BME 311 (14075): Network Analyses in Biomedical Engineering

Dr. Nina Telang

Fall 2016

General Information

Class Time	*MWF 9:00 am - 10:00 am, CPE 2.208*
Office	*BME 108B*
Contact	*telang@ece.utexas.edu*
Pre-requisites	*BME 303 (good fundamentals: MATH 427K and PHY 304L or 103N)*
Office Hrs	***WF 10-noon, BME 108B***
Website	*Canvas*
TAs, Grader	*Announced on Canvas site*

Catalog Description

Restricted to biomedical engineering majors. Basic concepts in circuit analysis and design of systems for biomedical engineering; Ohm's law, Kirchhoff's laws, and nodal and loop analysis; Thevenin's and Norton's theorem; operational amplifiers; high-order circuit and basic AC circuit analysis using Fourier and Laplace transforms.

Course objectives

1. an understanding of basic EE abstractions on which analysis and design of biomedical electrical and electronic circuits and systems are based, including basic circuit elements, lumped circuit, and operational amplifier.
2. the capability to use abstractions to analyze and design simple electronic circuits; the ability to formulate and solve the differential equations describing time behavior of circuits containing energy storage elements
3. the capability to design and construct circuits, take numerical simulations and experimental measurements of circuit behavior and performance, compare with predicted circuit models and explain discrepancies

The following subject areas will be covered in the lecture and homework material

Concepts of circuits, linear circuit elements; DC analysis of resistive circuits using Thévenin/Norton equivalents; nodal and loop analysis; operational amplifiers; capacitance and inductance; and network concepts of power and energy balance; the steady state sinusoidal analysis of linear network consisting of resistance (R), inductance (L) and capacitance (C); two-port and four-port representations of complicated networks; Laplace transforms; and computer-aided analysis and design.

Knowledge, abilities and skills you should have entering this course

Relation of linear differential equation to electrical, mechanical, and fluid flow (BME 314) Scientific computer programming and numerical methods (BME 303, MATH 427K) Properties of and governing equations for simple electrical components (PHY304L, PHY103N)

Knowledge, abilities and skills you will gain from this course

1. learn how to develop and employ circuit models for elementary electronic components, e.g. resistors, sources, inductors, capacitors
2. become adept at using various methods of circuit analysis, including simplified methods such as series-parallel reductions, voltage and current dividers, and the node method
3. appreciate the consequences of linearity, in particular the principle of superposition and Thevenin-Norton equivalent circuits
4. gain an intuitive understanding of the role of power flow and energy storage in electronic circuits
5. learn how to analyze simple first and second order linear circuits
6. learn how operational amplifiers are analyzed, and to design Op-Amp circuits to perform operations such as integration, differentiation and filtering on electronic signals
7. learn sinusoidal steady state analysis of first and second order systems
8. acquire experience in building and trouble-shooting simple electronic circuits using both numerical simulations and experimental characterizations; apply computer simulations for solution of complex networks

Text

Fundamentals of Electric Circuits; Alexander and Sadiku; McGraw Hill, 6th edition

Grading Criteria

Assignment	Percentage
Homeworks	20%
Pop-Quizzes/Classwork	15%
Two Mid-terms (20% each) Midterm 1: Midterm 2:	40%
Final Exam	25%

Homework

Weekly assignment: Problem sets will be assigned each Wednesday to ensure understanding of the presented material and assist students in preparing for exams. The homework is due online through Canvas by the following Wednesday 5PM. Late homework will not be accepted.

Pop-Quizzes/Classwork

Quizzes will be held on a regular basis during classtime to test the understanding of the covered material and the preparation. Attendance is mandatory.

Honor Code

Assignments, examinations must be the product of work performed exclusively by you. You may discuss problem sets in a group but your submission must be your own work. Allegations of Scholastic Dishonesty will be dealt with according to the procedures outlined in Appendix C, Chapter 11, of the General Information Bulletin, http://www.utexas.edu/student/registrar/catalogs/

Tentative Lecture Schedule

Week	Topics	Chapter
1	Course introduction Ch1: Concepts of circuits	Ch. 1
2	Ch2: Basic Laws - Ohm's Law and Kirchhoff's laws. Resistors topology, voltage and current division	Ch. 2
3	Ch2: Wye-Delta Transformations, Applications. Ch3: Circuit analysis fundamentals, Nodal analysis	Ch. 3
4	Ch3: Nodal/Mesh analysis Linear systems Linear systems: properties and applications	Ch. 3
5	Ch4: Circuit Theorems: Superposition, Source transformation, Thevenin's theorem, Norton's Theorem, Power transfer	Ch. 4
6	Operational amplifiers fundamentals, **Mid-term #1 (Chapters 1-4)**	Ch. 5
7	Inverting and noninverting amplifier Summing and difference amplifier Cascade Op Amp circuits	Ch. 5
8	Capacitors, Inductors	Ch. 6
9	Integrator, Differentiator, Analog Computer	Ch. 6
10	RC/RL circuits, Step response of First-order circuit	Ch. 7
11	Delay Circuits, Photoflash Unit, Relay Circuit and Automobile Ignition Circuit **Midterm #2 (Chapters 5-7)**	Ch. 7
12	**Part II AC Circuits** Sinusoids and phasors Impedance and admittance Sinusoidal steady-state analysis I Sinusoidal steady-state analysis II AC power analysis	Ch. 9-11
13	Frequency Response I Frequency Response II Laplace Transform (LT)	Ch. 14
14	**Part III Advanced Circuit Analysis** LT properties and applications Convolution and applications Transfer function of LT	Ch. 15-16

Week	Topics	Chapter
15/16	Applications of LT Fundamentals of Fourier Analysis Introduction to multi-ports network analysis	Ch. 17

Disclaimer

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

Class information on-line:
The on-line information for this course is available on the Canvas site: http://canvas.utexas.edu. In order to use this site you need your EID. Some things that will be available on this site:

- All lecture slides
- Homework assignments for the semester.
- Lab documents.

Web-based, password-protected class sites are associated with all academic courses taught at The University. Syllabi, handouts, assignments and other resources are types of information that will be available within these sites. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1. For information on restricting directory information see: http://www.utexas.edu/student/registrar/ferpa/ferpa.qs.faculty.htm

Getting help: If you have a question please ask! Do not wait till the last minute. **I am available to answer questions after class during my office hours**, or by email.

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 **not** be tolerated and will be dealt with according to the policy established by the office of the Dean of Students.

Students with disability: The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, or the College of Engineering Director of Students with Disabilities at 471-4321.

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.