

THE UNIVERSITY OF TEXAS AT AUSTIN
Department of Biomedical Engineering
BME 311: Network Analysis in Biomedical Engineering
Fall 2023: 15490

Professor: Adam Bush, PhD

Office room #: BME 5.202J

Email: adambush@utexas.edu (include “BME 311” in the subject line of correspondence)

Web Page: Canvas, <http://canvas.utexas.edu>

Important Times and Locations

Class Period: M, W, F: 10am – 11am, JESSE H. JONES COMM. CTR. (BLDG. A) (CMA) 2.306

Office Hours: Tuesday and Wednesday 1 – 2 pm or by Appointment

Physio Laboratory: BME 1.338

Text: Fundamentals of Electric Circuits; Alexander and Sadiku; McGraw Hill, 7th edition

Purchasing the textbook and/or ebook should come with an online “Connect” software. Although the “Connect” software has many useful study materials, it is completely optional. We will discuss several options in class.

Teaching Assistant: Thien Nguyen, Office Hour, Monday 11am-noon, BME 5.202H, thientylera@utexas.edu

Learning Assistants:

1) Mrigayu Ghosh, Office Hour: TBD, mrigayu@utexas.edu

2) Siem Yonas, Office Hour: TBD, siemyonas@utexas.edu

Description: Basic concepts in analysis and design of electrical and cardiovascular circuits for biomedical engineering; Ohm's law, Kirchhoff's laws, and nodal and loop analysis; image based cardiac output quantification, Poiseuille's vascular resistance, Thevenin's and Norton's theorem; operational amplifiers; high-order circuit, windkessel modeling, and basic AC circuit analysis. This course is required for the BSBME degree.

Prerequisites: Physics 303K with a grade of at least C-; and credit with a grade of at least C- or registration for: Mathematics 427J or 427K, and Physics 303L. Offered on the letter-grade basis only.

Required Devices: Paper, pencil and personal computer that meets departmental requirement. Phone, tablet or computer for in-class participation.

Learning Outcome Objectives:

Develop an understanding of basic engineering abstractions on which analysis and design of electrical and cardiovascular biomedical circuits and systems are based, including basic circuit elements, network theory, lumped circuit models, and cardiovascular physiology.

Develop the capability to use abstractions to analyze and solve unknowns in simple electrical and cardiovascular circuits.

Develop the ability to build, formulate and solve the differential equations describing time variant behavior of electrical and cardiovascular circuits containing energy storage elements.

Develop the ability to describe, contrast and build electrical and cardiovascular circuit models in healthy and common cardiovascular diseases states.

ABET Student Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
3. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions
4. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

BME Program Criteria:

1. Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics; and
2. Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;
3. Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes.
4. Making measurements on and interpreting data from living systems.

Grading and Evaluation:

Letter Grades: 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 = 0-59

Your final grade will be composed of 4 item scores.

Items:

Item (Total Items)	% of Final Grade per Item (Total)
Midterm Exams (2)	25% (50%)
Final Exam (1)	25%
Homework/ Class Participation (1)	25%
Project (1)	25%

Each item is scored on a 100% scale. Each item is worth 25% of your final grade. Student will have the option to drop their lowest item score. Choose and plan wisely.

WARNING: Your total grade in Canvas does not always reflect your ACTUAL grade in the class based on this grading system. Keep that in mind when making decisions.

Exams: All exams will be taken in class on the exam date. All exams are closed book and only non-graphing calculators will be allowed. The use of an equation “hint-sheet” will be discussed in class. Given the drop policy, make-up test will rarely be offered and only in the most compelling circumstances. The Final exam will be cumulative. In the event that the exam class average is below 75%, the exam grades will be curved to 75%. Please note that a curve WILL NEVER “hurt” your grade in that your final letter grade cannot be lower when a curve is applied than when it isn’t. There is no pre- determined number of A’s, B’s, etc for this course.

Homework/Class Participation:

Homework/ Class Participation is divided into two categories. Homework is worth 80% and class participation is worth 20%.

Homework: Homework will be assigned each class period and collected during the next class session. Homework solutions will be given in/after class and the homework will not be graded but scored for completion in an all or nothing manner. For example, show up to class and turn anything in with your name on it to get maximum credit.

Class participation: Periodically, questions will be asked during class activities using the Kahoot question and answer system. The total number of responses will be divided by the class enrollment. That score will be shared amongst the entire class.

Bonus: Students will receive stickers for raising their hand and answering questions in class. Receiving a sticker will give you a 100% in the class participation score regardless of the daily class participation score.

Project: Individual and group projects will be used to re-enforce circuit principles and their applications in medicine and cardiovascular physiology. Projects will involve physiological measurements using non-invasive imaging on oneself and classmates and often require the use of MATLAB. Students will usually have a one week to complete individual, small scope projects collectively worth 50% of the project score. A larger scope group will be assigned before Thanksgiving worth the remaining 50% of the project score.

COVID and Sickness Policy: Students are encouraged not to attend class while ill. Notify Dr. Bush as soon as possible. Contact Dr. Bush before class and missed homework assignments during an excused illness will not be counted against your final homework grade. Any missed exams can either be counted as your dropped item OR replaced by your final exam grade.

