Winter 2025

Contaminant Transport in the Environment

Civil and Environmental Engineering

ENVE 3004 (v1)

Teaching Team

Instructor: Amir Hakami (amir_hakami@carleton.ca)

Office hours: by appointment

TA: Rachel Parson: RachelParson@cmail.carleton.ca (office hour will be posted later)

Course Description and requirements

1) Course schedule

Lectures: Please refer to the public class schedule

PA session: Please refer to the public class schedule

2) Course description

Physical phenomenon governing the transport of contaminants in the environment: diffusion, advection, dispersion, sorption, interphase transfer. Derivation and application of transport equations in air, surface and groundwater pollution; analytical and numerical solutions. Equilibrium partitioning of contaminants among air, water, sediment, and biota.

3) Prerequisites and recommended knowledge

CHEM 1000 or CHEM 1101, ENVE 3002

4) Precluded courses

None

5) Learning Outcomes

By the end of this course you should have developed strong conceptual understanding of the basic concepts of advection, dispersion and diffusion in air, surface water and groundwater. You should also be able to:

- Evaluate contaminant concentrations in air, surface water and groundwater in response to releases and/or spills in the environmental.

- Design stack heights to protect downgradient receptors from emissions from a stack at manufacturing or energy facilities.

- Evaluate the impacts of effluent discharges in a river and understand the impacts of a bank discharge versus a discharge at the centre of a river.

- Evaluate contaminant concentrations in an aquifer that has been impacted by an accidental spill or release.

- Evaluate how a contaminant released in a lake will partition between the water, sediment, aquatic life and the atmosphere.

6) Graduate Attributes

Engineering programs are accredited by the Canadian Engineering Accreditation Board (CEAB). As part of this process, we collect Graduate Attributes (GA) data to assess how effectively we are teaching or conveying the GAs with a goal to continually improve our programs. The GA data are aggregate data for a course and are NOT linked to student names or student numbers. This course is not designated for GA assessment; however, the following GAs are covered in this course.

GA - Indicator	Assessment Tool
GA1: Knowledge base	NA
GA2: Problem Analysis	NA
GA4: Design	NA

For information on GAs and continual curriculum improvement, visit the Accreditation section of Engineers Canada website.

7) Accreditation Units

Math	Natural Science	Complementary Studies	Engineering Science	Engineering Design
-	-	-	70%	30%

8) Textbook(s)/References

Students are not required to purchase textbooks or other learning materials for this course. Your main source for course content should be your notes. Parts of the course content are taken from the following textbook which can be used as supplementary/reference material.

- Ramaswami, A.; Milford, J. B.; Small, M. J., Integrated environmental modeling: pollutant transport, fate, and risk in the environment, John Wiley and Sons, 2005 (List Price: $220.95).

9) Topics and Tentative Plan

The following timeline is approximate and due dates are subject to change. Final exams are scheduled centrally by Examination Services.

Weeks	Topics	Milestones
1	Welcome and introduction, models, categorization of environmental models, sources and receptors in environmental transport modeling, physical properties, equilibrium and partitioning.	
2-3	Equilibrium and partitioning coefficients, partitioning in mixtures, fugacity, kinetics of intermedia transfer.	Assignment 1 (partitioning)
4	Advection, advection formulation, advection in different media.	
5-6	Molecular diffusion and random walk, Reynolds decomposition, turbulence and dispersion, multidimensional dispersion, puff equation, advection-dispersion equation, temporal and spatial scales in dispersion.	Assignment 2 (random walk computer model)
7-8	Contaminant transport in air: structure of the atmosphere, wind in atmosphere, pressure structure and barometric law, buoyancy, lapse rate and stability, Gaussian plume models, plume rise calculations, atmospheric dispersion modeling.	Assignment 3 (transport modelling) Assignment 4 (Gaussian dispersion modelling)
9-11	Contaminant transport in groundwater: saturated and vadose zones, Darcy's law, 1-D equation for instant and continuous sources, retardation and sorbed transport of reactive contaminants, transport in vadose zone.	Midterm (March 6 – tentative) Assignment 5 (subsurface transport)

12-13	Contaminant transport in surface water: pollutant release and mixing in rivers and streams, dispersion coefficient in rivers, dissolved oxygen, DOD and BOD in rivers, Streeter-Phelps equation	Assignment 6 (transport in rivers)

10) Evaluation and Marking Scheme

Acquiring a passing grade in this course requires a) an overall passing grade and b) a minimum final exam grade of 40%.

Evaluation in the course is based on the following breakdown:

10% Assignments

20% Midterm

20% Oral exam

50% Final exam

a) Missed term work and exams

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work or midterm exams are held responsible for immediately informing the instructor concerned and for alternate arrangements with the instructor and in all cases this must occur no later than three (3) days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. Consult Section 4.4 of the University Calendar.

b) Final Examination

i) Final exams are for evaluation purposes and will not be returned to students.

ii) The weight of the final exam is 50%

iii) Final exam is closed-books and closed-notes. Scientific calculators are necessary for the exam. The final exam will cover the entire material covered in the course.

iv) Students must obtain a minimum of 40% in the final exam to receive a passing grade, regardless of their overall grade.

v) Students who are unable to write the final examination because of a serious illness/emergency or other circumstance beyond their control may apply for accommodation by contacting the Registrar's office. Consult the Section 4.3 of the University Calendar.

c) Late Submission Policy

Penalties for late submissions are 10% within an hour, 25% within 8 hours, and 50 % within a day. Submissions after 24 hours receive no credit. If solutions are posted (or provided in another fashion, e.g., the PA session) within a day from the due date, late submissions won't be accepted.

d) Oral Exam (20%)

Evaluations will include an individual oral exam (10-15 minutes) of the concepts covered in the course. The oral exam sessions will be recorded for documentation and evaluation purposes.

