國立臺灣科技大學
113學年度碩士班招生

試題

系所組別：0340機械工程系碩士班丁組

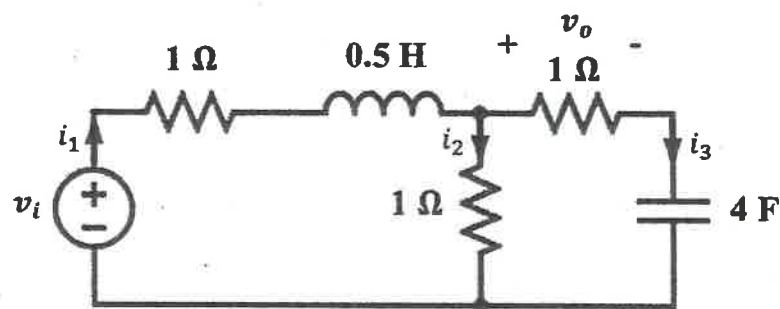科　　目：系統控制

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（ 總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分 ）

1. (20%) A circuit diagram is shown below. The input is v_i, and the output is v_o. Answer the following questions.

(a) (5%) Write the system of differential equations where i_2 and i_3 are independent variables.

(b) (5%) Derive the state-space representation with i_2 and i_3.

(c) (5%) If the initial conditions are zero, find the transfer function of the output.

(d) (5%) If v_i is a unit step input, evaluate the response of the output in the time domain. Hint: $\mathcal{L}\{e^{at}\sin bt\} = \dfrac{b}{(s-a)^2+b^2}$
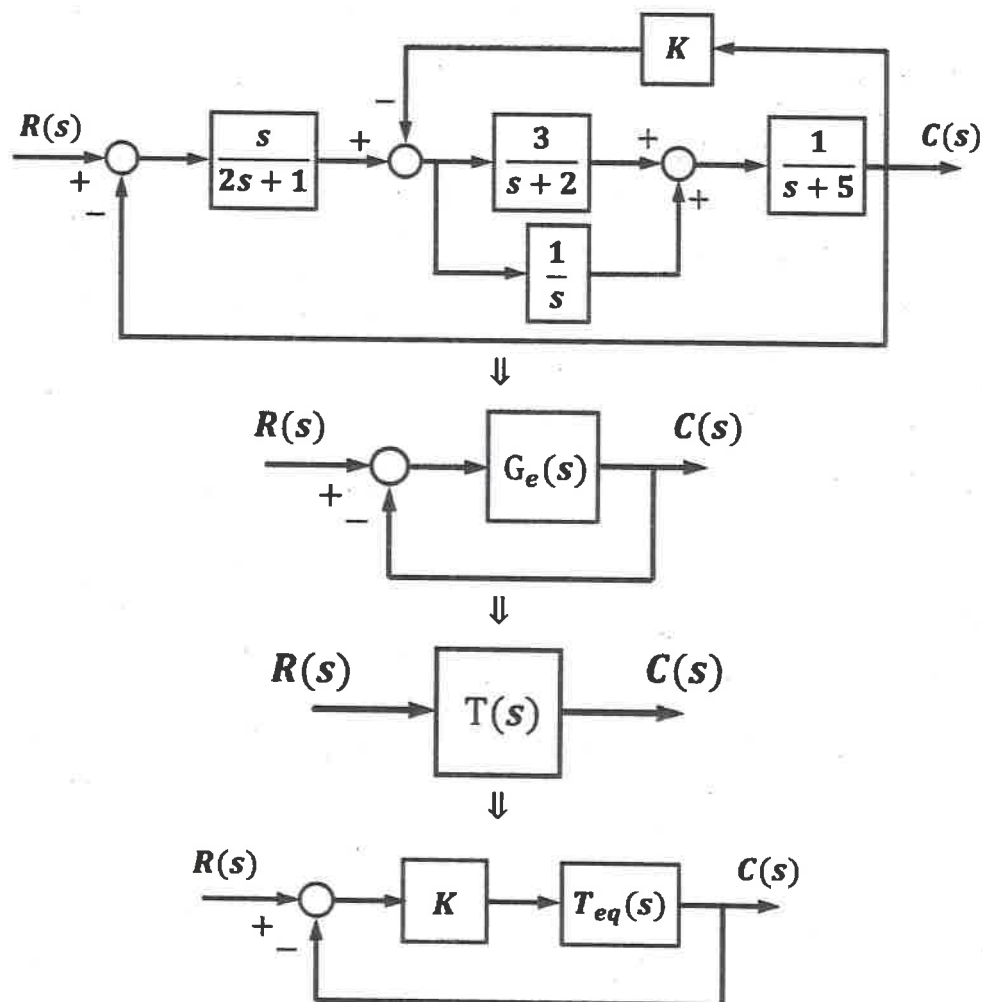
（總分為100分；所有試題務必於答案卷內頁依序作答，否則不予計分）

2. (20%) The block diagram of a control system is shown below. Answer the following questions.

