

**BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING)
FIFTH YEAR SECOND SEMESTER EXAM 2024**

Advanced Instrumentation -II

Time: Three Hours

Full Marks: 100

(50 Marks for each part)

Use a separate Answer Script for each Part

PART-I

Answer any two Questions

- Q.1a)** Explain the principle of duality. **10**
- b) Define controllability and observability of a linear dynamic system. **10**
- c) What is the condition for full observability and full controllability of a system? **5**
- Q.2a)** Briefly discuss the characteristics of magnetic materials used in magnetic particle testing. **7**
- b) How angle beam transducer is used to detect flaw in ultrasonic testing? **6**
- c) Explain with neat sketch the principle of operation of non-destructive liquid penetrant inspection testing method. **12**
- Q.3a)** Explain the principle of thermal evaporation process. **7**
- b) Briefly explain the PECVD process to deposit silicon nitride. **7**
- c) What is micromachining? Name the different processes involved in micromachining. **5**

[Turn over

d) The system is given as

$$\dot{x} = Ax + Bu$$

$$y = Cx$$

Where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -5 & -6 & 0 \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$, $C = [1 \ 0 \ 0]$

Prove that the system is completely state controllable.

6

Q. 4. Write short notes on (any two):

12.5*2

- i) Eddy Current Testing
- ii) Bulk and surface micromachining
- iii) Radiographic Testing

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Time: Three hours

Use a separate Answer-Script for each part

No. of Questions	PART II	Marks
<i>Answer any TWO questions</i>		
1. (a)	What is the significance of employing Wiener filtering, when the signal and the noise spectra overlap? Draw the block diagram of a discrete Wiener filter and derive the condition for minimum mean square error in terms of relevant auto-correlation and cross-correlation quantities and the filter coefficients. What will be the expression of this mean square error when the optimal filter coefficients h_m are obtained?	03+10 +03
(b)	Explain the importance of a reference signal in developing an adaptive noise canceller scheme. In this context, explain in detail why and how a reference filter be employed to achieve desired noise cancellation.	09
2. (a)	Show that, in an adaptive FIR digital filter using Widrow-Hoff LMS algorithm, the vector of filter coefficients at $(n+1)$ th iteration is given as: $H_{n+1} = H_n + 2\mu E_n R_n$, where each symbol has its usual meaning. Draw the schematic representation and comment on the number of additions and multiplications required to implement this algorithm.	10+04
(b)	With a neat diagram, explain in detail how can adaptive digital filters be employed for noise cancellation in speech signals. Also explain how can FIR modeling of an unknown system be carried out.	05+06
3. (a)	How can images be enhanced by employing dynamic range compression and power law transformations? Explain in detail how can Gradient-based first derivative filters be employed for image sharpening. Describe how can Sobel and Prewitt operators be employed for this purpose.	05+07 +04

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No. of Questions	PART II	Marks
3. (b)	How can image enhancement be carried out in frequency domain by employing convolution theorem in two-dimensions? Why and how is post-filtering processing carried out in high frequency emphasis filtering?	05+04
4.	Write short notes on <i>any two</i> of the following:	12.5×2 =25
(i)	Necessary condition for convergence in steepest descent based adaptive digital filtering algorithm.	
(ii)	Mamdani-type and Sugeno-type fuzzy inferencing systems with examples.	
(iii)	Laplacian-based image filters in spatial domain.	