CASE SCHOOL OF ENGINEERING
Department of Electrical Engineering and Applied Physics
EEAP 243 and 244
Circuits, Signals and Systems Syllabus[1]
Spring Term 1993

Week 1	January 18th		
Mon (L)	HOLIDAY! NO CLASS!		
Tues(L)	Overview of course, voltage, current, power, energy concepts.	1.3, 1.4, 1.5, 1.6	
Weds(L)	Introduction to laboratory, scheduling, etc.		
Thurs(L)	Voltage and current sources, Ohm's Law, Kirchoff's Voltage Law.	2.1, 2.2, 2.3, 2.4	
Fri(L)	Circuit elements, terminal characteristics and their ideal behavior. Switches, ideal diodes, and ideal op-amps		Did inductor pretty thoroughly, simple capacitor. Applied ramps and pulses to inductors.
Fri(R)	Analysis of simple dc circuits, introduction to using PSpice; Quiz #1	2.5, PSpice 1.2	
HW 1	1.4, 1.5, 1.10, 1.11, 1.16, 1.25		
Lab 1	Using the digitizing oscilloscope.		

Week 2	January 25th		
Mon (L)	Kirchoff's current Law, simple equivalent circuits (Drill 2.6).	2.4, 2.5	
Tues(L)	Resistors in series and parallel, voltage divider, current divider, controlled sources, solving circuits with dependent sources.	3.1, 3.2, 3.3, 3.4	
Weds(L)	Terminal relationships for L and C, series and parallel combination of L and C. Real circuit elements. The physics of inductors and capacitors.	7.1, 7.2, 7.3	Finish inductors and capacitors.
Thurs(L)	Nodal voltage circuit analysis, computer analysis of circuits.	4.1, 4.2, 4.3, 4.4	Didn't do PSpice op-amp model.
Fri(L)	Sinusoidal sources, sinusoidal responses using sine or cosine terms in differential equations; introduction to operational amplifiers.	2.5, 6.1, 6.2	
Fri(R)	Analysis of multi-branch circuits with controlled sources.		
HW2	2.2, 2.3, 2.7, 2.8, 2.10, 2.14, 2.22, 3.1, 3.2, 3.3, 3.4, 3.8, 3.12, 3.18, 3.22, 7.3, 7.5, 7.13, 7.15		Also originally had 7.6, 7.14, 7.18, 7.27, 7.30
Lab 2	Kirchoff's Laws		
	Idea for computer project. Apply voltage waveforms to R, L, C's. How about computer analysis of the Wheatstone Bridge!!!!!!		

[1] L= lecture, R= recitation

Week 3	February 1		
Mon (L)	Quiz #2; finish node voltage method.		
Tues(L)	Mesh current techniques. Thevenin and Norton equivalent circuits.	4.6, 4.7, 4.8, 4.10	
Weds(L)	Superposition; Thevenin and Norton equivalent circuits..	4.13	
Thurs(L)	Problem examples; source transformations.	4.19	
Fri(L)	Superposition with controlled sources.		
Fri(R)	Analysis of op-amp circuits.		
HW3	4.1, 4.26, 4.32, 4.56, 4.58, 4.62, 6.1, 6.2, 6.4		
Lab 3	Thevenin and Norton equivalent circuits		

Week 4	February 8		
Mon (L)	Quiz #3		
Tues(L)	Op-amp circuits: the inverting amplifier	6.3	
Weds(L)	Replacing differential equations by algebraic equations.		
Thurs(L)	More op-amps: the non-inverting amplifier, summing amplifiers	6.4, 6.5	Didn't do difference amplifiers.
Fri(L)	More op-amps; emitter-follower.		
Fri(R)	Analysis of op-amp circuits.		
HW4	6.12, 6.14, 6.15, 6.22, 6.23, 6.34		Assigned 3.53 and 4.79 as PSpice problems.
Lab 4	Op-amp circuits.		

