Ref No: **Ex/PG/EE/T/128B/2024**

M.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION, 2024

SUBJECT: - COMPUTER APPLICATION IN INSTRUMENTATION (MS)

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 two questions.	
1. (a)	For a system defined as $\dot{\mathbf{x}} = \mathbf{Ax} + \mathbf{Bu}$ where, $\mathbf{x}$ = state vector ($n \times 1$-vector) $\mathbf{u}$ = control vector ($r \times 1$-vector) $\mathbf{A} = n \times n$ matrix $\mathbf{B} = n \times r$ matrix state and justify the conditions for complete state controllability of the system, when (*i*) the eigenvectors of matrix **A** are distinct and (*ii*) the eigenvectors of matrix **A** are non-distinct.	08
(b)	What is the condition for complete output controllability of a system? When a system is said to be stabilizable?	05
(c)	Give a detailed, step by step procedure of determining state feedback gain matrix **K** in pole placement control, using Ackermann's formula.	12
2. (a)	In designing predictive controllers, how can model following design help in overcoming the drawbacks of direct single-step design? Derive the block-diagram realization of the model following design based predictive controller in *z*-domain. How can a more general closed loop characteristic be accommodated in this design?	12
(b)	A two-input-one-output fuzzy system has been developed using Sugeno-type inferencing and first-order Sugeno models. Both input variables x_1 and x_2 can vary over a universe of discourse of 0 to 10. Each input variable is fuzzified using three triangular MFs: denoted by A_1, A_2, and A_3 for x_1 and B_1, B_2, and B_3 for x_2. These MFs are represented by the sets (x_1(or x_2); left base, vertex, right base) and these sets are given as (0, 2.5, 5.0), (2.5, 5.0, 7.5), and (5.0, 7.5, 10.0), respectively.	08

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	The system has three governing fuzzy rules given as: *Rule* 1: If x_1 is A_1 and x_2 is B_1, Then $f_1 = 0.7x_1 + 0.5x_2 + 0.3$, *Rule* 2: If x_1 is A_2 and x_2 is B_2, Then $f_2 = 0.4x_1 + 0.6x_2 + 0.8$, *Rule* 3: If x_1 is A_3 and x_2 is B_3, Then $f_3 = 0.8x_1 + 0.7x_2 + 0.25$. Determine the crisp output of the system, when the crisp inputs of the system are $x_1 = 5.5$ and $x_2 = 6.8$.	
2. (c)	Draw the block diagram of a PD-type, two-input-one-output fuzzy controller based continuous-type system and mention the characteristic features of the PDFLC designed.	05
3. (a)	Differentiate between "reaching mode" and "sliding mode" in sliding mode control. What are the basic strengths of sliding mode control? Why the sliding surface is also called the switching surface? In sliding mode control, is it always guaranteed that a sliding mode will exist? Describe in detail, how, in the method of equivalent control, the system motion is determined on the switching surface?	12
(b)	In diagonalization method based controller design for SMC, how can the sufficient conditions for existence and reachability of a sliding mode be satisfied?	09
(c)	What are the causes of chattering in sliding mode control? How can the detrimental effects of chattering be reduced?	04
4.	Write short notes on ***any two*** of the following:	$12\frac{1}{2}\times 2$ $=25$
(*i*)	Effects of the addition of an observer on a closed loop system and the transfer function of the observe-based controller.	
(*ii*)	Defuzzification strategies in fuzzy systems.	
(*iii*)	Incremental form of the predictor in predictive controllers.	

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Time: Three hours **Full Marks 100**
(50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART-II	Marks
	Answer any two	**2X25=50**
1. a)	What is **"Gain Scheduling Control"** in the context of Adaptive control? Explain with a block diagram.	10
b)	A process, whose dynamics are not well known, is initially at steady state. An input signal is introduced to the system. The sampled values of the input as well as the output response at different time instants are as follows:	15

Sampling instant	Input variable (units)	Output variable (units)
0	1.0	0.0
1	0.8	0.4
2	0.4	0.6
3	0.1	0.85

Identify the parameters of the process assuming first order model.

2. a)	Explain the operation of a Digital vector voltmeter using synchronous detection technique.	10
b)	A two dimensional data is shown in the table given below. Two dimensions are taken as x and y. Physical significance of each dimension is not disclosed. Find and choose a suitable principal component for the data set to reduce its dimension. Show the modified reduced data in tabular form.	15

x	y
4	6
8	11
10	28
24	33
45	65
55	22
22	40
10	13

3. a)	What is a lock-in-amplifier? Explain with a basic scheme.	1+4
	How can you employ digital synthesis technique in such a lock-in-amplifier for better performance?	6

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b)	Explain the terms "*scale*" and "*translation*" in Continuous Wavelet Transform (CWT).	4
c)	How can you the use wavelet transform for denoising a signal.	5
d)	Samples of a signal is shown as $f = \{\underset{\uparrow}{2}, 5, 7, 6, 1, 0, 1, 2\}$. Find Wavelet coefficients after Haar Transform for the above signal. Show that energy does not change after Haar transform.	5
4.	Write notes on following topics (**any two**)	$(2\text{X}12\frac{1}{2}$ $=25)$
a)	The algorithm for computing Continuous Wavelet Transform of a time series.	
b)	Direct Digital Synthesis (DDS) based Frequency synthesizer.	
c)	Different levels of Sensor Fusion	