BME 311 Network Analyses in Biomedical Engineering

Lecture Time: MWF 9-10am @ BUR 112
Prerequisite: BME 314, BME 303 (good fundamentals: MATH 427K and PHY 304L or 103N)

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Textbook:
Fundamentals of Electric Circuits bundled w/Netgrade CD;
Alexander and Sadiku;
McGraw Hill, ISBN: 0073643300

Reference:
Electric Circuits
Nilsson and Riedel
Addison-Wesley, ISBN 0-201-55707-x

Pspice student edition download: details in TA Pspice review session

Class URL: https://courses.utexas.edu (UT Blackboard Learning System)

Class email list: announcements will be sent out through Blackboard

Grading

Homework:	20%
Quiz:	10%
Midterm I, II:	30%
Mini Project:	10%
Final Exam:	30%

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 at beginning of class the following Wednesday. Late homework is not accepted.

Pspice and Matlab Questions

We will include one simulation question (either using Pspice or Matlab) in every homework. Students are encouraged to work as a team to discuss the problem. But each student should write his or her own solutions.

Quiz

Quizzes will be held on a regular basis (aim at Friday) during the class, to test the understanding of the covered material and the preparation. There will be questions from reading assignment, and the lecture sessions.

What you will learn

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 Thevenin/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

Course syllabus

All topics listed in this handout will be covered in class. The schedule is subject to change and changes will be announced in class and on the web page. There may be additional times when attendance will be required, such as for examinations and presentations. The times for these meetings will be determined in class. Additional assignments may be made if deemed necessary by the instructor.

Week	Topic	Reading
1	**Part I DC Circuits** Review of matrix operations, complex numbers Introduction to Pspice Introduction to MATLAB	App. A/B/C
2	Course introduction Concepts of circuits Problem session	Ch. 1, 2
3	Ohm's Law and Kirchhoff's laws Resistors topology, voltage and current division Circuit analysis fundamentals, Nodal analysis	Ch. 3 (Quiz #1)
4	Nodal/Mesh analysis Linear systems Linear systems: properties and applications	Ch. 4
5	Thevenin's theorem Norton's Theorem, Power transfer Operational amplifiers fundamentals	Ch. 4 (Quiz #2)
6	Inverting and noninverting amplifier Summing and difference amplifier Cascade Op Amp circuits **Mid-term #1 (6-8pm)**	Ch. 5 (Quiz #3)
7	Examples of Op Amp analysis Microfab of Very Large Scale Integrated Circuits (VLSI) **Tour of UT NNIN Micro-Nanofab facilities**	Ch. 6
8	Capacitors Inductors RC circuit	Handout
9	**Spring break (no class)**	
10	RL circuit Step response of 1^{st} order circuit	Ch. 7

		(Quiz #4)
11	Second order circuit Serial and parallel RLC Step response	Ch. 8
12	General 2nd order system analysis **Midterm #2 (6-8 pm)** **Part II AC Circuits** Sinusoids and phasors Impedance and admittance	Ch. 9
13	Sinusoidal steady-state analysis I Sinusoidal steady-state analysis II AC power analysis	Ch. 10-13 (Quiz #5)
14	Frequency Response I Frequency Response II Laplace Transform (LT)	Ch. 14
15	**Part III Advanced Circuit Analysis** LT properties and applications Convolution and applications Transfer function of LT	Ch. 15-16 (Quiz #6)
16	Applications of LT Fundamentals of Fourier Analysis Introduction to multi-ports network analysis	Ch. 17-19 Mini-Project
17/18	**Review Sessions** **Final Exam (3 hours): date and location TBD**	