Week 5	February 15		
Mon (L)	Quiz #4 (all period)		
Tues(L)	Non-linear op-amp circuits: the comparator and Schmitt trigger; real op-amps: offset voltage, slew rate, bias currents	Not in Nilsson. Supplemental material.	
Weds(L)	Linear systems, linearity, response to complex sinusoids, real and imaginary parts, phasors.	10.1, 10.2, 10.3	
Thurs(L)	Professional Day — NO CLASS		
Fri(L)	Sinusoidal-steady-state response; impedance; passive and active circuit elements in the phasor domain.	10.5, 10.5, 10.7	
Fri(R)	Schmitt triggers; sinusoidal steady state.		
HW4	7.8, 7.12, 7.15, 7.16, 7.22, 10.1, 10.6, 10.11	Reading 379-409.	PSpice HW#1: 3.53, 4.79.
Lab 4	Op-amp circuits.		

Week 6	February 22		
Mon (L)	Quiz #5; PSpice analysis of oscillator and slew rate limiting.		
Tues(L)	Circuit analysis using impedance.	10.8, 10.9	
Weds(L)	Geometrical interpretation of phasors; phasors in the s-plane.	10.10	
Thurs(L)	R,L,C circuits with controlled sources. Translating coupled differential equations to algebraic equations in the s-domain	14.1, 14.2, 14.3	
Fri(L)	The Laplace transform, step and impulse functions	15.1, 15.2, 15.3	
Fri(R)	Solution of R,L,C circuits using phasors, analysis of the op amp integrator in the s-domain; introduction to MATLAB.		
HW5	10.15, 10.18, 10.23, 10.26, 10.31, 10.35, 10.37, 10.61, 10.62, 10.63, 10.66		Extra credit #1 10.45, 10.67.
Lab 5	Transients in RL and RC circuits.		

Week 7	March 1		
Mon (L)	Laplace transforms of common functions, properties of the Laplace transform, inverse Laplace transforms	15.4, 15.5, 15.7	Examples: P11-11,P11-43, AP11-1.
Tues(L)	Detailed solution of series RLC circuit to a unit step. PSpice simulation of solution.	16.3	
Weds(L)	Natural response of RL circuits.		
Thurs(L)	Detailed op-amp example, problem 16-51.		
Fri(L)			
Fri(R)	Reviewed op-amp problems for EEAP 243 Quiz.		
HW7	simple math: 15.7, 15.13; RLC circuits: 15.19, 15.20, 15.21, 15.22; partial fractions: 15.23, 15.25		
Lab 7			

Week 8	March 8		
Mon (L)			PSpice #2 problems due.
Tues(L)	Properties of Laplace tranforms, initial and final value theorem, transfer functions.	17.1, 17.2, 17.3	
Weds(L)	243 Exam #1		
Thurs(L)	Superposition, the convolution integral; examples 17.3 and 8.58.	17.4	
Fri(L)	Review of 243 Exam #1; natural response of RLC circuits.		
Fri(R)	Using DOS PSpice.		
HW8	15.30, 15.32, 16.6, 16.18, 16.31, 16.34, 16.52, 16.53		
Lab 8			

SPRING BREAK!!!

Week 12	April 12		
Mon (L)	Multiple diode circuits; diode circuit transfer characteristics		
Tues(L)	Zener diodes, Quiz #10: diodes		
Weds(L)	Fourier integral		
Thurs(L)	Enhancement MOSFETs: dc characteristics and load lines	9.1, 9.2	
Fri(L)			
Fri(R)	FET circuit analysis.		
HW11	Circuits: 9.1-1, 9.1-4, 9.1-7, 9.1-12, 9.1-18, 9.1-20; Fourier 18.12, 18.22, 18.23, 18.28, 18.29, 19.1, 19.14		
Lab 11			

Week 13	April 19		
Mon (L)	Quiz #11: MOSFETs and multiple diode circuits	9.2 depletion mode MOSFETs, JFETs; 11.1 simple amplifiers	
Tues(L)	Multiple diode problems; dc characteristics of depletion MOSFETs and JFETS		
Weds(L)			
Thurs(L)	FET amplifiers; small signal FET amplifiers.		
Fri(L)			
Fri(R)	FET biasing.		PSpice_HW4 due. Extra_Credit#4 due.
HW13	Circuits: 9.1-18 (repeat), 9.1-20 (repeat), 9.2-1 (depletion MOSFET biasing), 9.2-4 (JFET biasing), 9.2-6 (JFET biasing), 9.2-8 (simple amplifier analysis)		
Lab 13			

Week	April 26		
Mon (L)	Quiz #12 (extra credit)		
Tues(L)	Frequency and time response of FET amplifiers.		
Weds(L)			
Thurs(L)	Biasing and design considerations for FET amplifiers.		
Fri(L)			
Fri(R)	FET amplifier analysis.		
HW			
Lab			

Week	May 4		
Mon (L)	Quiz #13: FET circuits		Last day of classes.

