

## NE 113: Engineering Computation

### Course Description

Engineering Computation is an entry level course into digital computers, and hardware and software organization. It covers programming fundamentals, algorithms and control structures, computer communication and problem solving by plotting, fitting data, building new functions and creating iterations and loops. The primary software for the course is MATLAB, which will be utilized to problem solve, create plots, and design more complex programs in the programming environment. The aforementioned material will be applied in MATLAB and more advanced functions and tools will be used. The second half of the course introduces elementary numerical methods and their execution in MATLAB as well as their applications in Nano Engineering. Welcome to NE 113!

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**Office Hours:** Wednesdays from 3:30-4:30pm or by appointment.

### Teaching Assistants :

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### Scheduled Sessions:

**Lectures:** Monday, Wednesday, Friday @ 8:30am – 9:20am, DWE-1501

**Labs:** Wednesday @ 12:30pm – 3:20pm, B1-370

**Make-up Lectures:** Monday Sept. 24, Oct 10, Nov. 5, Nov. 19, Dec. 3, 2:30-3:20pm, B1-271

**Important:** Labs and lectures cancelled on the week of October 15<sup>th</sup>

## Course Objectives:

Upon completion of this course, the student should be able to:

- Understand fundamental programming concepts
- Apply concepts of problem solving to engineering problems
- Be able to design and implement simple computer programs in MATLAB to solve basic engineering problems
- Have a sound understanding of basic numerical techniques for solving nonlinear equations, systems of linear equations, and performing numerical integration.

## Textbooks:

*MATLAB for Engineers (3<sup>rd</sup> Edition)* by Holly Moore, Pearson Education, Inc. (2011).

‘MATLAB for Engineers’ introduces students to the MATLAB environment and then using basic algebra, shows how it can be used to solve engineering problems from a wide range of disciplines. It is very appropriate for this course because it “[starts] at the beginning” while many other texts assume a higher level of mathematical and computer knowledge than most first-year students possess. It also takes an approach that fits a general engineering curriculum, and NE 113 is very much a course that teaches material and methods applicable to all areas and levels of engineering. The focus will be on Chapters 1 through 9 and 13 for the first half of the course but Chapter 12 is useful for the MATLAB tools available pertaining to the second half of course in which Numerical Methods are taught. Appendix A is a great quick-reference section for MATLAB built-in functions and symbols and Appendix B contains solutions to the practise problems at the end of each chapter.

*Applied Numerical Methods with MATLAB for Engineers and Scientists (3<sup>rd</sup> Edition)* by Steven C. Chapra, McGraw-Hill Companies, Inc. (2012).

This resource caters directly to the requirements of Engineering Computation in that it supports a one-semester course in numerical methods. The second half of NE 113 introduces Numerical Methods and demonstrates how they can be used to solve engineering problems. Chapra does an excellent job of explaining the concepts and providing diagrams and examples to motivate their applications in engineering. In addition, he shows implementation in MATLAB through examples of codes, which can be referenced when students are trying to create their own programs to solve problems. Chapters 4-6, 8-10, 12, 14-15, 17 and 19 in the 3<sup>rd</sup> Edition and Chapters 4-6, 8-10, 12-15, and 17 in the 2<sup>nd</sup> Edition contain the information covered in the course.

## Course Software:

- MATLAB, *Student Version 7.0 (R2011a)*

## Course Website:

<http://www.learn.uwaterloo.ca>

### Course Reference Material:

- [1] Etter, D.M., & Ingber, J.A., (2003). *Engineering problem solving with C++*. Upper Saddle River, New Jersey: Pearson Education, Inc.
- [2] Horowitz, E., Sahni, S., & Rajasekaran, S., (1998). *Computer algorithms*. New York, New York: Computer Science Press.
- [3] Nyhoff, L., & Leestma, S. (1999). *Introduction to fortran 90*. Upper Saddle River, New Jersey: Prentice-Hall, Inc.
- [4] Johnsonbaugh, R. & Schaefer, M., (2004). *Algorithms*. Upper Saddle River, New Jersey: Pearson Education, Inc.
- [5] Moore, H., (2007). *MATLAB for Engineers (2<sup>nd</sup> Ed.)*. Upper Saddle River, New Jersey: Pearson Education, Inc.
- [6] Chapra, S.C., (2008). *Applied Numerical Methods with MATLAB for Engineers and Scientists (2<sup>nd</sup> Ed.)*. New York, New York: McGraw-Hill Companies, Inc.
- [7] Cormen, T.H., (2001). *Introduction to Algorithms (2<sup>nd</sup> Ed.)*. Cambridge, Mass.: MIT Press.
- [8] Smith, D.M., (2010). *Engineering Computation with MATLAB (2<sup>ND</sup> Ed.)*. Pearson Education, Inc.
- [9] Gilat, A., (2008). *MATLAB: An introduction with applications (3<sup>rd</sup> Ed.)*. Hoboken, NJ: John Wiley & Sons, Inc.
- [10] Gilat, A., & Subramaniam, V., (2008). *Numerical Methods for Engineers and Scientists: An Introduction with Applications Using MATLAB*. Danvers, MA: John Wiley & Sons, Inc.
- [11] Hahn, B.H. & Valentine, D.T., (2010). *Essential MATLAB for Engineers and Scientists (4<sup>th</sup> Ed.)*. Burlington, MA: Elsevier Ltd.
- [12] Cutlip, M.B., Shacham, M., (1999). *Problem Solving in Chemical Engineering with Numerical Methods*. Upper Saddle River, NJ: Prentice-Hall Inc.
- [13] Palm, W.J., (2011). *Introduction to MATLAB for Engineers (3<sup>rd</sup> Ed.)*. New York, New York: McGraw-Hill Companies, Inc.
- [14] Constantinides, A. & Mostoufi, N., (1999). *Numerical Methods for Chemical Engineers with MATLAB Applications*. Upper Saddle River, NJ: Prentice-Hall Inc.
- [15] Palm, William J., (2005). *Introduction to MATLAB 7 for Engineers*. New York, NY: McGraw-Hill Companies Inc.

