國立臺灣科技大學 108 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)

1. Consider the electrical circuits shown in Figure 1. Determine the transfer function. (10%)

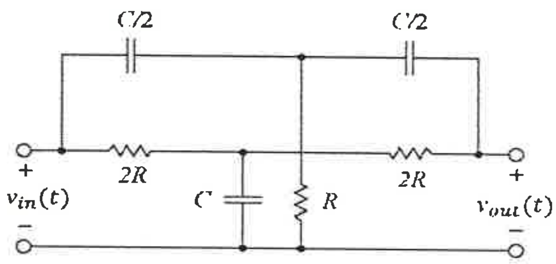

Figure 1

2. Given the dynamic equations of a time-invariant system:

$$\frac{d\mathbf{x}(t)}{dt} = \mathbf{A}\mathbf{x}(t) + \mathbf{B}u(t), \text{ and } y(t) = \mathbf{C}\mathbf{x}(t) \quad \text{where} \quad \mathbf{x}(t) = \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix}, \ \mathbf{A} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix},$$

$\mathbf{B} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$, and $\mathbf{C} = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix}$. Find the matrices $\mathbf{A}_1$ and $\mathbf{B}_1$ so that the state equations are written as $\frac{d\overline{\mathbf{x}}(t)}{dt} = \mathbf{A}_1\overline{\mathbf{x}}(t) + \mathbf{B}_1 u(t)$ where $\overline{\mathbf{x}}(t) = \begin{bmatrix} x_1(t) \\ y(t) \\ \frac{dy(t)}{dt} \end{bmatrix}$. (10%)

3. Draw a signal-flow diagram for the system with the state-space of

$$\frac{d\mathbf{x}(t)}{dt} = \begin{bmatrix} -5 & -6 & 3 \\ 1 & 0 & -1 \\ -0.5 & 1.5 & 0.5 \end{bmatrix}\mathbf{x}(t) + \begin{bmatrix} 0.5 & 0 \\ 0 & 0.5 \\ 0.5 & 0.5 \end{bmatrix}\mathbf{u}(t),$$

$$\mathbf{z}(t) = \begin{bmatrix} 0.5 & 0.5 & 0 \\ 0.5 & 0 & 0.5 \end{bmatrix}\mathbf{x}(t).$$

(10%)

4. The loop transfer function of a single-loop feedback control system is given as $G(s)H(s) = \frac{K(s+5)}{s(s+2)(1+Ts)}$. The parameters K and T may be represented in a plane with K as the horizontal axis and T as the vertical axis. Determine the regions in the T-versus-K parameter plane where the closed-loop system is asymptotically stable and where it is unstable. Indicate the boundary on which the system is marginally stable. (10%)

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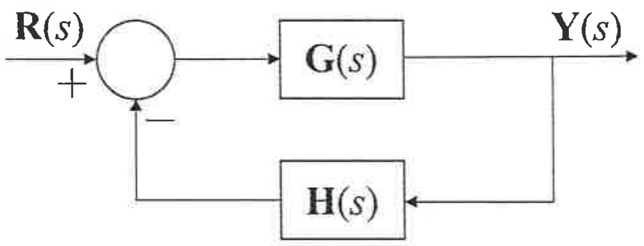
5. Consider that the forward-path transfer function matrix and the feedback-path transfer function matrix of the system shown in Figure 2 are

$\mathbf{G}(s) = \begin{bmatrix} \frac{2}{s(s+2)} & 10 \\ \frac{5}{s} & \frac{1}{s+1} \end{bmatrix}$, $\mathbf{H}(s) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, respectively. Find the closed-loop transfer function matrix.



(10%)

Figure 2

6. Suppose the state and output equations of a control system are given by

$$\dot{\boldsymbol{x}} = \begin{bmatrix} 0 & 3 & 1 \\ 2 & 8 & 1 \\ 10 & -5 & -2 \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} u$$

$$\boldsymbol{y} = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \boldsymbol{x}.$$

(a) Find the system transfer function G(s)=Y(s)/U(s). (6%)

(b) Evaluate the system stability. (4%)

(c) Find the number of poles in left-hand plane, right-hand plane and jw axis. (5%)

7. Sketch the root locus of the following control system for $K \geqq 0$ and a=1.

$$s(s^2 + 2s + a) + K(s + 2) = 0$$ (15%)

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8. Suppose the transfer function of a closed loop system is given by

$$\frac{Ke^{-T_d s}}{s(s+1)(s+2)}.$$

The Bode diagram for K=1 is shown in Figure 3.

