



University
of Windsor

Faculty of Engineering

GENG 8010– Engineering Mathematics

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First things first

- All the material that is shared with you in this course (assignments, exams, handouts of any form including this document) are copyrighted ©, and you must not distribute or share it, and that includes uploading any material to sites such as Course Hero, Chegg, etc.
- Please **read this course outline carefully**, as it serves as a *contract* between you, the student, and myself as the instructor of the course.

Course Objectives

This course is intended for incoming MEng students as a part of their core coursework requirement. The objective of the course is to set the students on a level playing field in terms of their applied engineering mathematical skills so that they can better handle their future courses in their respective fields. Some of the topics that will be discussed in the course will be the review of what you have (or should have) studied in your undergraduate education, and certain more advanced topics may be new for some or all of you. Certainly, there is much more material than a one-semester course that may be useful to you. And certainly, not all of you will encounter the same type of problems or require the same skills to handle what you may encounter in other courses during your MEng education. As a result, I have attempted to strike an optimum balance here and with a constraint of a one-semester course. I will attempt to cover the essential background that will find utility in many branches and fields of engineering. The hope is of course that you will develop and refresh your skill sets so that even in the future if you encounter a subject that was not covered in this course, you would have the essential background to read further and educate yourself on that specific subject. Remember that as a graduate student, the ability to learn and develop your skills on your own is essential. Topics that are covered are split into two parts although time permitting I may cover additional parts. The first part deals with differential and difference equations. Conditions for existence and uniqueness along with various solutions techniques from direct to solutions based on transform techniques for systems of the first order; second order and higher order equations will be discussed; special equations and functions such as the Bernoulli equation and Green function along with its parallel in engineering system theory will be discussed. Integral and integro-differential equations will be considered. The discussion will then carry over to certain topics in continuous and discrete time engineering systems and how differential or difference equations can be used to solve problems in these domains. The second part of the course will deal with a review of matrix algebra; elements of vector spaces; basis and change of bases; linear operators and their matrix representation; solution of linear algebraic equations; generalized and Moore-Penrose pseudo inverses and their application in

solving linear algebraic and matrix equations; least square; least-norm problems; system identification; eigenvalue and eigenvectors of matrices; matrix diagonalization and canonical forms; quadratic forms and singular value decomposition; matrix exponential and a function of a matrix calculation, and their applications to the solution of vector differential or difference equations; Sylvester and Cayley-Hamilton Theorems, etc.

Text

- Primary source: My own lecture notes.
- Erwin Kreyszig, **Advanced Engineering Mathematics**, 10th Edition, Wiley, 2011.

Reference

There are many other texts on the subject such as

Michael D. Greenberg, **Advanced Engineering Mathematics**, 2nd Edition, Prentice Hall, 1998.

Instructor

Mehrdad Saif

Office: CEI 3002. email: msaif@uwindsor.ca

The Implied Contract

I as the instructor will strive to

- establish an educational environment conducive to learning,
- provide quality instruction, and
- provide differentiating assessment, i.e., not every student deserves an A.

You, as a student in this class, will strive to

- follow directions and instructions,
- prepare for class,
- attend the lectures, be proactive and engaged in the course,
- complete the assigned work,
- prepare for the tests,
- know how your grade will be determined and plan accordingly,
- seek GA or instructor help when needed
- adhere to high standard of academic integrity

Important Instructions

Please note that this course has nearly 600 students enrolled in it. Therefore, to have a smooth operation, I have set the following ground rules and I expect you to adhere to them. *I certainly plan to follow these rules and they are non-negotiable.*

1. **Academic Honesty** plays a key role in our efforts to maintain a high standard of academic excellence and integrity. Students are advised that all acts of intellectual dishonesty are

subject to disciplinary action; serious infractions are dealt with in accordance with the [Senate Bylaw 31 on Academic Integrity](#). It is your responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. Further, all academic integrity expectations that apply to in-person assignments, quizzes, and exams also apply to online assignments, quizzes, and exams as well.

