

# Spring 1997

## ME 555. LINEAR CONTROL SYSTEMS

**Mondays, Wednesdays and Fridays: 11:15 AM to 12:05 PM at 208 Hammond**

**Instructor:** Professor Asok Ray; Room: ME 234; Tel: 865-6377

**Recitation and Conference Hours:** Time and Location to be announced

### **Instructional Objectives:**

The objectives of this first level graduate course are: (1) introduction to the theory and applications of linear systems and optimal control; and (2) preparation for advanced course work and research in both deterministic and stochastic control systems.

### **Course Outline:**

Basic Concepts of linearity, time invariance, and causality. State space representation of linear time-invariant (LTI) and linear time-varying (LTV) dynamical systems. Decomposition of the system dynamics into zero-input and zero-state responses. Formulation of the state transition matrix. Concepts of controllability, observability, their duality, and adjoint spaces. Grammians for LTV systems, and their simplification for LTI systems. State variable feedback, modal controllability, pole placement, and zeros of transfer functions. Different forms of canonical realization. Homework problems using MATLAB toolboxes.  
5 weeks

Optimal state feedback control of linear dynamical systems in the setting of a quadratic cost functional, and the associated two-point boundary value problem. Guaranteed gain and phase margins of the single-input time-invariant Linear Quadratic Regulator (LQR). Luenberger observer and reduced-order observer. Concept of duality between the minimum-variance observer and the LQR. Properties of the Riccati equation and the Hamiltonian matrix. Asymptotic properties of the LTI steady-state observer. Stability analysis of output feedback compensators for LTI systems. Homework problems using MATLAB toolboxes.  
8 weeks

Rudimentary concepts of transmission zeros, matrix fraction description, and minimal realization for Multiple-Input Multiple-Output (MIMO) LTI systems.  
2 weeks

**Prerequisites:** (ME 455 or EE 428) and a course in Linear Algebra such as Math 436

### **Text Book:**

C-T. Chen, *Linear System Theory and Design*, Rinehart, 1984

### **Reference Books:**

T. Kailath, *Linear Systems*, Prentice-Hall, 1980.

R.E. Kalman, P.L. Falb and M.A. Arbib, *Topics in Mathematical Systems Theory*, McGraw Hill, 1969.

H. Kwakernaak and R. Sivan, *Linear Optimal Control*, Wiley-Interscience, 1972.

R.J. Schilling and H. Lee, *Engineering Analysis*, John Wiley, 1988.

G. Strang, *Linear Algebra and Its Applications*, 3rd ed., Academic Press, 1988.