ME 422 – Final Exam Study Guide

Fall 2011

Dichotomies

Transient response vs. steady state response
First order vs. second order systems
s-plane analysis (root locus) vs. frequency response analysis (Bode diagram)
Open loop vs. closed loop
Positioner vs. regulator

Capabilities

Be able to solve a differential equation using Laplace transforms
Be able to perform a partial fraction expansion on a conventional *s*-domain system
Be able to use the Final Value Theorem
Be able to manipulate a moderately complicated block diagram into a common feedback loop
Be able to get the closed-loop transfer function of a regulator loop with a disturbance input
Be able to come up with the system transfer function for a simple mechanical, fluid, or electrical system
Find first- or second-order transient response parameters for common physical systems
Be able to generate transfer function of first or second order system from its step response curve
Know how to tune a model to match experimental output
Be familiar with lab systems, their operation, and their block diagrams
Know how to get closed-loop pole locations from a step response, then match coefficients with a transfer function from first-principles model to determine unknown system parameters (hydraulic positioner)
Know how to linearize a non-linear system about an operating point
Be able to assess system stability via the Hurwitz criteria for systems of order < 5
Be able to generate an approximate root locus
Know complex-plane trigonometry of a dominant pair of closed-loop poles in s-plane
Know how to use the static error constants to calculate steady-state error
Know what the angle and magnitude criteria are for closed-loop poles
Be able to design a PI or PD controller using root locus to meet transient or steady-state error specifications
Know the structure of a PID controller and the function of each term in this controller
Know how to calculate Bode plot data points given a transfer function and a specific frequency
Be able to interpret an oscilloscope output of sinusoids to get *M* (dB), ϕ, and ω (see Figure 8.2)
Be able to get transfer function of system from Bode plot
Be able to generate a Bode plot from a transfer function
Be able to assess stability of system from Bode (gain and phase margins, $\omega_{\Phi M}$ and ω_{GM}
Be able to get static error constants from Bode plot
Be able to design P, PI, PD, and PID controllers using Bode plots to meet both steady-state error requirements and transient response requirements (%*OS* and speed)
Be able to use a typical PID faceplate and describe the operation of a loop in manual and auto
Be able to design P, PI, and PID controllers using the Ziegler-Nichols tuning method

General

The exam will consist of 5 or 6 problems. One problem will be pulled off of one of the quizzes for this quarter.
You may bring one, double-sided, 8.5x11 formula sheet. All entries must be in your own hand. No worked out problems. No photocopied material. Include your name on this sheet.
Do not worry about tabular data (like Laplace transforms, e.g.). Any such data will be provided. Bring your Bode component table with you to the exam.
The last four "capabilities" above are ripe for exam questions, since you have not been tested on them so far.
Bring drawing tools in order to construct Bode-plot asymptotes.