**Ref. No.: Ex/EE/T/422D/2019**

**B. E. ELECTRICAL ENGINEERING 4TH YEAR 2ND SEMESTER EXAMINATION, 2019**

## 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) | Prove that the optimal filter gain in a discrete Wiener filter can be obtained as: $H(\omega)=\dfrac{S_{ss}(\omega)}{S_{ss}(\omega)+S_{nn}(\omega)}$, where each symbol has its usual meaning. State if any assumption(s) is/are made in deriving this relation. | 07 |
| | OR | |
| | Prove that in a discrete Wiener filter the filter coefficients are obtained by solving the equations: $\sum_{m=0}^{N-1} h_m R_{xx}(m-j)=R_{xd}(j),\quad j=0,1,2,\cdots,(N-1)$ where each symbol has its usual meaning. | 07 |
| (b) | "In normalized LMS method, the window length employed in the running average filter must be as large as possible" - Justify or correct the statement citing suitable reason. | 04 |
| | OR | |
| | "In RLS algorithm, the forgetting factor should be chosen as small as possible and the regularization parameter should be chosen as large possible" - Justify or correct the statement citing suitable reason. | 04 |
| (c) | How does feedback coefficient in steepest descent algorithm, employed in adapting digital filters, control stability and rate of convergence? | 04 |
| (d) | Write a short note on ***any one*** of the following:<br>(*i*) Transient behavior in primed coordinates in adaptive digital filters.<br>(*ii*) Gray-level slicing and bit-plane slicing based image enhancement. | 07 |

**Ref. No. : Ex/EE/T/422D/2019**

**B. E. ELECTRICAL ENGINEERING $4^{TH}$ YEAR $2^{ND}$ SEMESTER EXAMINATION, 2019**

## 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 |
|---|---|---|
| 2. | Justify or correct ***any two*** of the following statements with suitable reasons/derivations, in brief. | 05×02 =10 |
| (a) | Predictive controllers can handle measurable disturbances effectively employing feedforward compensation. | |
| (b) | The diagonalization method of designing controllers in sliding mode control employs an arbitrary diagonal matrix to enable independent and flexible weighting of each channel of the control vector. | |
| (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. | How can direct synthesis method be employed for designing digital controllers in a conventional sampled data control system? How can the pulse transfer function of a first order process with delay be determined in such systems? | 06 |
| | OR | 06 |
| | What is ringing in digital controllers and what is its main cause? What will be the effects of ringing if the controller has a complex conjugate pole pair? How can ringing be minimized in digital controllers? | |
| 4. | 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. This system is controlled employing sliding mode control philosophy. How can the method of equivalent control be employed to design the switching surface for this system? What will be the characteristic of the reduced order equivalent LTI system when the system is in sliding mode? How will the desired eigenvalues chosen for the equivalent system influence the design of the switching surface? | 12 |

**Ref. No. Ex/EE/T/422D/2019**

**B.E. Electrical Engineering Fourth Year Second SemesterExamination, 2019**

**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 radiographic non- destructive testing method.

How the nature of defects does affect liquid penetrant testing?

What are the basic differences between acoustic emission testing with that of other NDT methods? **4+4+2**

**OR**

What type of sensors are used in eddy current testing method and how they are used to detect defects in part?

Define acoustic impedance. Why it is important for ultrasonic testing?

Mention the advantages and disadvantages of magnetic particle testing. **3+3+4**

b) What is micromachining? Name the different processes involved in micro-machining.

Explain the dry oxidation and wet oxidation processes for growing oxide on silicon and give the relative merits and demerits of each process. **3+5**

**OR**

Explain the process steps involved in transferring the geometric pattern on the photoresist. Briefly explain the sputter deposition process. **5+3**

**Q.2**a) Prove that the state observer gain matrix Ke is the conjugate transpose of state feedback gain matrix K i.e. $K_e = K^*$ **5**

**OR**

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

b) A state space representation of a system in controllable canonical form is given by

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -0.4 & -1.3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u \text{ and}$$

$$y = \begin{bmatrix}0.8 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

Write down the above equations in observable canonical form. Prove that the system equations given in controllable canonical form is state controllable but not observable. Also prove that the equations in observable canonical form are observable but not controllable. Explain what causes the apparent difference in the controllability and observability of the same system. **7**

**Q.3**a) Derive the expression for posteriori error covariance of Kalman filter **6**

**OR**

Derive the expression for Kalman filter gain. **6**

b) Why Kalman filter is known as optimal state estimator? **4**

**Q. 4.** 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 ± 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 $\mathbf{K_e}$. Also determine the transfer function of the observer controller. **10**

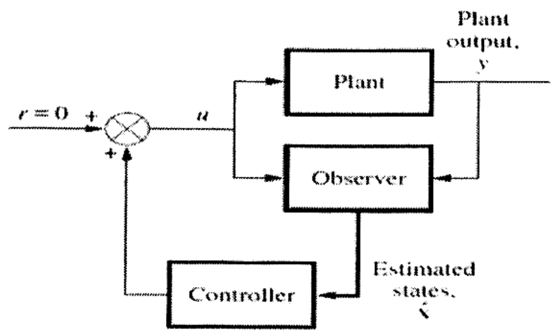


**Fig. 1**

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** $C = [1 \; 0]$

**OR**

The state and output equations of a system is given by

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

$$y = Cx$$

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

The output **y** can be accurately measured. Design a minimum order observer with eigen values are $\mu_1 = -2 + j\sqrt{3}$, $\mu_2 = -2 - j\sqrt{3}$. **10**