BME 113L
Introduction to Numerical Methods in Biomedical Engineering Spring 2014

Instructor:

Tim Yeh
BME 5.202C (office)
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Teaching Assistants:

Nishant Verma (Tuesday and Thursday labs; vnishant@utexas.edu), BME 5.108
Cong Liu (Wednesday and Friday labs; cong.liu@utexas.edu), BME 5.202R

Graders:

Allen Liu (ylliu@utexas.edu)
Austin Batson (abatson@utexas.edu)

Communication with the Instructor and Teaching Assistants:

If you have questions about course content or organization, you should post it to the discussion board on BlackBoard. Students are encouraged to answer each other's questions on the discussion board in addition to responses from the instructor and the TAs. Specific questions (*e.g.* a request to attend a different lab section) should be submitted by email to instructor while TAs should be copied.

Office Hours:

Instructor: TW 1-2pm: appointment must be made (*i.e.* please email to let me know that you are coming).
Nishant Verma: M 4-6pm
Cong Liu: W 4-6pm

Meeting Times and Locations:

Unique: 14520 (**Nishant Verma**)
Lecture: Monday 13:00 to 14:00, CLA 0.126
Laboratory: **Tuesday** 10:00 to 13:00, BME 3.312

Unique: 14525 (**Cong Liu**)
Lecture: Monday 13:00 to 14:00, CLA 0.126
Laboratory: **Wednesday** 10:00 to 13:00, BME 3.312

Unique: 14535 (**Nishant Verma**)
Lecture: Monday 13:00 to 14:00, CLA 0.126
Laboratory: **Thursday** 14:00 to 17:00, BME 3.312

Unique: 14530 (**Cong Liu**)
Lecture: Monday 13:00 to 14:00, CLA 0.126
Laboratory: **Friday** 13:00 to 16:00, BME 3.312

Prerequisites:

Biomedical Engineering 314, Electrical Engineering 319K, Mathematics 427K, and credit or registration for Biomedical Engineering 311 and 335.
In addition, the course will have the following requirements: desire to learn, common sense, being able to enjoy challenges, ability to work alone, curiosity, aptitude to modify and control sleep habits, and, finally, knowledge of programming.

Course Objectives:

The primary purpose of this course is to introduce some of the numerical methods often used in biomedical engineering. It is the secondary purpose of the course to strengthen students' programming skills.

Knowledge, skills and abilities that students will gain from this course: Ability to identify, implement, and

evaluate an appropriate numerical method for a given problem in biomedical engineering. This include the ability to quantitatively specify a biomedical problem, choose the most suitable method from among several alternatives, and to implement the selected method in a specified programming language.

Course Description:

This course introduces principles and techniques of numerical analysis of biomedical engineering problems. The main objective of this course is to expose you to principles and approaches in numerical modeling of biomedical engineering problems. Broadly, the course will cover numerical methods of integration, differentiation, interpolation, curve fitting, data analysis, sampling and estimation, error analysis, analysis of ordinary differential equations, symbolic computation, and scientific visualization.

The course will be divided into 6 modules (12 laboratories).

Module 1: Modeling, Computers, and Error Analysis
Introduction to programing (MATLAB) Round-off & truncation errors
Module 2: Roots
Bracketing Methods Open Methods
Module 3: Linear Systems
Linear Algebraic Equations, Matrix Algebra, Gauss Estimation
Iterative Methods Eigenvalues
Module 4: Curve Fitting
Linear Regression
General Linear Least-Squares and Nonlinear Regression Polynomial Interpolation
Module 5: Integration and Differentiation
Numerical Integration Formulas Numerical Integration of Functions Numerical Differentiation
Module 6: Ordinary Differential Equations Initial-Value Problems Boundary-Value Problems

For each module, the following approach is used: 1) formulate the problem; 2) analyze possible approaches and select specific approach; 3) develop an algorithm/solution; 4) obtain and analyze the results, sources of "noise and artifacts"; 5) discuss the findings.

