國立臺灣海洋大學103學年度研究所碩士班招生考試試題

考試科目：控制系統（含線性系統理論）

系所名稱：電機工程學系碩士班控制組

1. 答案以橫式由左至右書寫。2. 請依題號順序作答。

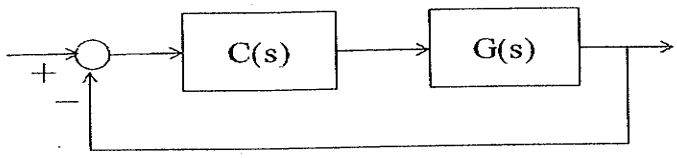

Figure 1: unity feedback system

Problem 1: Consider the system setup in Figure 1 with 20 %

$$G(s) = \frac{1}{s+2} \quad \text{and} \quad C(s) = \frac{K}{s+K}.$$

- Plot the root locus for $K > 0$ and compute its break points.
- Can you improve the steady-state error by designing K?

Problem 2: Consider the system setup in Figure 1 with 20 %

$$G(s) = \frac{1}{s(s-1)} \quad \text{and} \quad C(s) = K(s+0.5) \text{ (PD-controller)}.$$

- Find the stabilizing range of K by Routh criterion.
- Verify it again using Nyquist stability criterion.

Problem 3: Consider the system setup in Figure 1 with 20 %

$$G(s) = \frac{1}{s^2} \quad \text{and} \quad C(s) = K\,\frac{s+a}{s+b} \text{ (lead controller)}.$$

- In case without controller ($C(s) = 1$), what is the phase margin?
- Design K, a, b such that the system has crossover frequency $\omega_c = 2$ rad and PM $= 30^o$.

Problem 4: Consider the system 20 %

$$\begin{aligned}\dot{x}(t) &= Ax(t)+Bu(t)\\ &= \begin{bmatrix} 0 & 2 \\ -1 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 2 \\ -1 \end{bmatrix} u(t); \quad x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}\\ y(t) &= Cx(t)\\ &= \begin{bmatrix} -1 & -3 \end{bmatrix} x(t)\end{aligned}$$

- Transform the system (A, B, C) to $(\bar{A}, \bar{B}, \bar{C})$ with $\bar{A}$ being diagonal. Conclude the controllability of the system.
- Compute the zero input response of the system.

Problem 5: Consider the system 20 %

$$\begin{aligned}\dot{x}(t) &= Ax(t)+Bu(t)\\ &= \begin{bmatrix} 0 & 1 & 0 \\ 6 & 5 & 0 \\ 0 & 0 & -1 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u(t)\end{aligned}$$

- Is the system completely controllable?
- Can you design a state feedback $u(t) = -Kx(t)+v(t)$ such that all eigenvalues are at the same location?