

ECE 580: System Modeling and Simulation **Elective Course**

2001-2003 Catalog Description:

This is a first course in the principles of mathematical modeling of stochastic and deterministic systems. It will focus on analytical models, mathematical rigor and computer simulation of problems. Students will simulate a number of systems using appropriate stochastic and deterministic models using a computer. This course is crosslisted as ME 580.

Prerequisites: ECE 371 and ECE 380 or approval of the instructor.

Credits: 3 credits (3 hours lecture, 0 laboratory)

Textbook and related materials:

[required]: Text: *System Modeling and Simulation* by Frank L. Severance; John Wiley and Sons, 2001.

Course Coordinator:

Dr. Frank L. Severance, Professor, ECE

Instructor (Winter 2005):

Dr. Frank L. Severance, Professor, ECE

Prerequisites by Topic:

1. Differential and Integral Calculus
2. Laplace transforms
3. Fourier transforms
4. Linear system descriptions in the time and frequency domains
5. Transient and steady state analysis of linear systems
6. The ability to program in a suitable high-level programming language.

Course Objectives:

This course develops (objectives include listing of relevant ECE Department undergraduate learning outcomes)

1. an ability to analyze, design, simulate, and experimentally validate electronic that utilize operational amplifiers while taking into account practical limitations of operational (a, b, c, e, k);
2. an ability to analyze, design, simulate, and experimentally validate electronic circuits utilizing metal-oxide semiconductor field-effect transistors, including MOS based operational amplifiers (a, b, c, e, k);
3. an ability to design, analyze, simulate, and experimentally validate electronic oscillator circuits (a, b, c, e, k);
4. an ability to design, analyze, simulate, and experimentally validate nonlinear waveshaping circuits (a, b, c, e, k);
5. an ability to utilize circuit simulation and/or mathematical software tools for electronic design and analysis (k);

6. an ability to use appropriate statistical measures to characterize experimental error (a, b, k);
7. an understanding of negative and positive feedback systems and their application to electronic circuit analysis and design (a, c);
8. an understanding of frequency compensation and its application to electronic circuit design (a, c);
9. a basic understanding of electronic noise analysis (a, c);
10. an ability to use electronic test instrumentation to validate and debug electronic circuits (k);
11. an ability to prepare effective written technical communications for engineering analysis and design work (g);
12. an ability to thoroughly and accurately document laboratory work using a laboratory notebook (b, g); and
13. an ability to function as an effective engineering team member (d).

Topics:

This is a course in the principles of mathematical modeling of both physical and nonphysical systems and the practice of realizing these models via computer simulation. The principles will be taught in the traditional lecture/test format while the practice will require several computer assignments. This course satisfies the ABET design requirements.

Visual Basic

- computer programming
- object oriented programming
- Visual Basic as a simulation tool

Time driven models

- discrete signal representation
- continuous signal representation
- system modeling

Autonomous systems

- differential equations
- initial value problems
- boundary value problems
- difference equations

Stochastic signal models

- stochastic generators
- random walks, white noise and Brownian motion
- ARMA processes
- Markov models

Time based models with external inputs

- overt inputs
- disturbances
- simulations

Evaluation:

- Midterm examinations (2) - 20%
- Assignments (12) - 65%

Final examination (1) - 15%

Computer Assignments:

The nature of this course is to first model a system, then simulate that system using a general-purpose high level programming language. In this case we use Visual Basic since it is so well adapted to the purpose of simulation. The models used are

1. Stochastic assembly line operation
2. Numerical integration techniques
3. Non-anonymous systems
4. Statistical modeling
5. Creation and analysis of random processes
6. Numerical computation of autocorrelation and spectral density
7. Sampling using an s-order hold
8. Steady-state temperature distribution on a rectangular plate
9. GPS data reduction using the relaxation method
10. Convergence characteristics of an autoregressive noise model
11. Analysis of empirical data for a stochastic system
12. Design of a time driven system using distributed delays

Contribution to Professional Component:

ABET professional component content as estimated by faculty member who prepared this course description:

Engineering Design: 0 credit

Engineering Science 3 credits

Relation of Course to Program Outcomes:

This course provides significant support for:

EE program objectives: 2, 3; and

ECE expected learning outcomes: a, b, c, e, g, k.

Person who prepared this description and date of preparation:

Frank L. Severance

Date: 22 March 2004