國立臺北科技大學

九十三學年度電機工程系碩士班入學考試

控制系統試題

填准考證號碼

注意事項：

1. 本試題共六題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. The signal flow graph (SFG) is shown in Fig. 1.
   (a) Find the number of forward paths and the associated forward path gains between Y_1 and Y_7. (5%)
   (b) Find the number of loops and the associated loop gains. (5%)
   (c) Find Y_7/Y_1. (5%)
   (d) Find Y_2/Y_1. (5%)
2. Consider the mechanical system shown in Fig. 2, where K_1, K_2, K_3 are spring constants, and B_1, B_2, B_3 are viscous frictional coefficients.
   (a) Determine the corresponding differential equation. (10%)
   (b) Find the dynamic equation with the output $y(t)=x_1(t)$ (5%)
3. For the system

$$\dot{x}=\begin{bmatrix}0 & 1\\ -3 & 2\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}u$$
$$y=\begin{bmatrix}0 & 1\end{bmatrix}x$$

   (a) Check the observability and controllability. (5%)
   (b) Design a state feedback law $u=-Kx+r$ such that the closed loop system has a damping ratio $\zeta = 1/\sqrt{2}$ and the peak time $t_p = \pi$. (5%)
   (c) Design a state observer such that the observer poles are -10, -10. (5%)

4. A unity negative feedback system has the following open-loop transfer function.

$$G(s)=\frac{K}{s(s+1)(s+5)}$$

Answer the questions about root locus.

(a) Determine the values of roots for $K=0$ and $K=\pm\infty$.(3%)

(b) What are the asymptotes and the intersection with the real axis. (3%)

(c) Find the separation points of the root locus. (3%)

(d) Determine the stability region of K. (3%)

(e) Find the intersection of the root locus with the imaginary axis. (3%)

(f) Draw the root locus for $0 \le K \le \infty$. (5%)

5. Consider the discrete data system with an ideal sampler shown in Fig. 3. Derive the expression of $C(z)/R(z)$ where $C(z)$ and $R(z)$ are z transforms of $R^*(s)$ and $C^*(s)$, provided that the sampling period is equal to T. (10%)

6. Consider a unity feedback system with the plant $G(s)=2500/s(s+25)$ and the controller $KD(s)$, where $D(s)=\frac{(Ts+1)}{(\alpha Ts+1)}$ and $\alpha>1$.

(a) Justify the type of compensation. (5%)

(b) Find the value of K such that the steady-state error to a unit ramp input is equal to 1/100. (5%)

(c) If the controller provides -20 dB attenuation, please find the value of α. (5%)

(d) Suppose the value of controller zero is chosen to be at 1/10 the value of 20 rad/sec. Find T. (5%)

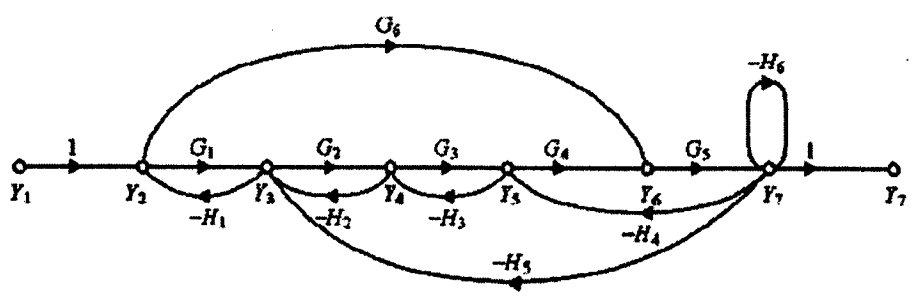

Fig. 1 SFG for Problem 1.

注意：背面尚有試題

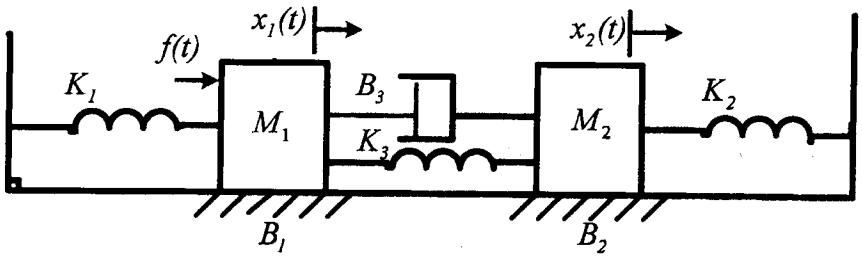

Fig. 2 Mechanical system form Problem 2.

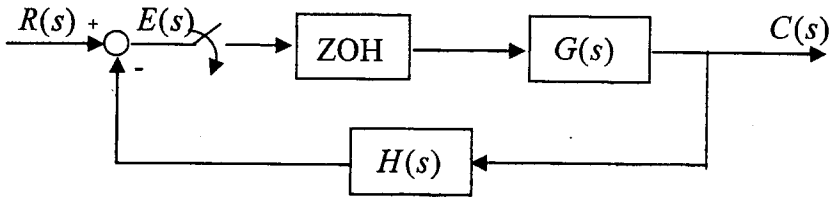

Fig. 3 Discrete system for Problem 5.