BMEN 5315 – Computational Methods in Biomedical Engineering
BMEN 4310 – Biomedical Modeling
Department of Biomedical Engineering
University of North Texas
Fall 2022

INSTRUCTOR

Fateme Esmailie, PhD
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Office Hours: Tu,Th, 2:30 – 3:45 pm (CT) (Office K240A)
Laboratory Sessions:
Wednesday 1:00 -3:50 pm (CT) Discovery Park K140
Thursday 11:30 am – 2:20 pm (CT) Discovery Park K140
Friday 11:30 am – 2:20 pm (CT) Discovery Park K140
Friday 02:30 – 5:20 pm (CT) Discovery Park K140

CLASS TA

Omar Cavazos, omar.cavazos@unt.edu

Office Hour: Tuesdays 2-3 pm (K240 TA room)

LECTURES

Percyval Seddoh, percyval.seddoh@unt.edu

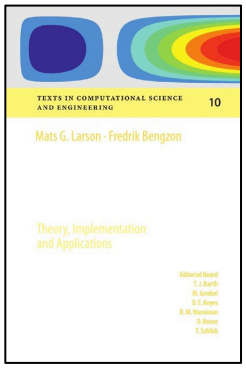
Office Hour: Mondays 12:30-1:30 pm (K240 TA room)

Tu/Th. 4:00 pm – 5:20 pm (CT)

TEXTS

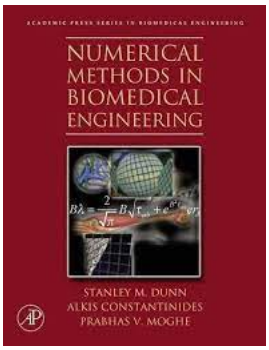
Required Text(book)s:

1. The Finite Element Method: Theory, Implementation, and Applications by Mats G. Larson, Fredrik Bengzon, DOI 10.1007/978-3-642-33287-6, ISBN (eBook) 978-3-642-33287-6. It is available for download on UNT university library (https://library.unt.edu/)



2. Class Notes/Lectures and Posted Reading Assignments will be important resources

3. Numerical Methods in Biomedical Engineering by Stanley Dunn, Alkis Constantinides, Prabhas Moghe, 1st Edition, eBook ISBN: 9780080470801, Hardcover ISBN: 9780121860318, Academic Press

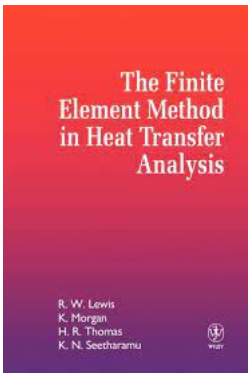


Picture from Google Books

4. V&V 20–2009, Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer, Publisher: ASME, Publish Date: 2009, ISBN: 9780791832097

Additional References:

5. The Finite Element Method in Heat Transfer Analysis by R. W. Lewis, K. Morgan, H. R. Thomas, K. N. Seetharamu, ISBN 047193424;0471943622, John Wiley & Sons Ltd



Picture from Google Books

6. V&V 40–2018, Assessing Credibility of Computational Modeling through Verification and Validation: Application to Medical Devices, Publisher: ASME, Publish Date: 2018, ISBN: 9780791872048

COURSE DESCRIPTION

Computational Methods in Biomedical Engineering (BMEN 5315) and Biomedical Modeling (BMEN 4310) is an introduction to equations and numerical analysis techniques important to the description of living systems and medical devices. In this course, we will focus on finite element modeling in 1D as one of the main numerical methods that is applied in biomedical computations. Assessing the credibility of computational modeling in medical devices and applications will be discussed in this course.