Overall, please use your judgment and good common sense. If you are doubtful or think something that you are about to do could violate our academic integrity expectations; it probably does, and should be avoided. In this course, all work submitted for quizzes and exams must be yours alone. Discussing quiz or exam questions with anyone during the quiz or exam period violates academic integrity expectations for this course. Using websites that charge fees or require uploading of course material (e.g. Chegg, Course Hero) to obtain exam solutions or assignments completed by others and present the work as your own violates academic integrity expectations in this course. Also, even though the exam between the sections will be different, you must not discuss the exam or quizzes with the others in a different section of the course. This may even hurt your final grade in the end.

2. Class attendance is not mandatory, but unless you are very good at this stuff, I urge you to attend. On the other hand, students will be asked to leave the class if they are being disruptive to the lecture. You are encouraged to attend all classes since I may make alterations to assignments and/or exam dates, and make other important course-related announcements.
3. Discuss questions/issues that may arise with your classmates and see if a question can be resolved in that way. This should be your first action. Brightspace site has a discussion board where you can also discuss course-related questions.
4. The next best approach to get an answer to your questions is to attend one of the weekly office hours and try to resolve your question that way.
5. If you have tried the above and still have an issue or question contact the **lead GA** corresponding to your course section (shown in bold red letters in the table below).
6. Again, there are nearly 600 students in the three sections of this course. So, the most efficient and speedy way to get your issue addressed, is best to not email me. Rather, always email the **Lead GA** for your section of the course first with a descriptive subject line for your email. Please do not copy several GAs or myself at the same time on an email as that can fill up all our mailboxes, create more confusion, and may result in your issues going unaddressed (again remember, there are nearly 600 students in the course and if many of you did this, it would create a massive amount of redundant emails and a higher chance of them going unanswered). Depending on the urgency of your email, you may or may not get an immediate response. Do not send further emails at least for 2-3 days and someone should get back to you.
7. Before quizzes or exams I normally will discuss the format of the quiz/exam, its duration, etc. These are non-negotiable, and you should pay careful attention to the instructions given, and follow them. If the exam or quiz has to be submitted at a certain time/deadline, you must submit it on time. Failure to do so will result in a loss of a percentage of your mark, and no excuses will be accepted. Please understand that the assessments must be fair to all involved, therefore, no exceptions will be made.
8. **Do NOT send me or the GAs emails immediately after tests and quizzes attempting to get an exception by explaining a late submission, your issues, etc. Once a test or quiz is taken, wait until your work is**

graded and your grade is announced. After you have received your grade, should you wish to discuss it, you can follow it up with your lead GA.

9. Email me only as a last resort and only after you have tried everything that is outlined above.
10. Finally, I and the GAs are in charge of this course. Please do not email others within or outside of the Faculty of Engineering as it is unlikely that they would be able to address your issues, and that you would unnecessarily be taking their time. Of course, if at the end of the course you believe that you should have received a higher grade for the course you can always go through a formal appeal process as outlined in the [University of Windsor's Bylaw 55: Graduate Academic Evaluation Procedures](#) and your concerns can be addressed through the formal process.

Resources

You are a graduate student, and as such, you should be able to explore and dig deep into topics and problems on your own and outside the classroom/office hours. The following are resources that can help you in that endeavor.

1. Textbook. Refer to it and try to find the answer to anything that you feel require more explanation and elaboration than what is in the lecture notes. The textbook comes with online resources that can be of great help to you in understanding the material through worked-out examples, video clips showing you how to go step-by-step to solve problems, etc. Do take advantage of the great online material.
2. MATLAB. Use this powerful computer software to re-enforce concepts through simulating and running your problems. You may also be required to use MATLAB for some homework assignments. If you have access to or know how to use other software packages such as MAPLE, MATHEMATICA, etc., I encourage you to use them in studying the material that we cover in this course. They can be of great help in you getting a good grasp of the concepts.
3. Brightspace site for the course material. Check regularly for announcements, assignments, exams, lecture notes, etc.

