國立雲林科技大學 104 學年度 碩士班招生考試試題

系所：機械系

科目：自動控制

1. (20%) For the system shown in Fig. 1a, the unit step response is plotted in Fig. 1b. Which of the following combinations is correct? Please **explain** your choice.

(A)

$$G_1(s)=\frac{4}{s^2+4s+4} \quad G_2(s)=\frac{25}{s^2+s+25} \quad G_3(s)=\frac{100}{s^2+2s+100}$$

(B)

$$G_1(s)=\frac{100}{s^2+2s+100} \quad G_2(s)=\frac{25}{s^2+s+25} \quad G_3(s)=\frac{4}{s^2+4s+4}$$

(C)

$$G_1(s)=\frac{25}{s^2+s+25} \quad G_2(s)=\frac{4}{s^2+4s+4} \quad G_3(s)=\frac{100}{s^2+2s+100}$$

(D)

$$G_1(s)=\frac{25}{s^2+s+25} \quad G_2(s)=\frac{100}{s^2+2s+100} \quad G_3(s)=\frac{4}{s^2+4s+4}$$

Fig. 1a

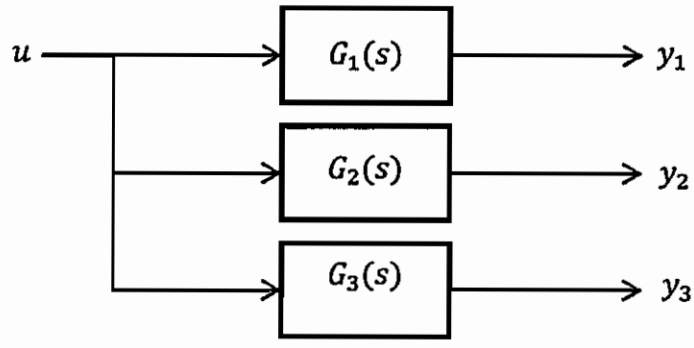
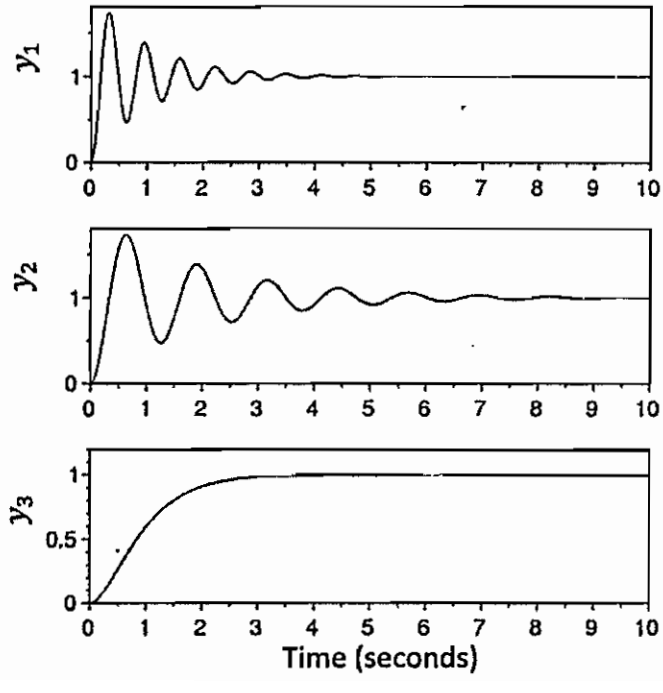


Fig. 1b



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2. Determine the transfer function between y and u for the following systems.

(A) Find $\frac{Y(s)}{U(s)}$ for the system shown in Fig. 2a, where u is the force applied to the mass and y is the displacement of the mass. (8%)

(B) Find $\frac{Y(s)}{U(s)}$ for the system shown in Fig. 2b. (8%)

Fig. 2a

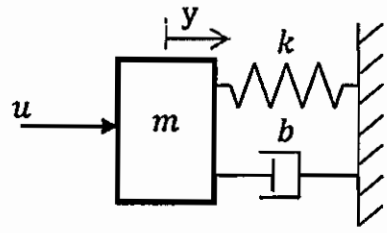
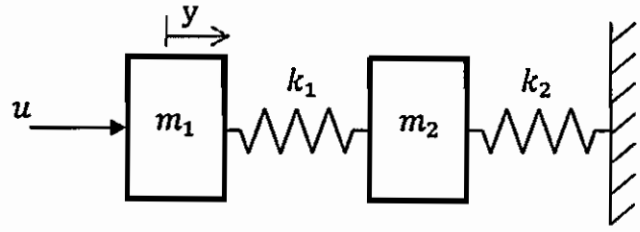