Tentative Course Schedule

Week	Lecture Dates	Material	Book Chapter(s)
1	Mon 8/21	Syllabus; Charge, current, voltage, circuit elements	Ch 1.1-1.4
	Wed 8/23	Flex Day	
	Fri 8/25	Power, energy and circuit elements	1.5-1.6
2	Mon 8/28	Ohm's Law/ Topology	2.1-2.3
	Wed 8/30	Kirchhoff's Laws	2.3-2.4
	Fri 9/1	Cardiovascular: Basics, Cardiac Output, Stroke Volume	Canvas
3	Mon 9/4	Labor Day: No Class	
	Wed 9/6	Voltage Division Current Division	2.5-2.6
	Fri 9/8	Nodal Analysis	3.1-3.2
4	Mon 9/11	Super Node	3.1-3.3
	Wed 9/13	Mesh Analysis	3.4
	Fri 9/15	Mesh Analysis: Super Mesh	3.5-3.7
5	Mon 9/18	more practice	
	Wed 9/20	Cardiovascular: Pouiselle, Resistance Vessels	Canvas
	Fri 9/22	Cardiovascular: Pouiselle, Resistance Vessels	Canvas
6	Mon 9/25	More Practice	
	Wed 9/27	More Practice/ Review	
	Fri 9/29	Midterm 1	

7	Mon 10/2	Superposition/ Source Transform	4.1-4.4
	Wed 10/4	Thevenin's Theorem, Norton's Theorem	4.5, 4.6
	Fri 10/6	More Practice	
8	Mon 10/9	Op-Amps	5.1-5.2
	Wed 10/11	Op-Amps	5.3-5.7
	Fri 10/13	BMES TRAVELING: No Class	
9	Mon 10/16	Capacitors	6.1-6.2
	Wed 10/18	Capacitors: Series and Parallel	6.3
	Fri 10/20	Inductors	6.4-6.5
10	Mon 10/23	More Practice	
	Wed 10/25	Source Free: RC	7.1-7.2
	Fri 10/27	Source Free: RL	7.3
11	Mon 10/30	Step Response: RC and RL	7.5
	Wed 11/1	Step Response: RC and RL	7.6
	Fri 11/3	Cardiovascular: Windkessel	Canvas
12	Mon 11/6	Cardiovascular: Windkessel	Canvas
	Wed 11/8	Cardiovascular: Windkessel	Canvas
	Fri 11/10	More Practice	
13	Mon 11/13	Review	
	Wed 11/15	Midterm 2	
	Fri 11/17	Project	
14	Mon 11/20	Thanksgiving Week: No Class	
	Wed 11/22	Thanksgiving Week: No Class	
	Fri 11/24	Thanksgiving Week: No Class	
15	Mon 11/27	AC Circuit: Phasors	9.1-9.3
	Wed 11/29	AC Circuit: Circuit Elements	9.3-9.4
	Fri 12/1	AC Circuit: Steady State	10.1-10.2
16	Mon 12/4	More Practice, Review, Survey	
	TBD	Final Exam	

Disclaimer

Instructor reserves the right to modify course policies, the course schedule, and assignment/problem-set/exam point values and due dates.

Getting help:

If you have a question, please ask! Do not wait until the last minute. This class compound rapidly and it's easy to fall behind. Stay vigilant! I am available to answer questions during my office hours or by email (please use "BME 311" in subject line). Please, seek help from the TA/LA and attend study sessions. We are here for you.

Drop Policy:

The last day to drop this course without permission from the Dean is the 4th class day. After this day, drops are approved only in the case of health or personal problems. An engineering student should make an appointment with his/her departmental advisor to discuss adding or dropping any course if the change will alter the classes that were originally approved by the departmental advisor. If the add or drop requires the approval of the Dean, then the student will need to schedule an appointment with an Academic Advisor in the Office of Student Affairs to discuss the request. Additional information can be found at:

http://www.engr.utexas.edu/current/policies/pol_add-drop-wdraw.cfm

Academic Dishonesty:

Cheating will be dealt with in the **harshes**t possibly way, according to the policies established by the office of the Dean of Students.

Artificial Intelligence:

The creation of artificial intelligence tools for widespread use is an exciting innovation. These tools have both appropriate and inappropriate uses in classwork. The use of artificial intelligence tools (such as ChatGPT) in this class is permitted for students on homework and project assignment for students who wish to use them, provided the content generated by AI is properly cited. Using AI writing tools for unsanctioned assignments (exams, finals) or failing to properly cite AI even where permitted, shall constitute a violation of UT Austin's Institutional Rules on academic integrity.

Class Recordings:

Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

Regrade Policy:

If you want your Exam regraded, you must approach me within 1 week of getting your exam back. Please be aware that I will grade the entire exam again, meaning that you could lose or gain unintended points.

Religious Holy Days:

A student who misses classes or other required activities, including examinations, for the observance of a religious holy day should inform the instructor at least 14 days in advance of the absence so that arrangements can be made to complete an assignment within a reasonable period after the absence.

Students who have questions or concerns may contact the [Office for Inclusion and Equity](#)

Students with disability:

The university is committed to creating an accessible and inclusive learning environment consistent with university policy and federal and state law. Please let me know if you experience any barriers to learning so I can work with you to ensure you have equal opportunity to participate fully in this course. If you are a student with a disability, or think you may have a disability, and need accommodations please contact Disability and Access (D&A). Please refer to D&A's website for contact and more information: <https://diversity.utexas.edu/disability/>. If you are already registered with D&A, please deliver your Accommodation Letter to me as early as possible in the semester so we can discuss your approved accommodations and needs in this course.

Classroom Evacuation for Students:

All occupants of university buildings are required to evacuate a building when a fire alarm and/ or an official announcement is made indicating a potentially dangerous situation within the building. Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building. If you require assistance in evacuation, inform your instructor in writing during the first week of class. For evacuation in your classroom or building:

1. Follow the instructions of faculty and teaching staff.
2. Exit in an orderly fashion and assemble outside.
3. Do not re-enter a building unless given instructions by emergency personnel.

