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

<u>CEE 2219b – Computational Tools for Civil Engineers –</u> <u>Course Outline 2023/2024</u>

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 nonlinear 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.

<u>Prerequisites/Corequisites:</u> 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.

<u>Corequisites:</u>	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: <u>mdagnew@uwo.ca</u> Office hours via Zoom (link will be posted on course OWL site) Date and time: To be determined.

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.

<u>Units:</u>

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. <u>Introduction</u>. 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. <u>Linear and non-linear algebraic equations</u>. 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. <u>Numerical integration and differentiation</u>. At the end of this section, the student should be able to **[ET2]**:

a) Use numerical solution techniques to integrate and differentiate functionsb) 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. <u>Computing skills</u>. 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	Т	Teamwork	Т	Ethics and Equity				
Investigation		Communication	E(I)	Economics and Project Management				
Design		Professionalism	Ι	Life-Long Learning	Ι			
Engineering Tools	E (I)	Impact on Society						

E=Evaluate. Level: I=Introduce; D= Develop; A=Advance

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. <u>Weekly Computer Laboratories:</u>

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.

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 "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).

Academic Consideration for Student Absence

Academic Consideration provides students with consistent, fair, and academically appropriate consideration, when they are unable to complete course components due to extenuating circumstances.

Academic Consideration for course-related components and assessments may include: Class Attendance, Tutorial Attendance, Laboratory Attendance, Midterm, Test, Presentation, Essay/Assignments, and Quizzes. Please provide notification and documentation in advance of due dates, examinations, etc.

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.

Western's <u>Academic Consideration for Medical Illness – Undergraduate Students</u> Western's <u>Accommodation for Religious Holidays</u>

Course Components other than Final Examinations

If you are missing a course-related component (Class Attendance, Tutorial Attendance, Laboratory Attendance, Test, Presentation, Essay/Assignment, Quiz), please notify your course instructor and check the course outline to see if the instructor has a policy for missed course components. If there is no policy in the course outline, please submit an <u>Academic Consideration Request Form</u>. For illness related absences, please include a completed <u>Student Medical Certificate</u>.

Upper-Year Students – Final Examinations

Sleeping in, misreading the timetable, or travel arrangements is not a valid reason to request accommodation.

If you are unable to write a final examination, please email your instructor immediately, then complete the <u>Academic Consideration Request form</u> **AND** the <u>Application for a Special Exam form</u>. For illness related absences, please include a completed <u>Student Medical Certificate</u>.

Undergraduate Services will schedule deferred exams for all engineering courses. For examinations outside of Engineering, please contact your course instructor for information on the deferred exam date and location.

Accommodated Exams

For <u>Accommodated Exams</u>, please complete the please complete the <u>Academic Consideration Request</u> form **AND** the <u>Application for a Special Exam form</u>. For illness related absences, please include a completed <u>Student Medical Certificate</u>. Please also cancel your booking on your <u>Examination Services</u> <u>Portal</u>.

It is the student's responsibility to check the date, time and location of the special examination.

Extended Absences

If you are absent more than one week or if you get too far behind to catch up, please contact your <u>Academic Counsellor</u>.

Documentation

Student Medical Certificate

The Student Medical Certificate is the only acceptable documentation.

It is not sufficient to provide documentation indicating simply that the student "was seen for a medical reason" or "was ill." This note must contain the following information: severity of illness, effect on academic studies and duration of absence.

Compassionate

Compassionate reasons range from bereavement, weddings, high school commencements, and more. We understand that life happens outside of your academics and there may be a time when you cannot meet your responsibilities due to something we would consider a compassionate reason. Please do not book or commit to any event prior to speaking with your instructor.

Please provide supporting documentation.

• Bereavement: Including funerals, visitations – death certificate, obituary notice; Wedding: Invitation and relationship to the wedding party; High School Commencement/University Convocation: Invitation or notification from institution that shows the date, time and location of the event; Non-Varsity Sporting Events, Non-Western Academic Events: Proof of date, time and duration along with evidence that you must attend the event.

