Ref. No.: Ex/EE/PE/B/T/421D/2023(S)

B. E. ELECTRICAL ENGINEERING FOURTH YEAR SECOND SEMESTER SUPPLEMENTARY EXAMINATION, 2023

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 block diagram and describe the operating principle of an *M*-weight adaptive digital FIR filter. How can the method of steepest descent be employed for adapting these filters? (CO3)	12
	OR	
	Prove that, under optimal condition, a discrete Wiener filter gives **RH**=**P**, where each symbol has its usual meaning. (CO3)	12
(b)	Describe in detail the principle of operation of the Widrow-Hoff LMS algorithm. (CO3)	10
	OR	
	What is the general performance criterion employed in a recursive least squares algorithm? How can generalized versions of auto-correlation matrix and cross-correlation vector of relevant quantities be employed to develop a recursive least squares algorithm? (CO3)	10
2.	Justify or correct ***any two*** of the following statements with suitable reasons/derivations, in brief. (CO4)	05×02 =10
(a)	In digital control loops, there is always a minimum delay of one sampling interval.	
(b)	In sliding mode control, during the sliding mode phase, the controller tries to maintain the plant's state trajectory on a switching surface.	
(c)	In digital control employing Dahlin's controller, the desired closed loop transfer function is considered to be a second order system with dead time.	

[Turn over

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No. of Questions	PART I	Marks
3.	What is ringing in digital controllers? What are the causes of ringing? How can ringing be overcome in digital controllers? (CO4)	06
	OR	
	In sliding mode control, what are the salient steps employed in designing a controller by diagonalization method? (CO4)	06
4.	Give a step-by-step, detailed description of how a predictive controller can be designed using model following design. What are its advantages over a direct single-step design? (CO5)	12

EX/EE/PE/B/T/421D/2023(S)

B.E. Electrical Engineering Fourth Year Second Semester Supplementary Examination, 2023

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. Explain the principle of liquid inspection non- destructive testing method.

Briefly discuss the characteristics of magnetic materials used in magnetic particle testing.

Mention the advantages and disadvantages of radiographic testing method. **5+4+3**

OR

Mention the important features and significances of AE (acoustic emission) signal with respect to the testing method. What are the main factors that affects eddy current signals in test piece? How angle beam transducer is used to detect flaw in ultrasonic testing?

4+5+3

Q.2 What is microfabrication? Name the different processes involved in microfabrication. **2+3**

OR

Briefly explain the sputter deposition process. **5**

Q.3 Prove that the state observer gain matrix K_e is the conjugate transpose of state feedback gain matrix K i.e. $K_e = K^*$ **5**

The system state and output equations are defined by

$$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{B}\mathbf{u}$$

$$\mathbf{y} = \mathbf{C}\mathbf{x}$$

[Turn over

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

Is the above system completely state controllable and observable? Explain what causes the apparent difference in the controllability and observability of the same system. 7

Q.4 a) Derive the expression a priori error covariance of Kalman filter. **6**

OR

Mention the expression for Kalman filter gain. How the parameters involved in the gain affects the estimation of state of a linear dynamic system? **6**

b) Why Kalman filter is known as optimal state estimator? **3**

Q. 5. The state and output equations of a system is given by

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

$$y = Cx$$

Where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

The system uses state feedback control u= -Kx. The desired eigen values are $\mu_1 = -5 + j5\sqrt{3}$, $\mu_2 = -5 - j5\sqrt{3}$ and $\mu_3 = -10$. Determine the state feedback gain matrix K. **12**