Alexandria University
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Automatic Control
Sheet 1(computer problems)

CP2.1. consider the two polynomials p(s) = s^2 + 7s + 10 and q(s) = s + 2. Compute the following :
(a) p(s)q(s)
(b) poles and zeros of G(s) = q(s)/p(s)
(C)p(-1)

CP2.2 Consider the feedback system depicted in Figure CP2.2.
(a) Compute the closed-loop transfer function using the series and feedback functions.

(b) Obtain the closed-loop system unit step response with the step function, and verify that final value of the output is 2/5.

CP2.3. Consider the differential equation $\ddot{y} + 4\dot{y} + 3y = u$, where $\dot{y}$ (0) = y(0) = 0 and u(t) is a unit step. Determine the solution y(t) analytically and verify by coplotting the analytic solution and the step response obtained with the step function

CP2.4 Consider the mechanical system depicted in Figure CP2.4.The input is given f(t) and the output is y(t). Determine the transfer function from f(t) to y(t) and, using an m-file, plot the system response to a unit step input. Let in = 10, k = 1, and b = 0.5. Show that the peak amplitude of the output is about 1.8.

CP2.5 A satellite single-axis attitude control system can be represented by the block diagram in Figure CP2.5. The variables k, a, and b are controller parameters, and J is the spacecraft moment of inertia. Suppose the nominal moment of inertia is J = 10.8E8 (slug ft^2), and the controller parameters are k = 10.8E8, a = 1, and 6 = 8. (a) Develop an m-file script to compute the closedloop transfer function T(s) = $\theta(s)/\theta_d(s)$. (b) Compute and plot the step response to a 10° step input. (c) The exact moment of inertia is generally unknown and may change slowly with time. Compare the step response performance of the spacecraft when / is reduced by 20% and 50%. Use the controller parameters k = 10.8E8, a = 1, and b = 8 and a 10° step input. Discuss your results.

CP2.6.Consider the block diagram in Figure CP2.6.

(a) Use an m-file to reduce the block diagram in Figure CP2.6, and compute the closed-loop transfer function.

(b) Generate a pole-zero map of the closed-loop transfer function in graphical form using the pzmap function.

(c) Determine explicitly the poles and zeros of the closed-loop transfer function using the pole and zero functions and correlate the results with the pole-zero map in part (b).

CP2.7. For the simple pendulum shown in Figure CP2.7, the nonlinear equation of motion is given by $\ddot{\theta} + \frac{g}{l}\sin(\theta) = 0$, where L = 0.5 m, m = 1 kg, and g = 9.8 m/s^2. When the nonlinear equation is linearized about the equilibrium point 6 = 0, we obtain the linear time-invariant model, $\ddot{\theta} + \frac{g}{l}\theta = 0$. Create an m-file to plot both the nonlinear and the linear response of the simple pendulum when the initial angle of the pendulum is θ(0) = 30° and explain any differences.

CP2.8 A system has a transfer function $\frac{X(s)}{R(s)} = \frac{(20/Z)(s+Z)}{s^2+3s+20}$

Plot the response of the system when R(s) is a unit step for the parameter z = 5,10, and 15.

CP2.9 Consider the feedback control system in Figure CP2.9, where

$$G(s) = \frac{s+1}{s+2} \; and \; H(s) = \frac{1}{s+1}$$

(a) Using an m-file, determine the closed-loop transfer function.

(b) Obtain the pole-zero map using the pzmap function. Where are the closed-loop system poles and zeros?

(c) Are there any pole-zero cancellations? If so, use the minreal function to cancel common poles and zeros in the closed-loop transfer function.

(d) Why is it important to cancel common poles and zeros in the transfer function?

CP2.10 Consider the block diagram in Figure CP2.10. Create an m-file to complete the following tasks: (a) Compute the step response of the closed-loop system (that is, R(s) =$\frac{1}{s}$ andT_d(s)=0) and plot the steady-state value of the output Y(s) as a function of the controller gain 0 < K ≤10.

(b) Compute the disturbance step response of the closed-loop system (that is, R(s) = 0 and T_d(s)= 1/s) and co-plot the steady-state value of the output Y (s) as a function of the controller gain 0 < K ≤ 10 on the same plot as in (a) above.