Graduate Teaching Assistants

The following are the GAs for the course

GENG 8010-1, 2:30–5:20PM-T		GENG 8010-30, 7-9:50PM-T		GENG 8010-31, 4-6:50PM-Th	
Milad	moradih@uwindsor.ca	Hossein	hassa12t@uwindsor.ca	Mahsa	jalali3@uwindsor.ca
Jayanthi	raghavaj@uwindsor.ca	Erfan	sadeghie@uwindsor.ca	Maryam	eshaghim@uwindsor.ca
Mehdi	mousavi9@uwindsor.ca	Ehsan	hallaji@uwindsor.ca	Mobina	mahmoo42@uwindsor.ca
Marieh	mirzagh@uwindsor.ca	Buddhika	guruwat@uwindsor.ca	Elham	hejadi@uwindsor.ca

Office Hours

There will be three time slots available every week for you to drop in on Teams and meet with a GA about your questions. These office hours are listed below:

- Mondays 1–2pm
- Wednesday 10–11am
- Fridays 10–11am

Please note that no matter which section you belong to, you can drop in during any of these time slots. However, do not expect the GAs to be able to answer any and all questions. If the GA cannot answer your question on the spot, they may ask you to give them some time to look into the matter. They may then follow up with you through email or you may need to attend a future office hour to get the issue resolved. It is important to plan and come forward early to leave yourself enough time to get your question resolved should it happen that the GA cannot address it in the first attempt. Also, please do not waste these scheduled times trying to resolve personal issues or issues concerning your grade in a quiz or exam. Questions about lecture material, or methods of solution to a problem will benefit others attending the office hours as well. On the other hand, a question as to why you lost so many points on a problem on your exam will not be of any benefit to others. You can send an email to your Lead GA for your section of the course about such issues.

Tentative Course Outline (time permitting)

Part 1–Differential and Difference Equations

- Introduction and definitions, general properties of differential equations, applications of differential equations in representing engineering systems
- Differential operator representation, solution of differential equations, types of solution, number of independent solutions, existence and uniqueness, direct solutions, exact differential equations, solution of exact equations, integrating factor.
- Integrating factor for solving linear and nonlinear equations, determination of an integrating factor, Bernoulli's equation, independent solutions.
- Nature of solution, homogeneous/particular solutions, characteristic equation, solutions of second order differential equations under different characteristic root conditions
- Higher order differential equations and their solutions, variation of parameters for 2nd and higher order solutions.
- Green function and second order systems, Laplace and inverse transform techniques, properties of Laplace transform, integral and integro-differential equations, continuous time system, system engineering concepts.
- Relationship between differential equations, continuous time engineering systems and system engineering concepts and system's response, transfer function, second order system response types, analysis and understanding of resonance phenomenon, pure resonance vs. practical resonance.
- Continuation of resonance discussion, difference equations, difference and shift operators, solution of difference equations, system engineering concepts
- Solutions of difference equations, discrete time systems, sampled data system, ideal vs. practical sampler, \mathcal{Z} transform, inverse transform, and solutions of difference equations using \mathcal{Z} transformation.

Part 2–Elements of Applied Linear Algebra

- Fields and vector spaces over fields
- Vector spaces and subspaces, linear independence of vectors; bases and dimension, orthonormal basis and Gram–Schmidt process, representation of vector and linear operators

- Change of basis and similarity transformation, linear algebraic equations, kernel space, solutions of algebraic equations
- Right and left inverses, least square problems, state estimation, applications to curve fitting and identification of systems from input/output data, generalized inverse of a matrix
- Moore–Penrose psuedo inverse, its properties and applications in solving matrix equations.
- Eigenvalues, and eigenvectors; Matrix diagonalization, generalized eigenvectors and Jordan Canonical forms.
- Quadratic forms, symmetric matrices, positive (negative) (semi) definiteness, matrix factorization and Singular Value Decomposition (SVD) with its applications.
- Function of a square matrix, functions of a square matrix; Cayley-Hamilton theorem and technique.
- Vector differential/difference equations, simulation diagrams, and solution of vector differential and difference equations.

