

ECE 210/211

Analog Signal Processing

Course Goals

ECE 210 is a required 4-hour course for both electrical engineering and computer engineering majors. The goals are to provide a solid foundation in analog signal processing that will serve as a strong base for further study in digital signal processing, communications, remote sensing, control, and electronics. Topics include circuit analysis, continuous-time linear system theory, Laplace and Fourier transforms, AM radio, and basic analog filter design. The course includes five laboratories to give students hands-on experience in exercising the theoretical concepts learned in class. The labs contain significant components of categories (a), (b), (c), (e), and (k) under Criterion 3, ABET Program Outcomes and Assessment. ECE 211 is the first half of ECE 210 and is taught as a service course for students outside electrical and computer engineering.

Course Instructional Objectives

A. At the time of Exam 1 (after 14 lectures), students should be able to:

1. Calculate node voltages and branch currents in linear circuits containing resistors, independent and dependent sources, and operational amplifiers. (a, m)
2. Design simple op amp circuits. (c)
3. Sketch voltage and current waveforms (given one, sketch the other) for capacitors and inductors. (a)
4. Design simple op amp integrators and differentiators. (c)
5. Solve first- and second-order differential equations with constant inputs. (a, m)
6. Manipulate complex numbers and demonstrate an understanding of their meaning. (a, m)

B. At the time of Exam 2 (after 28 lectures), students should be able to do all of the items under A., plus:

1. Understand phasor representation of co-sinusoidal signals and use the method for solving linear differential equations with co-sinusoid inputs. (a, m)
2. Apply the phasor concept to solve circuits for the sinusoidal steady-state response. (a, m)
3. Understand the distinction between instantaneous and average power and use the concept of maximum power transfer. (a, c, m)

4. Derive and sketch the frequency response of a linear circuit or system. (a, m)
5. Calculate the response of dissipative linear systems to multi-frequency inputs (a, m)
6. Calculate the Fourier series of a periodic signal. (a)
7. Apply the Fourier series concept to calculate the output of a system due to a periodic input. (a, m)

C. At the time of Exam 3 (after 42 lectures), students should be able to do all of the items under B., plus:

1. Calculate the Fourier transform of finite-energy aperiodic signals and understand the concepts of signal energy and bandwidth. (a, m)
2. Explain and analyze the concepts of AM coherent demodulation, noncoherent demodulation, envelope detection, and a complete AM superheterodyne receiver (built in the lab). (a, b, c, m)
3. Calculate and visualize convolution and apply the concept of impulse. (a, m)
4. Explain the sampling theorem and select a sampling rate according to the Nyquist criterion. (a, c, m)
5. Determine whether a system is linear or nonlinear, causal or noncausal, time-invariant or time-varying, and decompose system outputs into zero-input and zero-state components. (a, m)
6. Determine whether a circuit or system is stable or unstable and demonstrate an understanding of the definition of stability. (a, m)

D. At the time of the final exam (after 58 lectures), students should be able to do all of the items under C., plus:

1. Calculate the one-sided Laplace transform and its inverse. (a, m)
2. Apply the concept of impedance to find the transfer function of a circuit. (a, m)
3. Compute transfer functions from block diagrams. (a)
4. Explain the relationship between pole and zero locations of a circuit and its corresponding frequency response. (a, m)
5. Design a Butterworth filter having a desired cutoff frequency. (a, c, m)
6. Map a designed transfer function to a circuit composed of second-order op-amp building blocks. (a, c, m)

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