EP 3MN4
Computation Methods for Engineering Physics

Fall/Winter 2021/22
Course Outline

CALENDAR/COURSE DESCRIPTION

This course provides the fundamental numerical methods used in computational engineering and physics using MATLAB including: Algebraic solutions; Numerical integration and differentiation; Euler method; Runge-Kutta techniques; Partial differential equations; Finite difference and finite element methods; Monte Carlo simulation.

The course will be taught by means of lectures and tutorials. Attendance at the tutorials and lectures is mandatory. Late penalties will be applied totaling 5% per day late.
Since a large portion of the mark is based on computational projects, the University rules on academic dishonesty and originality (outlined below) will be strictly enforced.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): none.
Antirequisite(s): PHYSICS 2D03

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. D.R. Novog
NRB 119
novog@mcmaster.ca
ext. 24904

Office Hours:

By appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

TBD

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

http://avenue.mcmaster.ca/

COURSE OBJECTIVES

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

- Develop numerical algorithms for modelling physical problems using flow charts and pseudo-code and then implement and test these in a computing environment (MATLAB).
- Determine the roots of non-linear equations using bracketing and non-bracketing numerical methods.

- Solve a large system of linear algebraic equations using direct and iterative numerical methods.
- Calculate the numerical derivative or numerical integral of a set of discrete and continuous data and assess the accuracy of the result.
- Solve ordinary differential equations that occur in many branches of engineering using Euler's and high order numerical methods subjected to appropriate boundary and/or initial conditions and understand the discreatization error for each method.
- Use implicit and explicit methods for solving time dependent differential equations subjected to initial conditions and determine the impact of the time discretization on the numerical result.
- Apply the finite difference method to first and second order partial differential equations such as the Wave, Laplace and Heat Equations by discretization into a system of linear algebraic equations and application of the appropriate boundary and initial conditions.

MATERIALS AND FEES

Required Texts:

The final exam is open book, any edition of the following text will be allowed into the final exam.

"Numerical Methods for Engineers" by Chapra and Canale, 7th edition. While any edition of the book is acceptable it is the responsibility of the student to ensure questions/topics/tables and formulas are consistent with this edition.

Calculator:

Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

Other Materials:

MATLAB programing is a mandatory component in this class. Students must obtain a valid program and license for MATLAB prior to the first tutorial.

COURSE OVERVIEW

Module	Topic	Readings
1	Introduction to numerical methods, integer and floating point binary representation. Taylor Series.	Chapter 3, 4
2	Root finding (bracketing and open methods)	5.1-5.4, 6.1-6.3, 6.5
3	Direct and iterative solution of systems of linear algebraic equations with an introduction to solutions of non-linear algebraic equations.	9.1-9.3, 9.6/6.6,9.7 10.1-10.2 11.1-11.3
4	Local and global optimal, ascent based methods.	13.1-13.4, 14.1-14.2
5	Curve fitting and interpolation.	17.1-17.3, 18.1-18.2 19.1-19.6 (time permitting)
6	Numerical Integration	21.1-21.3,21.5, 22.1,22.2,22.4
7	Numerical Differentiation	23.1-23.5
8	Numerical methods for Ordinary Differential Equations	25.1-25.4, 26.1-26.2, 27.1-27.2
9	Numerical methods for Partial Differential Equations	29.1-29.4, 30.1-30.5

		Additional course notes mandatory.
10	Validation of numerical methods Important trade-offs in numerical computations	In-class Lecture Material

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- 3 online synchronous lectures per week
- 1 tutorial per week with two components each week. Each week there is a short assignment that must be completed and submitted on avenue to learn by the end of the tutorial period. The second is a take home component that must be submitted before 9am on the following Monday.
- Tutorials will be in person COVID restrictions permitting. In the event that in-person tutorials are not possible they will be conducted synchronously online. Attendance is mandatory. For persons unable to attend tutorials in person they should obtain instructor approval to participate online prior to the first tutorial.
- Students are required to complete an "Application Demonstration" by the end of November where they demonstrate the utilization of methods developed in 3MN4 to solve problems in a different course. A concise report, plots, and matlab code must be submitted..

ASSESSMENT

Component	Weight
Application Demonstration	25%
Tutorial hand in component	10%
Tutorial Computational Projects	30%
Final Exam	35%
Total	100%

ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only, and will not be directly taken into consideration in determining a student's actual grade in the course.

Outcomes	Indicators
Solve ordinary differential equations that occur in many branches of mathematics and engineering	1.1
Develop numerical algorithms for modelling physical problems using flow charts and pseudo-code and then implement and test these in a computing environment (MATLAB).	5.2
Create a finite difference method to first and second order partial differential equations such as the Wave, Laplace and Heat Equations.	5.3

For more information on Accreditation, please visit: https://www.engineerscanada.ca

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

ACADEMIC ACCOMMODATIONS

Students who require academic accommodation must contact Student accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities.

NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

1. The McMaster Student Absence Form is a self-reporting tool for Undergraduate Students to report absences DUE TO MINOR MEDICAL SITUATIONS that last up to 3 days and provides the ability to request accommodation for any missed academic work. Please note this tool cannot be used during any final examination period.
2. You may submit a maximum of 1 Academic Work Missed request per term. It is YOUR responsibility to follow up with your Instructor immediately (NORMALLY WITHIN TWO WORKING DAYS) regarding the nature of the accommodation. Relief for missed academic work is not guaranteed.
3. If you are absent for reasons other than medical reasons, for more than 3 days, or exceed 1 request per term you MUST visit the Associate Dean's Office (JHE/A214). You may be required to provide supporting documentation.
4. This form must be submitted during the period of absence or the following day, and is only valid for academic work missed during this period of absence.

5. It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.
6. You should expect to have academic commitments Monday through Saturday but not on Sunday or statutory holidays. If you require an accommodation to meet a religious obligation or to celebrate an important religious holiday, you may submit the Academic Accommodation for Religious, Indigenous and Spiritual Observances (RISO) Form to the Associate Dean's Office. You can find all paperwork needed here: http://www.eng.mcmaster.ca/current/documents.html

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. It is the students' responsibility to regularly check the course webpage (ex. Avenue to Learn) for updates and announcements.
2. Missed work without an approved MSAF will be assigned a zero.
3. For approved MSAF missed work grades will be transferred to the final exam.
4. For computational assignments a late penalty of 5% per day will be assigned.

NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

AUTHENTICITY / PLAGIARISM DETECTION

This course will use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK

In this course, we will be using Avenue to Learn. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this

disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

REFERENCE TO RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.