Physics 334: Electric Circuits Laboratory I

Based on Winter 2018 as taught by D. B. Pengra

Overview

Physics 334 is the first quarter of a two-quarter electronic circuits course (334-335), and is one of the lab courses that is required of all physics majors. It is a pre-requisite for all other 3xx and 4xx lab courses. The focus of this first quarter is on "analog" electronics and covers typical circuits with, and principles of, resistive networks, capacitors and inductors, diodes, transistors, and integrated-circuit amplifiers ("op-amps") and oscillators. More broadly, the goals of the course are to instill a clear understanding of voltage, current, power, and impedance—all of which are essential to effectively use standard apparatus in a physics lab, to develop a practical ability to analyze circuit behavior, and to design basic circuit building blocks based on transistor operation and the concept of feedback.

Structure

The course has a two one-hour lectures and one three-hour lab session per week.

Evaluation

The grade is based on weekly lab reports, lecture-related homework, in-class participation (i.e., clickers) and two exams.

Texts

Required: Learning the Art of Electronics, Thomas C. Hayes (2016)
Recommended: The Art of Electronics, Paul Horowitz and Winfield Hill. 3rd edition (2015), 2nd edition (1989) is less optimal for physics 335.

Topics by week

1. Basic concepts: inputs/outputs, active/passive, current/voltage. Equivalent circuit models. Idealized sources: voltage source, current source. Power.
2. Lecture & Lab 1: Test equipment; DC circuits; IV curves; diodes.
3. Lecture & Lab 2: Reactive components; RC circuits; frequency domain—amplitude and phase relations.
4. Lecture & Lab 3: Resonant circuits; diode circuits; DC from AC.
5. Lecture & Lab 4: Transistors I – "active" circuit concepts, amplifier gain, input & output impedance, basic circuits.
6. Lecture & Lab 5: Transistors II – Ebers-Moll model; amplifier distortion & basic feedback correction; differential amplifier.
7. Lecture & Lab 6: Op-amps I – Ideal model; op-amp "golden rules"; circuit design with golden rules; novel feedback tricks.
8. Lecture & Lab 7: Op-amps II – Departures from ideal; differentiator, integrator.
9. Lecture & Lab 8: Positive feedback: phase-shift oscillator; comparators; relaxation oscillators; 555 timer.