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CASE

Case School of Engineering

Department of Electrical Engineering and Applied Physics
EEAP 244 Circuits, Signals and Systems
Spring Semester 1993

EEAP 244. ELECTRONIC CIRCUITS AND SYSTEMS (5). Concepts of active and passive circuits and their responses to dynamic signals. Introduction to devices and models. An introduction to linear circuit analysis including: models for circuit elements, Ohm's and Kirchoff's laws, nodal and loop analysis, linearity, superposition, source transformations, Thevenin's and Norton's theorems, capacitors and inductors, RL and RC circuits, RLC circuits, sinusoidal excitation, phasors, impedance, complex frequency, amplifier frequency response with Bode plots, filters, resonant circuits, two-port networks. Linearity, superposition, signals in time and frequency domain. Analysis of transient circuit behavior. Laplace and Fourier transforms. Feedback and stability, pole-zero concepts.
Prerequisites: MATH 224, EEAP 243 Concurrently, any programming course.

Goals: To introduce students to fundamental electrical engineering analysis of electrical and electronic systems. Previous courses were taught as discrete packages, i.e. electrical circuits, signals and systems, etc. The goal of this course is to show the fundamental interrelation of mathematical analysis and modeling with real world devices relevant to modern electrical engineers. Many homework and laboratory problems will be done on the computer using two commercial engineering analysis programs (MATLAB® and PSpice™) for assignments allowing the student more time to explore the nature of the analysis rather than the programming of the problem. Applications to real engineering problems will be emphasized. We are very interested in providing you with the best educational opportunities and this first offering of the pair of courses, EEAP 243 and 244 is an expression of this desire. You can help us and the students who will follow you by providing us with comments and suggestions throughout the course and not just at its end.

Textbook: We will use a specially prepared version of Electric Circuits, Fourth Edition by James W. Nilsson, Addison Wesley, 1993. Since the Nilsson book does not include any electronic devices such as diodes and transistors we will be using a specially prepared supplement covering this material from Electrical Engineering Concepts and Applications, 2nd edition by A. Bruce Carlson and David G. Glasser, Addison Wesley, 1990. These have been put together for you in a special package by Addison Wesley which is available at the CWRU bookstore.

You should buy for this course:
James W. Nilsson, Electric Circuits, Fourth Edition, Addison Wesley, 1993.
The Mathworks, Inc., The Student Edition of MATLAB™, Prentice-Hall, 1992.

Topics:

- electrical components and their terminal characteristics: resistors, capacitors, inductors, voltage sources, current sources
- Ohm's Law, Kirchoff's Laws
- mesh analysis of circuits, computer analysis of circuits, using PSpice™ to analyze circuits
- equivalent circuit models, Thevenin and Norton equivalent circuits
- operational amplifiers: equivalent circuits for analysis and real devices, non-linear op-amp circuits
- transients in RL and RC circuits
- complex numbers, phasor representation of signals, replacing differential equations by algebraic equations
- the s-domain, sinusoidal steady state
- resonant circuits
- the Laplace transform, step and impulse functions, transforms of common functions, mathematical properties of the Laplace transform, the inverse Laplace transform
- transfer functions, superposition and convolution
- transfer functions in the s-plane, poles and zeros, frequency response of systems
- using MATLAB™ to analyze systems
- physics of diodes, ideal and real diodes, diode circuits, zener diodes
- Fourier series, representation of periodic signals, the Fourier transform, Parseval's Theorem
- two-port equivalent circuits, transfer functions of two-port networks, interconnected two-port networks
- physics of Field Effect Transistors (FETs), enhancement and depletion MOSFETs, biasing FETs, FET circuit analysis
- FET amplifiers, small signal equivalent circuits, frequency and transient response, biasing and design considerations for FET amplifiers
- signal processing: bandwidth, modulation, filtering, distortion, frequency translation and modulation, sampled signals

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A special electronic mail address and a bulletin board for this course will be established on Freenet. How to use these facilities will be described in the course recitations.