Learning outcomes

At the conclusion of this course you should

- Be able to model or relate the model of engineering systems with differential or difference equations.
- Be able to investigate the existence and obtain a solution for said equations using a variety of techniques including the transform techniques.
- Analyse and visualize the solutions and assess whether the solutions meet certain performance measures.
- Become re-familiar with matrix algebra techniques and have an appreciation for a vast array of engineering problems that can be cast in matrix/vector formulation suitable for computer aided design and solution.
- Relate the matrix representation of a linear operator mapping vectors from one space into another to problems in robotics, computer vision, image processing, etc.
- Study the solution space of linear algebraic equations, through the use of matrix generalized inverses, and singular value decomposition (SVD).
- Understand how to solve least square problems and how to apply it to solve practical problems such as curve fitting or system identification.
- Understand the important role of eigenvalues and eigenvectors of a matrix.
- Use invariant transformations to perform matrix diagonalization and other transformations into Jordan Forms, and use them to find solutions of vector differential or difference equations.
- Develop your ability to understand and communicate difficult concepts through application of numerical and graphical software such as MATLAB.

Homework

Homework is something for you to do at home to get better with the subject material and gain more understanding of the subject. Assignments from WileyPlus will be graded within the WileyPlus system and

Post-Assignment Review will be available to you after the assignment due date. I may also assign additional assignment of my own. These assignments will not be graded but solutions will be posted later. I also urge you to read the text and work out examples and problems available to you in the WileyPlus on your own.

Software Packages

I will use MATLAB in some of the examples that I use during the lectures. A numerical software tool such as MATLAB can greatly help you in better grasping the concepts and therefore I encourage its use. The Faculty of Engineering has a site license for MATLAB and you should be able to access and use MATLAB. If you are not familiar with MATLAB you run the demos that can help you become familiar with it. You can also visit the following (old) site for an overview of certain basic MATLAB functionalities.

MATLAB Tutorial

Also, a free MATLAB like software by the name of Scilab is available from [Scilab site](#). Those of you who want to have a numerical MATLAB like software installed on your own machine should give Scilab a try!

Required Technology

- A computer on which you can connect to Teams/Brightspace, see .pdf files, and with a reliable internet connection. If you don't have a reliable internet connection at home, I urge you to go to the university (especially for quizzes and exams).
- A video camera and a microphone for meetings, class discussions, etc.
- A smartphone scanning app. There are many free apps, such as "*CamScanner or Adobe Scan*". On an iPhone scanning is available under "Notes". If you do not have a smartphone, a traditional scanner can be used but a smartphone app is perhaps more convenient.

Important Dates

January 5th	First day of Winter classes.
January 18th	Academic Add/Drop for Winter 2023.
Feb. 1st	Financial Drop Date for Winter 2023.
Feb. 18 – 26th	Reading Week.
March 15th	Last Day to Voluntarily Withdraw through regular drop method for Winter 2023 courses.
April 5th	Last day of Winter 2023 classes.
April 10 – 20th	Final Exams for Winter 2023 term.

Assessments

1. Exam, tentatively on February 9 th & 14 th	20%.
2. Exam II, tentatively on March 9 th & 14 th	20%.
3. Bi-Weekly quizzes (none in exam weeks)	15%.
4. Assignments	15%.
5. Comprehensive Final Exam,TBA	30%.

Grading policy

Grades for the course will be consistent with the following table, per the University of Windsor Policy on Grading and Calculation of Averages.

Letter	A ⁺	A	A ⁻	B ⁺	B	B ⁻	C ⁺	C	C ⁻	F
% Range	90-100	85-89.9	80-84.9	77-79.9	73-76.9	70-72.9	67-69.9	63-66.9	60-62.9	0-59.9

Assessment considerations

- **Late assignments, reports, or projects**

It is expected that students who are experiencing difficulty meeting a deadline will contact the course instructor as soon as possible to discuss the situation in advance of the deadline.

