**Faculty of Engineering and Applied Science**

# MNTC P01: Engineering Mathematics

Course Outline – Summer 2016

This is your course syllabus. Keep it for future reference.

# Instructor Information

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| **Saber Jafapour**, PhD  Queen’s University [saber.jafapour@queensu.ca](mailto:saber.jafapour@queensu.ca) |  |

# Teaching Assistant Information

Please see the class website for information about Teaching Assistants (TAs) present in this course, if applicable.

# Course summary

This course provides a detailed introduction to the fundamentals of calculus and linear algebra as applied to engineering applications.  The purpose of the course is to provide a mathematical foundation for students pursuing upper-year engineering-related courses.  The course covers topics such as derivatives, implicit differentiation, partial derivatives, integrals, first-order and higher-order linear ordinary differential equations, fundamentals of Laplace transforms, matrices and matrix inverses, solving systems of linear equations, vector spaces, orthogonality, and determinants.  Topics are introduced by way of engineering examples.

# Course learning outcomes (CLO)

By the end of this course, learners should be able to:

**In Single Variable Differential Calculus:**

CLO1. Express and use the tangent/slope and rate of change meanings of the derivative. [PLO 1[[1]](#footnote-1)]

CLO2. Construct application models from word problems and use derivatives to investigate properties of the models. [PLO 1]

**In Single Variable Integral Calculus:**

CLO3. Express and use the relationship between integration and the area under a curve/rate graph. [PLO 1]

CLO4. Construct application models from word problems and use integrals and/or derivatives to investigate properties of the models. [PLO 1]

**In Mathematical Modelling:**

CLO5. Construct mathematical models from word problems. [PLO 1]

CLO6. Select and apply appropriate differential or integral techniques to investigate properties of the models. [PLO 1]

**In Differential Equations:**

CLO7. Construct differential equations and interpret their meaning. [PLO 1]

CLO8. Be able to identify different types of differential equations and use the correct technique to solve them. [PLO 1]

**In Linear Algebra:**

CLO9. Create and solve linear systems that model real-world situations. [PLO 1]

CLO10. Use linear algebra techniques to gain deep understanding of engineering problems and solutions. [PLO 1]

# Prerequisite knowledge

This course is designed for learners with some college-level mathematics background.

# Course length and pace

This course represents a study period of one 12-week semester. The course material is divided by week on the class website. Learners can expect to invest on average 7-9 hours per week in this course. At the end of this document is a Timetable and more detail is found on the class website.

Learners who adhere to a pre-determined study schedule are more likely to successfully complete the course on time.

# Expectations for interaction

Every week there are graded activities in this course. Some of these activities require asynchronous interaction with your classmates and your instructor in discussion forums. In addition, questions or comments regarding the course material that can be of benefit to other learners should be posted in the Q&A forum on the class website. Both learners and instructors are encouraged to answer these questions directly in the discussion forum for the benefit of everyone in the course. Please avoid emailing the instructor questions about the course material. The class discussion forum is a much better place for these discussions.

If you have a confidential matter that you would like to discuss with your instructor, their email address is found near the top of this document. Expect email replies within 48 hrs and in some cases within 24 hrs.

Instructors will routinely post course news in the NEWS section on the main course homepage. Please sign up to be automatically notified by email when the instructor posts new information in the NEWS section. Instructions on how to modify your notifications are found in the **BEGIN HERE (Course Admin)** section of the content on the class website.

The Instructor will be providing feedback to learners on graded activities. Expect feedback within 7 days of the due date.

# Online Office Hours (optional)

In addition to the interaction in the Q&A discussion forum, each week learners will have the opportunity to interact in a synchronous fashion with either a TA or the Instructor. The schedule will be posted in the discussion forum on the class website.

# Course-specific policies

In keeping with the Faculty of Engineering and Applied Science[Faculty Regulation 5b](http://engineering.queensu.ca/Calendar/CurrentYear/Faculty_Regulations.html#Reg5), “A student who claims illness or compassionate grounds as a reason for missing any required component of the course other than the final exam is responsible for making alternative arrangements with the instructors concerned.” Note that unacceptable reasons include: malfunctioning computer, travel plans to go home for holidays, generally behind on schoolwork, etc. The instructor may request some substantiating documentation. If alternate arrangements are not agreed upon, then the normal late penalty will apply as described in the assignment.

