國立台灣科技大學九十五學年度碩士班招生試題

系所組別： 電機工程系碩士班乙二組

科　　目： 控制系統

『總分 100 分』

1. Given the Laplace transform of a time function $y(t)$, $t \geq 0$,
$Y(s) = \dfrac{\omega_n^2}{(s + 2\omega_n s + \omega_n^2)s^2}$, $\omega_n > 0$, compute $y(t)$. (10%)

2. Sketch the Nyquist plot of the loop transfer function $L(s) = \dfrac{Ks}{s^2 - 25}$ as shown in the Figure P2; and apply the Nyquist Stability Criterion to find the range of gain K, $K > 0$, such that the closed loop system is stable. Please note that there is no credit if you use other methods to check the system stability. (20%)

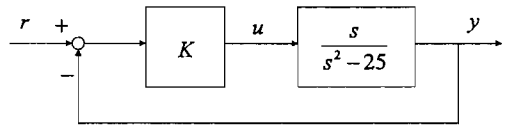

Figure P2

3. Consider an unity feedback system as shown in the Figure P3, where
$G(s) = \dfrac{4}{(s+2)(s+4)}$, design a phase lead-lag controller
$KG_c(s) = K\beta \dfrac{1 + T_2 s}{1 + \beta T_2 s} \dfrac{1 + T_1 s}{1 + \alpha T_1 s}$, $0 < \alpha < 1$, $\beta > 1$ and $T_1, T_2 > 0$,
such that the loop transfer function, $L(s) = KG_c(s)G(s)$, satisfies (a) position error constant $K_P \geq 100$, (b) phase margin $PM \geq 45°$, and (c) gain crossover frequency $20 \leq \omega_c \leq 30$. (20%)

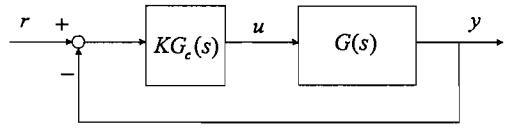

Figure P3

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4. The state equation of a linear time-invariant system is represented by

$$\dot{X}(t) = AX(t) + Bu(t)$$

Given that

$$A = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \quad \text{and} \quad B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

(a) Compute the eigenvalues and eigenvectors of the matrix A (5%).

(b) Find the state transition matrix $\phi(t) = e^{At}$ using the infinite series expansion of e^{At} and express it in a closed form (10%).

(c) Find the state transition matrix $\phi(t) = e^{At}$ using the inverse *Laplace* transform of $(sI - A)^{-1}$ (5%).

5. The block diagram of a control system is shown in Fig. P5.

(a) Determine the transfer function $\frac{C(s)}{R(s)}$ (10%).

(b) Determine what value (or values) of K must be avoided if the system is to be both completely state controllable and observable (10%).

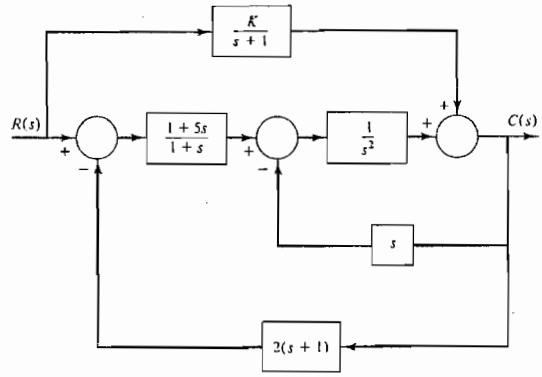

Figure P5

6. Find the following gain relations for the signal flow graph shown in Figure P6.

(a) $\frac{y_7}{y_1}$ when the input $y_8 = 0$ (5%)

(b) $\frac{y_7}{y_8}$ when the input $y_1 = 0$ (5%)

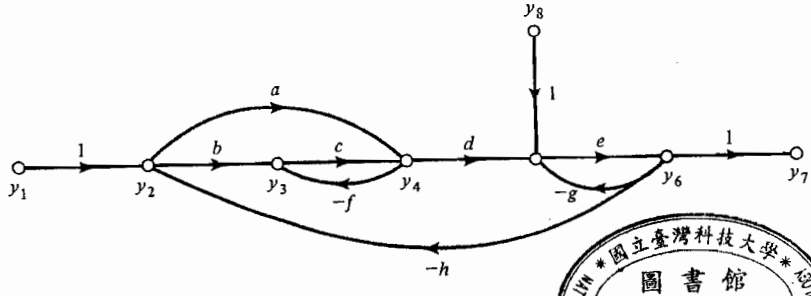

Figure P 6

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