Department of Civil and Environmental Engineering  
Carleton University  
ENVE3002: Environmental Engineering Systems Modelling  
Fall 2017

Instructor: Prof. Anh Pham (ME 2368)  
Email: a.pham@carleton.ca  
Office hours: T and Th (11:30-1p)  
Lecture: 16:05 – 17:25 T, Th  
Tutorial: 16:35 – 17:25 W  
Lab: 8:35 – 11:25 T

Teaching Assistants:  
Heline Chow (helinechow@cmail.carleton.ca)  
Marjan Soltanzadeh (marjansoltanzadeh@cmail.carleton.ca)  
TA’s office hour: they will tell you.

Lab supervisor: Marie Tudoret, Marie.Tudoret@carleton.ca

Grading:  
Laboratory 20%  
Assignments 10%  
Midterm 20%  
Final exam 50%

Students must have completed all laboratory work with a passing grade to be eligible to write the Final Examination.

Course objective: This course covers reaction kinetics and reactor design principles commonly used in chemical and biochemical systems and processes. It relies on an understanding of the conservation of mass principle applied to reacting systems and develops the capability to design and analyze systems governed by the rate of reactions. Natural or engineered systems where chemical/biochemical reactions play a major role are frequently encountered in environmental engineering and thus constitute a fundamental aspect of environmental engineering practice. The course is therefore a prerequisite for some key courses in the Environmental Engineering Program: ENVE3001 Water Treatment Principles and Design, ENVE3004 Contaminant Transport in the Environment, ENVE4005 Wastewater Treatment Principles and Design, ENVE4101 Waste Management.

Learning outcomes:  
Students passing the course are expected to:  
  • Understand the techniques used for collecting kinetic data to determine the dependence of reaction rates on temperature and the concentration of species  
  • Apply kinetic data in different types of reactors/systems to analyze the performance of the reactors/systems or to determine the required size for design
• Analyze the fluid flow behavior in natural and engineered systems in terms of idealized models
• Evaluate the effect of divergences from idealized models in terms of the expected performance or required size of reactors/systems

Textbook

References

Late policy: Assignments and lab reports should be turned in by the due date. If you cannot meet a deadline, please make arrangements with the professor before the assignment deadline; otherwise a mark of zero will be assigned. 50% of the grade will be deducted from the work that was turned in late unless you can provide appropriate documentation.

Content by weeks (approximate)

Week 1 Introduction
Introduction. Review of mass balances for reacting systems

Week 2-4 Chemical Reaction Kinetics
Reaction rate, molecularity and order, rate constants, kinetic models, integral and differential method of analysis for batch reactor data. (Levenspiel Chp. 1-3)

Week 5-8 Reaction Engineering and Design
Ideal batch, plug flow and mixed flow reactors, residence time distribution and non-ideal flow. (Levenspiel Chp. 4-6, 11-14)

Week 9-11 Biochemical Systems
Review of microbiological concepts, enzyme and microbial fermentation, Michaelis-Menten and Monod kinetics, biochemical reactors. (Levenspiel Chps.27-29, Metcalf & Eddy p.359-376, 1275-1279)

Week 12: Introduction to Process Control.
Sensors and instrumentation, control parameters, control systems.

Laboratory: Interpretation of batch reactor kinetic data (BOD test), investigation of fluid flow patterns in different reactor types by tracer residence time distribution experiments.

Contribution to CEAB Graduate Attributes
The Canadian Engineering Accreditation Board (CEAB) requires institutions offering engineering programs to demonstrate that the graduates of a program possess the attributes listed under thirteen categories. These attributes are interpreted in the context of candidates at the time of graduation but are clearly acquired throughout the program. This course aims to contribute to the following attributes as defined by CEAB1:
1. A knowledge base for engineering: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.

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.

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.

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.

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.

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

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.

8. Professionalism: An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.

**Academic Accommodation**: Students may need special arrangements to meet academic obligations during the term. For an accommodation request, the processes are described below.

*Pregnancy obligation*: Write to me with any requests for academic accommodations during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: [http://carleton.ca/equity/](http://carleton.ca/equity/)

*Religious obligation*: Write to me with any requests for academic accommodations during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: [http://carleton.ca/equity/Academic Accommodations for Students with Disabilities](http://carleton.ca/equity/Academic Accommodations for Students with Disabilities): The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your **Letter of Accommodation** at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable) at [http://carleton.ca/pmc/students/dates-and-deadlines/](http://carleton.ca/pmc/students/dates-and-deadlines/). You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at [http://www2.carleton.ca/equity/](http://www2.carleton.ca/equity/)