Ref No: **Ex/EE/T/423D/2017 (Old)**

B.ELE.ENGG. 4TH YEAR 2ND SEMESTER EXAMINATION, 2017 (OLD)

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 any three questions	
1.	Justify or correct ***any four*** of the following statements with suitable reasons/derivations, in brief.	
(a)	In sliding mode control, a sliding mode will exist for a system, if, in the vicinity of the switching surface, the state vector is directed towards the surface.	$4 \times 4\frac{1}{2} = 18$
(b)	The leaky LMS algorithm is utilized for adaptive filtering in those situations where the input signal has poor spectral content.	
(c)	In RLS algorithm for adaptive filtering, the regularization parameter is introduced to weight most recent data samples more heavily.	
(d)	For a process which has a dead time and controlled by a digital controller designed using direct synthesis method, the desired closed loop transfer function must include the same dead time.	
(e)	The weighting factor in control weighting design of predictive controllers can be suitably varied to simultaneously achieve increase in forward path gain and decrease in severity of the ringing pole of the controller.	
2. (a)	Describe in detail how can Diagonalization Method be employed in sliding mode control for designing controllers. Assume that the sliding surface has been designed using the method of equivalent control.	09
(b)	What are the possible causes of chattering in sliding mode control? How are boundary layers introduced in ideal saturation control and practical saturation control to overcome this?	03+04

[Turn over

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No. of Questions	PART I	Marks
3. (a)	"In discrete Wiener filter, the calculation of mean square error under optimal filtering condition requires knowledge of R_{xx}, R_{xd} and R_{dd}, where each symbol has its usual meaning." – Justify or rectify the statement.	04
(b)	"In the method of steepest descent employed in adaptive digital filters, a feedback coefficient is employed to control the rate of convergence only". – Justify or rectify the statement.	03
(c)	For a 7th order digital adaptive FIR filter, adapted using LMS algorithm, the running estimate of the average input power is 1.46. The step size in the LMS adaptation algorithm is chosen to achieve the maximum permissible speed of convergence. The theoretical minimum value of mean square error is 0.23. The magnitude of the average Eigen value of the reference correlation matrix R is 2.57. What will be the values of the learning curve time constant and excess mean square error for this system?	06
(d)	How can Wiener-Khintchine theorem be employed to derive the system function of an optimal digital filter?	03
4. (a)	Can direct synthesis method be employed for digital controllers, when the delay in the process is not an integral multiple of sampling time chosen?	03
(b)	In what respect control weighting design is more suitable than model following design for designing predictive controllers? Prove that, in a predictive controller, designed using control weighting design, where each symbol has its usual meaning, we shall have: $$M(z)=\frac{1}{\left[\left(b_1+\frac{\gamma}{b_1}\right)+b_2z^{-1}\right]}\left[R(z)+C(z)\left(a_1+a_2z^{-1}\right)\right]$$	03+06

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B.ELE.ENGG. 4TH YEAR 2ND SEMESTER EXAMINATION, 2017 (OLD)

SUBJECT: - ADVANCED INSTRUMENTATION – II

Time: Three hours

Full Marks 100
(50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
4. (c)	"In Dahlin's controller, the presence of complex conjugate pole pairs in the controller transfer function in both negative and positive halves of z-plane gives rise to the phenomenon of ringing". – Justify or rectify the statement.	04
5.	Write short notes on ***any two*** of the following:	8×2=16
(i)	The necessary condition for convergence in adaptive FIR digital filters.	
(ii)	Incremental form of predictive controllers.	
(iii)	Recursive computations of generalized auto-correlation matrix and cross-correlation vector in RLS algorithm.	

[Turn over

Ref. No. Ex/EE/T/423D/2017(old)

B. Electrical Engineering. 4th Year Second Semester Examination, 2017(old)

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 *Any Two* Questions

Q.1 a) Mention the condition for complete state controllability and complete state observability of a linear dynamic system. What causes the apparent difference in controllabity and observability of the same system?

5

b) Prove that the state observer gain matrix $\mathbf{K_e}$ is the conjugate transpose of state feedback gain matrix $\mathbf{K}$ i.e. $\mathbf{K_e} = \mathbf{K}^*$. **5**

c) The system state and output equations are defined by

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

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

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

Design this system by pole-placement with observer approach. The desired close-loop poles for pole placement are located at

$s = -1 \pm j$, $s = -5$

the desired observer poles are located at

$S_1 = -6$, $S_2 = -6$ and $S_3 = -6$.

Obtain the observer gain matrix K_e and draw the block diagram of observed state feedback control system. Also obtain the transfer function of the observer controller. **15**

Q.2 a) Briefly discuss the characteristics of penetrant materials used in liquid inspection testing. What is role of a developer in this testing? Mention the two uses of this method of testing. **4+2+2**

b) Write down the "Time Update" and "Measurement Update" equations of Kalman Filter. Explain the significance of these two equations in estimating the state of a linear dynamic system. **3+3**

c) Explain the principle of thermal evaporation process and sputter deposition process. List some materials for which evaporation approach is practical.

4+2

d) The system is given as

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 1\\ 2 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u,$$

Prove that the system is completely state controllable. **5**

Q.3 a)How does the orientation of defects effects magnetic particle testing? Why continuous magnetization technique is advantageous over residual magnetization technique? **3+3**

b) The state feedback gain matrix (K) is not unique for a given system – justify the statement. **5**

c) Write down the expression for Kalman Filter gain. How the measurement noise covariance and a priori estimate error covariance affects the estimation of state in the filter? **2+5**

d) With the help of diagrams explain the different process steps involved in transferring the pattern on to the photo- resist. **7**

Q. 4. a) Explain with neat sketch the principle of operation of non destructive eddy current testing method. What is acoustic emission testing? How noise affects the sensitivity of acoustic emission testing? **4+2+2**

b) Explain how principle of duality plays an important role in the design of a state observer? **5**

c) What is micro-machining? Name the different processes involved in micro-machining. **6**

d) Derive the expression for a posteriori error covariance P_k of Kalman Filter. **6**