國立成功大學

115學年度碩士班招生考試試題

編　號：120

系　所：電機工程學系

科　目：控制系統

日　期：0203

節　次：第 2 節

注　意：1.不可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

1. (30%) Suppose the transfer function of a system is $G(s)=\dfrac{\omega_n^2(s+2)}{2(s^2+2\zeta\omega_n s+\omega_n^2)}$.

(a) (15/%) Suppose the unit step response for the system is described by

$y(t)=1-\dfrac{b}{a}e^{-ct}\cos(\omega_d t+e)$. Please derive and determine a,b,c,ω_d, and e.

(b) (15%) Derive and determine the step response overshoot, M_p, of this system.

2. (20%) A linear system is described by $\dot{\mathbf{x}}(t)=\mathbf{A}\mathbf{x}(t)+\mathbf{b}\mathbf{u}(t)$ and $\mathbf{y}(t)=\mathbf{c}\mathbf{x}(t)$, where

$$\mathbf{A}=\begin{bmatrix}0 & 1 & 0 & 0\\ 3\omega^2 & 0 & 0 & 2\omega\\ 0 & 0 & 0 & 1\\ 0 & -2\omega & 0 & 0\end{bmatrix},\ \mathbf{b}=\begin{bmatrix}0 & 0\\ 1 & 0\\ 0 & 0\\ 0 & 1\end{bmatrix},\ \mathbf{u}=\begin{bmatrix}u_1\\ u_2\end{bmatrix},\ \mathbf{c}=\begin{bmatrix}1 & 0 & 0 & 0\\ 0 & 0 & 1 & 0\end{bmatrix},\ \mathbf{y}=\begin{bmatrix}y_1\\ y_2\end{bmatrix}.$$

(a) (5%) Derive and determine whether the system is controllable?

(b) (5%) Derive and determine which input, or whether both inputs are controllable.

(c) (5%) Derive and determine whether the system is observable?

(d) (5%) Derive and determine which output, or whether both outputs are observable?

3. (10%) A system is described by $\dot{x}(t)=Ax(t)$ with $A=\begin{bmatrix}-1 & 0\\ 1 & -2\end{bmatrix}$. Suppose that the initial state is given by $x(0)=\begin{bmatrix}1\\ 1\end{bmatrix}$, determine the state at $t=1$. (Note: $e^1=2.7183$, $e^{-1}=0.3679$ and $e^{-2}=0.1353$).

4. (20%) For a unity negative feedback system with open loop transfer function $L(s)=\dfrac{as+1}{s^2(s+a)}$. Suppose that $a>1$,

(a) (10%) Determine the gain margin of the system.

(b) (10%) Determine the phase margin of the system.

5. (20%) A system is described by the following equation $\ddot{y}+\dot{y}-3y+y^3=u$ where y is the output and u is the input. Suppose that the input is $u=-2$,

(a) (10%) Find the equilibrium points of the system.

(b) (10%) Determine the local stability around each equilibrium point.