

## MECH ENG 3F04 - Numerical Methods

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Office Hours: I am available in the class after lectures for questions and consultation. Please email me if you would like to meet at a specific time.

Lectures: Mon, Wed, Thurs 4:30-5:20 in KTH B135 and Wed 10:30-11:20 in KTH B135

### Course evaluation

Assignments:	20%
Midterms (2):	15% each
Final:	50%

Midterms and the final are closed book (standard calculators only), but a summary sheet is provided with the questions.

### References

#### Course Text:

Chandra & Canale, Numerical Methods for Engineers, 7<sup>th</sup> edition.  
note: 4<sup>th</sup> - 6<sup>th</sup> edition versions of this text would still be fine

#### Other References

- Numerical Recipes
- Numerical Methods, Gilat & Subramaniam
- Numerical Mathematics, Grasselli & Pelinovsky
- Engineering Problem Solving with MATLAB, Etter
- Numerical Methods for Engineers, Chapra
- [Matlab site: www.mathworks.com](http://www.mathworks.com)
- [Wolfram mathworld site: www.mathworld.com](http://www.mathworld.com)

### Software:

The MATLAB software package will be used to apply methods learned in class. This software is available in the computer clusters in JHE219A, 233/234 and BSB241/245 (and almost every other cluster on campus), and a student version is available in the bookstore if you wish to use it on your own computer. Octave is an opensource program very similar to matlab, and can be used as well.

## **COURSE TOPICS:**

1. Preliminaries - modelling principles, approximation, and truncation errors
2. Sets of linear equations - matrix basics, Gauss elimination, special matrices
3. Roots of single equations - several methods
4. Sets of nonlinear equations - fixed point iteration, Newton-Raphson
5. Optimization - uni and multivariate
6. Curve Fitting - regression, interpolation, splines, Fourier methods
7. Numerical differentiation and integration - Newton-Cotes, Gauss quadrature
8. Ordinary Differential equations - single step and multi-step methods
9. Partial Differential Equations - introduction and applications

**LEARNING OUTCOMES:** Upon successful completion of the course the student are expected to be able to:

1. Solve systems of linear equations using direct and iterative methods based on properties of the matrix while understanding the significance of matrix parameters (condition number) on accuracy
2. Solve nonlinear equations and systems of non-linear equations using a variety of methods, understanding differences in the methods in terms of convergence and speed
3. Perform one- and multi-dimensional unconstrained optimizations using a variety of methods, understanding differences in the methods in terms of convergence and speed
4. Perform polynomial and spline Interpolations while understanding the limitations/benefits of the various approaches
5. Perform regressions on data sets using least squares methods including linearization of non-linear data sets.
6. Demonstrate and understand how a Fourier analysis is done on a noisy data set, and the limitations of such an analysis in terms of frequency resolution
7. Calculate numerical derivatives of discrete data and be able to assess their accuracy
8. Solve ordinary differential equations (sets of first order equations) as initial value problems using Euler's and Runge Kutta methods with an understanding of their solution accuracy
9. Solve boundary value problems using shooting methods and by applying finite difference methods and solving the resulting linear equation set.

**GRADUATE ATTRIBUTES:** This course provides the students opportunity to develop the following measures of graduate attributes

Graduate Attributes	Learning Objectives where it is measured
Knowledge base for engineering (Indicator 1,3)	1-9
Use of engineering tools (Indicator 2,3)	1-9

## **Procedure for Remarking Term Test Answer Books**

if a student has an issue with the way in which an assignment or midterm test has been evaluated, he/she may lodge their objections within a week of returning the marked papers or posting of solutions (whichever is later). Midterm tests written in pencil will not be considered for re-marking.

*Please follow the steps below while submitting material for remarking:*

Compare your solutions to that posted on the course website. Write your complaint in a separate piece of paper indicating: (i) Problem number(s) you have a complaint about, (ii) Detailed nature of the complaint, and (iii) The marks you think you should have received, in reference to the solution/marking scheme posted on the course website. Please submit this along with your answer book personally to the relevant TA. The student will receive a written response from the TA that marked the paper; if the student does not agree with the response, the student may submit the whole documentation to the instructor for arbitration.

## **Policy Reminders:**

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.

Students are reminded of the following Policies, which could be relevant to activities in this course.

### **Calculators**

Only McMaster Standard Calculator (Casio FX-991 MS or MS Plus ONLY) may be used during term tests and the final examination.

### **Adverse Discrimination**

"The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons concerned, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible."

### **Academic Integrity (Ethics and Dishonesty)**

"You are expected to exhibit honesty and use ethical behavior 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 behavior 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 [www.mcmaster.ca/academicintegrity](http://www.mcmaster.ca/academicintegrity). 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."

#### Online Element

"In this course we will be using a course website. 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."

#### 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 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 requiring a RISO accommodation 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."

#### 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, labor disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email."

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