CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering
Department of Electrical Engineering and Computer Science

COURSE INFORMATION

ENGR 210: Introduction to Circuits and Instruments
Fall 2013

Lecture Schedule: MWF from 9:30 - 10:20 AM in Ford Auditorium.
Instructor: Prof. Frank Merat, Glennan 518, 368-4572 (flm@case.edu)
Office Hours: MW from 10:30-11:30

***Summary Description (as listed in the Bulletin)*:**

Modeling and circuit analysis of analog and digital circuits. Fundamental concepts in circuit analysis: voltage and current sources, Kirchhoff's Laws, Thevenin and Norton equivalent circuits, inductors capacitors, and transformers. Modeling sensors and amplifiers and measuring DC device characteristics. Characterization and measurement of time dependent waveforms. Transient behavior of circuits. Frequency dependent behavior of devices and amplifiers, frequency measurements. AC power and power measurements. ~~Noise in real electronic systems.~~ Electronic devices as switches. ~~Digital logic circuits. Introduction to computer interfaces. Analog/digital systems for measurement and control.*~~
Prerequisite: MATH 122. Co-requisite: PHYS 122.

*NOTE:
The above is the official catalog description. This course will not cover the crossed out topics: "Noise in real electronic systems. Digital logic circuits. Introduction to computer interfaces. Analog/digital systems for measurement and control."

***Required Textbook*:**
"Circuits, 2nd Edition," Fawwaz Ulaby and Michel Maharbiz, National Technology and Science Press, 2012, ISBN: **978-1-934891-19-3**

***Supplemental Lab Reference*:**
"Hands On Electronics: A Practical Introduction to Analog and Digital Circuits", Daniel Kaplan and Christopher White, Cambridge University Press, 2003, ISBN: **978-0-521-89351-0**. (Available on-line to CWRU students at
http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=2723)

Recitations

Non-required recitation sections are scheduled for Tuesdays (Homework) and Thursdays (Quiz Review) from approximately 6:15 PM to 8:00 PM in White 411. Due to a room conflict the Quiz Recitation on 9/12/13 will be held in an alternate location.

Flipped Classroom

Students will be responsible for watching assigned videos before each lecture and lab section. The Monday and Wednesday class periods will be principally devoted to student solution of typical circuits problems related to the video assignment. Problem solutions will be done by teams of 4 students. These students will be initially student selected but we may go to assigned teams. Student teams will present their solutions to the class and one randomly selected assignment per week will be selected for formal grading for extra credit (amount of extra credit will be announced later).

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Accommodations for Students with Disabilities

Academic accommodations are available to students with documented disabilities. In order to access the accommodations for which you may be qualified, please register with the office of Disability Resources (ESS, Sears 470). The staff there will verify your need for specific accommodations and provide you with a memo to inform me of your needs. Once you have received this memo, please contact me to discuss your needs. Please be aware that any needed accommodations cannot be implemented retroactively; therefore, timely notification of your needs is in your best interest.

Course Outcomes

Students completing ENGR 210 should be able to analyze:

1. DC behavior of circuits: independent and dependent sources, Ohm's Law, Kirchoff's Voltage Law, Kirchoff's Current Law, node voltage and mesh current methods, operational amplifiers
2. Linear properties of circuits: constant of proportionality (gain), Thevenin and Norton equivalent circuits, superposition, maximum power transfer
3. Time dependent behavior of first and second order circuits: capacitors and inductors, energy and power, ability to write and solve first and second order circuit differential equations, initial and final values, time constants
4. Frequency dependent behavior of RLC circuits: forced sinusoidal steady state response, phasors, frequency response, Bode plots

and should know

5. Laboratory techniques: how to use oscilloscopes and DMMs for circuit measurements, how to use laboratory power supplies and function generators, how to build a circuit from a schematic

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COURSE GRADING

Basis of Grades

Homework (***25 %***): Homework assignments will be posted on Wednesdays and due on the following Wednesday during lecture. Students may work together on homework assignments, but each student is responsible for his/her own work. Lowest two HW assignments will be dropped.*

Laboratory (***25 %***): The laboratory for ENGR 210 is located in the Sally & Larry Sears Design Laboratory (Glennan 313). Labs will be done in groups of two. *Students must attend regular lab sessions*, but labs may be completed during open lab hours. Lab reports, one per group, must be completed in a one-week period and turned in to the lab instructor at the beginning of the next regularly schedule lab period. The laboratory requires key card access and workstation accounts, which will be provided based on the class roster. Lowest two labs (Labs 1-11) will be dropped; Lab 12 cannot be dropped.*