Fig. 2b



(C) Find $\frac{Y(s)}{U(s)}$ for the following system: (7%)

$$\ddot{x}_1 + 2\dot{x}_1 = x_2$$
$$\dot{x}_2 + x_2 = u$$
$$y = x_1$$

(D) Find $\frac{Y(s)}{U(s)}$ for the following system: (7%)

$$\begin{bmatrix}\dot{x}_1 \\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1 \\ -1 & -2\end{bmatrix}\begin{bmatrix}x_1 \\ x_2\end{bmatrix} + \begin{bmatrix}0 \\ 1\end{bmatrix}u$$

$$y = \begin{bmatrix}2 & 0\end{bmatrix}\begin{bmatrix}x_1 \\ x_2\end{bmatrix}$$

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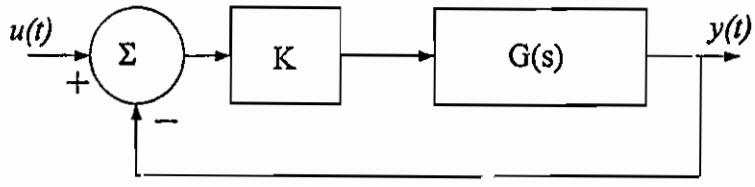
3. (total 50%)

A feedback control system is given as below:



The open loop transfer function G(s) is a rational function and $G(s) = N_o(s)/D_o(s)$, where $N_o(s)$ and $D_o(s)$ are two polynomials. The root-locus plot is shown in figure 3a

(1) If the control gain K changes from zero to infinite,
what is the direction of each locus segment in which the closed loop roots move along its root locus? (6%) and please show why they should be? (8%)

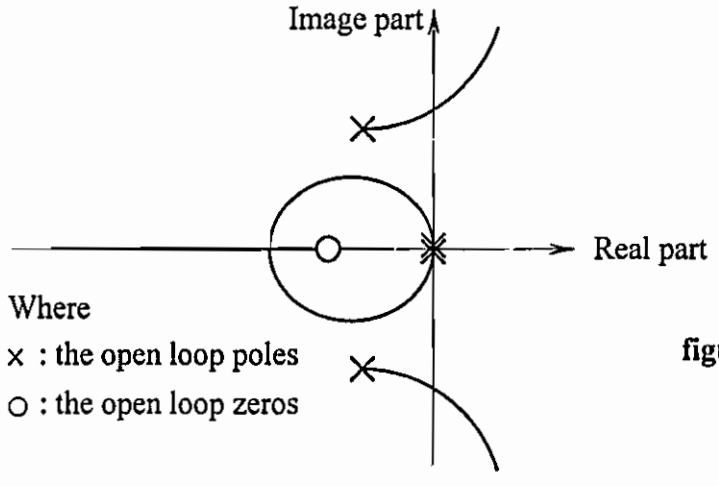


figure 3a

(2) According to the information given in figure3b, what is the stable range of control gain K if you apply the Routh's table and stability criterion to the given control system? (5%)

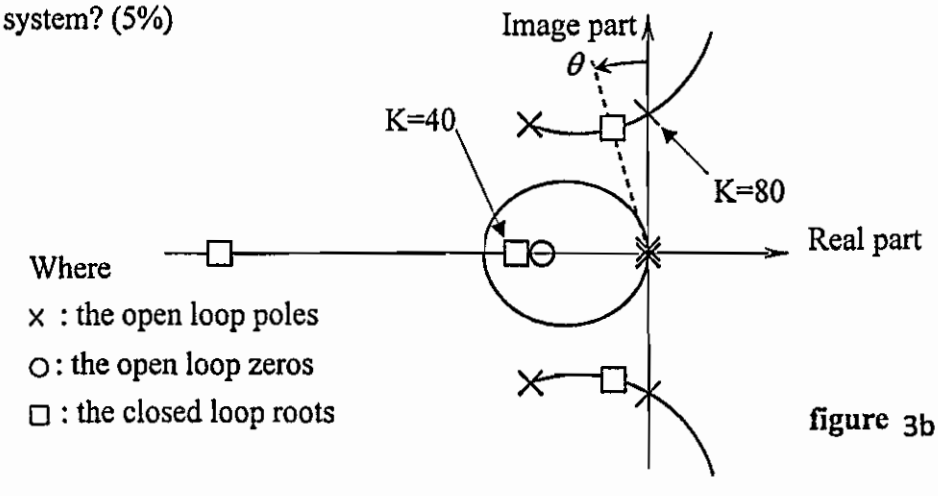


figure 3b

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(3) If the control gain K=40 is chosen as shown in figure 3b, is this control system stable? (3%) and please give the reason why it should be. (3%)

(4) What is the damping ratio of this control system with the control gain K=40 as shown in figure 3b, which may be estimated from **the dominant poles**, where $\theta = 15^{\circ}$? (10%)

(5) What is the gain margin (GM) in this control system if the control gain K=40 is chosen? (5%) Note that **the unit of dB** must be used in your answer.

(6) How do you improve the performance of this control system to **reduce the percentage of over shoot in its unit step response**? (5%)

(7) What is the steady state error for the input $u(t) = 10t$? (5%)