Ref. No.: Ex/EE/PE/B/T/421D/2024

B. E. ELECTRICAL ENGINEERING 4TH YEAR 2ND SEMESTER EXAMINATION, 2024

SUBJECT: - ADVANCED INSTRUMENTATION-II

Full Marks 100

Time: Three hours (50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
	Answer all the questions.	
1. (a)	Draw the schematic of an adaptive digital FIR filter and explain its operating principle. Show that the mean square error for this filter is a quadratic function of the filter weight vector *H*. (CO3)	08
	OR	
	Explain in detail how can an adaptive noise canceller be designed as a notch filter. How can this concept be utilized for ECG signal processing? Also explain in detail how can adaptive digital filters be employed for vibration separation from two variable speed motors? (CO3)	08
(b)	Differentiate between spatial domain approaches and frequency domain approaches used in image enhancement. Why and how is contrast stretching and gray-level slicing methods employed for image segmentation Explain in detail how can Butterworth and Gaussian low pass filters be employed for image filtering in frequency domain? (CO3)	14
	OR	
	Differentiate between discontinuity based approaches and similarity based approaches used in image segmentation. How can isolated point detection be carried out using computation of second derivative? How can local processing be employed for edge linking and boundary detection in edges? (CO3)	14
(c)	Give the general time-varying performance criterion employed in RLS method of adapting digital filters and explain the importance of forgetting factor and regularization parameter in this criterion. Also give the formulations of generalized versions of auto-correlation matrix and cross-correlation vector employed in RLS method. (CO3)	06

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Full Marks 100

Time: Three hours (50 marks for each part)

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No. of Questions	PART I	Marks
2.	Justify or correct ***any two*** of the following statements with suitable reasons/derivations, in brief. (CO4)	05×02 =10
(a)	In fuzzy systems, center-of-gravity and center-of-sums methods produce identical defuzzified outputs, for same set of inputs.	
(b)	In sliding mode control, the order of the equivalent system in sliding mode becomes (*n*+*m*), where *n* is the number of states of the original system and *m* is the number of control inputs employed.	
(c)	In sliding mode control, the condition: $\sigma^T(x)\sigma(x) \geq 0$ has to be satisfied, for existence and reachability of a sliding mode.	
3.	Explain the importance of employing a nonsingular transformation in disgonalization method of designing sliding mode controllers. Here, can all elements of matrix **Q** be arbitrarily chosen? (CO4)	06
	OR	
	Draw the schematics of a discrete-time fuzzy PI controller and a discrete-time fuzzy PD controller and describe their operating principles. What is the importance of input and output scaling factors for these controllers? (CO4)	06
4.	A two input-one output fuzzy system is designed using first-order Sugeno type inferencing. Input 1 varies over the range from 0 to 10 and Input 2 varies over the range from 0 to 1. Each input is fuzzified using three identical, symmetric, unbiased, triangular MFs. Design a suitable fuzzy rule base for this system. Also explain how the final Output will be calculated if the two inputs are measured as: Input 1 = 6.0 and Input 2 = 0.6. (CO5)	06

Ref. No. Ex/EE/PE/B/T/421D/2024

B.E. Electrical Engineering Fourth Year Second Semester Examination 2024

Advanced Instrumentation-II

Time: Three Hours **Full Marks: 100**

(50 Marks for each part)

Use a separate Answer Script for each Part

PART-II

Answer *All* Questions

Q.1 a) Briefly explain the principle of eddy current non- destructive testing method. What are the factors affecting the eddy current response? (CO1)

Why continuous magnetization technique isadvantageous over residual magnetization technique? (CO1) **4+4+2**

OR

What is an ultrasonic transducer? Briefly discuss the different parts of this type of transducer. How angle beam transducer is used to detect flaw in ultrasonic testing? (CO1)

How does the nature of defects effects liquid penetrant inspection test? (CO1) **2+3+2+3**

b) Explain the dry oxidation and wet oxidation processes for growing oxide on silicon. (CO1)

Briefly discuss the reactive ion etching method in removing unwanted material from the silicon wafer. (CO1) **5+3**

OR

With the help of diagram explain the process steps involved in transferring geometric patterns on to the photoresist.(CO1)

Mention the differences between wet and dry etching processes. (CO1)

5+3

Q.2a) Define controllability and observability of a linear dynamic system (CO2). **3**

OR

Explain the principle of duality. (CO2) **3**

b) The system state and output equations are given by

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

$$\mathbf{y} = \mathbf{Cx}$$

Where $\mathbf{A} = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -2 \end{bmatrix}, \ \mathbf{B} = \begin{bmatrix} 0 \\ 4 \\ 0 \end{bmatrix}, \ \mathbf{C} = [1 \ \ 1 \ \ 1]$

Is the above system completely state controllable and observable? (CO2)

4

c) Explain "separation principle". (CO2) **3**

Q.3a) Derive the expression for a posteriori error covariance of Kalman filter.(CO2) **8**

OR

Write down the Time and Measurement Update equations of Kalman filter and explain each term in it. (CO2) **8**

b) Why Kalman filter is known as filter? (CO2) **2**

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Q. 4. The system state and output equations are defined by

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

$$\mathbf{y} = \mathbf{Cx}$$

Where $\mathbf{A} = \begin{vmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{vmatrix}$, $\mathbf{B} = \begin{vmatrix} 0 \\ 0 \\ 1 \end{vmatrix}$,

By using state feedback control **u = -Kx**, it is desired to place the closed loop poles at s_1 = -2-j4, s_2 = -2+j4 and s_3 = -10. Determine the state feedback gain matrix **K.** (CO5) **12**

OR

The control system of the following plant has been designed for 0.8 sec settling time and 16.3% overshoot. Design an observer to respond five times faster than the closed loop system design. Also obtain the transfer function of the observer controller. The state and output equations of the system are given by

$$\begin{vmatrix} \dot{x} \\ \dot{x_2} \end{vmatrix} = \begin{vmatrix} 0 & 1 \\ -3 & -2 \end{vmatrix} \begin{vmatrix} x_1 \\ x_2 \end{vmatrix} + \begin{vmatrix} 0 \\ 1 \end{vmatrix} u, y = [0 \ 1] \begin{vmatrix} x_1 \\ x_2 \end{vmatrix}$$ (CO5) **12**