

大同大學 九十 學年度研究所碩士班入學考試試題

考試科目：控制系統

所別：電機工程研究所

第 2/2 頁

$\frac{16}{20}$

註：本次考試 不可以 參考自己的書籍及筆記； 不可以 使用字典； 不可以 使用計算器。

$4(5+85+16)$

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4. The forward-path transfer function of a unity-feedback control system is

$$G(s) = \frac{K}{(s+4)^4}$$

- (a) Construct the root loci of the characteristic equation of the closed-loop for $K \geq 0$ including the asymptotes, departure angles and breakaway points for each pole.
- (b) What is the range of values of K for which the system is unstable?

Handwritten calculations for problem 4:

$$\begin{aligned} & \frac{1+8+16}{1+8+16} = \frac{25}{25} \\ & \frac{16+1+8+16}{16+1+8+16} = \frac{41}{41} \\ & \frac{8+64+128}{1+8+16} = \frac{200}{25} = 8 \\ & \frac{1+16+96+246+256}{1+16+96+246+256} = \frac{514}{514} \\ & \frac{4+48+192+256}{4+48+192+256} = \frac{500}{500} \\ & \frac{4+32+64}{4+32+64} = \frac{100}{100} \end{aligned}$$

Root locus results:
 (8%) $-32 \pm j\sqrt{1000} = -32 \pm j31.62$
 (6%) $\frac{-32 \pm j31.62}{8}$

5. The block diagram of a guided-missile attitude-control system is shown in Fig. 3. The command input is $r(t)$, and $d(t)$ represents disturbance input.

- (a) Let $G_c(s) = 1$ and set $d(t) = 0$. Find the steady-state value of $e(t)$ when $r(t)$ is a unit-step function.
- (b) Let $G_c(s) = 1$ and set $r(t) = 0$. Find the steady-state value of $y(t)$ when $d(t)$ is a unit-step function.
- (c) Let $G_c(s) = (s+\alpha)/s$, $\alpha > 0$, and set $r(t) = 0$. Find the steady-state value of $y(t)$ when $d(t)$ is a unit-step function.

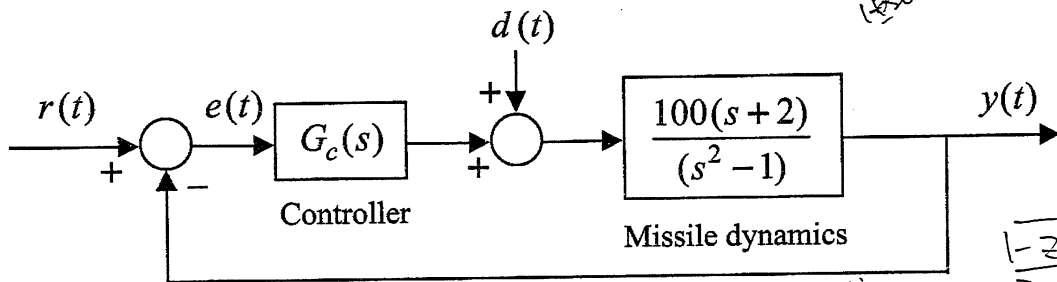


Fig. 3

Handwritten calculations for problem 5:

(a) $\lim_{s \rightarrow 0} \frac{1}{1 + \frac{100(s+2)}{(s^2-1)}} = \lim_{s \rightarrow 0} \frac{1}{1 + \frac{200}{-1}} = \lim_{s \rightarrow 0} \frac{1}{-199} = -\frac{1}{199}$

(b) $\lim_{s \rightarrow 0} \frac{100(s+2)}{(s^2-1)} = \frac{200}{-1} = -200$

(c) $\lim_{s \rightarrow 0} \frac{(s+\alpha)}{s} \cdot \frac{100(s+2)}{(s^2-1)} = \lim_{s \rightarrow 0} \frac{(s+\alpha) \cdot 100(s+2)}{s(s^2-1)}$

6. The block diagram of the discrete data control system is shown in Fig. 4.

- (a) Find the transfer function $G_T(z) = Y(z)/R(z)$ of the system.
- (b) Find $Y(z)$ when the input $r(t)$ is a unit-step function.
- (c) Find $y(kT)|_{k \rightarrow \infty}$ when the input $r(t)$ is a unit-step function.

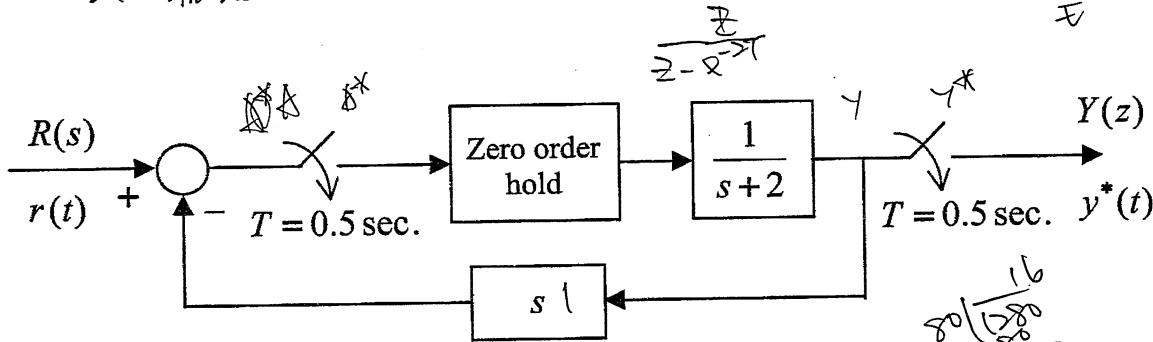


Fig. 4

Handwritten calculations for problem 6:

