This course introduces computational tools and numerical methods for environmental and civil engineering analysis. The course emphasis is placed on problem formulation, solution algorithm designs, and programming applications. The general objectives are for the student to become able to:

- solve problem sets relevant to civil and environmental engineering through problem formulation, solution algorithm design, and programming application;
- identify and apply appropriate numerical methods for solving sets of linear and non-linear algebraic equations, ordinary differential equations, and differential-algebraic systems;
- introduce numerical methods for CEE problem-solving such as finite difference methods for the solution of differential equations;
- formulate engineering problems using optimization;
- develop an awareness of the shortcomings, approximations, and uncertainties associated with numerical methods and modeling;
- improve computational skills and be proficient in programming language required to solve engineering problems; and
- Recognize the need for life-long learning and the advancement of computational skills for solving complex civil and environmental engineering problems.

**Calendar Copy:**
The first course in numerical methods for civil and environmental engineers, emphasizing problem formulation, solution algorithm design, and programming application. Methods for solving non-linear algebraic equations, ordinary differential equations, and differential-algebraic systems. Introduction to the systems approach and system analysis terminology for application to engineering planning, design, and operations. (0.5 course)

**Contact Hours:**
**Three lecture hours/week:**
Lectures will be primarily delivered asynchronously, and a video record of the lecture will be posted to the course OWL site. Lectures will be organized into learning modules, which students should review weekly. Besides, students are required to attend one live lecture per week via zoom. More specifically, the lecture hours will be used for discussion and class exercises will be handed in after the lecture. Review of lecture material and self-study should take approximately 6 hours per week.

**Three computer lab/tutorial hours:**
Attendance at the computer lab/tutorial session is mandatory. Laboratory modules will be delivered synchronously and asynchronously, and pre-recorded videos will be posted to the course OWL site according to the laboratory schedule outlined below. A 3-hour weekly computer lab sessions will be held synchronously through Zoom. During this period, students will work on a specific problem(s) using the computer software MATLAB. Students will hand in their work at the end of each session. The link to the Zoom meeting will be posted to OWL.
**Video copyright:**
The lecture notes and online lecture videos are copyrighted to the Instructor and legally protected. Do not post these videos and lecture notes on any other website or online forums. The recording of the synchronous sessions of the course without permission from the Instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal actions.

**Prerequisites:**

**Corequisites:**
Applied Mathematics 2411 or 2415.

**Antirequisite:**
CBE 2291A/B, the former CEE 2218A/B.

**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:**
Martha Dagnew, CMLP 1302
email: mdagnew@uwo.ca
Office hours via Zoom (link will be posted on course OWL site)
Date and time: To be determined

Administrative Assistant: Sandra McKay (smckay@uwo.ca)

**Textbook:**

**Other References:**


Units:
SI units will be used in lectures and examinations

Specific Learning Objectives:
The lectures and tutorial assignments will prepare students to do the following [Graduate attribute Indicator]

1. Introduction. At the end of this section, the student should be able to [ET2]:
   a) Understand and recognize when engineering problems need to be solved numerically.
   b) Identify, classify and analyze different systems of equations, i.e., linear, non-linear equations, first or higher-order, ordinary or partial differential equations.
   c) Understand various methods available to formulate a solution to a system of equations.
   d) Appreciate the types of problems that arise in civil and environmental engineering applications that require numerical analysis.

2. Linear and non-linear algebraic equations. At the end of this section, the student should be able to [ET2]:
   a) Apply numerical algorithms for the solution of linear equations including direct and iterative methods.
   b) Use numerical solution techniques for solving single and systems of non-linear algebraic equations including Newton's method and several root/s finding methods.
   c) Optimize an engineering problem numerically

3. Numerical integration and differentiation. At the end of this section, the student should be able to [ET2]:
   a) Use numerical solution techniques to integrate and differentiate functions
   b) Apply numerical algorithms to solve ordinary differential equations with initial value and boundary value problems
   b) Understand the error bounds and convergence rates of numerical algorithms and perform error analysis.

4. Computing skills. At the end of the course, the student should be able to [ET 3]:
   a) Program numerical algorithms to solve equation sets.

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

General Learning Objectives:
E=Evaluate, T=Teach, I=Introduce (Beginner or Intermediate or Advanced Level)

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ET2 and ET3 are evaluated at a "beginner" level.

