

**Western University - Faculty of Engineering**  
**Department of Civil and Environmental Engineering**

**CEE 3386a – Numerical Modeling for Environmental Engineers - Course**  
**Outline 2017/18**

In this course students will use of mathematical models to explore physical and chemical processes associated with common environmental engineering problems. Modeling plays an important role in environmental engineering. The general objectives are for the student to become able to:

- Formulate conceptual models for 'real world' environmental problems and identify when problems can be solved numerically.
- Formulate and implement numerical models related to the fate and transport of contaminants in environmental systems.
- Program numerical algorithms and interpret the physical meaning of model results.
- Undertake the different stages of numerical modeling including development, implementation, calibration and validation of models.
- Identify the benefits and limitations of modeling methods in searching for solutions to environmental problems.
- Improve communication skills by documenting model development, implementation, results and interpretation.
- Recognize the need for life-long learning, and advancement of computational skills for solving complex environmental engineering problems.

**Calendar Copy:**

Principles of model development and solution for environmental systems including river and lake water quality, groundwater flow and contamination, and atmospheric pollution. Application of these principles using a range of numerical techniques, including current commercial software packages, through all stages of the modeling process from conceptualization to calibration and validation.

**Contact Hours:**

3 lecture hours; 3 design lab/tutorial hours

Attendance at the tutorial/laboratory session is **mandatory**

**Prerequisites:** CEE 2219A/B or the former CEE 2218A/B

**Corequisites:** None

**Antirequisite:** None

**Note:** It is the **student's responsibility** to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the **student's responsibility** to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

**Instructor:**

Dr. Clare Robinson, SEB 3041, c Robinson@eng.uwo.ca

Dr. Ian Molnar, ian.molnar@gmail.com

**Textbook:**

Prepared class notes that can be downloaded from the course website should be brought to each class.

**Other References:**

Anderson, M. and Woessner, W., 1992. *Applied Groundwater Modeling*, Elsevier, San Diego.

Holzbecher E., 2007. *Environmental Modeling Using MATLAB*, Springer-Verlag, Berlin.

James, A. (ed), 1993. *An Introduction to Water Quality Modeling*, John Wiley & Sons, New York.

Ramaswami, A., Milford, J., et al., 2005. *Integrated Environmental Modeling*, John Wiley & Sons, New Jersey.

Vreugdenhil, C.B., 1989. *Computational Hydraulics: An Introduction*, Springer-Verlag, New York.

Wood, W.L., 1993. *Introduction to Numerical Methods for Water Resources*, Oxford University Press, Oxford.

Zheng, C., Bennett, G., 2002, *Applied contaminant transport modeling*, John Wiley & Sons, New York.

**Computer Laboratory:**

There will be seven computer laboratory sessions. These are held on Wednesday from 2:30-5:30pm. Each laboratory session is associated with an assignment that needs to be completed.

**Computing:**

Assignments will require the use of MATLAB and PMWIN 5.3.1 (pre-processor for MODFLOW and MT3DMS). These programs will be available in the engineering undergraduate computer laboratory. PMWIN 5.3.1 is also freely available to download from <http://www.pmwin.net/pmwin5.htm>.

**Units:**

SI units will be used in lectures and examinations

**Specific Learning Objectives:**

1. Introduction. At the end of this section, the student should be able to:
  - a) Appreciate the usefulness and limitations of modeling in searching for solutions to environmental problems.
  - b) Appreciate the importance of all stages of the modeling process including model development, solution, calibration and validation.
  - a) Determine the level of complexity required in a numerical model to meet specific objectives and understand the importance of model conceptualization.
  - d) Classify types of models including stochastic vs. deterministic, lumped vs. distributed, steady state vs. transient.
  - e) Assess the suitability of a particular level of modeling for specific goals (simple analytical versus complex numerical).
  - f) Identify types of differential equations and boundary and initial condition requirements.

2. Lumped “box” models. At the end of this section, the student should be able to:
  - a) Apply the law of mass conservation to a control volume to solve simple environmental problems.
  - b) Develop and apply finite difference schemes to initial value first order O.D.Es.
  - c) Evaluate the accuracy of finite difference schemes and appreciate sources of error in numerical modeling.
  - d) Appreciate the importance of step size for numerical accuracy and stability.
  
3. Fate and transport of contaminants. At the end of this section, the student should be able to:
  - a) Appreciate the mechanisms controlling the fate and transport of contaminants in the environment including diffusion, dispersion, advection and reaction.
  - b) Appreciate the difference and be able to solve contaminant transport problems with a continuous vs. instantaneous source and point vs. non-point source.
  - c) Develop finite difference schemes and apply in MATLAB to solve partial differential equations for (i) diffusion, (ii) advection-dispersion and (iii) advection-dispersion-reaction contamination problems.
  - d) Spatially and temporally discretize target systems, select appropriate boundary and initial conditions and undertake stability and accuracy analyses.
  - e) Compare numerical results to analytical solutions for contaminant transport problems and appreciate the sources of error.
  
