EEL 4652 - Control Systems I (Fall 2011)
Course Calendar Version 17.0 (11/16/2011 update)

Week / Lecture	Date	Topic	Comments
1/1	M 8/22	Course Syllabus; Review of Laplace Transform; Transfer Functions: Poles and Zeros; Transfer functions	
1/2	W 8/24	Review of Laplace Transform (cont'd); Transfer Functions: Poles and Zeros; Transfer functions from Differential Equations	
2/3	M 8/29	Introduction to Transfer Functions (cont'd): Transfer Function and Frequency Response, Pure Time Delay example Electrical examples of Transfer Function construction and analysis; Step response of a first-order linear system; Homogeneous and Particular Solution of a 2^{nd} order differential equation – the physical meaning of poles. Introduction to Matlab Control Systems Toolbox (CST): LTI Blocks, LTIVIEW; Poles and Zeros; Step and Impulse Response of First-Order Systems	
2/4	W 8/31	Block Diagrams; Simple block diagram manipulation: Cascade, Parallel and Feedback connections; Matlab CST: Block diagram manipulation; Mason's Formula – notation explanation	
3	M 9/5	**Labor Day Holiday**	
3/5	W 9/7	Mason's formula Examples – Finding transfer functions in complicated block diagrams; Modeling of a simple mechanical system example: mass-spring-damper and State-Variable Representation	HW1 given (CST, first order systems, block diagrams)
4/6	M 9/12	Introduction to Matlab Simulink and Dynamic Simulation Concepts: Simulink Tutorial as solving the simple mechanical system example	
4/7	W 9/14	Modeling of a simple electro-mechanical system: DC Motors/Generators basic equations, block diagram model	HW2 given – [Simulink (DC motor), CST (2^{nd} order models, model reduction)]
5/8	M 9/19	DC Motor block diagram: Related transfer functions Step Response of a Second-Order Linear System: Complex Poles, Rise Time, Peak Time, Peak	

		Overshoot and Settling Time; Physical Meaning of Zeros	
5/9	W 9/21	Matlab CST: Settling-time and Overshoot of a 2nd order system; First or Second vs. Higher order Systems; Theory combined with Matlab CST: Model Reduction Cases – Far Away Poles, High Above Poles, Dipoles; Stability of Linear Time Invariant Systems - Introduction	HW1 due
6/10	M 9/26	Simplified Block Diagram of a DC Motor; Stability of Linear Time Invariant Systems; The Routh-Hurwitz Stability Criterion and Examples	
6/11	W 9/28	Special Cases of Routh Criterion – Row of Zeros; Parametric Stability Conditions Example; Tracking Performance of Control Loops: Unity vs. Non-Unity Feedback; Tracking Performance of Control Loops and Steady-State Errors - Introduction	HW3 given – stability, steady-state error
7/12	M 10/3	Tracking Performance of Control Loops and Steady-State Errors: System Type and The Role of Integrators in the Loop; Theory and Simulink: Examples of simple non-linear systems: Effects of Saturation in a feedback System	HW2 due
7/13	W 10/5	Theory and Simulink: Linear System with Amplifier Saturation (cont'd); Rotating Pendulum ; Dog Tracking a Master	
8/14	M 10/10	Simulink: Master and Dog Example (cont'd); Matlab and Simulink: How to run Simulink from Matlab (using the Dog and Master Example)	HW4 given (Aircraft Landing)
8/15	W 10/12	Review for the Midterm – Solution of old exam problems and other examples	HW3 due
9/16	**M** **10/17**	**Midterm Exam** Material: Theory only, no Matlab/Simulink, <u>Material covered</u>: Time response of first, second and higher order linear systems, Block diagrams and transfer functions (including Mason's formula), stability (using Routh Criterion) and steady-state error; P, I and PI controllers	
9/17	W 10/19	Steady-State Errors due to Disturbance Inputs; The Internal Model Principle	**Half Lecture**
10/18	M 10/24	The Root Locus method - Basic theory: What is a root locus?, the Magnitude and Angle Rules; Start and End Points; Number of Branches; Symmetry; Real closed-loop poles; Simple Root Locus Examples	
11/19	M 10/31	The Root Locus method – Asymptotes; Simple examples; Breakaway Points; Angles of Departure and	HW5 given (Root Locus,

		Arrival; Calculation of K on the Root Locus; Root Locus intersection with the jω axis; Root Locus for negative K; Root Locus with respect to an arbitrary parameter; Introduction to Root Locus Design	IMP, Feedforward) HW4 due
11/20	W 11/2	Matlab CST: SISOTOOL and RLOCUS tutorials; Control Design using Root Locus – basic concepts	
11/21 make-up	F 11/4	Feedforward Control: Inverse Dynamics Perfect Tracking, Feedforward Signals, Feedforward by means of Pre-Processing of the Reference Command; Open-Loop vs. Closed-Loop Control: Perfect Tracking and advantages of closed-loop control in cases of model uncertainty and unknown disturbance signals; Why stabilization in open-loop is not possible	Make up class
12/22	M 11/7	Root Locus Design: Pole/Zero cancellations in LHP and their meaning, meeting time domain specifications by means of Root Locus Angle Criterion, controller gain calculation; How to deal with K_V specifications - Introduction	
13/23	M 11/14	Root Locus Design (concluded): K_V enhancement by means of Lag Compensation; Frequency Response Basics: From measured frequency response to an identified transfer function; Basic theory of Bode Plots – Basic Structures (Single LHP or RHP poles and zeros, Integrators, Differentiators, Multiple poles and zeros, Constant Gain); Example: Bode plot of an electronic amplifier transfer function	Remake of 11/9/2011 lecture (as the video came with no audio); Last 20 minutes is new material
13/24	W 11/16	System Identification from Frequency Response Data: Identification of Non-Minimum Phase transfer functions Bode Magnitude Plot: Basic Computations; Identification of Minimum Phase transfer functions; Matlab CST: Bode	HW5 due
13/25	F 11/18	Gain and Phase Margins and the Connection between Open-Loop Frequency Response and Closed-Loop Stability; The fundamental Loop Shaping Rule – "Always cross over at -20dB/dec"; Example of Dominant Pole / Lag Compensation Design: Stabilization of Multi-Stage Electronic Operational Amplifiers; Matlab CST demonstration of electronic amplifier's stabilization design	**Make-up Class Friday 11/18/2011 1:00-2:20 at CM 130**
14/26	M 11/21	Frequency Domain Design Specifications; Control Design using Bode plots; Time Domain vs. Frequency Domain System	HW6 given (Controller design using

		Performance Specifications Bode Design examples; Control Design with Bode Plots using SISOTOOL	SISOTOOL and Bode; Feedforward Control)
14/27	W 11/23	Controller Design with Bode Plots using SISOTOOL (cont'd) Control Design with Bode Plots: Systems with Pure Delay Time	
14		**Thanksgiving**	
15/28	M 11/28	More examples to Bode Design	
15/29	W 11/30	Review for the Final Exam – Problems from old tests and other examples	HW6 due
15	**F** **12/2**	**Final Exam 10:30-12:00** Material covered: Root Locus and Controller Design using Root Locus including use of the Internal Model Principle; Bode Plots and applications to System Identification and to Controller Design in the Frequency Domain; Feedforward Control **Not Covered**: SISOTOOL	In FL 427