國立成功大學
113學年度碩士班招生考試試題

編　號：131

系　所：航空太空工程學系

科　目：自動控制

日　期：0201

節　次：第 1 節

備　註：不可使用計算機

編號： 131 國立成功大學 113 學年度碩士班招生考試試題

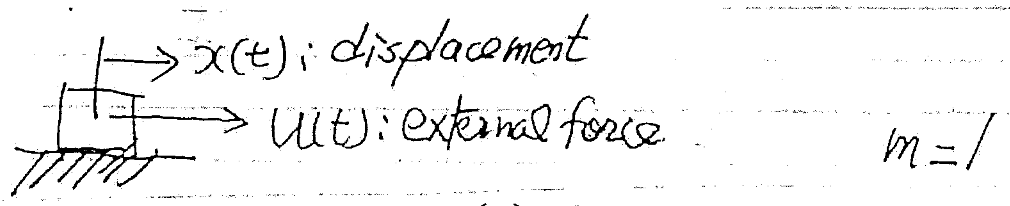
系 所：航空太空工程學系

考試科目：自動控制 考試日期：0201，節次：1

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

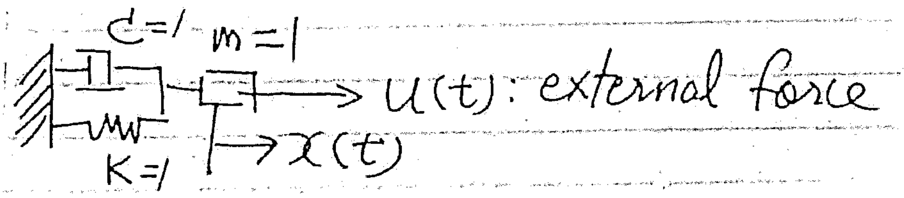
Prob. (一) Derive the state-space representation of the following dynamic systems and theirs “state transition matrix"

(10%) (i) For system:



Find $\frac{d}{dt}\vec{x}(t) = A_i\vec{x}(t) + B_i u(t)$ $\begin{matrix} x(t_0) = 0 \\ v(t_0) = 0 \end{matrix}$ and $e^{(t-t_0)A_i}$: state transition matrix

(10%) (ii)



Find $\frac{d}{dt}\vec{x}(t) = \frac{d}{dt}\begin{bmatrix} x(t) \\ v(t) \end{bmatrix} = A_{ii}\vec{x}(t) + B_{ii}u(t)$ and $e^{(t-t_0)A_{ii}}$

(10%) (iii) Discretize system (i) with $t = k \cdot \Delta t, k = 0, 1, 2, \cdots,$

$u(k) = u(k \cdot \Delta t) = \ u_k = \text{constant for } k\Delta t \le t < (k+1)\Delta t,$ so find

$$\begin{bmatrix} x_d(k+1) \\ v_d(k+1) \end{bmatrix} = A_d \begin{bmatrix} x_d(k) \\ v_d(k) \end{bmatrix} + B_k u_d(k), \begin{matrix} x_d(0) = 0 \\ v_d(0) = 0 \end{matrix}$$

(10%) (iv) Find and prove, for $\begin{bmatrix} y_1 \\ \vdots \\ y_m \end{bmatrix} = A_{\ell s} \begin{bmatrix} u_1 \\ \vdots \\ u_n \end{bmatrix}$

$A_{\ell s} \in R^{m \times n}$ $m < n$, the optimal solution that minimize

$$1/_2 \sum_{i=1}^{n} u_i^2$$

(10%) (v) For $\begin{cases} x_d(4) = 10 \\ v_d(4) = 0 \end{cases}$, $\Delta t = 1/_2$, with system (i), find $u_0^*, u_1^*, u_2^*, u_3^*$ that reach the goals and minimize

$$1/_2 \sum (u_0^2 + u_1^2 + u_2^2 + u_3^2)$$

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

(二) Consider the system shown in Fig.3 with $G(s)=\dfrac{2}{s^2}$.

(a). Draw the Bode plot of the system $G(s)=\dfrac{2}{s^2}$ (5%)

(b). Design a controller C(s) such that the resulting system has phase margin of 45° and gain crossover frequency of 10 rad/s. (10%)

(c). Draw the Nyquist plot of the system $G(s)C(s)$, and determine the corresponding gain margin by Nyquist plot. (10%)

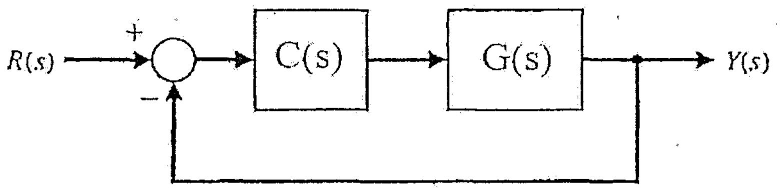


Fig.3

(三) Consider the system shown in Fig.3 with $G(s)=\dfrac{40}{(s+10)(s+2)(s+1)}$ and $C(s)=k_P+\dfrac{k_I}{s}$

(a). With $k_I = 0$, draw the closed-loop system root locus for $k_P > 0$. (10%)

(b). What will be the value of k_P such that the closed-loop system is critical stable (system output becomes oscillating) and what will be the period of the oscillatory output response (5%)

(c). For $k_P = 4$, determine the range of k_I such that the closed-loop system will be stable. (10%)