

Ref No: Ex/EE/PE/B/T/413D/2025 & Ex/EE/PE/B/T/414D(O)/2025
B.E. ELECTRICAL ENGINEERING
FOURTH YEAR FIRST SEMESTER EXAM 2025

SUBJECT: - ADVANCED INSTRUMENTATION-I

Time: Three hours

Full Marks 100

No. of Questions		Marks																						
Answer any five		5X20=100																						
1. a)	Explain the operation of Direct Digital Synthesis (DDS) based Frequency synthesizer.	8																						
b)	A digital frequency synthesizer employs a 4MHz crystal oscillator and gives a 256 step-sinusoid. Determine the maximum and minimum output frequency if the number of fractional bit is 4. Also find out the frequency control word for these cases.	4																						
c)	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.	2+6																						
2. a)	A two dimensional data are 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 and the reduced data. <table> <tr> <th>x</th> <th>y</th> </tr> <tr><td>2</td><td>7</td></tr> <tr><td>5</td><td>6</td></tr> <tr><td>6</td><td>8</td></tr> <tr><td>7</td><td>12</td></tr> <tr><td>4</td><td>8</td></tr> <tr><td>5</td><td>10</td></tr> <tr><td>2</td><td>4</td></tr> <tr><td>4</td><td>8</td></tr> <tr><td>6</td><td>9</td></tr> <tr><td>8</td><td>15</td></tr> </table>	x	y	2	7	5	6	6	8	7	12	4	8	5	10	2	4	4	8	6	9	8	15	15
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b)	Prove that the principal components are perpendicular to each other.	5																						
3. a)	Explain how the ADC resolution increases by 0.5 bit for each octave increase in the Oversampling Ratio (OSR) of an oversampling ADC.	7																						
b)	Explain how the resolution increases further for a first order Sigma-Delta Modulator ADC where oversampling is done alongwith noise shaping.	9																						
c)	Calculate the Effective Number of Bits (ENOB) for a four-bit first order Sigma-Delta Modulator ADC with a signal bandwidth of 20kHz and oversampling frequency of 2.56 MHz.	4																						
4. a)	Samples of a signal is shown as $f = \{0, 4, 10, 8, 0, 7, 0, 2\}$. ↑ Find Wavelet coefficients after Haar Transform upto the maximum level of decomposition possible. Show that energy does not change after Haar transform.	5																						

[Turn over

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- b) What is/are “Discrete” in Discrete Wavelet Transform? 2
- c) Explain the terms “scale” and “translation” in Continuous Wavelet Transform (CWT). 4
- d) What are the properties of a *mother-wavelet*? 3
- e) How can you use Wavelet Transform for denoising a one dimensional signal? 6
5. a) A Rough Set based decision rule generation system uses a data table as given below. Generate the set of decision rules from this table. 10

Objects	Condition Attributes			Decision Attribute
	A	B	C	
U ₁	0	1	0	1
U ₂	0	1	1	1
U ₃	1	1	1	0
U ₄	1	0	1	0
U ₅	1	0	2	1
U ₆	0	0	2	0
U ₇	1	0	0	0
U ₈	1	1	0	1

- b) 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. 10

Objects	Condition Attributes		Decision Attribute
	A	B	
U ₁	2.00	5.0	1
U ₂	1.25	3.5	1
U ₃	2.25	5.0	0
U ₄	0.75	2.5	0
U ₅	1.8	1.0	1
U ₆	1.25	3.5	0
U ₇	1.25	2.5	0
U ₈	2.25	3.5	1

6. a) Explain a method for face image classification based on “Eigenface”. 12
- b) Explain the algorithm for the computation of Continuous Wavelet Transform for a one dimensional signal. 8

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7.	Write notes on any two	(2X10=20)
a)	Different Levels of Sensor Fusion	
b)	Lock-in-amplifier using digital synthesis technique	
c)	Gradient Descent algorithm with regularization for least square solution	