Quizzes (***25 %***): 20 minute quizzes will be given at the beginning of the lecture on Friday mornings, and are based on the homework due on Wednesday. Quizzes are closed book, and students must work alone. Calculators are allowed and must be cleared of all programs and/or data before the quiz. Lowest two quizzes will be dropped.* Quizzes will be distributed beginning at 9:20 to ensure that everyone is seated in an orderly manner. Quizzes will end at 10:50 min. Extra quiz seating has been arranged in Rockefeller 304 and 306.

IMPORTANT: Anyone requiring special accommodations should contact Prof. Merat

*NOTE: The grading algorithm actually takes the 10 highest grades.

THERE IS NO MID-TERM EXAM!

Final Exam (***25 %***): The final exam will be given on the scheduled exam period. The exam is closed book (typically 10 problems), students must work alone, and calculators must be cleared of all programs and/or data before the exam.

GRADES:
will be computed as the weighted sum of normalized grades, i.e.,

$$Total\_pts = 25 \times \left(\frac{\sum hw}{total\_hw} \right) + 25 \times \left(\frac{\sum lab}{total\_lab} \right) + 25 \times \left(\frac{\sum quiz}{total\_quiz} \right) + 25 \times \left(\frac{\sum final}{100} \right)$$

A	Total_pts≥90
B	Total_pts≥80
C	Total_pts≥70
D	Total_pts≥60

Special Note:
A randomly selected team assignment from the Monday and Wednesday class will be collected and graded. This will be treated as extra credit. Details of this will be announced after class starts.

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COURSE POLICIES

Late Policy and Missed Assignments

LABS — Labs are due no later than 15 minutes after the lab section starts. You will lose 10% per day for late labs unless arrangements are made with your lab TA.

HOMEWORK — Homework is due at the beginning of class on the assigned due date. Homework received after the beginning of class will not be accepted or graded.

QUIZZES — There will be no make-ups for missing individual quizzes.

HOMEWORK AND QUIZ MAKEUP: Special makeup homework and quizzes will be available at multiple times during the semester for those having reasonable absences that are consistent with university policy. You must receive permission in advance from Prof. Merat for makeup homework and quizzes.

FINAL EXAM — As per University policy, the Final Exam is absolutely required. Excused absences must be approved by the Office of Undergraduate Studies.

NOTE: The function of dropping your lowest labs, homework and quizzes is not to improve your grade but to allow for the many expected and reasonable absences in a class of this size.

CWRU Student Ethics Policy

http://studentaffairs.case.edu/ai/policy.html
Violations of the Student Ethics Policy will be dealt with by failure in the assignment in question, failure in the course, or referral to the academic integrity board as per university policy.

All forms of academic dishonesty including cheating, plagiarism, misrepresentation, and obstruction are violations of academic integrity standards. Cheating includes copying from another's work, falsifying problem solutions or laboratory reports, or using unauthorized sources, notes or computer programs. Plagiarism includes the presentation, without proper attribution, of another's words or ideas from printed or electronic sources. It is also plagiarism to submit, without the instructor's consent, an assignment in one class previously submitted in another. Misrepresentation includes forgery of official academic documents, the presentation of altered or falsified documents or testimony to a university office or official, taking an exam for another student, or lying about personal circumstances to postpone tests or assignments. Obstruction occurs when a student engages in unreasonable conduct that interferes with another's ability to conduct scholarly activity. Destroying a student's computer file, stealing a student's notebook, and stealing a book on reserve in the library are examples of obstruction.

Unauthorized sources includes Instructor's Solutions Manuals. All violations will be forwarded to the academic integrity board.