- **Missed Assignments, Tests, Reports, or Projects**

- Documentation must be submitted to the Office of the Associate Dean no later than 72 hours following the absence. Documentation shall include the Faculty of Engineering Medical Form or other appropriate documents.
- In all instances, students who miss a test may be subject to a make-up test **at the instructor's earliest convenience** in a time slot that does not conflict with your scheduled classes. The test can be either an oral or written examination. There is no bargaining with the instructor to change the date of the make-up test.
- **Transferring the weight to the midterm/final exam may apply, if deemed appropriate.**

- **Late Registration into Course**

Students who register late for the course are responsible to familiarize themselves with course information that they missed prior to registration. No special accommodation will be provided for missed assignments/assessments.

- **Calculators**

Approved calculator _____

Acceptable Use of Technology During Class

The use of technology during lectures and tutorials is limited to resources associated with this course, such as Teams/Blackboard, lecture notes and property data information. Social media and general web surfing are never acceptable uses of technology during class. If a situation arises where you need to communicate by e-mail or cell phone, please respect your fellow students and leave the classroom to attend to the matter. You may return to class when the matter is resolved.

The Student Evaluation of Teaching (SET)

The SET will be administered in the course during the last two weeks of the semester.

Accommodation

Students with disabilities who require academic accommodations in this course must contact an Advisor in Student Accessibility Services (SAS) to complete SAS Registration and receive the necessary Letters of Accommodation. After registering with Student Accessibility Services, you must present your Letter of Accommodation and discuss your needs with me as early in the term as possible. Please note that deadlines for the submission of documentation and completed forms to Student Accessibility Services are available on their website: [Student Accessibility Services \(SAS\)](#).

Exams and fire alarms

Pulling a fire alarm (e.g. during an exam) is a serious offence. The Criminal Code of Canada dictates that initiating a false alarm is a criminal offence. Such an offence could result in a criminal record, a large fine, as well as disciplinary action under the University of Windsor Bylaw 31 where serious consequences would be likely.

Note that this sort of offence will affect your eligibility for the Iron Ring; additionally, a criminal record may preclude you from becoming a registered professional engineer. If you are considering pulling a fire alarm as a way to avoid a test, you are advised instead to own up to your poor preparation, take the F on the test, and ask yourself whether you have the dedication to become an engineer.

In the event that a fire alarm disrupts an exam session, the decision on how to proceed or not proceed with the exam will be made by the instructor. Therefore, if students are evacuated from the building due to a fire alarm they should wait outside and receive instructions from the instructor.

If a fire alarm sounds during a test, the instructor reserves the right to void the test and substitute a new test of greater difficulty during the next class period.

General Class Expectations

- **Attendance and punctuality**
Attendance in classes and labs is critical to student success; students should seize the opportunity to share and discuss information in labs, tutorials, and classes. The course is designed to move swiftly and efficiently. If a student is going to miss a class or lab, s/he should inform the instructor and GA before missing the class or lab. Communication
- Students are encouraged to utilize office hours to ask questions. Only emails sent from a uwindsor email address will be responded to. Emails should be sent with courtesy; they should include an informative subject line, a salutation (e.g., Hello Dr. Name), a body, and a closing (e.g., Best regards, Name). Group work
- Groups are encouraged to develop ground rules, identify roles and responsibilities, set timelines, and set standards of communication for the group.
- **Academic Integrity**
All incidents of academic dishonesty will be documented with the Associate Dean of Engineering–Academic. University procedures will be followed. Such incidents may include, but are not limited to: submission of assignments other than your own, receiving or sharing prior knowledge of test questions, sharing or receiving information during a test by any means (including electronic), possession of any electronic device (including cell phones) during a test except for an approved calculator, sharing or receiving knowledge of a test with students who have not yet written the test, sharing a calculator or formula sheet during the test, using a solutions manual to prepare submitted assignments.

