大同大學九十三學年度研究所碩士班入學考試試題

考試科目：控制系統　　：電機工程研究所　　

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。

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1. Consider the network shown in **Fig. 1**, where $R_1 = 1\Omega$, $R_2 = 2\Omega$, $L_1 = 2H$, $L_2 = 1H$, and $C = 1F$. The voltage across the capacitor, $e_c(t)$, and the currents in the inductors, $i_1(t)$ and $i_2(t)$, are assigned as the state variables, as shown in **Fig. 1**. Define the state vector $\mathbf{x} = [\, i_1(t) \quad i_2(t) \quad e_c(t) \,]^T$.

(a) Write the state equations of the network in vector-matrix form: $\dot{\mathbf{x}}(t) = \mathbf{A}\,\mathbf{x}(t) + \mathbf{B}\,e(t)$, where $\dot{\mathbf{x}}(t) \equiv [\, di_1(t)/dt \quad di_2(t)/dt \quad de_c(t)/dt \,]^{\mathrm{T}}$. (12%)

(b) Find the transfer functions $I_1(s)/E(s)$ and $I_2(s)/E(s)$ of the network. (12%)

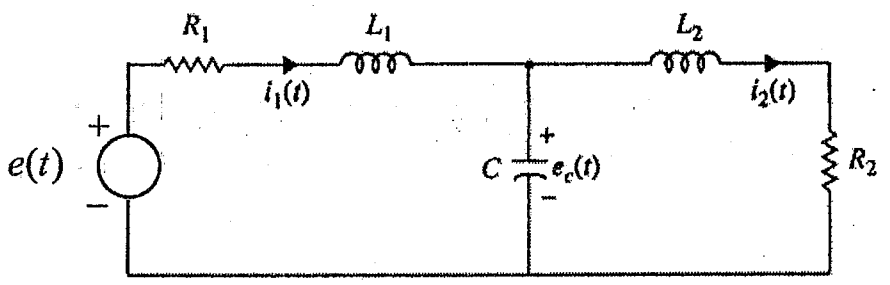

Fig. 1

2. **Fig. 2** shows the block diagram of a dc-motor control system. The signal $N(s)$ denotes the frictional torque at the motor shaft.

(a) Find the transfer function $H(s)$ so that the output $Y(s)$ is not affected by the disturbance torque $N(s)$. (8%)

(b) With $H(s)$ as determined in part (a), find the value of K so that the steady-state value of $e(t)$ is equal to 0.1 when the input is a unit-ramp function, $r(t) = tu_s(t)$, $R(s) = 1/s^2$, and $N(s) = 0$. Apply the final-value theorem. (8%)

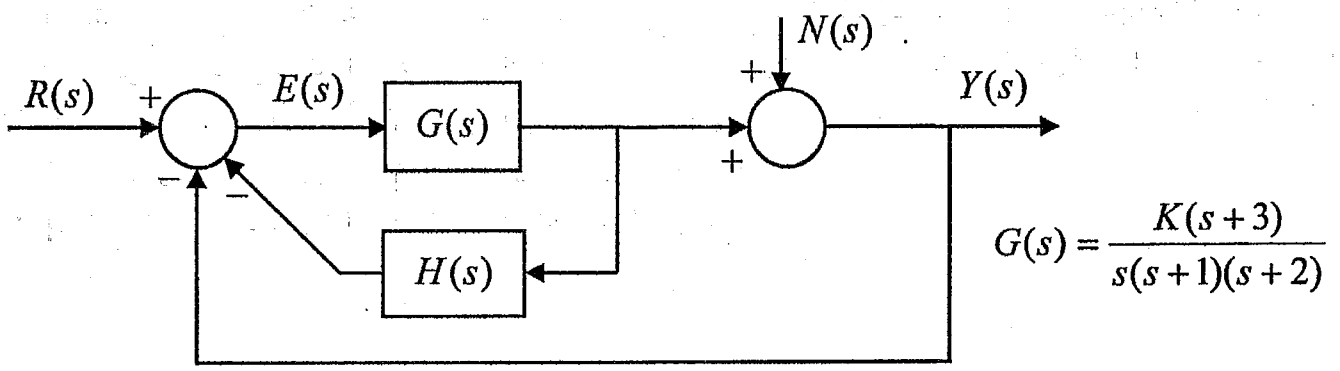

Fig. 2

3. Design a compensator using pole placement for the plant with transfer function $1/s^2$. Place the control poles at $\omega_n = 1$ rad/sec (the natural frequency), $\xi = 0.707$ (the damping ratio), and place the estimator poles at $\omega_n = 5$ rad/sec, $\xi = 0.5$. (14%)

