淡江大學 101 學年度碩士班招生考試試題

系別：航空太空工程學系　　　　　科目：自　動　控　制

考試日期：2 月 26 日(星期日) 第 2 節　　　　　本試題共　五　大題，　2 頁

本試題雙面印刷

1. (30%) Consider the linear system shown in Figure 1 with transfer function

$$H(s)=\frac{-2s+2K}{K(s+1)(s+2)}$$

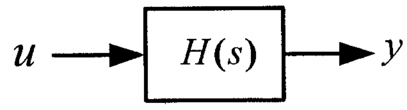

Figure 1.

where K is a scalar variable. This structure allows us to study the effects of a variable zero location, without affecting the location of the poles and the D.C. gain of the system.

(a). Find the step response of the system, i.e., determine $y(t)$ when $u(t)$ is a unit step function. (Hint: Use partial fraction expansion to express the step response in the form $y(t)=\frac{a}{s}+\frac{b}{s+1}+\frac{c}{s+2}$, express a, b, and c in terms of K) (10%)

(b). Sketch the step responses of the system for $K=-10,\ -0.2,\ -1,\ -2,\ 0.2,$ and 10 respectively. (10%)

(c). From the results in (b), comment the impact on the transient response for different zero locations. (Note: discuss the effect of slow, fast, stable, and unstable zeros) (10%)

2. (20%). A unity feedback control system is shown in Figure 2 below. The transfer function of the open loop system is

$$P(s)=\frac{K_m}{s(Js+B)}.$$

The parameters of the system are $J=100$, $B=140$, $K_m=500$. The control gain K is to be determined to satisfy certain performance requirement.

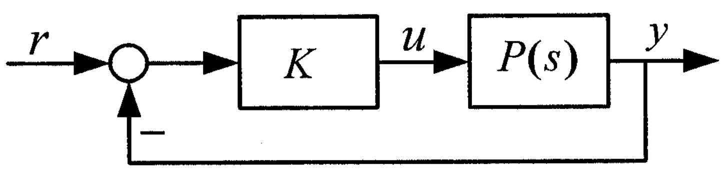

Figure 2.

(a). Find the range of values of the control gain K which ensure that the closed-loop system has a damping ration $\zeta \ge 0.7$. (10%)

(b). If the reference input is a unit ramp function, $r(t)=t$, ($t \ge 0$), find the minimum steady state error which can be attained such that $\zeta \ge 0.7$. (10%)

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3. (20%) Consider the unity feedback control system shown in Figure 3 with

$$P(s)=\frac{1}{(s-1)(s+2)} \quad ; \quad K(s)=4\frac{s+\alpha}{s}$$

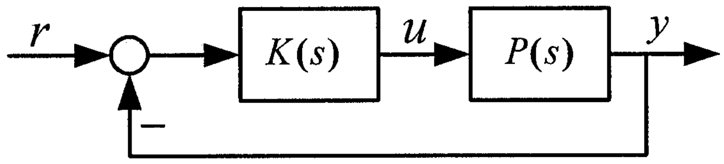

Figure 3.

Plot the root locus of the closed-loop system poles using α as the variable.

(a). On the root locus, show where $\alpha=0$, and $\alpha\to\infty$. Show the direction of travel of the roots. (5%)

(b). Find any asymptotes, centroids, and breakaway points. (5%)

(c). Find the intersection of the root locus with the imaginary axis. (5%)

(d). For what range of α is the closed-loop system stable. (5%)

4. (20%) Proportional plus integral controller (PI controller) is widely used in industrial process. Answer the following questions.

(a). What is a PI controller? Write its input-output transfer function. (6%)

(b). What are the effects of the PI controller on the steady-state error of the system? Does the PI control change the system type? (6%)

(C). What are the advantages and disadvantages of a properly designed PI controller for the control system. (8%)

5. (10%) State the general form and characteristic of a phase-lead compensator. What are the general effects of incorporating a lead compensator into a control system?