

## Course Outline

### 1. COURSE INFORMATION

<b>Session Offered</b>	Winter 2022	
<b>Course Name</b>	Modelling and Numerical Solutions	
<b>Course Code</b>	ENGTECH 2MS3	
<b>Date(s) and Time(s) of lectures and tutorials</b>	Lecture – Friday: C01 8:30am – 10:30am Tutorials – Friday: T01 11:30 am – 12:20 pm; T02 12:30 – 1:20 pm; T03 1:30 – 2:30 pm	
<b>Program Name</b>	Automotive and Vehicle Engineering Technology	
<b>Calendar Description</b>	Number systems and errors; solutions to nonlinear equations; interpolation by polynomials; matrices and systems of linear equations; differentiation and integration; differential equations; applications to mechanical systems.	
<b>Instructor(s)</b>	Dr. Dan Centea	E-Mail: Avenue email tool Office: by appointment

### 2. COURSE SPECIFICS

<b>Course Description</b>	Base number conversions; floating point representation; simple and double precision; computational error analysis; iterative methods to find roots of equations using bisection and Regula Falsi bracketing methods, as well as Newton-Raphson and secant iteration methods, discuss advantages and disadvantages; solve linear algebraic equations using Gaussian elimination and LU de-factorization; calculate polynomial and spline interpolation with Lagrange's and Newton's methods; compute integral using upper and lower sums, trapezoid rule, and Romberg algorithms; compute numerical solutions for first-order ordinary differential equation with initial condition using Taylor series and Runge-Kutta methods; decompose a set of higher-order ordinary differential equations into a simultaneous set of first-order ordinary differential equations and solve the system using numerical methods; develop C++ source codes to implement these methods		
<b>Instruction Type</b>	<b>Code</b>	<b>Type</b>	<b>Hours per term</b>
	C	Classroom instruction	35
	L	Laboratory, workshop or fieldwork	
	T	Tutorial	
	DE	Distance education	
	<b>Total Hours</b>		35
<b>Resources</b>	<b>ISBN</b>	<b>Textbook Title &amp; Edition</b>	<b>Author &amp; Publisher</b>
	7 <sup>th</sup> Ed: 978-1133103714 6 <sup>th</sup> Ed: 9780495114758	Numerical Mathematics and Computing, 7th Ed. (or 6th Ed.)	Cheney, W and D. Kincaid,
	<b>Other Supplies</b>	<b>Source</b>	
	USB flash drive	Students must provide their own USB flash drive 2+GB	
<b>Prerequisite(s)</b>	ENGTECH 1CP3, ENGTECH 1MT3, and registration in Level II of Automotive and Vehicle Engineering Technology		
<b>Corequisite(s)</b>	N/A		
<b>Antirequisite(s)</b>	CIVTECH 3MN3, ENGTECH 2MN3, ENGTECH 3MN3		

<p><b>Course Specific Policies</b></p>	<ul style="list-style-type: none"> <li>○ Licensed software is provided in the computer lab. The university is not responsible for providing individual software licenses to students or for installation support of the software on personal laptops.</li> <li>○ Students may use their own laptops to complete coursework as long as their submitted files are compatible with software versions installed in the lab.</li> <li>○ Students must have their own USB flash drive with enough space for storing their in-class course work. No student work should be left on lab computers.</li> <li>○ A paper, outlining major formulas, will be provided for the mid-term test and final exam. Other resources are not permitted during the tests unless specifically stated.</li> <li>○ Assignments: non-computer problems will be hand written; the C++ code for the computer problems must be submitted through Avenue; the assignments without the C++ part submitted will not be marked; late assignments will not be marked.</li> <li>○ All work must be shown in assignments, mid-term test and exam to get full credit</li> </ul>	
<p><b>Departmental Policies</b></p>	<ul style="list-style-type: none"> <li>○ Students must maintain a GPA of 3.5/12 to continue in the program.</li> <li>○ In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of “out-of-class” work for every scheduled hour in class. “Out-of-class” work includes reading, research, assignments and preparation for tests and examinations.</li> <li>○ Where group work is indicated in the course outline, such collaborative work is mandatory.</li> <li>○ The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception.</li> <li>○ Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class.</li> <li>○ The instructor has the right to submit work to software to identify plagiarism.</li> </ul>	
<p><b>3. SUB TOPIC(S)</b></p>		
<p>Jan. 14</p>	<p>Modeling and Computers; Number Representation and Errors.</p> <ul style="list-style-type: none"> <li>○ Representations of numbers in different basis</li> <li>○ Floating point representation</li> <li>○ Loss of significance</li> </ul>	<p>Ch.2</p>
<p>Jan. 21</p>	<p>Roots of Non-linear Functions</p> <ul style="list-style-type: none"> <li>○ Bisection method</li> <li>○ False position method</li> <li>○ Newton’s method</li> <li>○ Secant method</li> </ul>	<p>Ch.3</p>
<p>Jan. 28</p>	<p>Systems of Linear Equations</p> <ul style="list-style-type: none"> <li>○ Naïve Gaussian elimination</li> <li>○ Gaussian elimination with scaled partial pivoting</li> </ul>	<p>Ch.7</p>
<p>Feb. 4</p>	<p>Polynomial Interpolation</p> <ul style="list-style-type: none"> <li>○ Curve fitting</li> <li>○ Lagrange form of the interpolation polynomial</li> <li>○ Newton form of the interpolation polynomial</li> <li>○ Divided differences</li> </ul>	<p>Ch.4</p>