(a) $G_T(z) = \frac{1}{1 + \frac{1}{z-1}} = \frac{z-1}{z}$

(b) $Y(z) = \frac{1}{z} \cdot \frac{z-1}{z} = \frac{z-1}{z^2}$

(c) $\lim_{k \rightarrow \infty} y(kT) = \lim_{z \rightarrow 1} (z-1) Y(z) = \lim_{z \rightarrow 1} (z-1) \frac{z-1}{z^2} = \lim_{z \rightarrow 1} \frac{(z-1)^2}{z^2} = 0$

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1. Consider the block diagram of the system shown in Fig. 1.

(a) Find the impulse response of $y_1(t)$. (5%)

(b) Find the impulse response of $y_2(t)$. (5%)

(c) Find the value of $y_2(\pi/2)$. (5%)

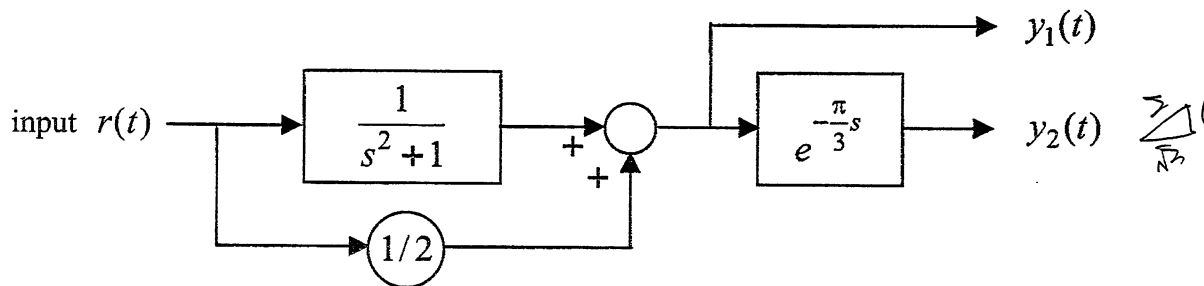


Fig. 1

$y_1(s) = \frac{1}{1-\frac{1}{2}-s^2}$

2. The state equation of the linear time invariant circuit system shown in Fig. 2 is

$$\dot{\mathbf{x}}(t) = \begin{bmatrix} 0 & -7 \\ 1 & -8 \end{bmatrix} \mathbf{x}(t) + \begin{bmatrix} 7 \\ 8 \end{bmatrix} u(t), \text{ where } \mathbf{x}(t) = \begin{bmatrix} i_L(t) \\ v_C(t) \end{bmatrix}$$

(a) Find the value of R, L and C. (9%)

(b) If input $u(t) = 0$, under the certain initial state $\mathbf{x}(0) = \begin{bmatrix} i_L(0) \\ v_C(0) \end{bmatrix}$, the output

$y(t) = v_C(t) = -e^{-t} + 7e^{-7t}, t \geq 0$. Find the initial state vector $\mathbf{x}(0)$. (6%)

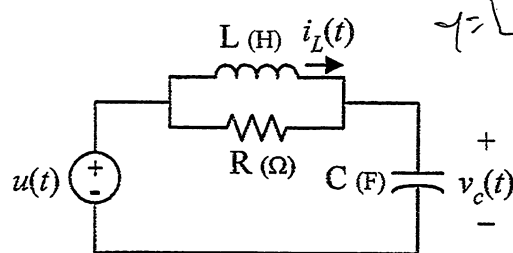


Fig. 2

$y = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \begin{bmatrix} i_L(t) \\ v_C(t) \end{bmatrix}$
 $u(t) = R i_L(t) + v_C(t)$
 $\frac{\lambda i_L(t)}{R} + i_L(t) = C v_C'(t)$

$i_L'(t) = -\frac{1}{C} v_C(t) + \frac{u(t)}{L}$
 $v_C'(t) = \frac{\lambda i_L(t)}{C} + \frac{i_L(t)}{C}$
 $= \frac{1}{C} (-\frac{1}{C} v_C(t) + \frac{u(t)}{L}) + \frac{i_L(t)}{C}$
 $= \frac{\lambda i_L(t)}{C} - \frac{1}{C^2} v_C(t) + \frac{u(t)}{C L}$
 $\begin{bmatrix} -\lambda & -1 \\ 1 & -8-\lambda \end{bmatrix} + \frac{u}{C L}$
 $= \lambda^2 + 8\lambda + 7$
 $= (\lambda+7)(\lambda+1)$

3. The flow of traffic in a single lane can be described by the following dynamical equation:

$$\frac{dy}{dt} = V - A e^{-\alpha/y},$$

where y = relative distance between two cars,
 V = constant velocity of the lead car,
 A, α = real positive constants.

(a) Obtain the equilibrium value Y that results in $dy/dt = 0$. (6%)

(b) Obtain the range of V/A in $0 \leq V/A \leq \infty$ for which $Y > 0$. (6%)

(c) Linearize the equation around Y , and write the resulting linearized equation. (6%)

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$y_1 = 9 - 7Y$
 $(9-7Y)Y = 0$