Ref No: **Ex/PG/EE/T/128B/2018**

M.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION, 2018

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)	A continuous-time system is defined as: $$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{B}u$$ $$y = \mathbf{C}\mathbf{x} + Du$$ where each symbol has its usual meaning. Prove that, if the system is completely state controllable, then this is a sufficient condition to ensure that all the eigenvalues of matrix **A** can be arbitrarily placed.	13
(b)	A regulator system is employed for a plant defined as: $$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{B}u$$ where $$\mathbf{A} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}, \mathbf{B} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$ The system uses the state feedback control, $u = -\mathbf{K}\mathbf{x}$. The desired closed-loop poles are to be placed at: $s = -2 + j4,\ \ s = -2 - j4,\ \ s = -10$. Determine the state feedback gain matrix **K** by (a) Direct Substitution Method and (b) Ackermann's Formula.	12
2. (a)	What are the problems associated with employing direct single-step design for predictive controllers? How can those problems be overcome?	04+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, we shall have: $$M(z) = \frac{1}{\left[\left(b_1 + \frac{\gamma}{b_1}\right) + b_2 z^{-1}\right]}\left[R(z) + C(z)\left(a_1 + a_2 z^{-1}\right)\right]$$ where each symbol has its usual meaning.	04+06

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No. of Questions	PART I	Marks
2. (c)	Why and how are boundary layers introduced in sliding mode control? Justify its utility, when it is introduced in the context of ideal and practical saturation control.	04+04
3. (a)	In the context of neural networks, differentiate between pattern space and weight space. With a suitable example, describe in detail how can a perceptron learning algorithm be designed in weight space.	06+07
(b)	Let us consider a system given as: $\dot{x}(t) = A(t,x)x(t) + Bu(t)$ $A(t,x) = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ a_{11}(t,x) & a_{12}(t,x) & a_{13}(t,x) & a_{14}(t,x) & a_{15}(t,x) \\ 0 & 0 & 0 & 0 & 1 \\ a_{21}(t,x) & a_{22}(t,x) & a_{23}(t,x) & a_{24}(t,x) & a_{25}(t,x) \end{bmatrix}$ $B = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}$ $a_{ij}^{\min} \le a_{ij}(t,x) \le a_{ij}^{\max}$ for all $x \in R^n$ and $t \in [t_0, \infty)$ The system is controlled using sliding mode control philosophy. The switching surface ($\sigma(x) = Sx = 0$) has been designed using the method of Equivalent Control and is given as: $S = \begin{bmatrix} 1 & 1.8 & 2 & 0 & 1 \\ 0 & 1.8 & 1 & 6 & 1 \end{bmatrix}$ Design a sliding mode controller for this system using *Diagonalization Method.* Choose: $Q = \begin{bmatrix} 3 & 0 \\ 0 & 1 \end{bmatrix}$ where Q has its usual meaning.	12

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No. of Questions	PART I	Marks
4.	Write short notes on ***any two*** of the following:	$12\frac{1}{2}\times 2$
(i)	Alternative Form of the condition for complete observability of continuous-time systems.	$= 25$
(ii)	Determination of state observer gain matrix by Transformation Approach.	
(iii)	Common neuronal signal functions in neural networks.	

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MEE 1ST YEAR 2ND SEM. EXAM 2018

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-II	Marks
	Answer any two	**2X25=50**
1. a)	Draw a schematic of a digital vector voltmeter using synchronous detection technique. A phase-locked frequency synthesizer provides all internal references from a common reference source. Explain the principle of operation of such voltmeter.	10
b)	Explain the operation of Lock-in-amplifier.	8
c)	A digital frequency synthesizer employs a 8 MHz crystal oscillator and gives a 128 step-sinusoid. Determine the maximum and minimum output frequencies if the number of fractional bits is 2. Also find out the frequency control word for these cases.	7
2. 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 and choose a suitable principal component for the data set to reduce its dimension. Show the modified data.	10

x	y
26	6
29	15
56	8
31	8
52	6
55	9
71	17
31	22
54	18
47	4
40	23
66	9
68	8

No. of Questions	PART-II	Marks
b)	Describe different architectures of Supervisory Control and Data Acquisition (SCADA) Systems.	10
c)	What are the advantages and disadvantages of Spread Spectrum Radio based deployment of a SCADA system?	5
3. 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.	4
c)	Explain 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*?	5
e)	Explain the algorithm for computing Continuous Wavelet Transform of a signal.	7

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MEE 1ST YEAR 2ND SEM. EXAM 2018

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(50 marks for each part)

Use a separate Answer-Script for each part

4. a) What is "Gain scheduling control" in the context of adaptive control? — 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	0.5	0.6
2	0.2	0.8
3	0.1	0.9

Identify the parameters of the process assuming first order model.

5. Write notes on any *two* — $(2X12\frac{1}{2}=25)$

a) Wavelet Transform based denoising technique
b) Direct Digital Synthesis (DDS) based Frequency synthesizer
c) Different levels of Sensor fusion