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FALL 2013 TOPIC-BASED LECTURE SCHEDULE*

Date	Class	Due	Agenda	Reading	Lab
8/26	1		Course Intro; passive sign convention; i-v curves; Ohm's Law	1.1–1.5, 2.1	**Lab1**
8/28	2		Components; power; Kirchoff's Laws	1.6, 2.1-2.3	**I-V**
8/30	3		Source-load model; i-v characteristics; batteries	2.3	**Characteristics**
9/2			***Labor Day***		
9/4	4	HW1	Dependent sources; circuit topology; series-parallel resistances	1.6, 1.3.2,2.3	**NO LAB**
9/6	5	Quiz1	Dependent sources	1.6,2-2.2	
9/9	6		Non-linear i-v; Δ-Y transformations	2.4,2.6	**Lab 2**
9/11	7	HW2	Source transforms; Wheatstone bridge	2.5	**equivalent**
9/13	8	Quiz2	Intro to Multisim	2.7	**circuits**
9/16	9		Intro to Node Voltage Method (NVM)	3.1.1-3.1.2	**Lab3**
9/18	10	HW3	NVM special cases; Intro to Mesh Current (MCM)	3.1.3, 3.2	**equivalent**
9/20	11	Quiz3			**circuits**
9/23	12		MCM special cases: dependent sources, supermesh	3.2-2-3.2-3	**Lab4**
9/25	13	HW4	Superposition; Thevenin/Norton equivalent circuits	3.4-3.5	**Wheatstone**
9/27	14	Quiz4	Calculate Rth by turning off sources	3.5.4	**Bridge**
9/30	15		Calculate Rth using test source; Basic Op-Amps	3.5.5.,4.1,4.2	**Lab5**
10/2	16	HW5	Op-Amps: difference, summing	4.3-4.6	**Oscilloscope**
10/4	17	Quiz5	Op-Amps in Multisim	4.13	**Measurement**
10/7	18		Non-inverting summer; follower, signal processing	4.7,4.8	**Lab6**
10/9	19	HW6	Difference and instrumentation amplifier; intro to BJT's	4.9	**DC OP-AMPs**
10/11	20	Quiz6	BJT common emitter amplifier	3.7	
10/14	21		BJTs and MOSFETs	4.11,5.1	**Lab7**
10/16	22	HW7	MOSFETs; basic capacitors	5.2,5.3	**Buffers &**
10/18	23		Voltage, current, power & energy; inductors; Intro to phasors	7.1-7.3	**Summing Amps**
10/21			***Fall Break***		
10/23	24	HW8	Phasor domain analysis; Impedance transformations	7.4-7.5	**No**
10/25	25	Quiz7	Phasor Diagrams	7.7	**Lab**
10/28	26		Equivalent circuits; Phasor Domain Analysis	7.6,7.7	**Lab8**
10/30	27	HW9	Frequency analysis in Multisim; Intro to Bode plots	7.11,9.3	**AC**
11/1	28	Quiz8	Types of filters	9.1	**Measurements**
11/4	29		RL and RC passive filters	9.1, 9.4	**Lab9**
11/6	30	HW10	RL and RC active filters	9.6	**Filters &**
11/8	31	Quiz 9	More Bode Plots	9.9	**Crossovers**
11/11	32		RMS, average power, complex power	8.1-8.3	**Lab10**
11/13	33	HW11	Power triangle	8.3-8.4	**RLC filters**
11/15	34	Quiz10			
11/18	35		Combining L and C, initial conditions	5.2.2, 5.3.2, 6.1	**Lab11**
11/20	36		Initial-final value theorem examples	6.1	**Integrators &**
11/22	37	Quiz 11			**Differentiators**
11/25	38		Integrators, differentiators, Multisim Transient Analysis	5.6, 5.8	
11/27	39	HW12	Pulse excitation of RL network; RLC networks	6.1,6.2	
11/29			***Thanksgiving Break***		
12/2	40		RLC Networks; damping	6.3,6.5	**Lab12**
12/4	41	HW13	Power supplies and Power systems	7.10	**IR Remote**
12/6	42	Quiz12	Review of final exam		**Control**
			Final Exam December 16 8:30 – 11:30 AM		

NOTES:
1. The dates and order of these topics are approximate and subject to some change in order and emphasis.
2. Reference lectures from previous semesters will be available on Echo 360.

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LAB INFORMATION

The labs teach how to perform electrical measurements using modern instrumentation. The emphasis will be upon applying classroom material in practical circuits. There will be a short lecture in Glennan 313 before each lab to discuss lab procedures and circuit applications as demonstrated in the lab. The reading assignments for the labs are from your textbook.

