國　立　清　華　大　學　命　題　紙

96 學年度 **動力機械工程學** 系（所） 乙 組碩士班入學考試

科目 控制系統 科目代碼 1101 共 叁 頁 第 壹 頁 *請在【答案卷卡】內作答

Note: Assuming whatever variables and/or parameters if necessary.

1. Considering the following feedback control system.

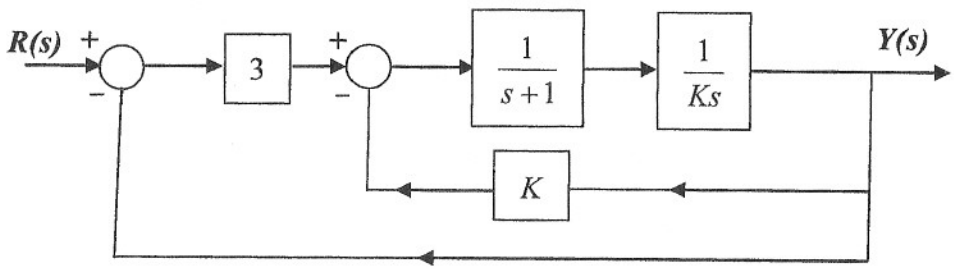

Fig. 1

(a) Obtain the transfer function of $\frac{Y(s)}{R(s)}$ (5 %)

(b) Draw a root locus for $-\infty < K < +\infty$ (10%)

(c) Determine the stability region for k (5%)

(d) Determine the maximum oscillating frequency. (5%)

2. Consider the following feedback control system, determine parameters K, α, and β such that the following specifications can be satisfied. (25%)

(a) K_v, the velocity constant, must be greater than $10\ sec^{-1}$

(b) Phase Margin (PM) must be greater than 45°

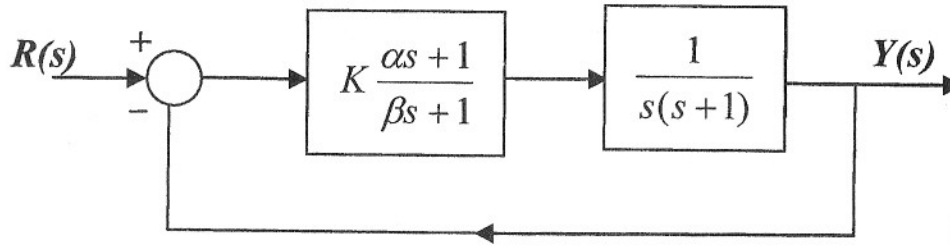

Fig. 2

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3. (a) Build a continuous-time state space representation for a system having a unit step response given by

$$y(t) = 2 - 2e^{-t} + te^{-t}; \quad for\ t \geqq 0 \qquad (5\%)$$

(b) Build a discrete-time state space representation for a system with the following discrete transfer function: $\dfrac{Y(z)}{U(z)} = \dfrac{0.4}{z^2(z-8)}$ (5%)

4. A state space model for a linear system is given by $(\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D})$, where

$$\mathbf{A} = \begin{bmatrix} -3 & 2 \\ 0 & -1 \end{bmatrix}; \ \mathbf{B} = \begin{bmatrix} -1 \\ 1 \end{bmatrix}; \ \mathbf{C} = \begin{bmatrix} -1 & \alpha \end{bmatrix}; \ \mathbf{D}=0$$

(a) Determine, if it exists, a state-feedback gain $\mathbf{K}$ such that the closed-loop poles are located at -5 and -6. (5%)

(b) Determine, if it exists, a state-feedback gain $\mathbf{K}$ such that the closed-loop natural modes have the form $\beta_1 e^{-2t}\cos(0.5t + \beta_2)$ (5%)

(c) Find the range of values of α for which the systems is completely observable. (5%)

(d) Choose a particular value of α that makes the system completely observable, and build an observer, whose error decays faster than e^{-5t}. (5%)

5. Consider a plant with input $u(t)$, input disturbance $d(t)$, and output $y(t)$. The nominal model of this plant is

$$Y(s) = G(s)(U(s) + D(s)), \text{ where } G(s) = \frac{2}{(s+2)}$$

If the disturbance is constant but unknown, build an observer that generates an estimate for the disturbance and for the model state. The characteristic equation of the observer should be chosen as $E(s) = s^2 + 8s + 40$. (Hint: $\dot{d} = 0$) (10%)

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6. Given a system

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}\mathbf{u}$$

Your task is to design a control law for $\mathbf{u}$ so that the state vector $\mathbf{x}$ can asymptotically track a desired state trajectory $\mathbf{x}_d$ where $\mathbf{x}_d$ is generated by the dynamic equation

$$\dot{\mathbf{x}}_d = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}\mathbf{x}_d \quad (\mathbf{x}_d(0) \neq \mathbf{0}).$$

Assuming both $\mathbf{x}$ and $\mathbf{x}_d$ are measurable, design such a controller. (10%)

**** ***The End*** ****