Figures:

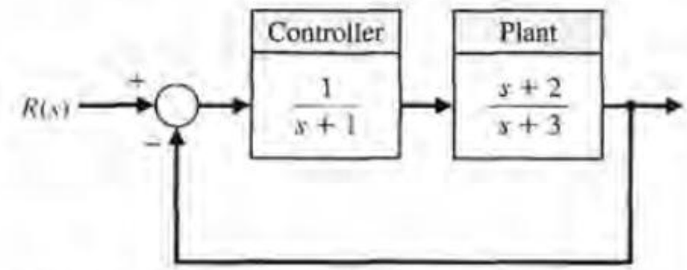

FIGURE CP2.2 A negative feedback control system.

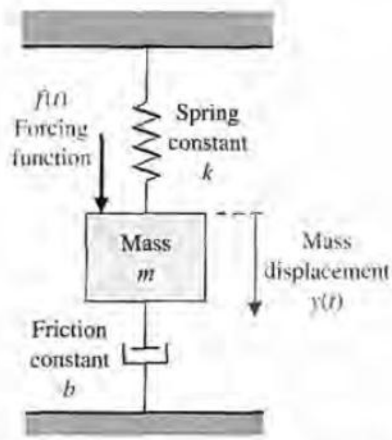

FIGURE CP2.4 A mechanical spring-mass-damper system.

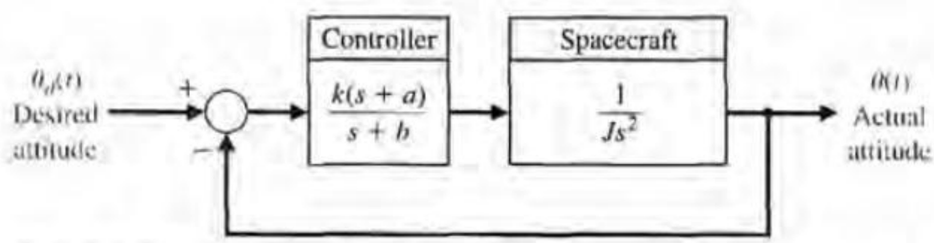

FIGURE CP2.5 A spacecraft single-axis attitude control block diagram.

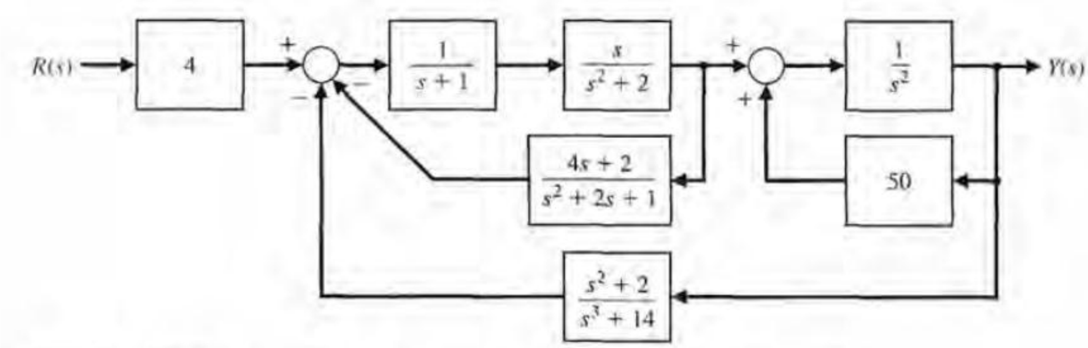

FIGURE CP2.6 A multiple-loop feedback control system block diagram.

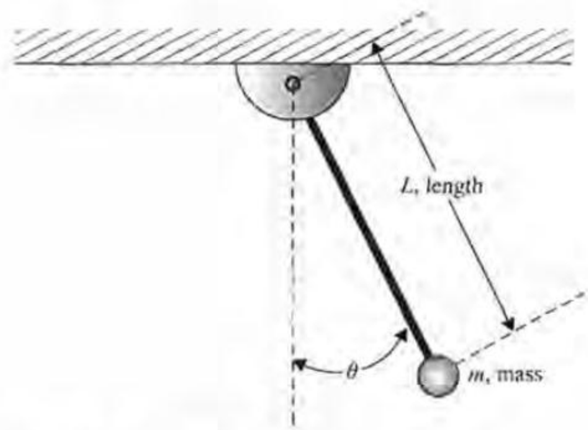

FIGURE CP2.7 Simple pendulum.

FIGURE CP2.10 Block diagram of a unity feedback system with a reference input $R(s)$ and a disturbance input $T_d(s)$.