ESE 406 - SPRING 2012
Useful Review Questions

Complete each of the following questions. Write *1 or 2 short sentences* explaining what you did. THIS IS FOR YOUR OWN PRACTICE ONLY. DO NOT SUBMIT YOUR SOLUTIONS!

1. A system is governed by the equation

$$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = 17u$$

   Find the transfer function, H(s), that describes the system.

2. Draw a block diagram that uses proportional feedback to cause the output, y(t) to track a reference signal, r(t). (That is, let u(t)=K*[r(t)-y(t)].)

3. Write the closed-loop transfer function for the block diagram of the previous problem.

4. By hand, on graph paper, make a reasonably accurate sketch of a root locus for the system. You may use MATLAB to check your answer. Use your 1 or 2 sentences to explain what the locus shows.

5. What value of the gain gives a closed-loop damping ratio of 25%?

6. By hand, on graph paper, make a reasonably accurate sketch of the closed-loop unit step response, using the gain from the previous problem. You may use MATLAB to check your answer. Use one sentence to explain how the response relates to the root locus of the previous problem. Use the second sentence to explain the final value of the output.

7. Use MATLAB to make a bode plot that shows the stability margins of the system with the gain set at the value you used in the previous 2 problems. Use your two sentences to explain what stability margins are.

8. For what value of the gain is the phase margin 60 degrees? Use your two sentences to explain how this could be found using only the bode plot of the previous problem.

9. If the original transfer function, from problem #1, were converted to a discrete-time system using the Tustin method, with a sampling time of 0.04 seconds, what would the discrete-time transfer function, H(z), be?

10. If we were to write the system in state-space form, with $x_1 = y$ and $x_2 = dy/dt$, what would the A and B matrices be?

11. For the state-space description given in the previous problem, what gain matrix, K, would place both of the closed-loop poles at $s = -6 + 0j$?

12. What PD controller gains are equivalent to the full-state feedback of the last problem?