ESE305: Deterministic Signals and Systems
Fall 2011

2010-2011 Catalog Description:
Continuous-time (CT or analog), discrete-time (DT) and digital signals. Manipulation of simple signals. Frequencies of CT sinusoids and DT sinusoidal sequences. A simplified sampling theorem. Fourier transform and the concept of frequency spectra for signals. Concepts of linearity, time-invariance, causality, and lumpedness in systems. Discrete and integral convolutions; FIR and IIR digital filters. Differential and difference equations. Laplace transform, transfer functions, poles and zeros. Stability, frequency response, and filtering. Computer simulation and op-amp circuit implementations using state-space equations. Model reduction.

Course Designation: Required for EE and CE

Text Book: Chi-Tsong Chen, "Signals and Systems: A fresh look", (345 pages), 2009. Free and can be downloaded from www.ece.sunysb.edu/~ctchen/.

Corequisite: ESE 271

Coordinator: Chi-Tsong Chen

Goals: Introduce basic concepts in signals and systems and associated mathematical and computational tools.

Course Learning Outcomes: Understand the concepts of frequency spectrum for signals and four mathematical descriptions for LTI lumped systems. Use transfer functions to carry out qualitative analyses and designs and use state-space equations to carry out computer simulation and op-amp circuit implementations. Stability and frequency responses of systems with application in model reduction.

Topics Covered:

Week 1.	Continuous-time (CT), discrete-time (DT), and digital signals. Manipulation of signals. Complex exponential functions. Frequency components of CT signals.
Week 2.	Frequency of DT sinusoids. Nyquist frequency range. Frequency aliasing due to time sampling. A Simple version of sampling theorem.
Week 3.	CT signal analysis: Fourier series and Fourier transform. Frequency spectrum and distribution of energy in frequencies. Modulation and properties of Fourier transform.
Week 4.	Systems with and without memory. Concepts of causality, state (set of initial conditions), lumped and distributed. Forced (zero-state) and natural (zero-input) responses. Concepts of Linearity (L), time-invariance (TI) and impulse responses. FIR and IIR. Convolutions for DT and CT LTI systems. Exam I.
Week 5.	Modeling of CT LTI lumped systems. Examples include mechanical systems, RLC networks and operational amplifiers (op amps). State-space (ss) equations and their computations. Higher-order differential equations.
Week 6.	Laplace transform and rational transfer functions. Transform impedances.

	Complete characterization. Comparison of ss equations and transfer functions.
Week 7.	Realizations of transfer functions into state-space (ss) equations. Basic block diagram and op-amp circuit implementation of ss equations.Exam. II.
Week 8.	Qualitative analysis: More Laplace transforms. Proper rational transfer functions. Poles and zeros. Inverse Laplace transform. Roles of poles and zeros. Responses of poles.
Week 9.	Steady-state and transient responses. Time constant. Stability: its definition, conditions on impulse responses and transfer functions, and Routh test.
Week 10.	Frequency responses of systems and frequency spectra of signals. Ideal lowpass filters. Speed of response. Conventional way of developing the frequency response, phase analysis. Exam III.
Week 11.	Double- and single-pole models of op amps. Stability of op-amp circuits and their operational frequency ranges. Model reduction. Seismometers and accelerometers.
Week 12.	Composite systems, loading problem and reasons of introducing feedback. Stability of feedback systems.Feedback implementation of inverse systems. Wien-bridge oscillator.
Week 13.	Feedback model of Wien-bridge oscillator. Barkhausen criterion. AM and DSB-SC modulations and their demodulations.
Week 14	Review and Exam IV.

Class Schedule: 3 lecture hours.