Ref. No.: Ex/EE/PE/B/T/421D/2022

B. E. ELECTRICAL ENGINEERING 4TH YEAR 2ND SEMESTER EXAMINATION, 2022

SUBJECT: - ADVANCED INSTRUMENTATION-II

Time: Four hours

Full Marks 70
(35 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*-tap adaptive digital FIR filter. How can the method of steepest descent be employed for adapting these filters?	08
	OR	
	Under what circumstances Wiener filtering is employed? Describe the basic operating principle of discrete Wiener filter and derive the set of linear equations for the optimal Wiener filter in terms of relevant auto-correlation and cross-correlation quantities and the filter coefficients.	08
(b)	Prove that, in Widrow-Hoff LMS algorithm, the filter coefficients at $(n+1)$th iteration are expressed in terms of the same coefficients at nth iteration, by the following relation: $H_{n+1} = H_n + 2\mu E_n R_n$ where each symbol has its usual meaning.	07
	OR	
	How is the general time-varying performance criterion employed in RLS algorithm? Describe in detail how can the RLS algorithm be developed and implemented in terms of recursive formulations of generalized cross-correlation vector and generalized auto-correlation matrix.	07
2.	Justify or correct ***any two*** of the following statements with suitable reasons/derivations, in brief.	04×02 =08
(a)	In a digital control loop, there is always a delay of one sampling interval in achieving the process output.	
(b)	In sliding mode control, the system dynamics, when restricted to the switching surface, becomes insensitive to parametric uncertainty and external disturbances.	

[Turn over

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No. of Questions	PART I	Marks
2. (c)	A Dead-Beat controller designed for a process usually provides better wear and tear performance for the final control element than a Dahlin controller designed for the same process.	
3.	Prove that, in a predictive controller, designed using model following design, we shall have: $$M(z)=\frac{1}{b_1+b_2z^{-1}}\left[(1-\beta)R(z)+\left\{(a_1+\beta)+a_2z^{-1}\right\}C(z)\right]$$ where each symbol has its usual meaning.	04
	OR	
	What will be the effects of ringing if a digital controller has a real pole? How can ringing be minimized in digital controllers?	04
4. (a)	Differentiate between reaching mode and sliding mode in sliding mode control. Under what circumstances a sliding mode will exist for a system under control?	03
(b)	A system is given as: $\dot{x}(t)=A(t,x)x(t)+Bu(t)$ where $x(t) \in R^n$, $u(t) \in R^m$, and $A(t,x)$ comprises some elements that experience bounded variations. How can the method of equivalent control be employed to design sliding surface for this system? How will this method help in achieving the reduced order dynamics in sliding mode? What are the special characteristics possessed by this reduced order dynamics?	05

Ex/EE/PE/B/T/421D/2022

B.E. Electrical Engineering Fourth Year Second Semester Examination, 2022

Advanced Instrumentation-II

Time: Four Hours **Full Marks: 70**

(35 Marks for each part)

Use a separate Answer Script for each Part

PART-II

Answer *All* Questions

Q.1a) 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. **2.5+2.5+2**

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? **3+2+2**

b) What is microfabrication? Name the different processes involved in microfabrication. Explain the dry oxidation and wet oxidation processes for growing oxide on silicon and give the relative merits and demerits of each process. **2+3**

OR

Explain the process steps involved in transferring the geometric pattern on the photoresist. Briefly explain the sputter deposition process. **3+2**

Q.2a) Prove that the state observer gain matrix K_e is the conjugate transpose of state feedback gain matrix K i.e. $K_e = K^*$ **3**

b) The system state and output equations are defined by

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

$$y = Cx$$

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. **5**

Q.3a) Derive the expression a priori error covariance of Kalman filter. **5**

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? **5**

b) Why Kalman filter is known as optimal state estimator? **2**

Q. 4. The state and output equations of a system is given by

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

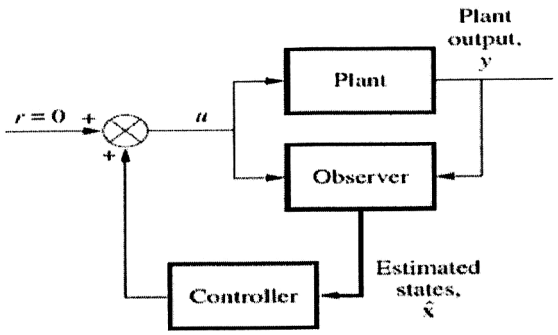
$$y = Cx$$

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. **8**

OR

With the help pole placement with observer approach, design an observer controller for the system shown in Fig.1. The desired closed-loop poles for the pole placement are located at $s = -1.8 \pm j2.4$. Determine the state feedback gain matrix **K.** The desired observer poles are located at $s = -8$, $s = -8$. Obtain the observer gain matrix K_e. Also determine the transfer function of the observer controller. **8**



The equation of plant is given by

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

$$y = Cx$$

Where $A = \begin{bmatrix} 0 & 1 \\ 20.6 & 0 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ and $C = [1\ 0]$