MEEN 651 CONTROL SYSTEM DESIGN
LECTURES OUTLINE

Reference Books: See Overview Syllabus for a detailed list of references

PART 1. MEASUREMENTS IN DYNAMIC SYSTEMS

Week 1 - August 31 - September 3, 2004
Lecture 1: Introduction to dynamic systems; representation of signals and systems; modeling, types of models; measurements in dynamic systems; continuous-time, discrete-time representations; Fourier analysis and Fourier transforms.
Lecture 2: Laplace transforms; Sampling and aliasing phenomena; Sampling rate selection; Nyquist frequency.

PART 2. MODELING OF DYNAMIC SYSTEMS

Week 2 - September 6 - September 10, 2004
Lecture 3: Modeling of mechanical systems; translational and rotational systems;
Lecture 4: Modeling of mechanical systems; examples on formulating the state-space representation; modeling of electromechanical systems.

Week 3 - September 13 - September 17, 2004
Lecture 5: Elementary fluidic and thermal system components; associated governing laws; modeling of process systems (thermal and fluid); modeling transport delays.
Lecture 6: Linearization and scaling; equilibrium and operating points; impedance matching.

PART 3. ANALYSIS OF DYNAMIC SYSTEMS

Week 4 - September 20 - September 24, 2004
Lecture 7: Transfer functions; poles and zeros; relation between transfer functions and state-space; stability of equilibrium and determination of stability using eigenvalues; dynamic response of systems; transient response of dynamic systems.
Lecture 8: Transient response of dynamic systems (continued); system damping and natural frequency; time-domain specifications; transient response of systems and relevance of pole locations; impact of zeros.

Week 5 - September 27 - October 1, 2004
Lecture 9: Frequency domain analysis; neutral stability; Bode plots of dynamic systems.

PART 4. FEEDBACK CONTROL SYSTEMS

Lecture 10: Properties and characteristics of feedback; open-loop vs closed-loop transfer functions; sensitivity; steady-state error; disturbance rejection; PID Controllers; performance of feedback control systems.
Week 6 - October 4 - October 8, 2004
Lecture 12: Examples of root-locus for PID controller design.

Week 7 - October 11 - October 15, 2004
Lecture 13: Nyquist stability criterion; relative stability; phase and gain margins.
Lecture 14: Closed-loop frequency response and system bandwidth; compensation and design of PID controllers.

MID-TERM EXAM - October 13, 2004; 7 - 9 PM; Room TBD

Week 8 - October 18 - October 22, 2004
Lecture 15: Use of Bode plots for PID controller design; PD and lead compensation.
Lecture 16: PI and lag compensation; PID compensation.

Week 9 - October 25 - October 29, 2004
Lecture 17: Control system design specification; frequency domain specifications.
Lecture 18: Sensitivity functions and limitations of feedback control; Bode integral.

Week 10 - November 1 - November 5, 2004
Lecture 19: Advantages of state-space and canonical forms.
Lecture 20: Analysis of state equations.

Week 11 - November 8 - November 12, 2004
Lecture 22: Pole placement and the optimal linear quadratic regulator (LQR).

Week 12 - November 15 - November 19, 2004
Lecture 23: Full-order estimators (observers) and duality of estimation and control.
Lecture 24: Compensator design and reduced order estimators.

Week 13 - November 22 - November 26, 2004
Lecture 25: Command-following in regulator design and integral action; the internal model principle; time delay compensation.
Lecture 26: THANKSGIVING HOLIDAY

Week 14 - November 29 - December 3, 2004
Lecture 27: Sampled-data systems and the z-transform.
Lecture 28: Design by emulation and direct digital design.

FINAL EXAM - COMPREHENSIVE
Friday, December 10, 2004; 3:00 PM - 5:00 PM; Room ENPH 205