TO BE CONTINUED

4. For a unity-feedback control system with the open-loop transfer function

$$G(s) = \frac{b}{s(s+a)}$$

Find values for a and b so that the damping ratio is $\xi = 0.707$ and the velocity constant $k_v = 20\ \text{sec}^{-1}$. (16%)

5. The block diagram of a control system is shown in **Fig. 3.**

(a) Write the dynamic equation in vector-matrix form:

$\dot{\mathbf{x}}(t) = \mathbf{A}\,\mathbf{x}(t) + \mathbf{B}\,u(t)$, $y(t) = \mathbf{C}\mathbf{x}(t)$, where $\mathbf{x}(t) \equiv [\,x_1(t) \quad x_2(t)\,]^T$. (10%)

(b) Determine the condition on α and β so that the system is completely controllable. (5%)

(c) Determine the condition on α and β so that the system is completely observable. (5%)

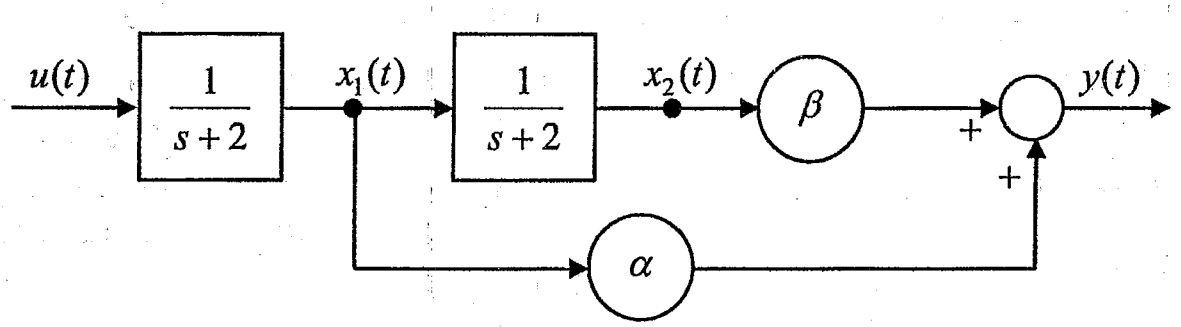

Fig. 3

6. The block diagram of a discrete-data system is shown in **Fig. 4.**
If the input $u(t) = u_s(t)$, unit step function, ideal sampler T=1 sec.

(a) Find $Y_1(z)$. (5%)

(b) Find $Y_2(z)$. (5%)

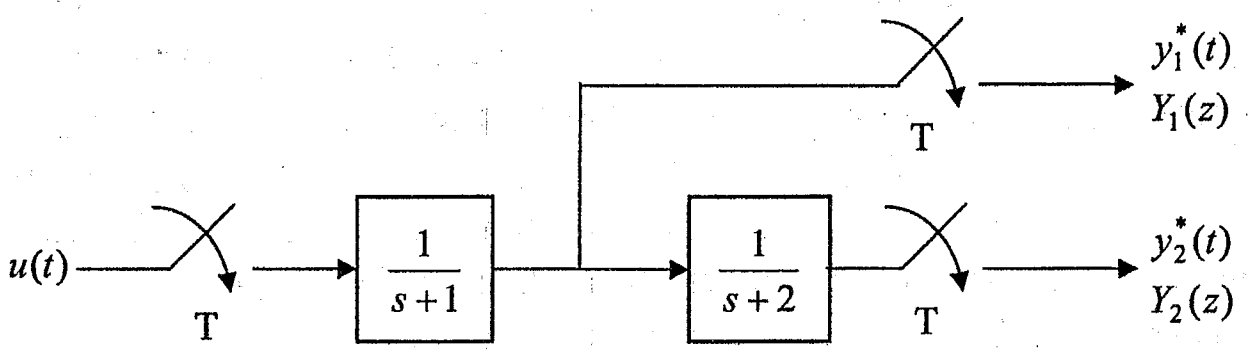

Fig. 4

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