Overall, fundamental similarities between various numerical approaches will be stressed, and vital differences will be discussed.

Textbooks

Required:

Steven C. Chapra: Applied Numerical Methods with MATLAB for Engineers and Scientists, 3rd Edition, McGraw Hill, 2011.
Lecture notes and other materials available through the BlackBoard.

Supplemental/Optional:

Mathworks website (http://www.mathworks.com/)
MATLAB documentation http://www.mathworks.com/help/techdoc/

Teaching Approach:

The students will attend one lecture (1 hour) and one laboratory session (3 hours) per week. There will be reading and laboratory assignments every week.

Attendance Policy:

Attendance is required for lectures and laboratory sessions. Attendance of the laboratory session will affect the grading for the assignments (there will be a sign-in sheet for each lab session)!

Lab Assignments:

Laboratory assignments are due on your next lab session day at 8:59 am. For instance, if you come to the Tuesday lab session, your weekly assignment is due next Tuesday at 8:59 am. No late assignments will be accepted unless a documented emergency or excused absence in accordance with the policies of the University of Texas. Submitted laboratory modules should be your own work, but general methods may be discussed with other students.

Grading & Evaluation

The course grade will be determined by laboratory sessions (12 · 3.5 = 42%), in-class quizzes (8 · 1 = 8%), three mid-term examination (16%+17%+17%=50%), and final examination (see below).

Lab Modules:

Each lab (weekly) will be graded, all labs are graded equally.

Re-grade Requests:

Re-grade requests have to be filed with the instructor within 7 days of the return of the laboratory assignment or examinations. The re-grade request should be in writing with an explanation that addresses the error in the grading. Requests that do not address an error will not be considered.

Mid-Term Examinations:

The in-class written comprehensive mid-term examinations will cover the corresponding topics (see schedule).

Final Examination:

The written comprehensive final examination will cover all of the topics. Students that performed exceptionally well during the semester as determined by their laboratory grades and mid-term examinations, may be exempt from the final examination.

Final Grade:

Final letter grades will be assigned as:

90% ≤ **A**; 80 ≤ **B** ≤ 89%; 70 ≤ **C** ≤ 79%; 60 ≤ **D** ≤ 69%; **F** < 60%

Should the median of the class prove to be less than 80%, the grades will be curved. In the curve calculation, "M" stands for the median score of the class and SD is the standard deviation of the class.

M + SD ≤ **A**; M ≤ **B** < M + SD; M - SD ≤ **C** < M; M - 2*SD ≤ **D** < M - SD; **F** < M - 2*SD

Please notice that a curve cannot "hurt" you in the sense that your grade cannot be lower when a curve is applied than when it isn't.

Individual assessments are not curved. For example, there is no curve on a lab module. If a curve is applied, it is only to the *total* score at the *end* of the semester.

Class Web site:

All materials for the class will be distributed electronically via Blackboard (http://courses.utexas.edu) You will be responsible for checking the Blackboard course site regularly for class work and announcements.

Use of E-mail

In this course e-mail will be used as a means of communication with students. You will be responsible for checking your e-mail regularly for class work and announcements.

All students should become familiar with the University's official e-mail student notification policy. It is the student's responsibility to keep the University informed as to changes in his or her e-mail address. Students are expected to check e-mail on a frequent and regular basis in order to stay current with University-related communications, recognizing that certain communications may be time-critical. It is recommended that e-mail be checked daily, but at a minimum, twice per week. The complete text of this policy and instructions for updating your e-mail address are available at http://www.utexas.edu/its/policies/emailnotify.html

Academic Integrity

Each student must be vigilant of Academic Integrity at all times. The University of Texas at Austin Honor Code states:

The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

Academic dishonesty will not be tolerated and will be dealt with in as severe a manner as possible. Standards for Academic Integrity at UT Austin are detailed at http://deanofstudents.utexas.edu/sjs/acint_student.php

ABET Criteria:

The UT BME Department continuously documents progress in successfully achieving the Department's program outcomes for the "Accreditation Board for Engineering and Technology" (ABET). For more information on ABET go to: http://www.abet.org/.