Lab #Content

1 In this lab you will examine the current and voltage relationships for two components: the resistor and the light emitting diode (LED). You will demonstrate that resistors obey Ohm's law while nonlinear devices, such as LEDs, do not. You will measure the relationships in voltage and current dividers and learn how to analyze circuits using LEDs
READING: Technology Brief 5: Light-emitting diodes; Section 1.5 Circuit Elements; The Diode: A Solid-State Nonlinear Element; Example 2-11: Diode circuit

2 In this lab you will develop equivalent circuits for multiple resistors networks and for simple "real-world" batteries. As long as two circuits have the same i-v characteristics either may be used for analysis.
READING: Textbook, Section 1.5.1 Circuit Elements; Section 2.4 Equivalent Circuits; Horowitz & Hill, Section 14.02 Power Sources

3 This lab will continue the basic concept of equivalent characteristics based upon i-v characteristics. In this lab you will be given unknown devices which you will characterize by their i-v characteristics.
READING: Textbook, Section 2.4 Equivalent Circuits; Technical Brief 4, resistors as Sensors, p. 56; Paul, Nasar and Unnewehr, Introduction to Electrical Engineering 2/e, Chapter 7, Figure 7.5 and Sections 7.4-7.6

4 A potentiometer is a resistor with an additional moveable connection called the wiper. The resistance from the wiper to the other two terminals depends on the position of the wiper producing a variable resistor. One application of a potentiometer is in a bridge circuit. When you are measuring small voltages which is typically encountered when working with sensors it is easier to compare two voltages and determine when they are equal (also called a null) than to directly measure the small voltage. This lab will use a potentiometer in a Wheatstone bridge circuit to measure small resistance changes.
READING: Textbook, Section 2-6 The Wheatstone Bridge, Technology Brief 4: Resistors as Sensors; Wolf & Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Chapter 10 Resistors and the Measurement of Resistance, Prentice-Hall, 1990

5

6 One of the most useful electronic devices is an integrated circuit amplifier called an operational amplifier (abbreviated OP AMP). This circuit can be used to amplify small voltages and currents such as you might get from a sensor. In this lab you will gain experience with inverting and non-inverting amplifiers using the 741 op-amp.
READING: Textbook, Section 4-1, Op-Amp characteristics, Section 4-2, Negative Feedback, Section 4-3, Ideal Op-Amp, Section 4-4, Inverting Amplifier.

7 The signals from sensors often require signal processing. This can be done using computers but a very inexpensive OP AMPs can also perform many mathematical functions on signal waveforms. In this lab you will use OP AMP as buffer amplifiers, to sum signals, and to compute the difference of signals.
READING: Sections 4.5-4.8

8 Up to now you have worked with relatively slowly changing electrical voltages and currents. However, when these quantities are changing rapidly you need to use a faster measurement device such as an oscilloscope. In this lab you will learn how to set up and use the oscilloscope to make electrical measurements. This lab will also introduce electronically controlled switches and electromechanical switches called relays. The typical op amp can only control 10-20 mA at a few volts yet you will often need to electronically control up to hundreds of volts at many amperes.
READING: supplements: http://en.wikipedia.org/wiki/Oscilloscope; http://en.wikipedia.org/wiki/Relay

9 Inductors and capacitors respond to how rapidly electrical quantities are changing. In this lab you will use the oscilloscope to study the time dependent behavior of basic inductors and capacitors, examine how pulses pass through RC and RL networks, and combine op-amps with capacitors to make integrators and differentiators.
READING: Textbook: Section 5-2, Capacitors; Section 5-3 Inductors; 5-4 Response of the RC Circuit; Section 5-5 Response of the R-L Circuit; Section 5-6 RC Op-Amp Circuits

10 Inductors and capacitors can be combined with OP AMPs to perform complex mathematical functions for manipulating signals from sensors. In this lab you will combine operational amplifiers with inductors and capacitors to make integrators, differentiators, and complex filters.
READING: Textbook: Section 7-5 Impedance Transformations; 7-6 Equivalent Circuits; 7-9 Phasor Domain Analysis Techniques

11 Filters are used to manipulate signals in the frequency domain. One common application of filters is to separate different components of signals. In this lab you will study how filters can be used to separate and direct high and low frequency signal components to the woofers and tweeters in an audio speaker system.
READING: Textbook: Section 9-6 Active Filters; Technical Brief-18 Electrical Engineering and the Audiophile; Section 9-7 Cascaded Active Filters

12 One of the most important applications of circuits is to combine the simple devices you have studied in this class to make more complex and useful devices. In this lab you will examine how ENGR 210 components can be combined to make an infrared remote control similar to those used with many consumer electronics devices.
READING: http://electronics.howstuffworks.com/remote-control.htm/printable
http://electronics.howstuffworks.com/inside-rc.htm