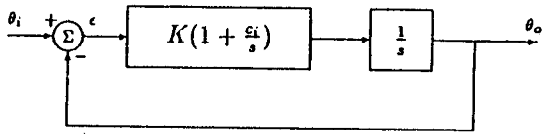
淡江大學九十三學年度碩士班招生考試試題

系別：航空太空工程學系　　　　科目：自　動　控　制

准帶項目請打「○」否則打「×」
簡單型計算機
○

本試題共 叁 頁 －1

#1 (20%) Consider the system, as shown in the block diagram below.



(a) Show that the closed-loop transfer function is given by

$$Y(s) = \frac{1 + s/c_i}{s^2/Kc_i + s/c_i + 1}$$

(b) Determine the formula for the characteristic roots λ_1 and λ_2 of the closed-loop system in terms of K and c_i.

(c) Determine formulas for K and c_i in terms of the undamped natural frequency ω_n and damping ratio ζ for the closed-loop system.

(d) For $\omega_n = 20$ rad/sec. and $\zeta = 0.5$, determine the required values for K and c_i.

(e) Determine the steady-state response θ_{os} for $t > 0$ when the input is the unit ramp function defined as following (for the values of K and c_i obtained in (d)):

$$\theta_i = 0, \qquad t \le 0$$
$$= t, \qquad t > 0$$

What is the steady-state error?

#2 (15%) A control system has an open-loop transfer function given by

$$G(s) = \frac{K(c_i + s)}{s(s+2)^2}$$

(a) For $c_i = 1$, sketch the root locus for $0 < K < \infty$.

(b) Determine the value of c_i such that $-1.8 + j2$ lies on the root locus. What is the corresponding gain K?

(c) For the K in (b), what are the other two closed-loop roots ?

◀注意背面尚有試題▶

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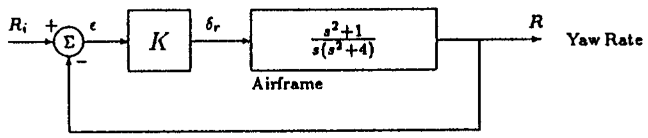
#3 (25%) Consider the closed-loop yaw damper control system shown below, where the system output is the airplane yaw rate R. We wish to make a root locus plot for $0 \leq K < \infty$.



(a) Show that the open-loop zeros are $\pm j$ and the open-loop poles are $0, \pm j2$.

(b) Find the angles at which the locus leaves the poles $\pm j2$ and the angles at which the locus terminates at the zero $\pm j$.

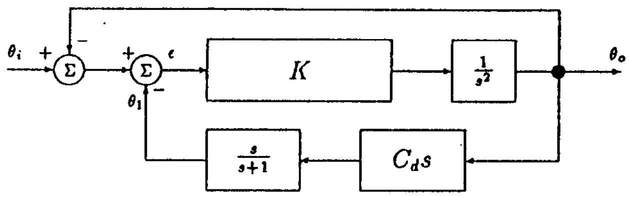
(c) Assume that the point $-.736 + j1.5$ is on the locus. Sketch the root locus.

(d) What is the gain constant K such that $-.736 \pm j1.5$ are closed-loop roots (a graphical calculation from your sketch is O.K.).

(e) What is the damping ratio ζ for the root pair in (d) ?

#4 (15%)

(a) Determine the closed-loop transfer function for the control system shown below.



(b) Will the closed-loop system as shown have a steady-state error for a constant velocity (ramp function) input ? Why?

(c) How many characteristic roots will the closed-loop system have ? Why?

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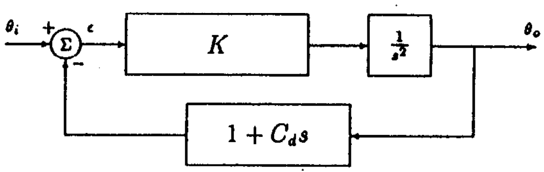
#5 (25%) The pure inertia plant shown in the figure below is part of a control system with proportional and derivative feedback.



(a) We wish to make a root locus plot for $0 < C_d < \infty$. Show in this case that the open-loop transfer function for such a root-locus plot is given by

$$G(s) = \frac{Ks}{K + s^2}$$

(b) Using $G(s)$ in (a) with $K = 4$, sketch the root locus plot for $0 < C_d < \infty$. To help in making your plot, calculate the angles at which the locus leaves the open loop poles and any breakaway points.

(c) From your root locus sketch in (b) estimate the value of the closed-loop roots corresponding to $\zeta = 0.5$.

(d) From your result in (c) determine (graphically, if you wish), the value of the rate-constant C_d which gives the roots shown.

(e) From the closed-loop transfer function, $Y(s) = \theta_0/\theta_i$, determine the analytic formula for the closed-loop characteristic roots in terms of K and C_d. For $K = 4$ determine C_d such that $\zeta = 0.5$. Compare with your result in (d).