Per the University of Windsor Policy on [Student Code of Conduct](#) “Plagiarism: the act of copying, reproducing or paraphrasing significant portions of one’s own work, or someone else’s published or unpublished material (from any source, including the internet), without proper acknowledgement, representing these as new or as one’s own. Plagiarism applies to all intellectual endeavours: creation and presentation of music, drawings, designs, dance, photography and other artistic and technical works. (Students have the responsibility to learn and use the conventions of documentation as accepted in their

area of study and instructors have the responsibility of informing students in writing of any significant individual interpretations of plagiarism.)”

Supplemental Privileges

☒ A supplemental examination is NOT allowed in this course.

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The final grade for the supplemental evaluation will (or will not necessarily) include the student's term work grade. According to the University of Windsor Undergraduate Calendar, [policy on supplemental exam](#), the Academic Standing Committee may grant a supplemental evaluation privilege for a failed course provided that the student:

1. has failed only one course in the evaluation period; and
2. has a grade below 50
3. has a cumulative average of 60

If a supplemental evaluation privilege is granted and the student decides to exercise this privilege, the student must register for the supplemental and pay the appropriate fee. Once a student has registered for a supplemental evaluation and the required evaluation method has been prescribed, the evaluation will occur at the time and place prescribed by the Faculty of Engineering. Failure to write after registering for the supplemental evaluation will result in a grade of F being assigned. Both the resulting grade and the original grade will be shown on the student's transcript and will be included in the determination of the student's cumulative average.

Use of Plagiarism-Detection Software in This Course

☒ Plagiarism-detection software, [insert specific software name], will NOT be used in this course.

☐ Plagiarism-detection software, [insert specific software name], may be used in this course.

1. Rationale. The University believes in the right of all students to be part of a University community where academic integrity is expected, maintained, enforced, and safeguarded; it expects that all students will be evaluated and graded on their own individual work; it recognizes that students often have to use the ideas of others as expressed in written, published, or unpublished work in the preparation of essays, assignments, reports, theses, and publications. However, it expects that both the data and ideas obtained from any and all published or unpublished material will be properly acknowledged and sources disclosed. Failure to follow this practice constitutes plagiarism. The University, through the availability of plagiarism-detection software, desires to encourage responsible student behaviour, prevent plagiarism, improve student learning, and ensure greater accountability.
2. Procedure. Plagiarism-detection software, [insert specific software name], will be used for all student assignments in this course. You will be advised how to submit your assignments. Note that students' assignments that are submitted to the plagiarism-detection software become part of the database. This assists in protecting your intellectual property. However, you also have the right to request that your assignment(s) not be run through the student assignments database. If you choose to do so, that request must be communicated to me in writing at the beginning of the course.

3. Privacy and Copyright. Your privacy is protected even if your name and/or student number is on your assignments because the plagiarism-detection software does not make students' assignments available to outside third parties. Further, you retain the copyright in your work. Copyright, in relation to a work, is defined in Canada's Copyright Act, R.S.C. 1985, c. C-42, s. 3(1), which is available on the Department of Justice Canada website. Plagiarism-detection software use of student work complies with Canadian copyright and privacy laws.
4. Originality Reports. If the results of an originality report may be used to charge you with academic misconduct, you will be notified of the result of the report, and you will be given the opportunity to respond before any disciplinary penalty is imposed.
5. Plagiarism. Information about plagiarism and appropriate acknowledgement of sources can be found at the [Office of Academic Integrity](#)

Services Available to Students at the University of Windsor

Students are encouraged to discuss any disabilities, including questions and concerns regarding disabilities, with the course instructor. Let's plan a comfortable and productive learning experience for everyone. The following services are also available to students:

- [Student Accessibility Services](#).
- [Skills to Enhance Personal Success \(S.T.E.P.S\)](#)
- [Student Counseling Centre](#)
- [Academic Advising Centre](#)

Bylaws and Policies

The following are links to the University of Windsor bylaws and policies. The intention is to share these policies and bylaws with engineering students in a way that is straightforward and clear—because our learning depends on our ability to create an environment and culture that supports our individual and collective needs for learning and teaching.

[University Senate Bylaws](#)

[University Senate Policies](#)