BIOE 391
NUMERICAL METHODS
9:00 - 9:50 am MWF

INSTRUCTOR

Lucas G. Camargo
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Teaching Assistants

See contact information on Canvas

COURSE OBJECTIVES AND OUTCOMES

Course objectives: Students should learn:

1. To state and apply several different numerical approximation techniques to bioengineering systems.
2. To solve open-ended engineering problems including engineering evaluation and mathematical modeling.
3. To work collaboratively on a group environment and elaborate a scientific review paper.
4. To recognize the complex contemporary issues faced by bioengineers and the ethical responsibilities required of bioengineers.
5. The course is designed to meet ABET engineering accreditation requirements.

Course outcomes: Students completing the course should be able to:

1. Introduction to numerical approximation techniques with bioengineering applications. and partial differential equations. Matlab and other software will be used for solving equations.
2. Stablish the error propagation of systems and identify main components of these.
3. Compute the Taylor's Series expansions for a given dataset for curve fitting.
4. Calculate the roots of equations for different types of systems and using different methods.
5. Evauate the numerical differentiation and integration of experimental values and utilize optimization procedures.
6. Solve ordinary differential equations with several different numerical methods, including Euler and Runge-Kutta methods.
7. Assess the solutions for partial differential equations utilizing methods such as finite-element methods.
8. Implement knowledge of MATLAB and other software to apply the different numerical methods learned and extend knowledge of the software.
9. Mathematically model a physiological system using engineering principles and comprehend the methods required to solve it.
10. Work collaboratively on an engineering team environment.
11. As a member of a team, collaborate on writing a review paper of a bioengineering application of a numerical method.
12. Demonstrate an understanding of the ethical and professional responsibilities of engineers.

COURSE ASSIGNMENTS

Homework

One homework problem set is assigned approximately every week. Homeworks will be due at 11:59pm via Canvas on the day it is due (please check the schedule on Canvas for the updated deadlines as the semester may require changes to the proposed schedule).

You will get two late homework passes – no penalty, no questions asked. You can use it for a one-day extension on two homeworks. All you must do is send the TA an email and let them know you will use your late homework pass before the deadline. This only applies to homework (exams and project deadlines do not qualify for homework pass extensions). Besides these, no other late homework will be accepted without explicit permission of the instructor before the homework is due. If accepted, the grades on these other late homeworks will be reduced 25% per day (including weekends). Illness and family emergencies will be dealt with on an individual basis – contact Lucas as soon as possible.

Solutions to homework problems will be made available in the course website. **You are not allowed to take pictures, copy, download or transcribe the solutions in any format**. Individuals turning in late homeworks are expected to not consult the posted homework solutions (Honor Code). Students may not consult homework from previous years (Honor Code).

Quizzes

To encourage reading ahead of class and review of previous class materials, there will be periodic Canvas-embedded quizzes based on assigned readings. Quizzes are an individual effort only and must be completed by 9AM of due date (before class). Two lowest quiz grades will be dropped.

This course builds upon what you learned in CAAM 210 (Intro to Engineering Computation with MATLAB) and MATH 211/212 (Ordinary Differential Equations/Multivariable Calculus). MATLAB refresher information will be posted on canvas for you to study at your leisure.

Exams

There will be three mid-term exams and a final exam. For each mid-term there will be up to two parts – one part in person limited-time, closed book part to test your understanding of the lecture material to be given in the evening (6-10pm); and an open-book untimed programming part. You will be allowed one handwritten letter page of notes (front and back). The other possible part will be a take-home exam, which involves MATLAB programming and will be posted online and to be taken over a week-long period. These will be graded on a 60/40 proportion, respectively.

All students are required to complete all exams, unless previously authorized by Lucas. The instructor retains the right to fail a student who does not complete an exam or a make-up exam.

Group Project

Students will write a review paper on the application of numerical methods to a real-world bioengineering or biomedical problem. Students will work in teams chosen early in the semester.

Grading Policy - The final grade will be based on the following.

- Quizzes 10%
- Homework 20%
- Project 20%
- Midterm exams 30%
- Final exam 20%

Final Course Grades (A, B, etc.) are based your average numerical grade, and is dependent on how the class in general is going to decide the grade breaking points, but the letter grade distribution will not be higher than A=92-100, A-=90-91, B+=88-89, B=82-87, B-=80-81, etc., Pass = 60 and above. Thus, all students have a chance to get an A on this class; you are not competing against one another. At the end of the semester, grades will be rounded-up based on student's performance. Depending upon the class average there may be a curve, but this is not guaranteed. Top 2-3 students in the class (or everyone with enough extra credit to be above 100) will get A+.

If you believe that your work has not be graded correctly or fairly, you must submit a written explanation to Lucas and the course TA within seven days of when the work was graded and returned. No late regrade requests will be accepted. A regrade request may lead to a regrade of your entire work and may result in a lower grade.

COURSE ADMINISTRATION

Attendance

Class time will be used in a variety of ways, including lectures, active learning and problem solving, and attendance is required. Please do not be late, as class will start at 9am. If you must miss a class for any reason, you are responsible for reaching out to other students in the class and obtaining any course material missed.

Participation

Students are expected to be actively engaged in and out of the classroom. Your participation in class benefits all students and creates a bertter learning environment. Please show up to class awake and ready to work. Cold calls might be implemented depending on participation levels.

Office Hours

Review sessions and office hours will be offered (check course schedule for additional information and Canvas for updated information). Please come to office hours prepared with questions and ready to work. TAs will be there to facilitate learning, not to provide you with answers to the homework.

