in general; however, late assignments may not be accepted depending on course schedule.

In-class quiz: The reason for having an in-class quiz is to ensure that you know very essential course materials. There will be one in-class quiz exam. The quiz date will be announced a few days in advance.

Laboratory experiments: Each student must participate in mandatory laboratory sessions, which will provide supplemental exposure to important concepts we will be covering in the course. We will have four regular lab

sessions in addition to a preliminary lab. The dates for lab sessions are available on the Avenue calendar. Lab experiments will be conducted in groups of four students. All group members must participate in all labs. Each group is responsible for submitting a report. All group members are expected to take part in report preparation. Expected formats and structure of a lab report will be posted on Avenue. A late penalty of 20% per academic day will be applied. All group members must read the lab handout prior to a lab session. There may be pre-lab quizzes to ensure that you have read the lab handouts and understand experimental steps and materials. Both of the lab report and quiz will be included in your lab evaluation. During the preliminary lab session, we will have a safety presentation and group assignment. Attendance at this preliminary lab is also mandatory.

Field Trip: There will be a field trip to a local wastewater treatment plant. Detailed plan will be announced later.

Tutorials: Prerequisite materials, design examples, ASM development, new wastewater treatment technologies will be covered in tutorials. We will also learn to use commercial software tools. We do not have tutorials every week and tutorial dates will be announced on Avenue.

MSAF Policy: When a self-reporting relief is submitted, the portion of the missed academic work will be automatically transferred to the final examination. It is your responsibility to notify the instructor of your MSAF submission. For a group assignment (including lab attendance, term project reports), MSAF will NOT be accepted.

3. SCHEDULE (TENTATIVE)

WEEK 1	Introduction of biological wastewater treatment	
WEEK 2	Characterization of wastewater: Suspended solid, oxygen demand, nitrogen and phosphorus	Safety Lab (Mandatory)
WEEK 3	Kinetics of microbial growth and substrate utilization: Monod equation and its applications	HW1 due
WEEK 4	Estimation of kinetic parameters in biological wastewater treatment	Lab1 Basic wastewater analyses
WEEK 5	Conventional activated sludge (CAS)	Tutorial #1 BioWin @ Computer labs
WEEK 6	Conventional activated sludge design	Lab2 Microbial growth kinetics Tutorial #2 CAS design practice HW2 due
WEEK 7	Midterm recess	
WEEK 8	Activated Sludge Model #1 (ASM1)	Mid-term Exam (12:30-2:20pm on Feb 24)
WEEK 9	Gas transfer and aeration system design	Lab3 Nitrification/denitrification kinetics Tutorial #3 Aeration system design practice Term project dues
WEEK 10	Aeration system design (continued); Settling and thickening	Tutorial #4 GPS-X @ Computer labs HW3 due
WEEK 11	Settling and thickening of wastewater sludge	Lab4 Type III & IV settling
WEEK 12	Nutrient removal; Sequencing batch reactors; Membrane bioreactors	Field trip (TBD)
WEEK 13	Attached growth reactors; Anaerobic digestion for wastewater sludge treatment	HW4 due
FINAL EXAMINATION	Scheduled during the regular University Final Examination period established by the Registrar's Office	

4. ASSESSMENT OF LEARNING	WEIGHT %
Assignment (4 homework assignments)	20% (5% each)
In-class quiz	2%
Mid-term examination	20%

Term project and report (ASM#1)	12%
Lab experiments and reports (4 group lab reports)	16% (4% each)
Final examination	30%

5. LEARNING OUTCOMES

CEAB Learning Indicators Measured in This Course

1. Knowledge Base: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.

1.1 Competence in Mathematics
1.2 Competence in Natural Sciences
1.3 Competence in Engineering Fundamentals
1.4 Competence in Specialized Engineering knowledge

2. Problem Analysis: An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.

2.1 Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem.
2.2 Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions.

3. Investigation: An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.

3.2 Synthesizes the results of an investigation to reach valid conclusions.

4. Design: An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.

4.1 Defines the problem by identifying relevant context, constraints, and prior approaches before exploring potential design solutions.
4.2 Explores a breadth of potential solutions, considering their benefits and trade-offs as they relate to the project requirements.
4.3 Develops models/prototypes; tests, evaluates, and iterates as appropriate.

5. Use of engineering tools: An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.

5.1 Evaluates engineering tools, identifies their limitations, and selects, adapts, or extends them appropriately.
5.2 Succesfully uses engineering tools.