PREREQUISITES

BMEN 5315: Calculus, Linear Algebra, Transport Phenomena
BMEN 4310: BMEN 3321 and senior standing

COURSE GRADING METRICS

BMEN 4310

Final Composite Score to be Based On:	weighting
Homework	20%
Attendance	5%
Quizzes	15%
Mid-term Exam	20%
Final Exam	20%
Final Project	20%

BMEN 5315

Final Composite Score to be Based On:	weighting
Homework	20%
Attendance	5%
Quizzes	15%
Mid-term Exam	20%
Final Exam	20%
Final Project (Including Final Presentation)	20%

Letter Grade Cutoffs

Score	**Grade**
A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	< 60%

HOMEWORK

a) Homework assignments will be made for each week along with a due date.
b) All assignment sets should be scanned (use a smart phone app or a dedicated printer/copier/scanner) and uploaded to *Canvas*.
c) Homework must be turned in by 11:59 p.m. on the assignment due date to avoid a late penalty.
d) The late penalty is 10% per day. This penalty will be assessed unless there are extenuating circumstances (i.e. documented illness); however, homework may be submitted early. On a homework due date immediately preceding a test, no late homework will be accepted in order that solutions may be made available following the deadline.
e) Late homework will be accepted up to 48 hours following the original due date and time (Except for the homework before midterm and final exams). Weekends are not considered as part of the late period.
f) Homework solutions will be made available on the *Canvas* course site after the late period for an assignment set has expired.
g) Students are expected to work all assigned problems, check their solutions against the posted solutions, and rework problems if necessary.
h) Unofficial test and homework scores will be listed on the course *Canvas* site. It is the student's responsibility to check that scores have been properly recorded.
i) Requests for reviewing any graded work must be made by submitting a detailed request through *Canvas* within one week of the grade being posted.

EXAMS

a) One mid-term exams and a required comprehensive final exam are scheduled. All exam scores will be included in the final determination of grades.
b) In the event of a missed exam, students will be required to provide a valid explanation for the conflict and will be required to complete a make-up exam.

Please notify the instructor ASAP if you are unable to take an exam at the scheduled time.

c) The final exam will be comprehensive.

d) The midterm exam will be offered during the posted class meeting time 4:00 pm – 5:20 pm on dates indicated in the schedule. The final exam is scheduled for 1:30 – 03:30 pm on December 15, 2022.
https://registrar.unt.edu/exams/final-exam-schedule/fall

e) Exams format is open book/open notes. Exams will be in person.

f) Requests for reviewing any graded work should be made by submitting a detailed request through *Canvas* within one week of the exam grade being posted.

QUIZZES

A quiz is scheduled for each Thursday, except during weeks with Exams. Quizzes will be taken on *Canvas*. Each quiz will consist of multiple-choice questions. Each quiz will be available for 36 hours (12:01 pm Wednesday to 11:59 pm Thursday). A quiz must be completed during the allotted time (approximately 30 minutes) at one sitting. You will not be allowed to log in more than once for a quiz. The lowest quiz score will be discarded in the determination of final grades.

IMPORTANT DATES

Dec. 15 (Th) Final Exam (01:30 – 03:30 pm (CT))

BMEN 5315 only

Nov 29 (Tu) Final Presentation (4:00 pm – 5:20 pm (CT))
Dec 1 (Th) Final Presentation (4:00 pm – 5:20 pm (CT))

Final Project

Dec 08 (Th) Final Project Submission (11:59 pm (CT))

COURSE OBJECTIVES

At the completion of this course, students will be able to:

1. Identify and execute effective approaches to solving biomedical engineering problems and effectively communicate their solutions.
2. Gain an understanding of biomedical modeling
3. Understand the application of modeling to various biomedical engineering applications
4. Develop a knowledge of Finite Element modeling using Comsol and Matlab
5. Discuss the principles of quantitative approaches to modeling
6. Apply simulation techniques to design and evaluate a new medical device
7. Prove the credibility of numerical simulations using ASME Validation and Verification standards

ABET CRITERIA:

1. ABET OUTCOME 1: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. ABET OUTCOME 7: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

