國立中正大學九十學年度碩士班招生考試試題

系所別：機電光整合工程研究所　　　科　目：自動控制

1. (15%) Consider a linear system represented in the following differential equation.

$$y^{(3)} + 2y^{(2)} + y^{(1)} + \alpha\, y = u$$

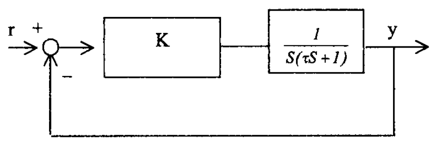
where $y^{(i)}$ indicates the i-th derivative of the output signal y(t) and α is an unknown parameter. Use the Routh-Hurwitz criterion, root locus technique, AND the Nyquist approach to determine the range of α over which the system is stable.

2. (25%) Consider the system shown in the figure below where the controller K is a constant.

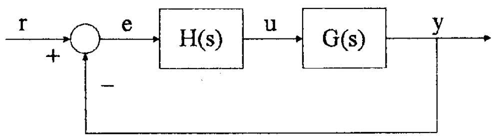
(a)(10%) What is the system type? Compute the steady-state tracking error due to a ramp input r(t)=2t?

(b)(7%) Assume K is equal to 25 and τ is equal to 1. What is the maximum overshoot of output y to a unit step input?

(c)(8%) If you are asked to redesign the controller K to reduce the maximum overshoot and keep the rising time about the same. What kind of controller you will choose? a PD or a PI controller. Explain why in detail?



3. (5%) Consider a negative feedback control system



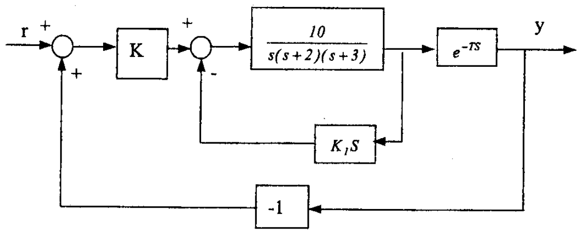
where $G(s) = (s - 2)/(s^5 + 4s^4 + 3s^3 + 2s^2 + s + 1)$ and H is a proportional control, i.e., H = k (a constant). Show that when the proportional gain k is too large the closed-loop system becomes unstable.

4. (25%) The block diagram of a closed loop system is shown in the figure shown below where the block e^{-Ts} represents the time delay effect of the plant. T is the delayed time. The controller

K is a constant.

(a) (12%) If the delayed time T equals to 0 and K_1 equals to 1, find the range of the K over which the closed loop system is asymptotically stable.

(b) (13%) When the delayed time T equals to 1 and K_1 equals to 1, describe the solution procedure which you will follow to determine the range of K giving rise to stable closed-loop system. Note that you do not need to solve for the range of K precisely. All you need is to describe the procedure.



5. (30%) Consider a feedback control system as shown in Problem 3 above except that now we have G(s) = 1/[s(s+1)].

(a) (5%) When H is a proportional feedback control, show that it is impossible to select a proper proportional gain such that with regard to the unit step response of the closed-loop system, the time to settle to within 2% of the final value is less than 5 seconds and the damping ratio of the dominant roots is greater than 0.5.

(b) (25%) Consider another case when H = K(s + b)/(s + a). Compared with the proportional feedback control case discussed in part (a), answer the following questions regarding their root locuses.

(b1) (3%) Is the breakaway point from the real axis changed?

(b2) (4%) Have the number and the angles of asymptotes been changed?

(b3) (10%) Discuss how the choice of parameters (a, b) affects the centroid of the asymptotes?

(b4) (8%) Discuss if it is possible to choose (K, a, b) properly such that the settling time and damping ratio requirements stated in part (a) of this problem can be satisfied?