

# 國立臺北科技大學

106 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 3 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. 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.

2. Consider the system defined by

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

where  $u(t)$  is the unit-step function occurring at  $t = 0$ , or  $u(t) = 1(t)$ .

- (10%) Find the state-transition matrix,  $\Phi(t)$ .
- (10%) Find the time response,  $\mathbf{x}(t)$ .
- (10%) Simplify the  $\mathbf{x}(t)$ , if the initial state is zero.

3. Consider the following system

$$\begin{aligned} \dot{\mathbf{x}} &= \begin{bmatrix} 1 & 2 \\ -6 & -12 \end{bmatrix} \mathbf{x} + \begin{bmatrix} -5 \\ 1 \end{bmatrix} u \\ y &= [4 \quad -3] \mathbf{x} \end{aligned}$$

- (10%) Is it controllable? Please justify your answer.
- (10%) Is it observable? Please justify your answer.
- (30%) Design a full-state feedback law and an observer by placing the closed-loop system poles at  $s_{1,2} = -1 \pm j$  and the observer poles at  $s_{1,2} = -12$ .