CLASS POLICIES

a) Students are responsible for all material provided in the recorded lectures and handouts.

b) All work (homework, quizzes, and tests) submitted for grading should represent your individual effort. However, studying and working with your peers (on outside class assignments) is not only acceptable, but greatly encouraged. Study groups can provide an extremely valuable resource to students, and you are encouraged to join one.

c) Submitting work from others (fellow students, solutions manual, Chegg, etc.) will be considered academic misconduct. Plagiarism of ideas or work as well as giving or receiving unauthorized information on examinations will be considered academic misconduct. All academic misconduct will be dealt with severely and may result in a course grade of E. Refer to the academic misconduct policy on the University of North Texas website. The definition of academic misconduct, including a list of examples, should be also be reviewed.

d) **Attendance**: **You MUST attend the class in person.** Please refer to the University attendance policy at https://policy.unt.edu/policy/06-039. There are a few exceptions that make you eligible to skip a class that are listed in the university policy (https://policy.unt.edu/sites/default/files/06.039%20Student%20Attendance%20and%20Authorized%20Absences.pdf)

RELEVANT POLICIES

https://clear.unt.edu/student-support-services-policies

COMMUNICATIONS

My email: Email is the preferred method of contact. Most emails will be answered within 48 hours. I will not respond to emails during the weekend and holidays.

Your email: Direct communications with students will be made via your university email address as compiled by the registrar. If your university email address is not checked frequently, you should update it and forward to your active email address through CIS. You may also want to set *Canvas* to notify you when items are posted to the course site.

Office hours: Office hours are blocks of time that are reserved for you. Please check office hours before making an email request for an appointment outside of office hours. Changes to office hours will be announced on *Canvas*.

CLASS WEB SITES

1) ***Canvas*:** All handouts (syllabus, homework assignments, homework and test solutions, etc.) will be distributed in pdf format at the course web site. Students must be registered with the *Canvas* course site by August 29th, 2022 to access the site throughout the semester. Electronic communication with all students will be made by a class email list compiled by the registrar, which is connected to *Canvas*. The *Canvas* gradebook is unofficial. Its purpose is to communicate all scores recorded for student work. It is your responsibility to verify that the correct scores have been recorded.

2) ***Zoom:*** Due to the limited space area, all lectures of the laboratory sessions will take place on *Zoom*, which is available on the Canvas class site. You must attend the lab sessions in-person, listen to the lecture and work on the assigned computer examples during the lab session.

INCLUSIVITY STATEMENT

My intent for this class is to create a space where students feel included, heard, and respected and that students' diverse identities and backgrounds are valued and viewed as an asset to our shared learning community. We all come to this course with unique life experiences, and there will be a diversity of perspectives in our discussions. This diversity is our strength as we strive to communicate and connect across differences and build an inclusive and equitable learning environment. If you have a conflict with a class or assignment and a religious/cultural/spiritual event, please notify me beforehand and we will make arrangements.

HOMEWORK GUIDELINES

The following format for homework is suggested as it provides the opportunity to systematically think about a problem before attempting the solution. The format consists of the following steps:

1. *Known:* After carefully reading the problem, state briefly and concisely what is known about the problem. Do not repeat the problem statement.
2. *Find:* State briefly and concisely what must be found.
3. *Schematic:* Draw a schematic of the physical system. If application of the conservation laws is anticipated, represent the required control surface by dashed lines on the schematic. Identify relevant heat transfer processes by appropriately labeled arrows on the schematic.
4. *Assumptions:* List all pertinent simplifying assumptions (if any).
5. *Properties:* Compile property values needed for subsequent calculations and identify the source from which they were obtained.
6. *Analysis:* Begin your analysis by applying appropriate conservation laws, and introduce rate equations as needed. Develop the analysis as completely as possible before substituting numerical values. Perform calculations needed to obtain the desired results.
7. *Comments:* Discuss briefly your results. Such a discussion may include a summary to key conclusions, an inference of trends, and a critique of the original assumptions.
8. *Computer Solutions:* If a computer solution is developed, be sure a copy of the program is included in addition to the items above.