Evaluation:
The final course mark will be determined as follows:

Weekly computer labs 15%
Weekly class exercises 15%
Midterm exam 20%
Final Exam: 50%

Total 100%
1. **Quizzes and Examinations:**
A one and half hour midterm exam will be held during a tutorial hour. The midterm exam date is *tentatively* scheduled for Wednesday, March 02.

A three and half hour written final examination will be held during the regular examination period. Both exams will be conducted via the OWL platform. The exams will be an open book, but students will be required to join the zoom session and turn on their cameras.

2. **Weekly class exercise:**
Class exercises will be conducted on a weekly basis. Class exercises are to be submitted at the end of the lecture hours. Late submissions will be assessed a penalty of 10% per day, to a maximum of 2 day, after which they will receive a mark of zero.

3. **Weekly Computer Laboratories:**
Computer labs will be presented through pre-recorded video, and students are required to solve problems based on pre-recorded and synchronous zoom support. Your computer lab work should be submitted at the end of the lab session.

**Use of English:**
In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper English use. 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.

**Course delivery with respect to the COVID-19 pandemic**
Although the intent is for this course to be delivered in-person, the changing COVID-19 landscape may necessitate some or all of the course to be delivered online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any assessments affected will be conducted online as determined by the course instructor.

When deemed necessary, tests and examinations in this course will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western’s Remote Proctoring website at: https://remoteproctoring.uwo.ca

**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

**Attendance:**
Any student who, in the opinion of the Instructor, has not engaged sufficiently in 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.
**Accommodation:**
Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: Academic Accommodation for Students with Disabilities.

**Academic Consideration for Student Absence**
Students will have up to two (2) opportunities during the regular academic year to use an online portal to self-report an absence during the term, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student's final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are not met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation. Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. **All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.**

For Western University policy on Consideration for Student Absence, see [Policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf)

**Religious Accommodation**
Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the [Western Multicultural Calendar](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf).

**Use of Recordings:**
All of the remote learning sessions for this course will be recorded. The data captured during these recordings may include your image, voice recordings, chat logs and personal identifiers (name displayed on the screen). The recordings will be used for educational purposes related to this course, including evaluations. The recordings may be disclosed to other individuals under special circumstances. Please contact the Instructor if you have any concerns related to session recordings. Participants in this course are not permitted to record the sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the Instructor.
**Conduct:**
Some components of this course will involve online interactions. To ensure the best experience for both you and your classmates, please honour the following rules of etiquette:

- please "arrive" to class on time
- please use your computer and/or laptop if possible (as opposed to a cell phone or tablet)
- ensure that you are in a private location to protect the confidentiality of discussions in the event that a class discussion deals with sensitive or personal material
- to minimize background noise, kindly mute your microphone for the entire class until you are invited to speak, unless directed otherwise
- [suggested for classes larger than 30 students] In order to give us optimum bandwidth and web quality, please turn off your video camera for the entire class unless you are invited to speak
- [suggested for cases where video is used] please be prepared to turn your video camera off at the Instructor's request if the internet connection becomes unstable
- unless invited by your Instructor, do not share your screen in the meeting

The course instructor will act as moderator for the class and will deal with any questions from participants. To participate please consider the following:

- if you wish to speak, use the "raise hand" function and wait for the Instructor to acknowledge you before beginning your comment or question
- remember to unmute your microphone and turn on your video camera before speaking
- self-identify when speaking.
- remember to mute your mic and turn off your video camera after speaking (unless directed otherwise)

General considerations of "netiquette":

- Keep in mind the different cultural and linguistic backgrounds of the students in the course.
- Be courteous toward the Instructor, your colleagues, and authors whose work you are discussing.
- Be respectful of the diversity of viewpoints that you will encounter in the class and in your readings. The exchange of diverse ideas and opinions is part of the scholarly environment. "Flaming" is never appropriate.
- Be professional and scholarly in all online postings. Cite the ideas of others appropriately.

Note that disruptive behaviour of any type during online classes, including inappropriate use of the chat function, is unacceptable. Students found guilty of Zoom-bombing a class or of other serious online offenses may be subject to disciplinary measures under the Code of Student Conduct.

