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

CEE 2219b – Computational Tools for Civil Engineers – Course Outline 2024/2025

This course introduces computational tools and numerical methods for solving Civil and Environmental Engineering problems. The course emphasizes on problem formulation, solution algorithm designs, and programming applications. The general objectives are for the student to be 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 solving differential equations.
- Formulate engineering problems using optimization.
- Develop an awareness of the shortcomings, approximations, and uncertainties associated with numerical methods and modelling.
- Improve computational skills and be proficient in the programming language required to solve engineering problems.
- Recognize the need for life-long learning and advancing computational skills for solving complex civil and environmental engineering problems.

Calendar Copy:

The course is 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 synchronously. Lectures will be organized into learning modules, which students should review weekly. During lecture hours, students will work on class exercises, which will be handed in after the lecture.

3 computer lab/tutorial hours. Attendance at the computer lab/tutorial session is **mandatory**. Laboratory modules will be delivered synchronously. During the computer lab, students will work on problems using MATLAB software. Students will hand in their work at the end of each session.

Review of lecture material and self-study should take approximately 6 hours per week.

Prerequisites/Corequisites: ES 1036A/B, Applied Mathematics 1411A/B or the former Applied Mathematics 1411A/B, NMM 1412A/B or the former Applied Mathematics 1412 A/B, NMM 2270A/B or the former Applied Mathematics 2270A/B.

Corequisites: Applied Mathematics 2277A/B

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

Note: The student is responsible for ensuring that all Prerequisite and Corequisite conditions are met or that the faculty has granted special permission to waive these requirements. It is also the **student's responsibility** to ensure 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: Tuesday 1-2 pm

Academic Support: SEB 3005 or civil@uwo.ca

Textbook:

Chapra, Steven C, 2018, *Applied Numerical Methods with Matlab® for Engineers and Scientists, 4th Edition* (Required). Lecture presentations and other material may be downloaded from the course website

Other References:

Charles ReVelle, Elbert Earl Whitlatch, Jeff R. Wright, 2004, *Civil and Environmental Systems Engineering*, Prentice Hall.

Bilal M. Ayyub, Richard H. McCuen, 1996, *Numerical Methods for Engineers*, Prentice Hall.

Kreyszig, E., 2000, *Advanced Engineering Mathematics, 9th Edition*, John Wiley & Sons, Inc. New York.

Etter, D.M. and D.C. Kuncicky, 1999, *Introduction to MATLAB® for Engineers and Scientists*, Prentice Hall, New Jersey.

Mathews, J.H. and K.D. Fink, 2004, *Numerical Methods Using MATLAB®, 4th Edition*, Prentice Hall, New Jersey.

Palm III, W.J., 2005, *Introduction to MATLAB® 7 for Engineers*, McGraw-Hill, Boston.

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 solving 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. Level: I=Introduce; D= Develop; A=Advance

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

ET2 and ET3 are evaluated at a "beginner" level. Breakdown: Math (70%), Engineering Science (30%)

Evaluation:

The final course mark will be determined as follows:

Weekly computer labs	10%
Weekly assignments	10%
Class exercises	10%
Midterm exam	20%
Final Exam:	50%

Total	100%

1. Examinations:

The midterm exam will be held during lecture hours. The midterm exam date is *tentatively* scheduled for the first week of March.

A three-hour written final examination will be held during the regular examination period. Both exams will be conducted in person.

To complete the course, one must achieve a passing grade on the final exam.

2. Weekly class exercises and assignments:

Class exercises will be conducted weekly. Class exercises will be submitted individually at the end of the lecture hours. Assignments are to be submitted in groups; late assignment submissions will be assessed a penalty of 10% per day to a maximum of 2 days, after which they will receive a zero mark.

3. Weekly Computer Laboratories:

Computer labs will be conducted in person, and students will solve problems and submit their work at the end of the lab session.

Use of English:

Students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper English use. Additionally, poorly written work, except for 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.

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.

Sickness and Other Problems

Academic Consideration for Absences

Students should immediately consult with the instructor if they have any problems that could affect their performance in the course. The student should seek advice from the instructor regarding how best to deal with the problem. Failure to notify the instructor (or as soon as possible thereafter) will have a negative effect on any appeal. Please visit for information on how to submit a request for Academic Consideration:

https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

Conduct:

Some components of this course will involve online interactions. To ensure the best experience for both you and your classmates, please honor 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 if 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] 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 the 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 a class moderator and 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 "etiquette":

- 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) and notices posted outside the Civil and Environmental Engineering Department Office