# Individual needs and support

Learners with diverse learning styles and needs are welcome at Queen’s. In particular, if you have a disability or health consideration that may require accommodations, please feel free to approach the instructor and/or Accessibility Services as soon as possible. The Accessibility Services staff is available by appointment to develop individualized accommodation plans, provide referrals and assist with advocacy. The sooner you let us know your needs, the better we can assist you in achieving your learning goals at Queen’s. For further information, visit the [Student Wellness Services](http://queensu.ca/studentwellness/) website. The class website is powered by the Brightspace by D2L Learning Environment that [complies with common accessibility standards](http://www.desire2learn.com/products/accessibility/standards/) and every effort has been made to provide course materials that are accessible. If you find any element of this course difficult to access, please discuss with your instructor how you can obtain an accommodation.

# Academic and student support

Queen’s has a robust set of supports available to you including the [Library](http://library.queensu.ca/), [Student Academic Success Services (Learning Strategies and Writing Centre)](http://sass.queensu.ca/), and [Career Services](https://careers.sso.queensu.ca/home.htm). Learners are encouraged to visit the Faculty of Engineering and Applied Science [Current Students](http://engineering.queensu.ca/Current-Students.php) web portal for information about various other policies such as academic advisors, registration, student exchanges, awards and scholarships, etc.

# Technical skills and support

No specialized computer-related technical skills are required for this course. If you require any technical assistance, please contact [Technical Support](http://engineering.queensu.ca/IT/help.html).

# Course materials

## Required textbook

* There is no required textbook for this course.

## Required calculator

* A Casio 991 OR a comparable calculator with appropriate stickers. **ONLY** this type of non-programmable, non-communicating calculator will be allowed during tests and exams.

## Other material

* You are required to purchase MATLAB and Simulink Student Suite for this course: <http://www.mathworks.com/academia/student_version/?s_tid=main_sv_ML_tb>

All other required material is found on the course website. After you have completed reading this Course Outline in detail, explore the **Content** link on the class website to find the module-specific material.

# Evaluation

| **Activity** | **Due Date**  (before midnight EST,  unless otherwise specified) | **Weight** | **Alignment with UDLEs[[2]](#footnote-2)** | **Alignment with CLOs** |
| --- | --- | --- | --- | --- |
| Webwork: Individual weekly practice (12) | Every Sunday | 5% total | UDLEs 1, 2, 3 | All CLOs |
| Concept Question & Check-in Quizzes (12) | Every Sunday | 5% total | UDLEs 1, 5 | ALL CLOs |
| Group Matlab Assignments (2) | Sunday of Week 7 and 11 | 2 @ 5%/each = 10% total | UDLEs 3, 4, 6 | CLOs 4, 5, 9 |
| Individual Tests (3) | Sunday of Weeks 4, 8, 12 | 3 @ 10% each =  30% total | UDLEs 1, 3, 4 | ALL CLOs |
| Final Exam (Proctored) | During the exam period. | 50%[[3]](#footnote-3) | UDLEs 1, 2, 3, 4 | ALL CLOs |
| Total | | 100% |  |  |

# Webwork

Each week you will demonstrate your skills by completing a webwork quiz.

* You can start as many new Webwork quizzes each week as you like.
* Within each quiz, you will have 3 chances to submit your answers.
* The highest grade on any attempt will be your final grade.

# Concept Question & Check-in Quiz

Each week you will complete a Concept Question & Check-In Quiz. Each quiz consists of 4 questions. The purpose is two-fold: 1) to demonstrate your skills on this week’s material and 2) to communicate to your instructor if you have an specific questions or comments about the week’s material. You have one attempt at each quiz (before the due date). On average, most students will complete this quiz within 20 minutes; however, to accommodate all learners the time allotted will be doubled to 40 minutes.

# Individual Tests

During the term, each student will complete 3 tests. Each test will be available during a 7 day window, so students can select a time to write that is convenient for them. Once begun, students will have one hour to complete the test, and then an additional 15 minutes to scan/photograph their hand-written work and submit it to a dropbox on the class website. In the week prior to Test 1, you will have an opportunity to practice this process with the “Zero Grade Test” activity.