11) Academic dates

Students should be aware of the academic dates (e.g., last day for academic withdrawal) posted on the Registrar's office web site https://carleton.ca/registrar/registration/dates/academic-dates/

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that **the work you submit is your own.** As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:

- any submission prepared in whole or in part, by someone else;
- using another's data or research findings without appropriate acknowledgement;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own; and
- failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks.

Copyright

The materials (including the course outline, slides, posted notes, videos, labs, projects, assignments, quizzes, exams, and solutions) created for this course are intended for personal use only. They may not be reproduced, redistributed, or transmitted in any form or by any means—electronic, mechanical, photocopying, recording, or otherwise—without written permission from the author(s), both during and after the semester.

Learning and Working Environment

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca

We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone's personal beliefs, choices, and opinions.

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

> **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.
>
> You should request your academic accommodations in the Ventus Student Portal, for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm. For final exams, the deadlines to request accommodations are published in the University academic calendars for both undergraduate and graduate students.
>
> **Accommodation for Student Activities**: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the Senate Policy on Accommodation for Student Activities (PDF).

Pregnancy Obligation: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation (PDF).

Religious Obligation: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation (PDF).

Survivors of Sexual Violence: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit the Sexual Violence Prevention & Survivor Support.

Engineering Academic Advising

The Engineering Academic Support Service assists undergraduate engineering students with course selection, registration, and learning support from first-year through to graduation.
Academic Advisors Contact can be found here: https://carleton.ca/engineering-design/current-students/undergrad-academic-support/undergraduate-advisors/.

Student Mental Health and Wellness

As a university student you may experience a range of mental health challenges that can significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator is designed to help students connect with mental health and wellness resources.
If you need to talk to someone from the department for more information and support with connecting to resources, you can contact the following faculty members, depending on your program. Or contact the department at orCEEUGChair@cunet.carleton.ca.

ACSE: Prof. Elie Azar
Email: Elie.Azar@carleton.ca, Office: 3432 Mackenzie

CIVE: Prof. Heng Khoo
Email: heng.khoo@carleton.ca, Office: 3364 Mackenzie

ENVE: Prof. Shoeleh Shams
Email: shoelehshams@cunet.Carleton.ca, Office: 4242 Mackenzie

Here is a list of on-campus and off-campus recourses:

1. **Carleton's Wellness Desk**: Located at 204A MacOdrum Library, is a space for students to learn about resources, connect with our Wellness Coordinator, and decompress during stressful times

of the year. You can pop into the Wellness Desk any time during its hours of operation – no appointments necessary! https://wellness.carleton.ca/mental-health/wellness-desk/

2. **Carleton's Health and Counselling Services:** To book an appointment contact the main clinic by calling (613) 520-6674. If urgent, let the Patient Care Coordinator know or go in person to the main clinic (2500 Carleton Technology and Training Centre Building) and indicate that they are in crisis and need to speak to someone right away. https://carleton.ca/health/

3. **Residence Counselling and Wellness Service:** Counselling services specifically for students in residence. https://carleton.ca/health/residence-counselling/

4. **Therapy Dogs:** Carleton's therapy dogs are around campus with their owners (who are Carleton University staff and faculty) to comfort and provide support to help you thrive as a university student. https://carleton.ca/wellness/dogs/

5. Emergencies and Crisis and Emergency Numbers

6. **Good2Talk (1-866-925-5454):** Good2Talk is a free, confidential helpline providing professional counselling and information and referrals for mental health, addictions and well-being to post-secondary students in Ontario, 24/7/36 https://good2talk.ca/

7. **Empower Me:** Undergraduate students have access to free counselling services in the community through Empower Me, either in person, by telephone, video-counselling or e-counselling. **This free service is accessible 24/7, 365 days per year.** Call **1-844-741-6389 (toll free)** to make an appointment with a counsellor in the community. More information is available https://students.carleton.ca/services/empower-me-counselling-services/

8. **The Walk-In Counselling Clinic (off-campus community resource):** The walk-in Counselling Clinic have offices in various locations across Ottawa and the greater Champlain region that are open 7 days a week. Individuals will be assisted, with no appointment, on a first-come, first-serve basis during the Walk-in Counselling Clinic hours. The Walk-in Counselling Clinic **offers services in many languages** and is free and confidential. More information can be found at: https://walkincounselling.com/

9. **Distress Centre of Ottawa and Region**: Available 10am-11pm, 7 days/week, 365 days/year. **Distress Line:** 613-238-3311, **Crisis Line:** 613-722-6914 or 1-866-996-0991, **Text:** 343-306-5550. https://www.dcottawa.on.ca/

10. **Distress and Crisis Ontario**, Available for chat 2 pm – 2 am EST. https://www.dcontario.org/

11. **BounceBack Ontario (Toll-Free: 1-866-345-0224)** is a free skill-building program managed by the Canadian Mental Health Association (CMHA). It is designed to help adults and youth 15+ manage low mood, mild to moderate depression and anxiety, stress or worry. Delivered over the phone with a coach and through online videos, you will get access to tools that will support you on your path to mental wellness. https://bouncebackontario.ca/.