**University of California at Berkeley**
**Department of Mechanical Engineering**

**ME232 Advanced Control Systems I** **Fall 2012**

**Class Notes:** ME232 Class Notes by M. Tomizuka

**References (not required to purchase):**

1. Joao P. Hespanha, Linear Systems Theory, Princeton, 2009
2. W. L. Brogan, Modern Control Theory, 3rd Ed., Prentice Hall.
3. Panos J. Antsaklis & Anthony N. Michael, Linear Systems, Birkhauser.
4. N. Nise, Control Systems Engineering, Wiley.

**ME232 Overview:**

ME232 is the first graduate course offered by the Department of Mechanical Engineering on dynamic systems and control. It is a pre-requisite to most of the other graduate courses offered by the department in this area. ME232 deals with analysis and design techniques for linear control systems.

It is assumed that you have taken or are taking concurrently one junior/senior level control course. If you have not taken any control course before, you can still take ME232 but you need to take ME134 Automatic Control Systems concurrently.

**Covered Topics:**

| Week | Material |
|---|---|
| 1 | Introduction, Laplace transformation and z-transformation (Continuous time function vs. Discrete time sequence) |
| 2 | z-transformation (continuation); Models of linear dynamical systems: transfer functions, state space models, various canonical forms |
| 3 | Modeling of physical systems: power, energy, sources, passive elements (C-, I-, R-, transformer, and Gyrator), through and across variables, linear graph, modeling examples for typical mechanical systems such as vehicle suspension, electrical motor, etc. |
| 4 | |
| 5 | Solutions of unforced linear state equations, matrix exponential, eigenvalues and eigenvectors, Jordan form. Solutions of linear state equations, transition matrix, discrete time models of continuous time systems. |
| 6 | |
| 7 | Stability, Lyapunov stability, Lyapunov function. |
| 8 | Controllability and observability |
| 9 | **Midterm I**, Singular value decomposition and balanced realization |
| 10 | State feedback and output feedback, pole assignment via state feedback |
| 11 | State estimation and observer, observer state feedback control |
| 12 | Linear Quadratic (LQ) Optimal Control, Linear Quadratic Regulator (LQR), Riccati equation, Solution of Riccati equation |
| 13 | Properties of LQR, gain margin/phase margin, Symmetric root locus |
| 14 | **Midterm II** |
| 15 | Properties of LQR continued, Discrete time LQR |