*Note: 請清楚標示答案

1. (25%) Considering the following state-space model $G:\begin{cases}\dot{x}=\begin{bmatrix}-1 & -1\\ 3 & 2\end{bmatrix}x+\begin{bmatrix}1\\1\end{bmatrix}u\\ y=\begin{bmatrix}1 & 1\end{bmatrix}x\end{cases}$

   (a) (5%) Find the corresponding transfer function $G(s)$.
   (b) (5%) Refer to the feedback structure of Figure 1 and suppose the controller K is constant, find the range of K such that the closed-loop system is stable.
   (c) (5%) Find the suitable value of K such that the damping-ratio of the closed-loop system is $\sqrt{3}/2=0.866$.
   (d) (5%) Derive the output response $y(t)$ to a unit step input $r(t)=\begin{cases}1, & \text{for } t\geq 0\\ 0, & \text{for } t<0\end{cases}$ with the K from (3).
   (e) (5%) According to (4), find the settling time (defined as variations less than 2%) of the response.

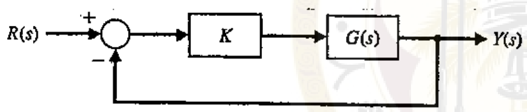

Figure 1

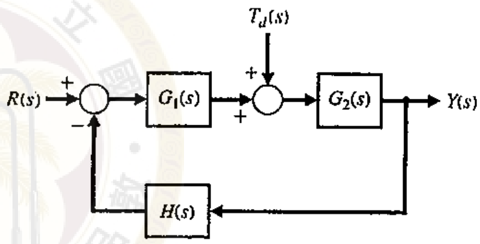

Figure 2

2. (25%) Considering the feedback system of Figure 2 with $G_2(s)=\dfrac{1}{s^2+2s+5}$ and $H(s)=1$, a first-order controller is required in order to arbitrarily assign the closed-loop pole.

   (a) (5%) Find a first-order controller $G_1(s)=K_1(s)=\dfrac{b_1s+b_0}{s+a_0}$, such that the characteristic equation of the closed-loop system is $\Delta(s)=(s+2)(s^2+4s+5)$.
   (b) (5%) Find the sensitivity of the closed-loop transfer function $T_{R\to Y}$ to the variations of a_0, using the parameters obtained from (1).
   (c) (5%) Find the steady-state error of the system due to a unit step input $R(s)$, using the first-order controller $K_1(s)$ from (1).
   (d) (5%) In order to eliminate the steady-state errors, an integral is normally applied to the controller, i.e. $G_1(s)=K_2(s)=\dfrac{b_2s^2+b_1s+b_0}{s^2+a_1s}$. Find the second-order controller $K_2(s)$ such that the characteristic equation of the closed-loop system is $\Delta(s)=(s+2)^2(s^2+4s+5)$.
   (e) (5%) Using the controller $K_2(s)$ from (4), find the transfer functions $T_{T_d\to Y}$, and the steady-state error of the output due to a unit step disturbance T_d.

見背面

3. (30%) A feedback control system shown in Figure 3 is to be designed to satisfy the following specifications: (1) steady state error for a ramp input ≤35% of input slope; (2) percentage overshoot for a step input ≤4.4%; (3) settling time to within 2% for a step input ≤3 sec; (4) peak time for a step input ≤ 2 sec.
   (a) (5%) If $G_c = K_1$ and $H_1 = 0$, explain why all specifications can not be met simultaneously.
   (b) (8%) If $H_1 = 0$, can the system with phase-lead or phase-lag controller G_c satisfies all the specifications? Explain your reasons.
   (c) (10%) If $G_c = K_1$ and $H_1 = K_2 s$, find appropriate parameters K_1 and K_2 of the system so all the specifications are met (using root locus technique).
   (d) (7%) Following (c), sketch Bode diagram of the closed-loop system.

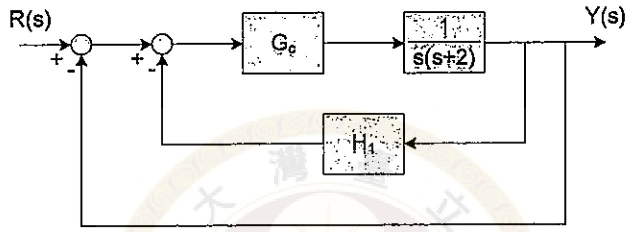

Figure 3

4. (10%) Sketch Nyquist diagram of the system whose bode diagram is shown in Figure 4.

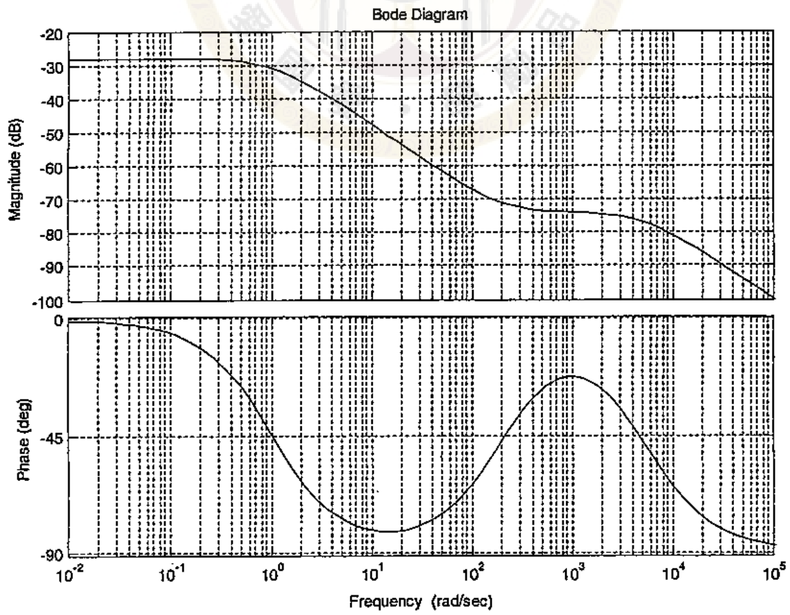

Figure 4

5. (10%) Analytically derive bandwidth ω_B of the closed-loop system with forward transfer function

$$G = \frac{\omega_n^{\ 2}}{s(s+2\zeta\omega_n)}$$ and negative unity feedback.

試題隨卷繳回