ECE 3340 Numerical Methods

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Office Hours: TR 10:00am – 11:30am

Description
This course is an introduction to numerical analysis with an emphasis on practical applications, implementation, and algorithm design. The primary objective of this course is to gain an understanding of the algorithms and pitfalls encountered when performing numerical operations on computational systems. The secondary objective is to gain practical programming experience with C/C++ and Matlab, including algorithm design and the proper understanding and use of available numerical algorithms.

Expected Course Outcomes
Students who successfully complete this course are expected to meet the following course outcomes:

1. Students should be able to apply basic numerical techniques to the solution of mathematical problems:
    a. representation of functions by Taylor polynomials
    b. calculate roots of equations
    c. perform interpolation, integration, differentiation
    d. solve linear systems and initial value problems
2. Students should understand the advantages/disadvantages of alternative numerical algorithms.
3. Students should recognize the importance of error estimates and be able to make simple estimates of truncation errors.
4. Students should be able to perform important matrix and vector operations
    a. solve systems of linear equations by Gaussian elimination and matrix inversion
    b. understand when each method is applicable and the nature of the results
    c. calculate eigenvalues and eigenvectors, and understand principal component analysis

Textbooks (recommended)
R.W. Hamming, *Numerical Methods for Scientists and Engineers*, Dover Publications, 1987
W. H. Press, et al., *Numerical Recipes: The Art of Scientific Computing*, Cambridge University Press, 2007

Prerequisites
ECE 3331 – Programming Applications in ECE
MATH 3321 – Engineering Mathematics
General – Matlab, C/C++, Differential Equations, Linear Algebra

Grading

5%	Homework Assignments
25%	Programming Projects
20%	Mid-Term Exam 1
20%	Mid-Term Exam 2
30%	Final Exam

Grade Point Scale:

A = 93-100	A- = 90-92	
B+ = 87-89	B = 83-86	B- = 80-82
C+ = 77-79	C = 73-76	C- = 70-72
D+ = 67-69	D = 63-66	D- = 60-62
F < 60		

(Thresholds may be **lowered** at my discretion.)

Topics

1. **Preliminaries of Computing**
   a) binary numbers
   b) quantization errors, floating-point
   c) algorithmic complexity
2. **Evaluating Functions**
   a) Taylor series
   b) reformulation and expansions
   c) calculating zeros of functions
3. **Linear Equations**
   a) Gaussian elimination, inversion
   b) rank
   c) ill-conditioned problems
4. **Random numbers**
   a) generating numbers and noise
   b) Monte-Carlo methods
5. **Numerical Integration**
   a) interpolation
   b) mid-point rule, Simpson's rule
   c) Gaussian quadrature
6. **Differential Equations**
   a) finite differences and gradients
   b) Euler's method
   c) Runge-Kutta methods
7. **Machine Learning (tentative)**
   a) Bayes rule, decision making
   b) dimension reduction, classification
   c) accuracy, confusion matrices, (ROC) curves

Programming Assignments (may be modified)

- Finding Real Roots (C/C++)
- Solving Linear Systems (C/C++)
- Monte-Carlo Methods (C/C++)
- Gravity assistance and The Kessel Run (Matlab)

Homework

There will be regular homework assignments, which will be collected, checked for completion, and randomly graded. Failure to do the work will result in your assignments being selected for more frequent grading. These homework assignments will be based on material from the book or your own notes. Students are encouraged to work together on the homework assignments, however I expect you to turn in actual (not copied) work. **Answers to homework assignments must be legible (typing is preferred) and include your name and the date it was assigned in the upper-left corner. Some assignments will require drawing figures, which should be done neatly by hand. No late homework will be accepted, because we will generally discuss the assignment in class on the due date. You may hand it in before the due date if you expect to be absent.**

Programming Projects

Programming projects must be written in the language specified (C/C++ or Matlab) and submitted in a single plain-text file via Blackboard. The naming convention will be specified in a handout for each assignment. C/C++ code will be compiled on Visual Studio, so make sure that your code works. Visual Studio is available in the computing lab and to all students through Microsoft DreamSpark. **Your grade will be based on how well the algorithm works and how well it is written (a rubric will be provided with the assignment). Programming projects may be turned in late for a penalty of 10% per day that it is past due.**

Examinations

Exam Schedule: Mid-term 1: **Sept. 24** | Mid-term 2: **Nov. 5** | Final Exam: **Dec. 10, 8am-11am**

Exams will be based on homework assignments, class notes, and my own notes. My slides and any relevant notes will be made available before the exam, providing at least one week for review.

Exams and quizzes are closed book, closed notes, unless otherwise announced. A crib sheet using both sides of a 5" by 8" note card will be allowed for each of the exams. All work must be done on the examination forms provided for that purpose. The seats for exams will be randomly assigned. All of these regulations are designed to reduce the possibility of cheating, so that all students will be graded as fairly as possible. **No makeup examinations will be given. If you have a medical emergency you should call your instructor as soon as possible, preferably before the examination. Medical documentation will be required in all such cases.**

Academic Honesty Policy

Students in this course are expected to follow the *Academic Honesty Policy* of the University of Houston. It is your responsibility to know and follow this policy. You must sign the Academic Honesty Statement on the last page of this handout, detach it, and submit it to your instructor by Wednesday, January 28, 2015. If you fail to do this, you may be dropped from the course. For more information, see the Academic Honesty section of the catalog, which is available on-line: http://www.uh.edu/academics/catalog/policies/academ-reg/academic-honesty/index.php

Religious Holy Days

Students whose religious beliefs prohibit class attendance on designated dates or attendance at scheduled exams may request an excused absence. To do this, you are **strongly encouraged** to request the excused absence, in writing, by Wednesday, February 11, 2015. Please submit this written request to your instructor to allow the instructor to make appropriate arrangements. For more information, see the *Student Handbook.*

Students with Disabilities

Students with recognized disabilities will be provided reasonable accommodations, appropriate to the course, upon documentation of the disability with a *Student Accommodation Form* from the *Center for Students with Disabilities*. To receive these accommodations, you must request the specific accommodations, by submitting them to the instructor in writing, by Wednesday, February 11, 2015. Students who fail to submit a written request will not be considered for accommodations. For more information, see the *Student Handbook*.