6. Individual and teamwork: An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.

6.1 Actively contributes to the planning and execution of a team project.
6.2 Manages interpersonal relationships, taking leadership responsibilities as needed.

7. Communication skills: An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.

7.2 Composes an effective written document for the intended audience.

Learning Outcomes (Corresponding Graduate Attributes in Parenthesis)

Wastewater analysis (1.2; 1.4); Microbial kinetics (1.2; 1.4)
Conventional activated sludge (1.1; 1.2; 1.3; 1.4; 3.2; 4.1; 4.2)
Estimation of microbial kinetics (1.2; 1.4; 3.2; 3.3)
Activated Sludge Model No. 1 (1.1; 1.2; 1.3; 1.4; 4.3; 5.1; 5.2; 5.3)
Aeration system design (1.2; 1.4; 4.1); Sedimentation tank design (1.4; 2.2; 4.1; 4.2; 5.2)
Nutrient removal (1.2; 1.3; 1.4; 4.3; 5.1)
Sequencing batch reactors and membrane bioreactors (1.1; 1.4; 3.2; 4.2)
Attached growth reactors (1.1; 1.3; 1.4; 3.2); Anaerobic Digestion (1.2; 1.3; 1.4; 4.2)

6. LABORATORY SAFETY

The Faculty of Engineering is committed to McMaster University's Workplace and Environmental Health and Safety Policy which states: "Students are required by University policy to comply with all University health, safety and environmental programs and policies". It is your responsibility to understand McMaster University's Risk Management system, which is supported by a collection of Risk Management Manuals (RMMs) that contain programs and policies in support of the Risk Management System. The RMMs are available from https://hr.mcmaster.ca/employees/health_safety_well-being/our-safety/risk-management-manuals-rmms/.
It is also your responsibility to follow any specific Standard Operating Procedures (SOPs) provided for specific experiments (see course lab manuals) and the laboratory equipment https://www.eng.mcmaster.ca/sites/default/files/civil_lab_health_and_safety_manual.pdf
Additionally, McMaster University's workplace health and safety guidance related to COVID-19 must always be followed (available from https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/).
The safety requirements for [JHE 220] are listed below. Students not abiding by these safety requirements will be given one warning. Second offences will result in the student being asked to vacate the laboratory and receiving a grade of zero for that particular lab.

[JHE 220]

• Safety glasses/goggles must be worn in the lab at all times.
• Contact lenses are not to be worn in the lab.
• No short (i.e., above the knee) pants or skirts are permitted in the lab – lab coats must be worn over top of your clothing in these instances.
• Closed-toe shoes must be worn at all times.
• No loose clothing is allowed.
• Long hair must be tied back.
• Disposable latex or nitrile gloves must be worn when working with hazardous chemicals.
• Heat resistant gloves must be worn when removing hot items from the drying oven (as indicated by the laboratory instructor).

7. COMMUNICATIONS

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their "@mcmaster.ca" alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

8. POLICIES

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy*, located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/.

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

The McMaster Student Absence Form is a self-reporting tool for **Undergraduate Students** to report absences that last up to 5 days and provides the ability to request accommodation for any missed academic work. Please note, this tool cannot be used during any final examination period. You may submit a maximum of 1 Academic

Work Missed requests per term. It is **your** responsibility to follow up with your Instructor immediately regarding the nature of the accommodation. If you are absent more than 5 days or exceed 1 request per term you **must** visit your Associate Dean's Office (Faculty Office). You may be required to provide supporting documentation. This form should be filled out immediately when you are about to return to class after your absence.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

PROTECTION OF PRIVACY ACT (FIPPA)

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should take care to protect student names, student numbers, grades, and all other personal information at all times. For example, the submission and return of assignments and the posting of grades must be done in a manner that ensures confidentiality – see http://www.mcmaster.ca/univsec/fippa/fippa.cfm.

ANTI-DISCRIMINATION

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer, or the Human Rights Consultant, as soon as possible.
https://www.mcmaster.ca/policy/General/HR/Discrimination_and_Harassment.pdf

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

9. MCMASTER GRADING SCALE

Grade	Equivalent Grade Point	Equivalent Percentages
A+	12	90-100
A	11	85-89
A-	10	80-84
B+	9	77-79
B	8	73-76
B-	7	70-72
C+	6	67-69
C	5	63-66
C-	4	60-62
D+	3	57-59
D	2	53-56
D-	1	50-52
F	0	0-49