國立臺灣科技大學 110 學年度碩士班招生試題

系所組別：自動化及控制研究所碩士班

科　　目：自動控制系統

(總分為 100 分)

1. Given the system represented in state space as follows:

$$\dot{\mathbf{x}} = \begin{bmatrix} -1 & -7 & 6 \\ -5 & 4 & 3 \\ 4 & 7 & -8 \end{bmatrix}\mathbf{x} + \begin{bmatrix} -5 \\ -1 \\ 5 \end{bmatrix} r$$

$$y = [-9 \quad -9 \quad -8]\mathbf{x}.$$

Convert the system to one where the new state vector, $\mathbf{z}$, is

$$\dot{\mathbf{z}} = \begin{bmatrix} -4 & 9 & -3 \\ 0 & -4 & 7 \\ -1 & -4 & -9 \end{bmatrix}\mathbf{x}.$$ (10%)

2. For the system shown in Fig. Problem 2, a step torque is applied at $\theta_1(t)$.

Find the transfer function, $G(s) = \theta_2(s)/T(s)$, and the peak time for $\theta_2(t)$. (15%)

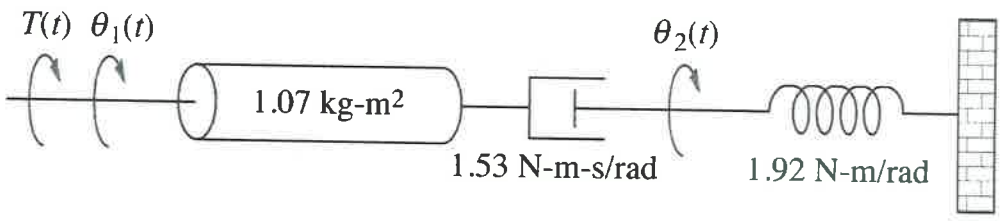

Fig. Problem 2.

3. For the circuit shown in Fig. Problem 3, find the values of R_2 and C to yield 8% overshoot with a settling time of 1 ms for the voltage across the capacitor, with $v_i(t)$ as a step input. (25%)

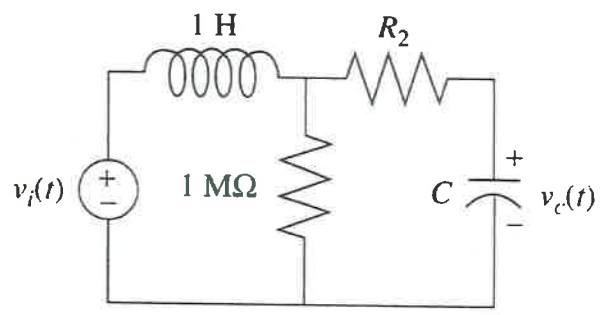

Fig. Problem 3.

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4. The block diagram of a control system with tachometer feedback is shown in Fig. Problem 4. Construct the root loci of the characteristic equation for $K \geq 0$ when $K_t \geq 0$. (13%)

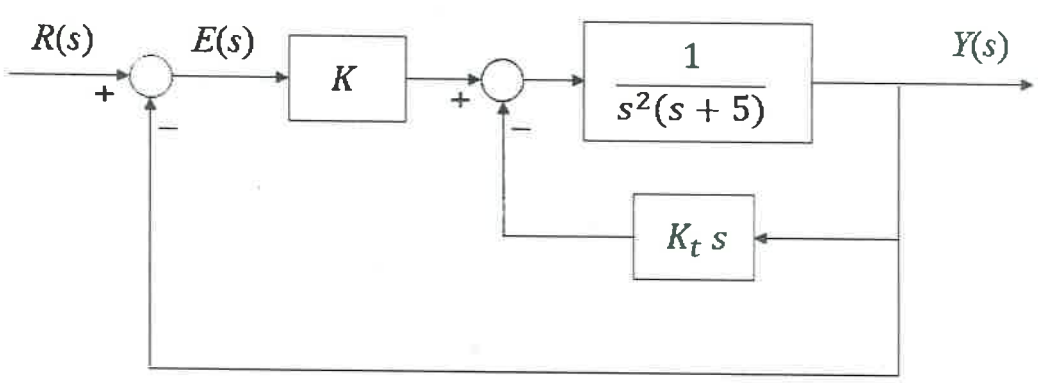

Fig. Problem 4.

5. The characteristic equation of a linear control system is given in the following equation $s(s^3 + 2s^2 + s + 1) + K(s^2 + s + 1) = 0$.

(a) Apply the Nyquist criterion to determine the values of K for system stability. (15%)

(b) Check the answers by means of the Routh-Hurwitz criterion. (10%)

6. Determine the conditions on b_1, b_2, c_1, and c_2 so that the following system is completely controllable and observable. (12%)

$$\frac{d\mathbf{x}(t)}{dt} = \mathbf{A}\mathbf{x}(t) + \mathbf{B}\mathbf{u}(t), y(t) = \mathbf{C}\mathbf{x}(t),$$

$$\mathbf{A} = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}, \mathbf{B} = \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}, \mathbf{C} = [c_1 \quad c_2].$$