Other points to keep in mind as you prepare your homework include:

1. On each page, use a heading that includes: your name, problem number, due date, and page number.
2. Use brief comments - in good English - to make your thinking clear, to connect parts of the problem, and to indicate where data and equations were obtained.
3. Clearly show all steps of the solution. Partial credit can only be considered if a sufficient amount of detail is provided.
4. Be sure your work is neat and readable. This will maximize your chances of receiving all the credit the work deserves.
5. Be sure units are correct, consistent, and clearly stated.
6. Show the appropriate number of significant figures.
7. Clearly identify the answer (box, arrow, etc.)
8. Use only one side of the paper.
9. Show only one problem solution per page.
10. Keep work inside the one-inch margin.

BMEN 5315 – Computational Methods in Biomedical Engineering / BMEN 4310 – Biomedical Modeling
Fall 2022 Schedule

Week	Class	Date	Day	Topics	Textbook	Sections	Homework		Quiz
							Number	Due (Class)	
1	1	**Aug** 30	Tu	Introduction	The Finite Element Method: Implementation, and Applications		0		
	2	**Sep** 1	Th	Piecewise Polynomial Approximation in 1D		1.1			0
2	3	6	Tu	Piecewise Polynomial Approximation in 1D		1.2	1		
	4	8	Th	Piecewise Polynomial Approximation in 1D		1.3 – 1.4			
3	5	13	Tu	Finite Element Method in 1D – Part 1		2.2.1 – 2.2.2	2	1	
	6	15	Th	Finite Element Method in 1D – Part 2		2.2.3 – 2.2.4			
4	7	20	Tu	Finite Element Method in 1D – Part 3		2.3	3	2	
	8	22	Th	Finite Element Method in 1D – Part 4		2.3			
5	9	27	Tu	Finite Element Method in 1D – Part 5		2.4	4	3	
	10	29	Th	Finite Element Method in 1D – Part 6		2.5	5	4	
6	11	**Oct** 04	Tu	*Review*		1 and 2		5*	
		06	Th	**Midterm Exam (Chapters 1, 2, 3)**					
7	12	11	Tu	Modeling Biosystems	Numerical Methods in Biomedical Engineering	1.1 – 1.4			
	13	13	Th	Linear and nonlinear Models of Biological Sys		4.1– 5.4			
8	14	18	Tu	Nonlinear Equations in Biomedical Engineering		5.4 – 5.8	6		
	15	20	Th	Dynamic Behavior- Finite Difference Methods		6.1- 6.5			1
9	16	25	Tu	Dynamic Behavior- Finite Difference Methods		6.6 – 6.11		6	
	17	27	Th	Dynamic Systems- ODEs		7.1 – 7.4	7		2
10	18	**Nov** 01	Tu	Dynamic Systems- ODEs		7.4 – 7.9		7	
	19	03	Th	Dynamic Systems- PDEs		8.14– 8.5	8		3
11	20	08	Tu	Dynamic Systems- PDEs		8.5		8	
	21	10	Th	Dynamic Systems- PDEs		8.5	9		4
12	22	15	Tu	Modeling Tools: Measurements, Models, and		9.1 – 9.5		9	
	23	17	Th	Modeling Tools: Measurements, Models, and		9.6 – 9.7			5
13	24	22	Tu	Modeling Biosystems: Applications		If we have time	10		
		24	Th	**Thanksgiving Break**					
14	25	29	Tu	Final Presentation				10	6
	26	**Dec** 01	Th	Final Presentation					
15	27	06	Tu	*Review*					
	28	08	Th	*Review*					
16		15	Th	**Final Exam (Comprehensive)**					

*No late homework is accepted