4. Groundwater flow and transport. At the end of this section, the student should be able to:
  - a) Derive groundwater flow equations for common hydrogeological problems.
  - b) Solve the groundwater flow equation using finite difference methods.
  - c) Spatially and temporally discretize target systems, select appropriate boundary and initial conditions and undertake stability and accuracy analyses.
  - d) Apply MODFLOW and MT3DMS to solve groundwater flow and transport problems and compare results with numerical solutions implemented in MATLAB.
  - e) Calibrate "real world" groundwater models.
  - f) Appreciate the advantages and limitations of finite difference methods.
  
5. Computing skills. At the end of the course, the student should be able to:
  - a) Proficiently program numerical algorithms to solve equation sets.
  - b) Be familiar with a number of computational software they will encounter in the environmental engineering profession.

Instructor may expand on material presented in the course as appropriate.

### **General Learning Objectives**

E=Evaluate, T=Teach, I=Introduce

Problem Analysis	E	Team Work		Ethics and Equity	
Investigation	T	Communication	I	Economics and Project Management	
Design	I	Professionalism	I	Life-Long Learning	I
Engineering Tools	E	Impact on Society			

## **Evaluation:**

The final course mark will be determined as follows:

Quizzes:	15%
Final Examination	50%
Assignments	25%
Presentation	10%
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Total	100%

**Note:** (a) **Students must pass the final examination to pass this course.** Students who fail the final examination will be assigned the aggregate mark, as determined above, or 48%, whichever is less.

(b) **Students must turn in all assignments and achieve a passing grade in this component, to pass this course.** Students who do not satisfy this requirement will be assigned 48% or the aggregate mark, whichever is less.

(c) **Students who have failed this course previously must repeat all components of the course.** No special permissions will be granted enabling a student to retain assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted.

### 1. Quizzes and Examinations:

Two 40 minute quizzes will be scheduled during the lecture periods. Programmable calculators are **not** permitted in the final examination and quizzes. Unless otherwise notified the quizzes and the final examination will be **CLOSED BOOK: no programmable calculators or other external sources of information, including books, notes or crib sheets, are permitted.** A list of acceptable calculators for closed book exams will be posted on the bulletin board across from the Department of Civil and Environmental Engineering Office: please be sure your calculator is on it!

### 2. Assignments

Assignments will be based on computer laboratories with some theoretical background questions. Assignments are to be done individually. Each assignment will be posted on the course website by Monday 4pm. The computer laboratory for working on the assignments will be on the Wednesday (2.30 - 5.30pm). You should review the assignment before the computer laboratory and may only ask for assistance on a question you have attempted. Completed assignments are due the following Tuesday at 10:30 a.m. Marked assignments will be handed back 8 days from the due date (i.e., at the following Wednesday laboratory session).

**Late Assignments:** Late assignments will be accepted for 3 days following their due date. 10% per day will be deducted for late assignments. Anytime on Tuesday after 10.30am will be considered a day late until after 10.30am Wednesday when it will be 2 days late. An assignment will not be accepted after Friday at 10:30 a.m. on the week the assignment was due. For extenuating circumstances, see details in the Faculty of Engineering Policy (attached). Extensions are to be negotiated with the course instructor, not the teaching assistants. If no assignment is received for a student, the mark assigned is zero for that week.

The maximum number of missed assignments for each student will be three; if more than three assignments are missed than a student may be barred from writing the final exam.

**Plagiarism on Assignments:** Each person must hand in an assignment that contains only their own work. If an assignment is deemed to be similar to another from this year (in the opinion of the TAs and the Prof.) this will be taken as a case of plagiarism. In such circumstances, both individuals (e.g., the person providing the answer and the person copying it) will both receive a mark of zero on the entire assignment. For a first offense, both individuals will receive a personal warning and the infraction will be recorded. For a second offense, further action will be taken.

### 3. Use of English

In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

#### **Plagiarism Checking:**

The University of Western Ontario uses software for plagiarism checking. Students are required to submit their Laboratory Reports in electronic form to Turnitin.com for plagiarism checking.

#### **Cheating:**

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.

For more information on scholastic offenses, please see:

[http://www.uwo.ca/univsec/handbook/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf)

#### **Attendance:**

Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

#### **Accessibility:**

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

#### **Conduct:**

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Late comers may be asked to wait outside the classroom until being invited in by the Instructor. Please turn off your cell phone before coming to a class, tutorial, quiz or exam.

