PHYS3360/AEP3630 **General Information** **Spring 2013**

Overview: PHYS3360/AEP3630 Electronic Circuits will introduce practical electronics as encountered in a scientific or engineering laboratory (using discrete components and integrated circuits). It will cover how to analyze and design electronic circuits and how to test them in the lab. A large variety of topics are surveyed with enough depth to be useful but without an overly rigorous treatment. The course starts at an introductory level and moves aggressively through many different topics. The necessary background is laboratory work with DC circuits (i.e. Ohm's law), AC signals, and oscilloscopes (at the level of PHYS2208 or 2213). Other than that no previous electronics experience is assumed.

The lab work will largely follow the experiments outlined in the Lab Manual and the Supplement. Completion of lab units is required to pass the course. Chapters 1-7 will cover analog electronics (resistors, capacitors, RC circuits, opamps, filters, diodes, bipolar, and MOSFET transistors) and comprise a little over half the course. Chapters 8-10 cover digital electronics (gates, adders, flip-flops, counters, shift registers, timers and one-shots). And finally in chapters 11-12 computer interfacing is introduced and used to investigate digital to analog conversion (DAC), analog to digital conversion (ADC) and signal sampling. Computer-aided design of circuits will also be introduced in the second half of the course, as well as the use of microprocessor prototyping boards.

Lecturer: Prof. Ivan Bazarov (410 PSB, Tel. 255-4198; 373 Wilson Lab, Tel. 254-2781; ib38@cornell.edu)
TA's: Ethan Geil (ecg33@cornell.edu)
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Textbooks: Required #1: E. Kirkland and R. Littauer, *PHYS3360/AEP3630 Laboratory Manual*
Required #2: I.V. Bazarov, *Electronic Computer-Aided Design (Supplement)*
Optional: P. Horowitz and W. Hill, *The Art of Electronics*

Lectures: **MWF 01:25PM - 02:15PM RCK 132**

Lab Sections: **LAB 401 MW 07:30PM - 10:30PM**
LAB 401 MW 07:30PM - 10:30PM
LAB 402 TR 01:25PM - 04:25PM

Clark Hall 409, 411, 413, 415, 417, 419; get off on the 4th floor elevators (doors open during lab hours for the first 2 weeks, then ID card access required). Make sure you are assigned to appropriate lab section and attending the same. If you are having difficulties with your schedule please see Rosemary French in 121 Clark Hall within the 1st week. Completion of all lab units is required to pass the course. Both lab attendance and written lab reports are mandatory.

Homework & Quizzes: Beyond the lectures and the labs, the third key element of the learning process is working the weekly problem sets and answering quizzes. A homework assignment will be made available every Friday, and will be due the following Friday (before the lecture). Solutions will be handed out when the homework is due and late homework will not be accepted. Quizzes will be posted on the Blackboard. The main purpose of the quizzes is to engage you in discussion.

Exams:
One mid-term covering material from Chapters I-V of the Lab Manual, plus lectures, and the homework.
One final covering material from Chapters VI-XII of the Lab Manual, plus lectures, and the homework.

Final Project:
You may choose to do a final project in place of your final exam. Talk to the professor.

Course Grade: A final grade will be based roughly on the following:
35% lab (lab reports and performance)
20% mid-term exam
25% final exam or project
20% homework
Your participation (attendance, discussion, mailing list, etc.), laboratory work ethics, and enthusiasm for learning will be reflected in the final course grade overriding the above breakdown where necessary.

Course Website: For HW assignments, announcements, additional material, and viewing your grades – *http://blackboard.cornell.edu* ⇒ *PHYS3360* (email prof. Bazarov for access)

Discussion: Use forum at *Blackboard* ⇒ *Discussions* to ask or answer questions, discuss lab procedures, home problems, quizzes, etc. You are encouraged to sign up for email notification.

Academic Integrity: Each student in this course is expected to abide by the Cornell Code of Academic Integrity. *http://cuinfo.cornell.edu/Academic/AIC.html*

Syllabus:

Introduction
Voltage and Current Sources; Resistors; Capacitors; Inductors; Kirchhoff's Laws; Superposition; High-Pass Filter; Low-Pass Filter; Thevenin's Theorem; Norton's Theorem

Operational Amplifiers
Overdriven Amplifier or Comparator; Positive Feedback; Schmitt Trigger Circuit; Astable Multivibrator

AC circuits
Phasor Representation; Complex Impedance; Transfer Function and Bode Plots; Poles and Zeros; Filters; Frequency Domain; Fourier Analysis

Negative Feedback Circuits
General Principle; Voltage Follower; Noninverting Amplifier; Inverting Configuration; Summing Circuit; Differential Amplifier; Active Filters; Nonlinear Operations

Diodes
Silicon Junction Diode; Diode Equation; Zener Diodes; Rectification; Voltage Doubler; Clipping Circuits (Limiters); AC Coupling (Level Shifting), DC Restoration; Pickoff Circuits; Pulse Stretching; Waveshaping with Circuits Containing Diodes; Diodes in Operational Configuration

Bipolar Junction Transistors
Basic Mechanism; Circuit Model for the Bipolar Transistor; Common-Emitter Transistor Characteristics; Saturating Inverter; DC bias and the Q-point; Voltage Control and Transconductance; The Emitter Follower; Constant-Current Source; Common Emitter Amplifier; Darlington Pairs; Power in Transistor Circuits

Field Effect Transistors
MOSFET Structure and Function; Current-Voltage Characteristics; MOSFET Amplifier; Transistor Differential Amplifier; Power MOSFETS; JFETs and Depletion Mode MOSFETs

Computer Aided Circuit Modeling
Simulation Tools for Analog Circuits; Time Transient and Frequency Domain (AC) Analysis; Digital Circuit Modeling

Combinational Logic Circuitry
Digital Signals; Logic Operations; Logic Combinations; DeMorgan’s Theorem; Gates; Addition of Binary Numbers; Multiplexers and Decoders; Programmable Logic Devices

Sequential Logic Circuitry
Digital Logic Families; TTL and CMOS; RS, D, T, JK Flip-Flops; Synchronous Systems; Registers; Counters

Timing Circuitry
555 Timer IC; One Shots; Oscillator; TTL Family of One-Shots; Clocks

Computers and Microprocessors
Computer Architecture Description; Microprocessor Evolution; Programming; Computer Interface; Micro-controllers; Pseudo-Random Number Generators; Signal Encryption/Decryption

A/D and D/A Converters
Digital-to-Analog Conversion; R-2R Ladder; Analog to Digital Conversion; Successive Approximation; Parallel A/D; Dual Slope A/D; Nyquist Sampling Theorem

Noise in Electronic Circuits
Types of Noise: Johnson, Shot, Flicker Noise; Noise Figure; Interference; Electric, Magnetic, and Electromagnetic Coupling; Noise Reduction Techniques