(a) (5%) Derive the transfer function $G_e(s)$ in a unity feedback structure.

(b) (5%) Find the closed-loop transfer function $T(s)$.

(c) (5%) Derive the equivalent open-loop transfer function $T_{eq}(s)$ treating K as the gain.

(d) (5%) Sketch the root locus.

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3. (10%) A closed-loop transfer function is given as below, determine the coefficients k_1 and k_2 if the overshoot is 5% and the settling time is 0.5 seconds when applying a unit-step input.

$$C(s) = \frac{9}{k_1 s^2 + (k_2 + 3)s + 9}$$

4. (5%) Consider the following equation, where $s = \sigma + j\omega$, as $j = \sqrt{(-1)}$, thus s is a complex number:

$$F(s) = \int_0^\infty f(t)e^{-st} dt$$

Please answer if the following statement is either true or false.

(a) This equation is called a heavy side (or one sided) Laplace transform

(b) Standard Laplace Transform has an integral range from $\int_{t=-\infty}^{\infty}$.

(c) This equation is the same as $\mathcal{L}\{f(t)u(t)\}$, where $u(t) = \begin{cases} 1, t > 0 \\ 0, t \le 0 \end{cases}$, is a unit step function

(d) If the above equation's variable $s = j\omega$, it can be called a Fourier transform as well.

(e) If $F(s) = 1/s$, then $f(t) = u(t)$ for standard Laplace transform, but in the above equation, $f(t) = 1$.

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5. (25%) A matrix is given below. Please answer the following question.

$$A = \begin{bmatrix} 1 & 0 \\ 0 & -2 \end{bmatrix}$$

(a) (5%) Please find the eigen value of the matrix.

(b) (10%) Please show that the eigen vectors are $e_1 = k_1 \begin{bmatrix} 1 \\ 0 \end{bmatrix}$, $e_2 = k_2 \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, and the range space of matrix A is an Identity Matrix.

(c) (10%) Find $e^{At} = I + At + A^2 \frac{t^2}{2!} + A^3 \frac{t^3}{3!} + \cdots$.

6. (20%) Simplify the following block diagram, find the equivalent form transfer function $G(s) = \frac{C(s)}{R(s)}$, and find the following answers.
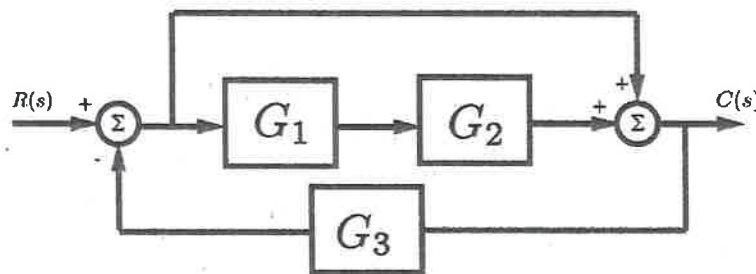
(a) (5%) What is $G(s)$ in terms of $G_1, G_2,$ and G_3?

(b) (5%) If $G_1(s) = \frac{1}{s}$, $G_2(s) = \frac{1}{(s-2)}$, and $G_3(s) = \frac{1}{(s-4)}$, what is $\lim_{s \to 0} G(s) =$?

(c) (10%) Considering closing the above system $G(s)$, with a unity feedback loop, as shown here:
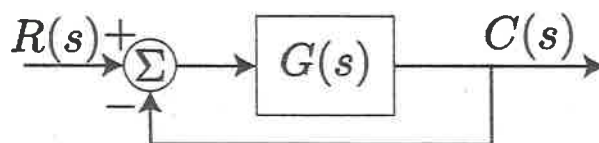
What is the steady state error for this feedback system, provided with a unit step input? Hint: $r(t) = u(t)$, $R(s) = \frac{1}{s}$, and $e(\infty) = \lim_{s \to 0} sE(s)$