# Group MATLAB Assignments

For some particularly quantitative problems, which benefit from a combination of by-hand mathematics and a little computer assistance via MATLAB, we will be conducting 2 group MATLAB Assignments. This assignments will involve modeling of larger-scale problems, but using the fundamental tools and ideas from the class. See the class website for more information.

# Final Examination

If you are located near Kingston, you will be writing your exam on Queen’s Campus at the prescribed date and location (see SOLUS for details). If you are located away from the Kingston area, you may write at an approved Off-Campus Test Centre (see SOLUS for details). The date, time and location of the Final Examination will be announced through SOLUS. The Final Exam is closed book and you may bring an approved calculator to the exam (see below).

# Academic integrity

Engineers have a duty to:

* Act at all times with devotion to the high ideals of personal honour and professional integrity
* Give proper credit for engineering work

*-Professional Engineers Ontario Code of Ethics, Section 77 of the O. Reg. 941* <http://peo.on.ca/index.php?ci_id=1815&la_id=1>

The quote above describes the standard of behaviour expected of professional engineers. As engineering students, you have made a decision to join us in the profession of engineering, a long-respected profession with high standards of behaviour.

As future engineers, we expect you to behave with integrity at all times. Our policies do not prohibit you from collaborating, even closely, with fellow learners in any class. Indeed, we strongly encourage collaboration and teamwork, when conducted responsibly. We have however, set firm guidelines on the quality of submitted work and have taken a strong stand against plagiarism and other forms of academic dishonesty. Briefly stated, we expect that submitted work bears the name of all those contributing to it, and that you do not allow others to copy your work.

Should a student’s submitted work be suspected of containing evidence of academic dishonesty, action shall be taken, as required by the Faculty of Applied Science policy on academic integrity: <http://appsci.queensu.ca/policy/Honesty.html>

Additional information on the University’s policies concerning academic dishonesty can be found on the Queen’s website. **All learners are expected to familiarize themselves with these policies** and to conduct themselves accordingly.

* [Senate Policy on Academic Dishonesty](http://www.queensu.ca/secretariat/policies/senateandtrustees/academicintegrity.html)
* [Procedures for dealing with departures from academic integrity in the Faculty of Engineering and Applied Science](http://appsci.queensu.ca/policy/Honesty.html)
* [Queen's code of conduct](http://www.queensu.ca/secretariat/policies/senateandtrustees/Code_of_Conduct_final_2008.pdf)

# Timetable

| **Week** | **Learning Outcomes (with alignment to CLOs shown in square brackets)** |
| --- | --- |
| **1** | **Derivatives – Foundations**  After completing this lesson, learners will be able to:   * Interpret the derivative, and be able to discuss the difference between the secant line and the derivative (CLO1, CLO2) * Compute the derivative of polynomial, exponential, logarithmic, powers, trigonometric functions and their combinations, with the correct application of the product and quotient rules, and the chain rule (CLO2) * Report the graphs, domain and range of the **inverse** trigonometric functions arcsin, arccos and arctan. (CLO1) * Apply the derivative rules for arcsin, arccos and arctan. (CLO2) |
| **2** | **Derivatives - Linearization and Applications**  After completing this lesson, learners will be able to:   * Describe the meaning and value of linearization (CLO2, CLO3) * Apply the technique of linearization to solve a variety of nonlinear equations (CLO3) * Use MATLAB to graph and compare functions with their linearizations (CLO2) * Use MATLAB to implement Newton’s method. (CLO3) |
| **3** | **Derivatives – Modeling**  After completing this lesson, learners will be able to:   * Calculate and interpret the first and second derivatives, as well as higher order derivatives (CLO2)Use the first and second derivatives to identify properties of a given function (CLO2, CLO3) * Calculate a Taylor Polynomial and apply them to a variety of problems (CLO2, CLO3) * Use MATLAB to graph and compare functions with their Taylor polynomial approximations (CLO2, CLO3) * Find the critical points of a function using derivatives (CLO2, CLO3) * Distinguish between global and local optimization (CLO2, CLO3) * Use the techniques of optimization to solve a variety of applied problems. (CLO2, CLO3) * Use MATLAB single-variable optimizers to identify optimal values for functions. (CLO2, CLO3) * Use MATLAB single-variable equation solvers to identify critical points given the derivative function (CLO2, CLO3) * Use MATLAB to graph and compare functions with their linearizations (CLO2, CLO3) |
| **4** | **Integrals – Foundations**  After completing this lesson, learners will be able to:   * Use the definite integral to model and find a solution to a posed area- or accumulation-related problem (CLO4, CLO5) * Scale and add definite integrals, describe the meaning of integral bounds and how to apply them (CLO4, CLO5) * Recognize an anti-derivative of a function, (CLO4, CLO5) * Apply the theory of the Fundamental Theorem of Calculus to evaluate simple integrals (CLO4, CLO5) * Distinguish between definite and indefinite integrals and their meaning (CLO4, CLO5) |
| **5** | **Integrals – Techniques**  After completing this lesson, learners will be able to:   * Recognize the family of functions that can be solved with the technique of integration by substitution (CLO4) * Solve integration problems using the technique of substitution (CLO4) * Recognize the family of functions that can be solved with the technique of integration by parts (CLO4) * Solve integration problems using the technique of integration by parts (CL04) |

