Engineering Physics
ENGPHYS 3NM4
Numerical Methods for Engineering
Fall 2024

Instructor Information

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Class Format

In Person (preferred). Lectures will be live broadcasted and recorded via MS Teams.

Course Dates: 09/03/2024 - 12/05/2024
Units: 4.00
Course Delivery Mode: In Person
Course Description: Applied numerical methods for engineering including solution of systems of algebraic equations; numerical integration and differentiation; finite difference and finite element methods; ODE solutions; Optimization; Partial differential equations; Monte Carlo simulation. Three lectures, one lab (three hours); first term Prerequisite(s): Registration in Level II or above of an Engineering program Antirequisite(s): ENGPHYS 2CE4, CHEMENG 2E04, CIVENG 2E03, COMPENG 3SK3, MECHENG 3F04, COMPSCI 4X03, MECHTRON 3X03, SFWRENG 4X03

Important Links

- [Mosaic](#)

- [Avenue to Learn](#)

- [Student Accessibility Services - Accommodations](#)

- [McMaster University Library](#)

- [eReserves](#)

[Google Colab](#)

[Textbook: Numerical Methods for Engineering in Python3](#)

[McMaster Data Analysis Support Hub (DASH) for Python programming](#)

Course Learning Outcomes

- Practical grasp how numbers are stored numerically (computationally), how functions are applied, and solutions represented.

- Proficiency in the theory and application of numerical methods and their parameters.

- Hierarchical decomposition of complex problems into simpler building blocks.

- Application of numerical methods to real-world engineering problems.

- Use of computational tools for numerical methods, including personal implementations, software packages, and AI generated solutions.

Graduate Attributes

The Canadian Engineering Accreditation Board (CEAB) is a division of Engineers Canada and is responsible for accrediting undergraduate engineering programs across Canada. Accreditation by the CEAB ensures that the engineering programs meet a national standard of quality and cover essential educational requirements. Graduate Attributes are a set of qualities and skills that the CEAB expects engineering graduates to possess. These attributes are a benchmark for the learning outcomes of accredited engineering programs. This section lists the Graduate Attribute Indicators associated with the Learning Outcomes in this course.

Lab Information

Labs will be conducted weekly, simultaneously in-person (please bring your own laptop) and virtually. TAs and the instructor will be available to help with issues and provide advice on the current assignment and general topics.

Assignments will be due at the end of the lab.

Note the oral defence (ref Course Evaluation) will occur during lab time. If you are unable to attend a lab, please notify the instructor ahead of time so defence arrangements can be made.

Lab Safety

As this is a computer-lab, please consider ergonomics during prolonged use: [Laptop ergonomics video](#)

Course Schedule

A weekly breakdown of the course schedule

Week	Topic	Readings
1	Truncation and round-off error	Instructor notes
2	Linear systems	Ch 2
3	Linear systems	Ch 2
4	Interpolation and curve fitting	Ch 3
5	Roots of equations	Ch 4
Midterm Break		
6	Numerical differentiation	Ch 5
7	Numerical integration	Ch 6
8	Differential equations: Initial value problems	Ch 7
9	Differential equations: Boundary value problems	Ch 8
10	Partial differential equations	Instructor notes / supplemental notes
11	Finite element method	Instructor notes / supplemental notes
12	Eigen value problems	Ch 9
13	Optimization	Ch 10

Required Materials and Texts

Textbook Listing: https://textbooks.mcmaster.ca

Access to a computer

Access to a computer is required for this course. A laptop brought to labs is ideal but public resources are available.

Python3

Students will need to write and execute Python3 code.

An introductory training will be delivered during the first lab, on Monday Sept 9th. All users, regardless of experience, are encouraged to attend.

 Python3 can be accessed:

- (recommended and introduced in class) use any modern browser with your google account and navigate to colab.google.com .
- Students are welcome to use their own installation, IDE, github, etc.

The former is recommended as all packages are preinstalled and tested. Furthermore, the environment is integrated with Gemini which we will use for rapid coding.

