國立成功大學
111學年度碩士班招生考試試題

編　號：128

系　所：系統及船舶機電工程學系

科　目：自動控制

日　期：0219

節　次：第 2 節

備　註：可使用計算機

※ 考生請注意：本試題可使用計算機，請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Consider a linear system expressed as

$$\begin{aligned} \dot{X} &= AX + BU \\ Y &= CX + DU \end{aligned} \tag{1}$$

(i) Please derive the closed-loop transfer function $G(s) = \dfrac{Y(s)}{U(s)}$ for Eq. (1). (10%)

(ii) Based on Eq. (1), giving the system matrices and vectors as below: (10%)

$$A = \begin{bmatrix} -1 & -1 \\ 6 & 0 \end{bmatrix}, B = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, D = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Please find out the closed-loop transfer $G(s) = \dfrac{Y(s)}{U(s)}$

2. Consider the following linear system:

$$\begin{aligned} \dot{x} &= Ax + Br \\ y &= Cx \end{aligned} \tag{2}$$

where $r = \dfrac{1}{2}t^2$ is a parabolic input.

(i) Please present the steady-state error $e(\infty)$ based on A, B and C without using "Final value theorem". (10%)

(ii) Using the derived result of (i), please find out the steady-state error $e(\infty)$ for the following system: (10%)

$$\begin{aligned} \dot{x} &= \begin{bmatrix} 0 & 1 \\ -5 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \\ y &= \begin{bmatrix} 1 & 0 \end{bmatrix} x \end{aligned} \tag{3}$$

3. Derive the "Separation Principle" based on the given system in Eq. (4) and explain the meaning of separation principle in the practical control design. (20%)

$$\begin{aligned} \dot{x} &= Ax + Bu \\ y &= Cx \end{aligned} \tag{4}$$

4. Please linearize the following nonlinear system with the operating point $[x_{01} \quad x_{02} \quad x_{03} \quad x_{04} \quad u_0] = [0 \quad 0 \quad 0 \quad 0 \quad 0]$. (20%)

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = x_1^3 + 4x_2 + \sin(x_3) + 2u\cos(x_1)$$

$$\dot{x}_3 = x_4$$

$$\dot{x}_4 = 2x_1 + x_4\cos(x_2) + 3\mathrm{u}$$

5. Find out the phase crossover frequency ω_p, the gain crossover frequency ω_g, phase margin PM and gain margin GM of the bode plot as shown in Figure 1. (20%)

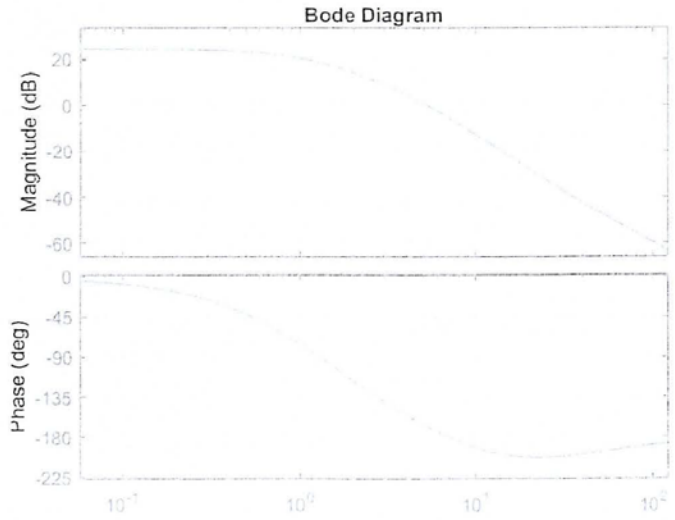

Figure 1