Textbook

1. Applied Numerical Methods with MATLAB for Engineers and Scientists, 5th Edition by S.C.Chapra; McGraw-Hill Science/Engineering/Math
2. Numerical Methods for Engineers, 8th Edition by S.C. Chapra and Canale; McGraw-HillScience/Engineering/Math

Both texts are recommended, not required. If you are using a previous version of this book, check with a classmate to make sure you are answering the correct problem numbers for the homework.

MATLAB

Rice University has signed the MATLAB Total Academic Headcount (TAH) agreement with MathWorks to provide all our students, faculty, and staff with campus-wide access to MATLAB Additional Rice-owned computers should have MATLAB software installed on them if you have trouble with your own device. A device with MATLAB installed should be brought to all Friday lab sessions. Please talk to a TA if you are having trouble installing MATLAB.

Honor Code Policy

In this course, all students will be held to the standards of the Rice Honor Code, a code that you pledged to honor when you matriculated at this institution. If you are unfamiliar with the details of this code and how it is administered, you should consult the Honor System Handbook at http://honor.rice.edu/honor-system-handbook/. This handbook outlines the University's expectations for the integrity of your academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process.

Students are encouraged to talk to each other, the teaching assistants, the instructors, or anyone else about any assignment in the course that is not specifically designated as pledged. This assistance is limited to the discussion of the problem and perhaps setting up of a solution (never copying). Students must complete their own work. Students are not allowed to look at homework problems or solutions or exams from the courses taught in previous years.

Disability Support Services

If you have a documented disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Disability Support Services (Allen Center, Room 111 / adarice@rice.edu / x5841) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs. Any student with a disability requiring accommodations in this class is encouraged to contact the instructor.

Inclusive Classroom

This classroom is a place where everyone will be treated with respect. I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class. Please let me know if there is anything I can do to create a better learning environment for you.

Syllabus Change Policy

This syllabus is only a guide for the course and is subject to change with advanced notice.

Consent Language Used in Syllabi for Umbrella IRB Protocol FY2017-294:

This semester your instructor will be conducting a study looking at teaching and learning. The purpose of this study is to determine the factors that influence teaching effectiveness and learning. Your participation in this study will last for the duration of the current semester and will entail activities no different from the regular activities you would otherwise engage in as part of the course. If you would like more information, please do not hesitate to ask. If you would like to opt out of the study, please talk to me as soon as possible.

Day	Date	Topic	Quizzes - Reading	HW Assigned	HW/Exam Due
M	01/09	Syllabus day			
W	01/11	Introduction to Numerical Methods	Chapra Ch 1	Hw1	
F	01/13	MATLAB Session 1	Chapra Ch 2-3		
M	01/16	Holiday - No Class			
W	01/18	Roundoff and Truncation Errors	Chapra Ch 4		
F	01/20	MATLAB Session 2			
M	01/23	Numerical Differentiation	Chapra Ch 21	Hw2	Hw1
W	01/25	Roots: Bracketing Methods	Chapra Ch 5		
F	01/28	MATLAB Session 3			
M	01/30	Roots: Open Methods	Chapter 6	Hw3	Hw2
W	02/01	Optimization	Chapter 7		
F	02/03	**REVIEW / - Exam 1 -**		Exam 1 - TH	
M	02/06	Linear algebra review	Chapra Ch 8		Hw3
W	02/08	Linear algebra methods	Chapra Ch 9		
F	02/10	SPRING RECESS			
M	02/13	Linear algebra methods	Chapra Ch 10	Hw4	Exam 1 - TH
W	02/15	Linear algebra methods	Chapra Ch 11		
F	02/17	MATLAB Session 4			
M	02/20	Iterative methods	Chapra Ch 12	Hw5	Hw4
W	02/22	Eigenvalues	Chapra Ch 13		
F	02/24	MATLAB Session 5			
M	02/27	Linear Regression	Chapra Ch 14	Hw6	Hw5
W	03/01	Regression	Chapra Ch 15		
F	03/03	**REVIEW / - Exam 2 -**		Exam 2 - TH	
M	03/06	Fourier Analysis	Chapra Ch 16		Hw6
W	03/08	Interpolation	Chapra Ch 17		
F	03/10	MATLAB Session 6			Exam 2 - TH
M	03/13	SPRING BREAK			
W	03/15	SPRING BREAK			
F	03/17	SPRING BREAK			
M	03/20	Splines	Chapra Ch 18	Hw7	
W	03/23	Numerical integration formulas	Chapra Ch 19		
F	03/24	MATLAB Session 7			
M	03/27	Numerical integration functions	Chapra Ch 20	Hw8	Hw7
W	03/29	Ordinary DEs	Chapra Ch 21-22		
F	03/31	**REVIEW / - Exam 3 -**			
M	04/03	ODE, continued	Chapra Ch 23	Hw9	Hw8
W	04/05	ODE, continued	Chapra Ch 24		
F	04/07	MATLAB Session 8			
M	04/10	ODE: Boundary value prob and eigenvalues	C&C Ch 27-28	Hw10	Hw9
W	04/12	Partial Differential Equations	C&C Ch 29		
F	04/14	MATLAB Session 9			
M	04/17	PDEs	C&C Ch 30-31		Hw10
W	04/19	Other methods and Bioengineering Examples			
F	04/21	**FINAL REVIEW**			Project due
Final's week		**Final Exam**			