University of California, Berkeley
Department of EECS
Fall 2003 EE128 Midterm Exam

10/15/2003, 4:10~6:10, Close-book , Use only provided paper.

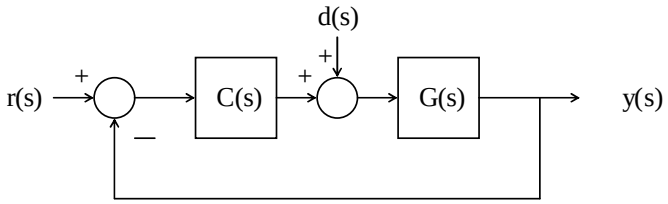
(1) The dynamic of a nonlinear system is modeled by the following equation where u is the input variable and y is the output variable.

(1.a) For u=0, there are more than one equilibrium state. One of the equilibrium states is the origin (i.e., all state variables are zero). Find another equilibrium state (for u=0). (10%)

(1.b) Linearize the system about the equilibrium found in (1.a) and express the linearized equation in the standard linear state equation form. (10%)

$$\ddot{p} = p\cos(\dot{p}) + q(1+u)$$
$$\dot{q} = p(p^2 - q)$$
$$y = p(q+u)$$

(2) Consider the following unity feedback system.



(2.a) Give a necessary and sufficient condition on C(s) and/or G(s) such that the system is of type k (an integer) with respect to the input r(s). (10%)

(2.a) Consider the following statement. If you agree with this statement, prove it. If not, explain why the statement is not true. (10%)

> If this system is of type k (an integer) with respect to the input (r), it must be also of type k with respect to the disturbance d(s).

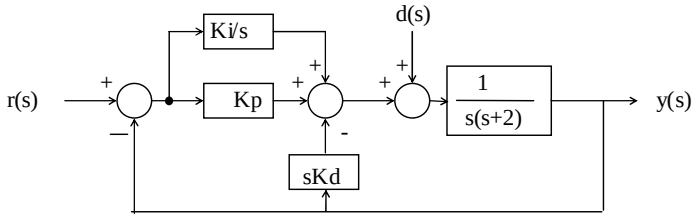
(3) Consider the following closed loop system with a PID controller.

(3.a) Assume, Ki=0, find Kp and Kd such that

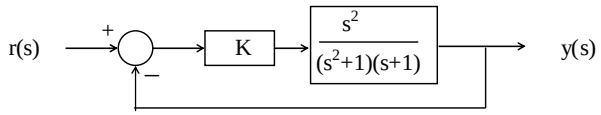
(i) the output is 0.05 at steady state when a unit step is applied to the disturbance input (and r(s)=0) and

(ii) the overshoot is less than 5% at the output y(s) due to a unit step input from r(t) (5% overshoot = 0.7 damping ratio) (10%)

(3.b) Assume Ki=1, Kd=1, find the range of Kp such that the system is stable. (10%)



(4) Sketchy the root locus for the following system. Determine <u>all</u> features of the root locus that apply to this particular system. Base on the root locus, find <u>a</u> positive value of K (if such a value exist) such that the system is stable. (20%)



(5) Plot the Nyquist plot of the following system. Use the concept of Nyquist criterion, find a positive value of K (if such a value exist) such that the system is stable. (20%)