ABET requires accredited BME programs to demonstrate that students gain:

(1) An understanding of biology and physiology.
(2) The ability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve problems at the interface of engineering and biology.
(3) The ability to make measurements on, and interpret data from living systems addressing the problems associated with the interaction between living and non-living materials and systems.

The UT BME department has defined the following seven program outcomes (POs) that every undergraduate student awarded a degree will be able to:

(1) Apply knowledge of biological and physical sciences, mathematics, and engineering to solve problems at the interface of engineering and biology.
(2) Design and conduct experiments and analyze and interpret data to support the understanding of biological systems and processes.
(3) Design a biomedical engineering system, component and/or process that meets specific needs, and demonstrate understanding of relevant technical professional and ethical issues.
(4) Function on multi-disciplinary teams.
(5) Communicate effectively in verbal, written, and graphical format.
(6) Identify, formulate, and solve biomedical engineering problems that address contemporary issues within a global, societal, and economic context.
(7) Recognize the need to pursue continuing educational opportunities in biomedical engineering and have the ability to do so.

The Program Outcomes (POs) for BME 113L are:

e) An ability to identify, formulate, and solve engineering problems
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

These two POs will be identified in assignments during the semester.

Notice for Students with Disabilities

Students with disabilities who require special accommodations need to get a letter that documents the disability from the Services for Students with Disabilities area of the Office of the Dean of Students (471-6259 voice or 471-4641 TTY for users who are deaf or hard of hearing). This letter should be presented to the instructor at the beginning of the semester and accommodations needed should be discussed at that time. Five business days before an exam the student should remind the instructor of any testing accommodations that will be needed. See websites below for more information:

http://deanofstudents.utexas.edu/ssd/providing.php
http://www.utexas.edu/diversity/ddce/ssd/

Accommodations for Religious Holidays

By UT Austin policy, you must notify the instructor of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a lab assignment, or a project in order to observe a religious holy day, you will be given an opportunity to complete the missed work within a reasonable time after the absence.

Date	Topic	Laboratory	Reading	Notes
13-Jan	Introduction	Lab #1	Ch. 1-3	
20-Jan	Round-off and truncation errors	Lab #2	Ch. 4	No lecture on 1/20
27-Jan	Roots of equations: bracketing methods	Lab #3	Ch. 5	
3-Feb	Roots of equations: open methods	Lab #4	Ch. 6	TA will give the lecture on 2/3
10-Feb	Linear algebraic equations, matrix algebra, Gauss estimation	Lab #5	Ch. 8-9	
17-Feb	**Mid-term exam #I**	No lab	**Exam #1 will cover Ch. 4-6 and 8-9**	
24-Feb	Iterative methods	Lab #6	Ch. 12	Exam results posted on 2/24
3-Mar	Eigenvalues	Lab #7	Ch. 13	
10-Mar	**Spring Break**			
17-Mar	Linear/nonlinear regressions and least-squares	Lab #8	Ch. 14-15	
24-Mar	Polynomial interpolation	Lab #9	Ch. 17	
31-Mar	**Mid-term exam #2**	No lab	**Exam #2 will cover Ch. 12-13, 14-15, 17**	
7-Apr	Numerical integration	Lab #10	Ch. 19-20	Exam results posted on 4/7
14-Apr	Numerical differentiation	Lab #11	Ch. 21	
21-Apr	Ordinary differential equations	Lab #12	Ch. 22 and 24	
28-Apr	**Mid-term exam #3**	No lab	**Exam #3 will cover Ch. 19-22 and 24**	Exam results posted on 5/3
TBD	**Final Examination**			