SCHEDULING

EEAP 244 will meet Monday, Tuesday and Thursday beginning at 9:30 am in White 411. The Monday lecture will last until 10:20, the Tuesday and Thursday lectures will last until 10:45. There is a required recitation on Friday from 2:30-3:20. The Kern Lab computers will be available for students to do homework analysis and a version of Spice (called CAPFAST) supporting schematic capture (i.e. drawing the circuit on the computer screen) will be made available for student use. The laboratory will be open for student use from 6 a.m. to 1 a.m. each day. Access by ID card will be given.

GRADING

Your grade in EEAP 244 (you will receive a separate grade for EEAP 243) will be based upon your performance on:

- 20 % graded homework. Ordinary homework will be assigned, but not collected or graded. Solutions will be posted. You are responsible for this homework for the Friday quizzes. Special homework problems which require design or computer analysis will be assigned. These problems will be collected and graded.
- 60 % weekly in-class quizzes. A 15-20 minute quiz will be given at the beginning of every Friday recitation. Fifteen quizzes are anticipated. There will be no makeups. Your lowest quiz grade will be dropped.
- 20 % comprehensive final exam.

There is the possibility that the final may be replaced with an independent project. A final decision on this will be announced during the semester.

REFERENCES

There are many references on analog and digital electronic circuits which are currently available. They range from textbooks to cook books containing hundreds of circuits to perform specific functions. The following books are excellent examples of the books that are available:

A. Bruce Carlson and David G. Glasser, Electrical Engineering Concepts and Applications, 2nd Edition, Addison Wesley, 1990.

R. Chattergy, Spicey Circuits: Elements of Computer-Aided Circuit Analysis, CRC Press, 1992.

M. Ghausi, Electronic Devices and Circuits: Discrete and Integrated, Holt, Rinehart and Winston, 1985.

P. R. Gray and R. G. Meyer, Analysis and Design of Analog Integrated Circuits, 2nd Edition, Wiley, 1984.

M. Horenstein, Microelectronic Circuits and Devices, Prentice Hall, 1990. This is an excellent new textbook. It can be ordered through the bookstore.

P. Horowitz and W. Hill, The Art of Electronics, 2nd Edition, Cambridge University Press, 1989. This book is chock full of information about analog and digital circuits with lots of circuit examples.

D. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Third Edition, McGraw-Hill, 1989.

T. Thorpe, Computerized Circuit Analysis with Spice, John-Wiley, 1991.

P. Tuinenga, SPICE: A Guide to Circuit Simulation & Analysis Using PSpice®, Prentice-Hall, 1988.

Circuit Tutor™, an interactive computer program which exists for both the Mac and PC, by Burks Oakley II, Addison Wesley, publisher is a useful means of improving your skills at solving circuits .

Textbook:

ISBN 0-201-54987-5 James W. Nilsson, Electric Circuits, Fourth Edition , Addison Wesley, 1993.

ISBN 0-201-14229-8 A. Bruce Carlson and David G. Glasser, Electrical Engineering Concepts and Applications, 2nd edition , Addison Wesley, 1990.

The above have been put together for you in a special package by Addison Wesley which is available at the CWRU bookstore.

Laura Steele, Addison-Wesley, (614) 621-0801

ISBN 85600-5 The Mathworks, Inc., The Student Edition of MATLAB™, Prentice-Hall, 1992.

ISBN 85599-9 The Mathworks, Inc., The Student Edition of MATLAB™, Macintosh book/disk, Prentice-Hall, 1992.

ISBN 85597-3 The Mathworks, Inc., The Student Edition of MATLAB™, MS DOS 3.5" book/disk, Prentice-Hall, 1992.

ISBN 85598-1 The Mathworks, Inc., The Student Edition of MATLAB™, MS DOS 5.25" book/disk, Prentice-Hall, 1992.

* Added: Diodes, Triodes, Semiconductors, Bipolar and Field Effect Transistors, the modeling problems.

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