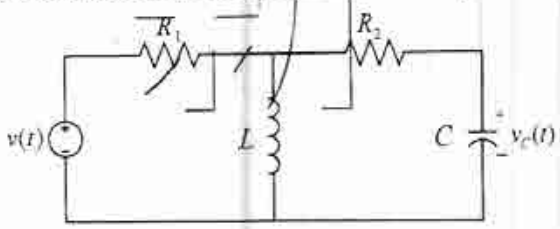
考生注意：1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分，並限以藍黑色筆作答。
3. 試題隨卷繳回，(餘請詳閱試場規則)

1. (20 pts.) In the frequency domain analysis of control systems, there is a wealth of graphical methods available. **Describe** what Bode diagram and Nyquist plot are, and **list** the advantages and disadvantages of them for comparison.

2. (30 pts.) Consider the system of a RLC network in the following:



   (a) **Determine** the transfer function from the voltage source input $v(t)$ to the output $v_C(t)$, the voltage across the capacitor.

   (b) **Find** the values of R_1, R_2, L and C to minimize the steady-state error, which is defined by $\lim_{t\to\infty} e(t)$ with $e(t) = v(t) - v_C(t)$ for a unit step input.

   (c) For $R_1 = 1\,\Omega$, $R_2 = 0$, $L = 2\,H$ and $C = 0.5\,F$, **determine** the zero-state response of the system for a unit step input if the output is chosen as the current through the capacitor.

3. (30 pts.) Consider the single-input-single-output system defined by the following dynamic equations, where $x(t)$ is the state vector, $y(t)$ is the output and $u(t)$ is the input:

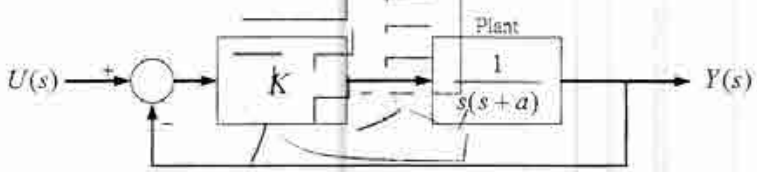
$$\dot{x}(t) = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} x(t) + \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} u(t) \quad \text{and} \quad y(t) = \begin{bmatrix} c_1 & c_2 \end{bmatrix} x(t).$$

   (a) **Determine** the conditions on b_1, b_2, c_1, and c_2 so that this system is completely controllable and observable.

   (b) Let $u(t) = r(t) - Kx(t)$, where $r(t)$ is a reference input, and $K = \begin{bmatrix} k & k \end{bmatrix}$, k is a real constant. If the required conditions in part **(a)** are totally violated, **determine** the values of k so that the resulting feedback system is either controllable or observable.

   (c) Let $b_1 = b_2 = c_1 = c_2 = 1$ and $u(t) = -\begin{bmatrix} -3 & k_2 \end{bmatrix} x(t)$, where $k_2 > 0$. **Determine** the value of k_2 so that the resulting feedback system is stabilized and all the closed-loop poles are repeated.

4. (20 pts.) For a unit-step input $U(s) = \frac{1}{s}$ and a given positive constant a, the unity feedback second-order control system is shown as follows:



   (a) **Determine** the values of control gain K so that the system can be classified to be **(i)** underdamped, **(ii)** overdamped, **(iii)** critically damped, or **(iv)** undamped, if possible.

   (b) **Sketch** the system output $y(t)$ roughly for each case in part **(a)**.