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| **6** | **Integrals – Modeling**  After completing this lesson, learners will be able to:   * Use MATLAB to solve a variety of integration problems (CLO4, CLO5) * Use integration to find the average value of a function (CLO4, CLO5) * Use MATLAB to find the average value of a function (CLO4, CLO5) * Use MATLAB to find the average value of a sequence of data. (CLO4, CLO5) |
| **7** | **Insert week-level topic title here**  After completing this lesson, learners will be able to:   * Express real world situations in terms of first order differential equations (CLO8) * Tell the difference between linear and nonlinear differential equations (CLO9) * Solve basic first order separable and linear differential equations (CLO9) * Use MATLAB to solve nonlinear first order differential equations (CLO9) |
| **8** | **Insert week-level topic title here**  After completing this lesson, learners will be able to:   * Express real world situations in terms of second order linear differential equations (CLO8) * Describe the difference between homogeneous and nonhomogeneous second order linear differential equations (CLO8) * Use MATLAB to solve linear and nonlinear second order differential equations, both homogeneous and nonhomogeneous. (CLO9) |
| **9** | **Insert week-level topic title here**  After completing this lesson, learners will be able to:   * Take problems that can be modeled by differential equations, both first and second order, and give solutions both by hand and MATLAB (CLO5, CLO8) * Examine case studies of differential equations applied to engineering problems and reproduce those solutions. |

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| **10** | **Insert week-level topic title here**  After completing this lesson, learners will be able to:   * Express vectors, linear combinations, and compute dot products (CLO9) * Write information in matrix form in the context of engineering applications (CLO9) * Apply the definition of the transpose, and use MATLAB to compute it (CLO9) * Use MATLAB to compute the inverse of a matrix (CLO9) |
| **11** | **Insert week-level topic title here**  After completing this lesson, learners will be able to:   * Use MATLAB to solve linear system and interpret the answer the program provides (CLO9) * Write the nullspace of A by solving Ax = 0 (CLO9) * Compute the rank and find row-reduced echelon form (CLO9) * Explain the notions of linear independence and bases (CLO10) |
| **12** | **Insert week-level topic title here**  After completing this lesson, learners will be able to:   * Describe the properties of the matrix determinant (CLO10) * Explain the concept of bases and orthogonal bases (CLO10) * Diagonalize a matrix and use the result to interpret the behavior of a linear system. (CLO10) |

# General feedback

Your input is essential for maintaining and improving the quality of this course material for future offerings, e.g., course content, typos, assignments, readings, course design. Email your comments to the instructor. Your input will also be solicited in course evaluation surveys.

# Important information

**Your instructor is your first point of contact.** If you have confidential information to discuss about this course, please email your instructor **and be sure to allow 24 to 48 hours for a response.** Their contact information can be found at the top of this document. If you have academic questions about the course material, please use the Q&A Discussion Forum on the class website.

1. PLO 1: Identify, formulate, analyze and solve mining engineering problems using a balance of mathematics, physics, chemistry and earth sciences. [↑](#footnote-ref-1)
2. As per “Guidelines for University Undergraduate Degree Level Expectations,” December 16, 2005. <http://www.queensu.ca/ctl/resources/topicspecific/quqaps/expectations.html> [↑](#footnote-ref-2)
3. There is no requirement to pass the final exam to pass the course. [↑](#footnote-ref-3)