**Notice:**
Students are responsible for regularly checking their email, course website ([https://owl.uwo.ca](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 the Instructor in tutorial sessions. Office hours will be arranged for the students to meet with the Instructor and teaching assistants. Other individual consultations can be arranged by appointment with the Instructor.
Online Proctoring Notice:

Tests and examinations in this course will be conducted using Zoom. You will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session will not be recorded.*

More information about the use of Zoom for exam invigilation is available in the Online Proctoring Guidelines at the following link:
Completion of this course will require you to have a reliable internet connection and a device that meets the system requirements for Zoom. Information about the system requirements are available at the following link:
https://support.zoom.us/hc/en-us.

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please discuss this with your Instructor in advance of the test or examination.

3. If using both Zoom and Proctortrack or alternative remote proctoring solution:

Tests and examinations in this course will be conducted using both Zoom and the remote proctoring service, Proctortrack.

When Zoom is used for exam invigilation, you will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session using Zoom will not be recorded.*

Proctortrack will require you to provide personal information (including some biometric data). The session will be recorded. By taking this course, you are consenting to the use of this software. More information about remote proctoring is available in the Online Proctoring Guidelines at the following link:
Completion of this course will require you to have a reliable internet connection and a device that meets the system and technical requirements for both Zoom and Proctortrack. Information about the system and technical requirements are available at the following links:
https://www.proctortrack.com/tech-requirements/,
https://support.zoom.us/hc/en-us.

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please discuss this with your Instructor in advance of the test or examination.
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.

NEW: Requests for Academic Consideration using the Self-Reported Absence Form

If you experience an unexpected illness or injury or an extenuating circumstance (48 hours or less) that is sufficiently severe to temporarily render you unable to meet academic requirements (e.g., attending lectures or labs, writing tests or midterm exams, completing and submitting assignments, participating in presentations) you should self-declare using the online Self-Reported Absence portal. This option should be used in situations where you expect to resume academic responsibilities within 48 hours or less. Each student will be allowed a maximum of two self-reported absences between September and April and one self-reported absence between May and August. Self-reporting may not be used for final exams or assessments (e.g. midterm exams, tests, reports, presentations, or essays) worth more than 30% of any given course. For full instructions about the Self-Reporting System refer to the Academic Calendar link Academic Calendar - Western University (uwo.ca).

A. GENERAL REGULATIONS & PROCEDURES (other than self-reported absences)

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 examination that is worth LESS THAN 10% of your mark, you should report to your department office to request relief. If your course work is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097.

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/MIDTERM TESTS (other than self-reported absences)

1. If you are in first year and you are unable to write a midterm/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 midterm/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 LESS THAN 10% of your mark, you should report to your department office to request relief. 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.

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 midterm/term tests.

**C. FINAL EXAMINATIONS (cannot be self-reported)**

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, headache, 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. PLEASE NOTE: 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 Assistant Dean, First Year Studies, 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, Undergraduate Studies. 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, Undergraduate Studies.

**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 are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

**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 2021 Western Academic Calendar available at www.westerncalendar.uwo.ca

Self-Reporting Absences
https://westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=1&Command=showCategory&Keywords=self-reporting&SubHeadingID=362&SelectedCalendar=Live&ArchiveID=#SubHeading_362

Absences Due to Illness
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_12

Academic Accommodations for Students with Disabilities
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_10

Academic Accommodations for Religious or Holy Days
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_16

Course Withdrawals
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=6&SelectedCalendar=Live&ArchiveID=#Page_75

Examinations
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&command=showCategory&SelectedCalendar=Live&ArchiveID=

Scheduling of Term Assignments
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading_78

Scholastic Offences
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_20

Student Medical Certificate

https://www.eng.uwo.ca/files/undergraduate/forms/smc.pdf

Engineering Academic Regulations

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page_86

**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.

**Add Deadlines:**

First term half course (i.e. “A” or “F”) September 16, 2021
Full courses and full-year half course (i.e. “E”, “Y” or no suffix) September 16, 2021
Second term half course (i.e. “B” or “G”) January 11, 2022

**Drop Deadlines:**

First term half course (i.e. “A” or “F”) November 12, 2021
Full courses and full-year half courses (i.e. “E”, “Y” or no suffix) November 30, 2021
Second term half or second term full course (i.e. “B” or “G”) March 7, 2022

**Contact Information:**

Undergraduate Services Office SEB 2097 Phone: 519-661-2130 E-mail: engugrad@uwo.ca

Civil Engineering: SEB 3005 Phone: 519-661-2139, E-mail: civil@uwo.ca