### Assessment:

- Assignments – covering programming concepts, MATLAB, numerical methods and numerical methods applied to solve chemical engineering problems
- Labs – covering MATLAB programming skills
- Labs and assignments **MUST** be submitted through Learn. There will be two due dates for assignments/labs:
  - **First due date:** Assignment/Lab marked on a 100% basis.
  - **Second due date:** (Usually two days after the first due date) Assignment/Lab marked on a 70% basis.

Assignments/Labs submitted by e-mail or handed in after the second due date will not be accepted and will receive a zero mark.

- Quizzes –Pop or scheduled quizzes
- Midterm and Final exam
- **You must pass the Final Exam (50% at least) to pass this course.**

### Course Grading Breakdown:

5-7 Assignments:	10 %
10 Labs:	10 %
1-4 Quizzes:	5 %
Midterm:	25 %
Final:	50%
<b>Total</b>	<b>100%</b>

### Important Dates:

Midterm Exam: TBA.

Final Exam: 2.5 hr, dates and location TBA

Thanksgiving: Monday Oct 8<sup>th</sup>, 2012

Final Day of Lectures: Dec 3<sup>th</sup>, 2012

### Preliminary Lab Schedule:

Lab	Subject
0	MATLAB Basic features
1	Introduction to MATLAB
2	Scripts and functions in MATLAB
3	Execution control in MATLAB
4	Midterm review in MATLAB
5	2D and 3D Plots in MATLAB
6	Output Formats in MATLAB
7	Advanced programming in MATLAB
8	Applied num. methods in MATLAB I
9	Applied num. methods in MATLAB II
10	Applied num. methods in MATLAB III

## **Course Topics:**

### **Part I.- Introduction to Engineering Computation.**

1. Programming Fundamentals.
  - Flow Charts and Pseudocode
  - Sequential Processing (order of precedence, arithmetic operations)
  - Comparison Operators and Boolean Expressions
  - Selection Structures (if-end, if-else-end, if-elseif-else-end)
  - Repetition Structures (for, while)

### **Part II.- MATLAB.**

2. Introduction to MATLAB
  - The MATLAB Interactive Environment
  - Arrays and Matrix Operations in MATLAB
  - Built-in Functions available in MATLAB
  - Plotting and Graphing
3. MATLAB programming
  - User-Defined Functions in MATLAB
  - User-controlled input and output
  - Logical functions and control structures in MATLAB
  - Additional methods to store data in MATLAB

### **Part III.- MATLAB Applications**

4. Elementary Numerical Methods.
  - Round off and truncation errors
  - Taylor Series Expansion
  - Solution of a nonlinear algebraic equation: Bracketing and open methods
  - Solution of a set of linear and nonlinear algebraic equations
  - Linear and nonlinear regression, curve fitting
  - Interpolation
  - Numerical Integration

## **Classroom Responsibilities:**

<https://uwaterloo.ca/engineering/current-undergraduate-students/academic-support/course-responsibilities>

## **Academic Integrity, Grievance, Discipline, Appeals and Note for Students with Disabilities:** see [www.uwaterloo.ca/accountability/documents/courseoutlinestmts.pdf](http://www.uwaterloo.ca/accountability/documents/courseoutlinestmts.pdf)

The text for this web site is listed below:

### **Institutional-required statements for undergraduate course outlines approved by Senate Undergraduate Council, April 14, 2009**

**Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/) for more information.]

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, <http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm>. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

**Discipline:** A student is expected to know what constitutes academic integrity to avoid committing academic offenses and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline, <http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm>. For typical penalties check Guidelines for the Assessment of Penalties, <http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm>.

**Appeals:** A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals, <http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm>.

**Note for students with disabilities:** The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

Level of Complexity

## Numerical Methods In Engineering

- Error + Taylor Series Expansion
- Roots in Engineering
- Linear and Nonlinear System of Equations
- Linear and Nonlinear Regression
- Interpolation Techniques
- Numerical Integration

## MATLAB Programming

Execution Control Statements

Local & Global Variables

Built-in Functions

## Introduction to MATLAB

MATLAB  
Environment

Basic Data  
Manipulation

Arrays/  
Matrices

Built-in  
Functions

2D and  
3D plots

Basic Scripts &  
Functions

## Programming Fundamentals

- Algorithms
- Basic Control Structures
- Comparison Operators &  
Boolean Expressions