Feb. 11	Spline Functions <ul style="list-style-type: none"> <li>○ First-degree splines</li> <li>○ Quadratic splines</li> <li>○ Normal cubic splines</li> </ul>	Ch.9
Feb. 18	Engineering Applications – <i>Review</i>	
<i>Mid-term Recess: Monday, February 21 to Sunday, February 27, 2022</i>		
March 4	<i>Mid-term test.</i> No tutorials	
March 11	Numerical Integration <ul style="list-style-type: none"> <li>○ Lower and upper sums</li> <li>○ Trapezoid rule</li> <li>○ Romberg Algorithm</li> </ul>	Ch.5
March 18	First Order ODE <ul style="list-style-type: none"> <li>○ Taylor-series method</li> <li>○ Runge-Kutta method</li> </ul>	Ch.10
March 25	Systems of First Order ODEs <ul style="list-style-type: none"> <li>○ Taylor-series method</li> <li>○ Runge-Kutta methods</li> </ul>	Ch.11
April 1	Higher Order ODE and Systems of Higher Order ODEs <ul style="list-style-type: none"> <li>○ Convert higher order ODEs into a system of first order ODEs</li> <li>○ Convert systems of higher order ODEs into multiple systems of first order ODEs</li> </ul>	Ch.11
April 8	Engineering Applications – <i>Review</i>	

Classes end: Tuesday, April 12

Final Examination Period: Thursday, April 14 to Friday, April 29

All examinations **MUST** be written during the scheduled examination period.

Note that this structure represents a plan and is subject to adjustment term by term.

The instructor and the 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.

4. ASSESSMENT OF LEARNING *including dates*	Weight
Assignments 8 x 2.5%	20%
Mid-term test – March 4, 2022	35%
Final examination (tests cumulative knowledge)	45%
<b>TOTAL</b>	<b>100%</b>

Percentage grades will be converted to letter grades and grade points per the University calendar.

5. LEARNING OUTCOMES
1. Understand the limitations of iterative computation methods when implemented in computer programs
2. Construct numerical solutions to engineering problems in a format that emphasizes insight into engineering, not just the presentation of numbers.
3. Compare and analyze various numerical computation methods used in solving engineering and technology problems

4. Evaluate and recommend the most appropriate approach for solving engineering problems using iterative computations

5. Perform error analyses and determine if the solutions are acceptable

6. Implement various numerical computation methods in C++ programs

## **6. COURSE OUTLINE – APPROVED ADVISORY STATEMENTS**

### **ANTI-DISCRIMINATION**

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

[http://www.mcmaster.ca/policy/General/HR/Discrimination\\_Harassment\\_Sexual\\_Harassment-Prevention&Response.pdf](http://www.mcmaster.ca/policy/General/HR/Discrimination_Harassment_Sexual_Harassment-Prevention&Response.pdf)

### **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-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty: 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.

### **AUTHENTICITY / PLAGIARISM DETECTION**

Some courses may 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](http://www.mcmaster.ca/academicintegrity).

### **COURSES WITH AN ON-LINE ELEMENT**

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), 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.

### COMMUNICATIONS

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

### 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.

### 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](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

### REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "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. <http://www.mcmaster.ca/policy/Students-AcademicStudies/Studentcode.pdf>

### **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, A2L and/or McMaster email.