Bachelor of Technology Partnership

Course Outline

1. COURSE INFORMATION

Session Offered	Fall 2015				
Course Name	Modelling and Numerical Solutions				
Course Code	ENG TECH 3MN3				
Date(s) and Time(s) of lectures	C01	Tu	14:30	16:20	ETB/238
	T01	Fr	15:30	16:20	ETB/B104
	T02	Fr	16:30	17:20	ETB/B104
Program Name	Process Automation Technology				
Calendar Description	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.				
Instructor(s)	Dr. Nasim Muhammad		Phone: (905) 525-9140 x 24425 E-Mail: nasimm@mcmaster.ca Location & Office Hours: ETB B110 - TBA		

2. COURSE SPECIFICS

Course Description

Learn the basic principles of modelling mathematical problems that occur in engineering; understand the main tools available in numerical analysis; write C++ programs that use numerical methods to solve engineering problems; numerical techniques including error analysis, root finding, linear algebraic equations, curve fitting, integration and differentiation, ordinary differential equations; sensitivity analysis; engineering applications.

Instruction Type

Code	Type	Hours per term
C	Classroom instruction	26
L	Laboratory, workshop or fieldwork	12
T	Tutorial	0
DE	Distance education	0
	Total Hours	38

Resources

ISBN	Textbook Title & Edition	Author & Publisher
1133103715 (7th Ed.) 0495114758 (6th Ed.)	Numerical Mathematics and Computing, 6th or 7th Ed.	Cheney, W and D. Kincaid, Thomson - Brooks/Cole

Other Supplies	Source
Course materials	All course materials, resources, and assignments/problem-sets will be posted on http://avenue.mcmaster.ca

Prerequisite(s)	ENG TECH 1CP3, 2MA3; and registration in Level III or above of Process Automation Technology
Corequisite(s)	None
Antirequisite(s)	CIV TECH 3MN3, ENG TECH 2MN3, 3SP3
Course Specific Policies	– Late assignments will not be graded. – Students who miss submitting more than one C++ program will not be

	accepted to write the mid-term test and/or final exam. – Overall 60% average is required in lab component. – The C++ code for the computer problems must be submitted through Avenue. The assignments without the C++ part submitted will not be marked. – One letter sized sheet of paper outlining the major formulas will be permitted in the mid-term test and final exam. No worked examples with solutions are permitted. – All work must be shown to get full credit.	
Departmental Policies	Students must maintain a GPA of 3.5/12 to continue in the program. 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. Where group work is indicated in the course outline, such collaborative work is mandatory. 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. 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. Instructor has the right to submit work to software to identify plagiarism.	
3. SUB TOPIC(S)		
Week 1 (Sep 8 – 11)	Modelling and Computers; Number Representation and Errors Root Finding: Bracketing Methods • Graphical • Bisection Method • False Position	
Week 2 (Sep 14 – 18)	Root Finding: Open Methods • Newton-Raphson • Secant Method • Muller's Method	
Week 3 (Sep 21 – 25)	Systems of Linear Equations • Gauss Elimination • Tridiagonal Banded Systems • LU Decomposition	
Week 4 (Sep 28 – Oct 02)	Polynomial Interpolation • Lagrange Interpolating Polynomials • Newton's Divided Difference • Inverse Interpolation	
Week 5 (Oct 5 – 9)	Spline Functions • First Degree Splines • Second Degree Splines • Cubic Splines	
Mid-term recess (Monday, October 12 to Saturday, October 17)		
Week 6	Midterm	

(Oct 19 – 23)		
Week 7 (Oct 26 – 30)	Least Squares Regression • Linear Regression • Polynomial Regression • Multiple Linear Regression	
Week 8 (Nov 2 – 6)	Numerical Differentiation • First Derivative via Taylor Series • Second Derivative via Taylor Series • Richardson Extraplolation	
Week 9 (Nov 9 – 13)	Numerical Integration • Trapezoidal Rule • Romberg Algorithm	
Week 10 (Nov 16 – 20)	Numerical Integration • Simpson's Rule • Gauss Quadrature	
Week 11 (Nov 23 – 27)	First Order ODE • Taylor Series Method • Runge-Kutta Methods	
Week 12 (Nov 30 – 04 Dec)	Systems of First Order ODE; Higher Order ODE • Uncoupled and Coupled Systems • Taylor Series Method • Runge-Kutta Methods	
Week 13 (Dec 7 – 8)	Review, if time permits	

Classes end – Tuesday December 8, 2015
Final examination period: Wednesday December, 9, 2015 to Tuesday, December 22, 2015
All examinations MUST BE written during the scheduled examination period.

