Ref No: **Ex/PG/EE/T/128B/2019**

M.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION, 2019

SUBJECT: - COMPUTER APPLICATION IN INSTRUMENTATION (MS)

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
	Answer any two questions	
1. (a)	Determine whether the following systems are completely observable or not: (i) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-1 & 0\\ 0 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}, y=[0 \quad 1]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$ (ii) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}2 & 1 & 0\\ 0 & 2 & 1\\ 0 & 0 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}, \begin{bmatrix}y_1\\ y_2\end{bmatrix}=\begin{bmatrix}3 & 0 & 0\\ 4 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$	08
(b)	"For investigating a necessary and sufficient condition for complete observability, if suffices to consider a system in its unforced form." – Justify or correct this statement citing suitable reasons.	05
(c)	Describe in detail how can Ackermann's formula be employed to determine the state observer gain matrix.	12
2. (a)	What is the key essence of predictive control? How can predictive controllers be designed using model following design philosophy? How can this design be modified to accommodate a more general version of a desired closed loop characteristic?	10
(b)	In sliding mode control, what are the possible causes of chattering? How can the continuation approach help in minimizing the effect of chattering? Discuss in detail different switching characteristics that are popularly employed to achieve this objective.	10
(c)	"In sliding mode control, when the system is in sliding mode, then the equivalent controlled system can always be represented by an equivalent reduced order LTI system". – Justify or correct this statement citing suitable reasons.	05

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No. of Questions	PART I	Marks
3. (a)	In the context of neural networks, explain the importance of adding a threshold in an activation function. What are the differentiating characteristics of supervised learning and unsupervised learning algorithms?	04+05
(b)	"When perceptron learning based neural networks are employed for classifying linearly non-separable training pattern sets, the weights of the neural networks will always grow to arbitrarily large values." – Justify or correct this statement citing suitable reasons.	05
(c)	A two-input-one-output fuzzy system has been developed using Sugeno-type inferencing and first-order Sugeno models. The universe of discourse for input variable x_1 is 0 to 10 and that for input variable x_2 is 0 to 5. x_1 is fuzzified using two trapezoidal membership functions (MFs) with their supports given as: A_1 (0,2,4,6) and A_2 (4,6,8,10). Similarly x_2 is fuzzified using two trapezoidal MFs with their supports given as: B_1 (0,1,2,3) and B_2 (2,3,4,5). The system has two governing fuzzy rules given as: *Rule* 1 : If x_1 is A_1 and x_2 is B_1, Then $f_1 = 1.4x_1 + 2.5\,x_2 + 0.6$, *Rule* 2 : If x_1 is A_2 and x_2 is B_2, Then $f_2 = 1.8x_1 + 2.2\,x_2 + 0.8$. Determine the crisp output of the system, when the crisp inputs of the system are $x_1 = 5.4$ and $x_2 = 2.6$.	07
(d)	"For a continuous-time system, the design of a PD-type fuzzy controller requires an integrator module but the design of a PI-type fuzzy controller does not require an integrator module." - Justify or correct this statement citing suitable reasons.	04
4.	Write short notes on ***any two*** of the following:	$12\frac{1}{2}\times 2$ $= 25$
(i)	Diagonalization method based design of sliding mode controllers.	
(ii)	Necessary condition for arbitrary pole placement.	
(iii)	Predictive controllers using incremental form of the predictor.	

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No. of Questions	PART-II	Marks
	Answer any two	**2X25=50**
1. a)	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 all principal components for the data and choose a suitable principal component to reduce the dimension of the datatset. Plot the data in a graph paper and show the principal components for the data set. Show the modified or reduced data in tabular form.	20

x	y
7	4
4	1
6	3
8	6
8	5
10	7
5	3
9	5
7	4
8	2

b)	Prove that, the principal components are mutually orthogonal.	5
2. a)	How is the limitation of Fourier Transform overcome by Short Time Fourier Transform (STFT)?	3
b)	What are the shortcomings of STFT? Justify the application of Continuous Wavelet Transform (CWT) to overcome them.	3
c)	Exnlain the terms "*scale*" and "*translation*" in CWT. What is the importance of the factor $\frac{1}{\sqrt{\lvert s \rvert}}$ in CWT? (all symbols carry their usual meaning)	4+2
d)	What are the properties of a *mother-wavelet*?	3
e)	Explain the algorithm for computing Continuous Wavelet Transform of a signal.	6
f)	Samples of a signal is shown as $f = \{ \underset{\uparrow}{1}, 4, 10, 8, 0, 0, 0, 2 \}$. Find Wavelet coefficients after Haar Transform. Show that energy does not change after Haar transform.	4
3. a)	What is a Self Tuning Regulator (STR) or Model Identification Adaptive System (MIAS) in the context of adaptive control?	10

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Use a separate Answer-Script for each part

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	0.4	0.7
2	0.2	0.8
3	0.1	0.9

Identify the parameters of the process assuming first order model.

4. a) A Rough Set based decision rule generation system uses a real valued data table as given below. Generate the discretized decision table using maximal discernible heuristics. Show the optimum set of cuts. 12

Objects	Condition Attributes		Decision Attribute
	A	B	
U_1	0.75	5.0	0
U_2	1.25	3.5	0
U_3	2.2	5.0	1
U_4	0.75	2.25	1
U_5	1.8	1.0	0
U_6	1.25	3.5	1
U_7	1.25	2.25	1
U_8	2.2	1.2	1

b) A Rough Set based decision rule generation system uses a data table as given below. Generate the set of decision rules from this table. 13

Objects	**Condition Attributes**			**Decision Attribute**
	A	**B**	**C**	
U_1	0	0	1	0
U_2	0	1	1	0
U_3	1	1	1	1
U_4	1	1	0	1
U_5	1	2	0	0
U_6	0	2	0	1
U_7	1	0	0	1
U_8	1	0	1	1

5. Write notes on any *two*

a) Wavelet Transform based denoising technique
b) Gain scheduling control
c) Different levels of Sensor fusion

$(2X12\frac{1}{2}$
$=25)$