Submitting a forged document constitutes student misconduct and is subject to academic sanctions.

Academic Integrity

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.

Students demonstrate **honesty** by:

- following their instructor's guidelines and expectations for assignments and tests
- submitting original work and completing individual assessments independently Students demonstrate **trust** by:
 - being dependable and reliable in their work, commitments and actions
 - following their instructor's directions and completing work by the set deadline

Students show **respect** by:

- consistently and accurately citing the work of others in their assignments
- keeping academic materials and instructor's intellectual property private (e.g., class slides, assignments, tests, etc.), and not sharing these without the instructor's permission

Students demonstrate fairness by:

- treating others equally without self-interest or prejudice
- following the University's rules and not trying to gain unfair advantages in assessments, midterms or tests (e.g., copying someone else's answers, using their phone to look up information during an exam etc.)

Students demonstrate **responsibility** by:

- completing their individual and group work to the best of their abilities and being accountable to themselves, their instructors, their classmates, and the University
- Seeking help if they are struggling or are not sure of expectations.

Students demonstrate **courage** by:

• being brave and standing up for what is right, even in challenging situations. If they think someone has committed an academic offense or is violating a rule - they alert their instructor, Associate Dean, or a staff member.

Please visit Academic Integrity Western Engineering

Academic Offences

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.

<u>Scholastic Discipline for Undergraduate Students</u> & <u>Cheating</u>, <u>Plagiarism and Unauthorized</u> <u>Collaboration: What Students Need to Know</u>

Attendance Requirements

Please be aware of attendance requirements for your courses. You could be prevented from writing the final exam if your attendance is not satisfactory.

Accessibility

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the <u>Accessibility Western University</u> for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit <u>Academic Support & Engagement -Academic Accommodation</u>.

Inclusivity, Diversity, and Respect

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the <u>Office of Equity</u>, <u>Diversity and Inclusion</u>.

Health and Well-Being

- <u>Health & Wellness Services Students -</u> Offers appointment-based medical clinic for all registered part-time and full-time students.
- <u>Mental Health Support</u> Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
- <u>Crisis Support</u> For immediate assistant, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click <u>here</u>.
- <u>Gender-Based Violence and Survivor Support</u> Western <u>is committed to reducing incidents of</u> <u>gender-based and sexual violence</u> and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, <u>here</u>. To connect with a case manager or set up an appointment, please contact <u>support@uwo.ca</u>.

Student Development Centre

Learning specialists in <u>Learning Development & Success</u> are ready to help students improve their learning skills. They offer support to all students at Western coping with the demands of post-secondary learning by helping to identify strengths and develop new skills and strategies for success.

Important Contacts

Engineering Undergraduate Services	SEB 2097	519-661-2130	engugrad@uwo.ca
Civil & Environmental Engineering	SEB 3005	519-661-2139	civil@uwo.ca
Office of the Registrar/Student Central	WSSB 1120	519-661-2100	

Important Links

- <u>WESTERN ACADEMIC CALENDAR</u>
- <u>ACADEMIC RIGHTS AND RESPONSIBILITIES</u>
- ENGINEERING PROGRESSION REQUIREMENTS AND ACADEMIC REGULATIONS
- UNIVERSITY STUDENTS' COUNCIL (USC) SERVICES
- IMPORTANT DATES AND DEADLINES
- <u>ACADEMIC CONSIDERATION FOR MEDICAL ILLNESS UNDERGRADUATE STUDENTS</u>
- <u>ACCOMMODATIONS FOR RELIGIOUS HOLIDAYS</u>
- SCHEDULING OF ASSIGNMENTS, TESTS, AND EXAMINATIONS
- <u>STUDENT FORMS</u>
- OFFICE OF THE REGISTRAR
- <u>RETENTION OF ELECTRONIC VERSION OF COURSE OUTLINES (SYLLABI)</u>
- <u>ACADEMIC APPEALS</u>