Numerical methods in engineering with Python 3
ISBN: ISBN : 1-107-23829-3
Authors: Kiusalaas, Jaan
Publisher: Cambridge : Cambridge University Press
Publication Date: 2013
Edition: Third edition
E-book available for free through McMaster library:

https://mcmaster.primo.exlibrisgroup.com/permalink/01OCUL_MU/deno1h/alma9910323{

Professor notes
Recorded presentation notes available online.

Optional Course Materials

Textbook Listing: https://textbooks.mcmaster.ca

Numerical Recipes
Numerical Recipes by William H. Press (published in multiple language-specific instances). The series is outdated, but the discussion on pragmatic algorithms is foundational and underpins most modern packages.

Numerical Methods for Engineers
Authors: Steven Chapra, Raymond Canale

Course Evaluation

1. Weekly comprehension quizzes every Monday. (20%)

These quizzes test your comprehension of the material from the past week.

- 2 multiple-choice questions in A2L, each of which should take you 1 minute.

- 5 minutes total are allocated for Universal Design principles.

- The top 10 marks will be counted towards your final score.

2. Assignments (15% solution + 15% oral)

Application of computational tools in Python3 to solve particular problems. You can use whatever you want to complete the assignment (numpy / scipy packages, AI, Internet forums, group work, etc), but the top layer must be exposed - i.e.: If we are studying optimization, you can use a linear system package but not an optimization package. Marks will be given for the correct answer and method.

Assignments will be distributed during the final lecture of the week and *due at the end of the Lab session*.

In the middle of the lab session, you will be randomly selected for discussion with the instructors. At the end of the lab you will **individually** discuss the approaches you took to the questions in the problem set. This is to test your comprehension of the methods, *not the correctness of the answer.*

3. Mid-term (20%) and Final (30%) exams

Exams will be hand-written, with use of the McMaster calculator. Show all your steps. You will be given 'functions' on a question-by-question basis so as to encourage hierarchical thinking and avoid laborious calculation.

Course Evaluation Details

The focus of evaluation is your understanding of the principles of numerical methods. Consider the evaluator a manager / client / peer who needs a solution from you which you must present and defend.

Grading Scale

The McMaster 12 Point Grading Scale

Grade	Equivalent Grade Point	Equivalent Percentages
A+	12	90-100
A	11	85-89
A-	10	80-84
B+	9	77-79
B	8	73-76
B-	7	70-72
C+	6	67-69
C	5	63-66
C-	4	60-62
D+	3	57-59
D	2	53-56
D-	1	50-52
F	0	0-49

Late Assignments

- 5% a day unless alternative arrangements are made **before** the deadline.

Absences, Missed Work, Illness

A missed quiz count for zero but only the top 10 are counted in the final mark.

Special arrangements for assignments / oral discussion will be considered on a case-by-case basis.

Generative AI: Unrestricted Use

Students are *encouraged* to use generative AI throughout this course in all facets including,

- Generation of code

- Syntax for application of common packages

- Documentation and development of testing examples

- Explanation and assistance debugging code

- Alternative explanation of core concepts

- Consultation and emotional support

In cases where students use AI generated code, you are required to include (as a comment) your prompt by way for 'showing your work' . In the interest of collaboratively learning as a class, students will be given the opportunity to discuss their experiences with AI during lab session.

The student is *solely* responsible for the correctness and quality of the submitted work. AI results and generated code should be used cautiously.

APPROVED ADVISORY STATEMENTS

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. **It is your responsibility to understand what constitutes academic dishonesty.**

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. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](), located at https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.

- improper collaboration in group work.

- copying or using unauthorized aids in tests and examinations.

Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, 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 a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

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.

Equity, Diversity, and Inclusion

The Faculty of Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Faculty, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or [sas@mcmaster.ca](#) to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

Academic Advising

For any academic inquires please reach out to the Office of the Associate Dean (Academic) in Engineering located in JHE-Hatch 301.

Details on academic supports and contact information are available from:

Requests for Relief for Missed Academic Term Work

In the event of an absence for medical or other reasons, students should review and follow the Policy on Requests for Relief for Missed Academic Term Work.

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.