(a) For T_d=0 sec, find Gain-crossover frequency, Gain margin, Phase-crossover frequency, Phase margin and the critical value of K for system stability. **(10%)**

(b) For T_d=1 sec, find Gain-crossover frequency, Gain margin, Phase-crossover frequency, Phase margin and the critical value of K for system stability. **(10%)**

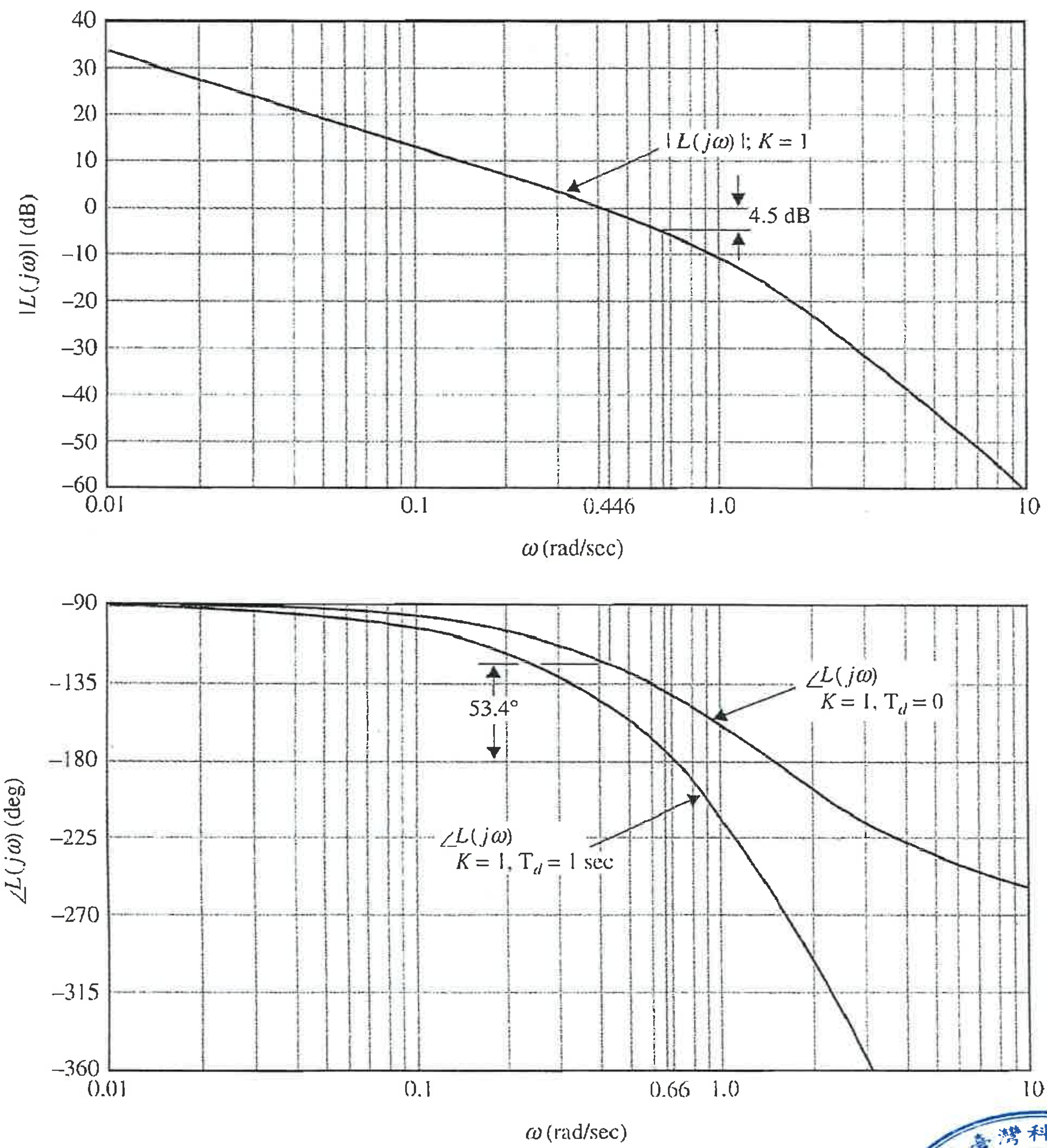

Figure 3