

國立臺北科技大學

101 學年第二學期電機系博士班資格考試

現代控制理論 試題

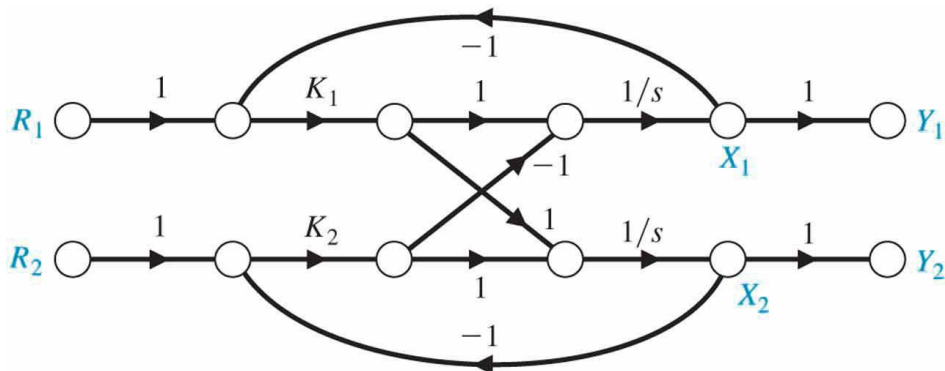
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注意事項：

1. 本試題共 5 題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在試卷答案欄內，否則不予計分。
4. 考試時間：二小時。
5. 可用計算機。

1. For the following two-axis control system,
 - a) (10%) Find the state differential equation.
 - b) (10%) Find the state transition matrix for $K_1=1$ and $K_2=1$.



2. Consider the system defined by

$$\dot{\mathbf{x}} = \begin{bmatrix} -1 & 0 & 1 \\ 1 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = [1 \quad 1 \quad 0] \mathbf{x}$$

Transform the system equations into

- a) (10%) controllable canonical form.
- b) (10%) observable canonical form.

3. (20%) Consider the following 2nd-order system

$$\dot{\mathbf{x}} = \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \mathbf{x} + \begin{bmatrix} k_1 \\ k_2 \end{bmatrix} u$$

$$y = [1 \quad 0] \mathbf{x}$$

For what values of k_1 and k_2 is the system completely controllable?

4. (20%) Consider the following 2nd-order plant model to be controlled

$$\dot{\mathbf{x}} = \begin{bmatrix} -5 & -2 \\ 2 & 0 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} u$$

$$y = [0 \quad 1] \mathbf{x}$$

Use state variable feedback and incorporate a command input $u = -\mathbf{K}\mathbf{x} + \alpha r$. Select the gains \mathbf{K} and α so that the system has a rapid response with an overshoot of approximately 1%, a settling time (with a 2% criterion) less than 1 second, and a zero steady-state error to a unit step input.

5. (20%) Design a full-state observer for the system by determining the observer gain matrix \mathbf{L} to place the observer poles at $s_{1,2} = -10 \pm j10$.