List of experiments

Lab 1	Number conversion, Floating point numbers
Lab 2	Root finding methods
Lab 3	Systems of Linear Equations
Lab 4	Polynomial Interpolation
Lab 5	Spline Functions
Lab 6	Least Squares Regression
Lab 7	Numerical Differentiation
Lab 8	Numerical Integration
Lab 9	First Order ODE
Lab 10	Systems of First Order ODE

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 /Labs	20
Mid-term test	35
Final examination (tests cumulative knowledge)	45
TOTAL	**100%**

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

5. LEARNING OUTCOMES

1. Define the errors inherent in all numerical calculations. Calculate machine epsilon and its relationship to roundoff error. Convert numbers to and from the 32-bit word length floating point representation. Understand simple and double precision.
2. Determine numerical solutions to engineering problems in a format that emphasizes insight into engineering, not just the presentation of numbers. Perform error analyses and determine if the solutions are acceptable.
3. Solve for the zero of a non-linear algebraic function using bisection and regula falsi bracketing methods, as well as Newton-Raphson and secant iteration methods. List their advantages and disadvantages. Develop C++ routines for these methods.
4. Solve a set of linear algebraic equations using the Gaussian elimination with partial pivoting and LU decomposition. Develop C++ code for these methods. List the advantages and disadvantages of the methods.
5. Determine the coefficients of the interpolating polynomial for a given set of data points using Lagrange's and Newton's methods. Use C++ code for finding a polynomial fit for a given set of data points.
6. Determine 1st order, quadratic and cubic spline curve fits for a given set of data points and evaluate intermediate values. Use C++ code to determine these splines and evaluate values between the given data points.
7. Compute the integral of a set of data points using upper and lower sums, trapezoid rule, and Romberg algorithm. Develop C++ code to implement these methods.
8. Compute the numerical solution for a first-order ordinary differential equation with initial condition using Taylor series and Runge-Kutta methods. Develop C++ routines to use these methods.
9. Obtain numerical solutions to simultaneous sets of first-order ordinary differential equations as an initial condition problem using Taylor series and Runge-Kutta methods. Develop C++ code to use these methods
10. 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.

6. POLICIES

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/Anti-Discrimination%20policy.pdf

Academic Integrity

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

Academic dishonesty is to knowingly act of 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 kinds of academic dishonesty please refer to the Academic Integrity Policy, located at: http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf .

The following illustrates only three forms of academic dishonesty:
1. Plagiarism. E.g. the submission of work that is not 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.

Requests for Relief for Missed Academic Term Work (Assignments, Mid-Terms, etc.)

The McMaster Student Absence Form is a self-reporting tool for **Undergraduate Students** to report absences 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.

You may submit a maximum of 1 Academic Work Missed requests per term. It is YOUR responsibility to follow up with your Instructor immediately regarding the nature of the accommodation.

If you are absent more than 3 days or exceed 1 request per term you MUST visit your Associate Dean's Office (Faculty Office). You may be required to provide supporting documentation.

This form should be filled out immediately when you are about to return to class after your absence. http://www.mcmaster.ca/msaf/

E-Learning Policy

Consistent with the Bachelor of Technology's policy to utilize e-learning as a complement to traditional classroom instruction, students are expected to obtain appropriate passwords and accounts to access Avenue To Learn for this course. Materials will be posted by class for student download. It is expected that students will avail themselves of these materials prior to class. 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 account, and program affiliation may become apparent to all other students in the 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 this disclosure please discuss this with the course instructor. Avenue can be accessed via http://avenue.mcmaster.ca.

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.

Turnitin (Optional)

This course will be using a web-based service (Turnitin.com) to reveal plagiarism. Students submit their assignment/work electronically to Turnitin.com where it is checked against the internet, published works and Turnitin's database for similar or identical work. If Turnitin finds similar or identical work that has not been properly cited, a report is sent to the instructor showing the student's work and the original source. The instructor reviews what Turnitin has found and then determines if he/she thinks there is a problem with the work. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to http://www.mcmaster.ca/academicintegrity/turnitin/students/

Protection of Privacy Act (FIPPA)

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should take care to protect student names, student numbers, grades and all other personal information at all times. For example, the submission and return of assignments and posting of grades must be done in a manner that ensures confidentiality.
http://www.mcmaster.ca/univsec/fippa/fippa.cfm

Academic Accommodation of Students with Disabilities Policy

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 contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca. For further information consult McMaster's policy for Academic Accommodation of Students with Disabilities
http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicAccommodation-StudentsWithDisabilities.pdf

Students must forward a copy of the SAS accommodation to the instructor of each course and to the Program Administrator of the B.Tech. Program immediately upon receipt. If a student with a disability chooses NOT to take advantage of a SAS accommodation and chooses to sit for a regular exam, a petition for relief may not be filed after the examination is complete. http://sas.mcmaster.ca

Student Code of Conduct

The Student Code of Conduct (SCC) exists to promote the safety and security of all the students in the McMaster community and to encourage respect for others, their property and the laws of the land. McMaster University is a community which values mutual respect for the rights, responsibilities, dignity and well-being of others. The purpose of the Student Code of Conduct is to outline accepted standards of behavior that are harmonious with the goals and the well-being of the University community, and to define the procedures to be followed when students fail to meet the accepted standards of behavior. All students have the responsibility to familiarize themselves with the University regulations and the conduct expected of them while studying at McMaster University.
http://judicialaffairs.mcmaster.ca/pdf/SCC.pdf