國立臺灣科技大學 111 學年度碩士班招生試題
系所組別：自動化及控制研究所碩士班
科　　目：自動控制系統

（總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分）

1. Given the system shown in Figure 1, find the values of K and K_f so that the closed-loop dominant poles will have a damping ratio of 0.5 and the underdamped poles of the minor loop will have a damping ratio of 0.8. (15%)

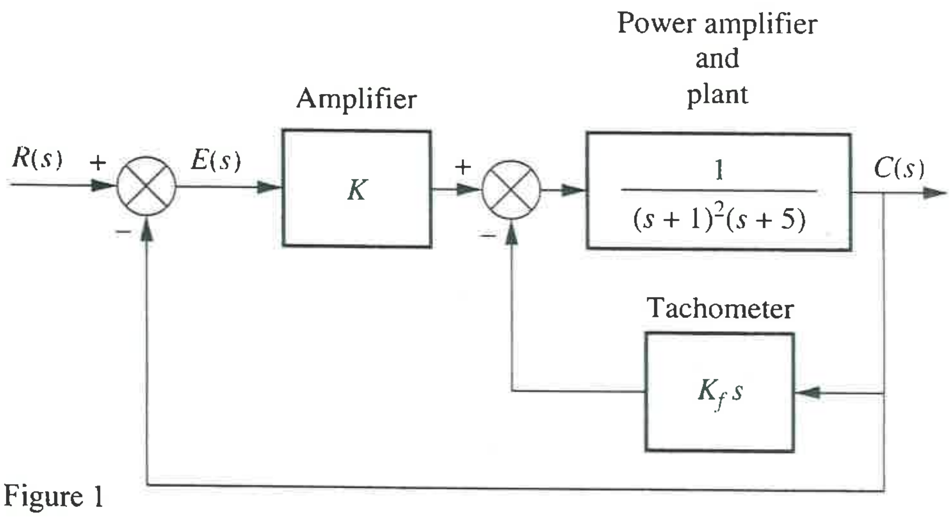

Figure 1

2. A ship's roll can be stabilized with a control system. A voltage applied to the fins' actuators creates a roll torque that is applied to the ship. The ship, in response to the roll torque, yields a roll angle. Assuming the block diagram for the roll control system shown in Figure 2, determine the gain and phase margins for the system. (20%)

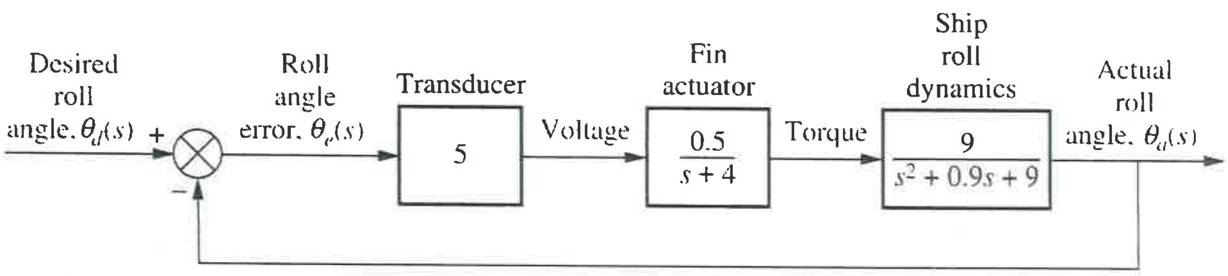

Figure 2. Block diagram of a ship's roll-stabilizing system

3. Sketch the root locus for the unity feedback system shown in Figure3, where

$$G(s)=\frac{K(s^2+4)}{(s+3)(s+4)}$$

Give the values for all critical points of interest. Is the system ever unstable? If so, for what range of K? (15%)

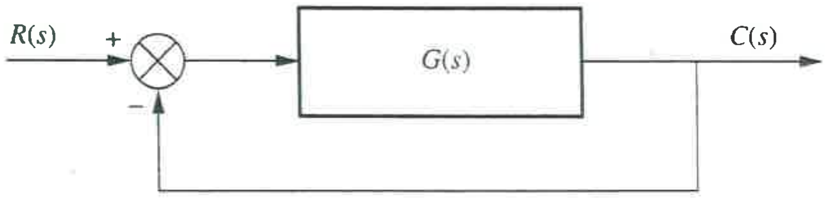

Figure 3

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4. Consider the open-loop system in Fig. 4(a)

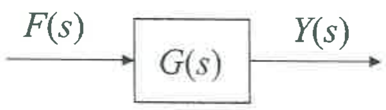

Fig. 4(a)

where $F(s)$ and $Y(s)$ are in the s domain; the corresponding $f(t)$ and $y(t)$ are in the time domain; $\frac{d^2y(t)}{dt^2} - \frac{g}{l}y(t) = z(t)$ and $f(t) = \tau\frac{dz(t)}{dt} + z(t)$. Our goal is to stabilize this system so the closed-loop feedback control will be defined as shown in the block diagram in Fig. 4(b). (18%)

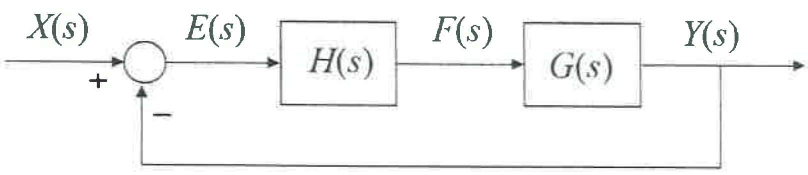

Fig. 4(b)

Assume $f(t) = k_p e(t) + k_d\frac{de(t)}{dt}$.

(1) Find the open-loop transfer function. (8%)

(2) Find the closed-loop transfer function. (10%)

5. Using the Routh-Hurwitz criterion, determine the stability of the closed-loop system that has the following characteristic equations. Determine the number of roots of each equation that are in the right-half s-plane and on the $j\omega$-axis. (16%)

(1) $s^6+2s^5+8s^4+15s^3+20s^2+16s+16 = 0$. (8%)

(2) $s^8+2s^7+8s^6+12s^5+20s^4+16s^3+16s^2 = 0$. (8%)

6. Find the time response of the following systems: (16%)

(1) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u.$ (8%)

(2) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-1 & -0.5\\ 1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0.5\\ 0\end{bmatrix}u,\ y = \begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}.$ (8%)