On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: <http://www.uwo.ca/univsec/board/code.pdf>

**Sickness and Other Problems:**

Students should immediately consult with the Instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, please see:

[http://www.uwo.ca/univsec/handbook/appeals/accommodation\\_medical.pdf](http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf)

**Notice:**

Students are responsible for regularly checking their email, course website (<https://owl.uwo.ca>) and notices posted outside the Civil and Environmental Engineering Department Office

**Consultation:**

Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

**Course breakdown:**

Engineering Science = 75% = 42.53 AU's; Mathematics = 25% = 14.18 AU's.

The document "INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED" is part of this course outline.

**INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED**

IF, ON MEDICAL OR COMPASSIONATE GROUNDS, YOU ARE UNABLE TO WRITE TERM TESTS OR FINAL EXAMINATIONS OR COMPLETE COURSE WORK BY THE DUE DATE, YOU SHOULD FOLLOW THE INSTRUCTIONS LISTED BELOW. YOU SHOULD UNDERSTAND THAT ACADEMIC RELIEF WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC RELIEF WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. PLEASE READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2017 UWO ACADEMIC CALENDAR).

**A. GENERAL REGULATIONS & PROCEDURES**

1. All first year students will report to the Undergraduate Services Office, SEB 2097, for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or exam that is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097. Otherwise, you will report to your department office to request relief.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your Department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

**B. TERM TESTS**

1. If you are in first year and you are unable to write a term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a term test, inform your instructor PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office. If the test is worth MORE THAN 10% of your final grade you will report to the Undergraduate Services Office, SEB 2097 to request relief. Otherwise, you will report to your department office to request relief.
3. Be prepared to provide supporting documentation to the Department Chair and/or the Undergraduate Services Office (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair or the Undergraduate Services Office is required when rescheduling term tests.

**C. FINAL EXAMINATIONS**

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

**N.B. It is the student's responsibility to check the date, time and location of the Special Examination.**

**D. LATE ASSIGNMENTS**

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
  - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.
  - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

## E. SHORT ABSENCES

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

## F. EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or Ms. Karen Murray in the Undergraduate Services Office, if you are in first year.

## G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

**In Case of Serious Illness of a Family Member:** Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**In Case of a Death:** Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**For Other Extenuating Circumstances:** If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

**Note:** Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

## H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. **You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.**
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

**Calendar References:** Check these regulations in your 2017 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

Absences Due to Illness: <http://westerncalendar.uwo.ca/2017/pg117.html>  
Academic Accommodations for Students with Disabilities: <http://westerncalendar.uwo.ca/2017/pg118.html>  
Academic Accommodations for Religious or Holy Days: <http://westerncalendar.uwo.ca/2017/pg119.html>  
Course Withdrawals: <http://westerncalendar.uwo.ca/2017/pg157.html>  
Examinations: <http://westerncalendar.uwo.ca/2017/pg129.html>  
Scheduling of Term Assignments: <http://westerncalendar.uwo.ca/2017/pg135.html>  
Scholastic Offences: <http://www.westerncalendar.uwo.ca/2017/pg111.html>  
Student Medical Certificate: [http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf)  
Engineering Academic Regulations: <http://www.westerncalendar.uwo.ca/2017/pg1442.html>

**Note:** These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

### **Drop Deadlines:**

First term half course (i.e. "A" or "F"):	November 5, 2017
Full courses and full-year half courses (i.e. "E", "Y" or no suffix):	November 30, 2017
Second term half or second term full course (i.e. "B" or "G"):	March 7, 2017

### **Contact Information:**

Undergraduate Services Office:	SEB 2097	Telephone: (519) 661-2130	E-mail: <a href="mailto:engugrad@uwo.ca">engugrad@uwo.ca</a>
Dept. of Chemical and Biochemical Engineering & Green Process Engineering:	TEB 477	Telephone: (519) 661-2131	E-mail: <a href="mailto:cbeugrad@uwo.ca">cbeugrad@uwo.ca</a>
Dept. of Civil and Environmental Engineering:	SEB 3005	Telephone: (519) 661-2139	E-mail: <a href="mailto:civil@uwo.ca">civil@uwo.ca</a>
Dept. of Electrical and Computer Engineering, Software Engineering & Mechatronics Engineering:	TEB 279	Telephone: (519) 661-3758	E-mail: <a href="mailto:eceugrad@uwo.ca">eceugrad@uwo.ca</a>
Dept. of Mechanical and Materials Engineering:	SEB 3002	Telephone: (519) 661-4122	E-mail: <a href="mailto:mmeundergraduate@uwo.ca">mmeundergraduate@uwo.ca</a>