Department	Electrical and Computer Engineering
Course Number	**EE 422**
Course Title	Control Systems II
Course Designation	Elective
University Catalog Description	Semester offered: Fall 3 credit lecture Prerequisites: EE 321 - Introduction to techniques of modern control with emphasis on discrete time, including matrices, norms, state-space, and stochastic processes. Stability, Lyapunov functions, Lyapunov stability. Observability, controllability, reachability. State feedback and observers. Model-based control. Performance and robustness.
Faculty Coordinator	Dr. Steve Shaw
Prerequisites by Topic	EE 321 - Analysis, classical (Laplace transform) design and realization of linear feedback systems. Validation of design and demonstration of performance by computer simulation.
Textbook and Software	Text: Santina, Stubberud and Hostetter, *Digital Control System Design 2nd Edition,* Saunders College Publishing, 1988 Software: MATLAB and SIMULINK with *Mathworks* Control System Toolbox.
Course Objectives	The primary objective of this course is to provide students with an introduction to modern (state-space) methods for analysis, design and realization of continuous-time and discrete-time control systems and processes. Emphasis is placed on topics that are prerequisite for control systems study at the graduate level.
Course Outcomes	At the conclusion of EE 422, students are expected to be able to: 1) Model linear time invariant (LTI) discrete-time and continuous-time systems and processes in modern control state-space form of a vector-matrix system of first order coupled linear differential equations. 2) Understand and use the methods of matrix analysis for solving system state-space models. 3) Understand and apply the important mathematical foundations of controllability, observability and reachability to traditional and optimal state-space feedback design methods. 4) Transform arbitrary state-space models to their controllable, observable and Jordan canonical forms. 5) Identify and obtain state-space models of non-linear systems and processes. 6) Understand and apply the definitions and theorems of Lyapunov stability and instability for nonlinear and linear LTI systems. 7) Identify, model and obtain expected state-space trajectories and corresponding n-sigma probability ellipses, for n-th order gauss-markov discrete random processes.
Topics Covered	1) Historical development of “modern”, vector-matrix, state-space control system design and applications. 2) State-Space representation of continuous and discrete LTI dynamical systems. 3) Solution of LTI state-space models vector-matrix methods and matrix transfer functions. 4) The modern control concepts of controllability, reachability and observablility 5) Full-state feedback methods. 6) Luenberger observers for deterministic state estimation. 7) Nonlinear time-invariant systems and the definitions and theorems (without proofs) of Lyapunov. 8) Introduction to stochastic processes: 2nd-order Gauss-markov random processes with white noise disturbances. 9) Use of MATLAB, SIMULINK and the Control System Design Toolbox.
Professional Component (Criterion 5)	EE422 strongly supports and helps to further develop a strong university background in mathematics and science. The course demonstrates, by example, the importance of mathematics and basic sciences for creative engineering applications.

ECE Program Outcomes	EE 422 supports the following ECE Outcomes: a. an ability to apply the knowledge of mathematics and engineering. b. an ability to design a system, component or process to meet desired needs. e. an ability to identify, formulate, and solve engineering problems. g. an ability to communicate effectively k. an ability to use the techniques and skills provided by modern engineering tools.
Total Credit Hours	3
Prepared by	Dr. Robert W. Gunderson 5/17/09