Ref. No.: Ex/IT/PC/B/T/424/2025

B.E. INFORMATION TECHNOLOGY FOURTH YEAR SECOND SEMESTER – 2025
DIGITAL IMAGE PROCESSING

Time: 3 hours **Full Marks: 100**

CO1: **Review** the fundamental concepts of digital image processing (K2)

1. Attempt **a** and any three (3) from {b, c, d, e} [6 + 3 × 3 = 15]
   a. List out the various types of adjacency between the pixels and define them.

   OR

   Explain the digitization process to obtain a digital image.

   b. Define and compare brightness and luminance.
   c. What is meant by machband effect?
   d. What is image translation and scaling?
   e. What is meant by spatial resolution and explain its significance.

CO2: **Analyze** images in the transform domain using different transforms like FT, DCT, HT, KLT, etc. (K3)

2. Attempt all questions [3 + 4 + 8 = 15]
   a. Why do we need image transform?
   b. Prove that any operation in frequency domain of an image is a global operation.
   c. State and prove the translation property of 2D FT in discrete domain.

   OR

   Prove the properties of twiddle factor, i.e., a) periodicity: $W_N^{k+N} = W_N^k$ and b) symmetry: $W_N^{k+N/2} = -W_N^k$. Symbols have standard meaning.

CO3: **Demonstrate** the techniques for image enhancement. (K3)

3. Attempt all questions [6 + 3 + 6+ 5 = 20]
   a. Perform Histogram Equalization for the following 2 bit image

   $$\begin{matrix} 0 & 0 & 1 & 2 \\ 2 & 3 & 3 & 1 \\ 1 & 2 & 1 & 3 \\ 2 & 3 & 2 & 3 \end{matrix}$$

   OR

   A binary image is process by histogram equalization. What will be the output?
   b. What is meant by bit plane slicing?
   c. Illustrate the sharpening of images in spatial domain with Gradient and Laplacian operations with required expressions.
   d. Determine the median value of the bold pixels of the given matrix using 3 × 3 mask.

$$\begin{pmatrix} 18 & 22 & 33 & 25 & 32 & 24 \\ \mathbf{34} & \mathbf{128} & \mathbf{24} & \mathbf{172} & \mathbf{26} & \mathbf{23} \\ 22 & 19 & 32 & 31 & 28 & 26 \end{pmatrix}$$

[Turn over

CO4: **Illustrate** different techniques of Image segmentation including morphology. (K3)

4. Attempt all questions [3 + 6 + 7 + 4 = 20]
   a. Write the conditions to be followed to perform region based segmentation.
   b. Compare the performance of first and second order derivatives in the detection of point, line and edge.

   OR

   Sketch the dilation and erosion of the object labeled A in the figure below, using the structuring element B. Note that the center of the binary structuring element B is given by the darker pixel.
   c. State and prove the 'associative' and 'distributive over union' properties of binary dilation using proper diagram.
   d. Write the effects of opening in gray scale domain with suitable diagrams.

CO5 : **Interpret** image representation and description techniques. (K3)

5. Attempt any three (3) questions [3 × 5 = 15]
   a. Consider 4-directinal chain code and prove that the order of the chain code of a given region is always even.
   b. How signature represents a region?
   c. Specify and explain different polygonal approximation methods.
   d. Define circularity and compactness of a region. Also, find a relation between them.

CO6 : **Describe** and illustrate various image compression techniques. (K3)

6. Attempt all questions [(3+5) + 7 = 15]
   a. Prove that using Huffman coding technique we cannot achieve bps (bits per symbol) < 1. Give an extension of this method so that we can achieve bps < 1.
   b. Design a lossy predictive image coding scheme which restrict the propagation of error. Draw a block diagram to explain the scheme.

   OR

   Consider the following transformed image block and quantization table, find the encoded stream obtained after the 'run level coding' step of the JPEG technique.

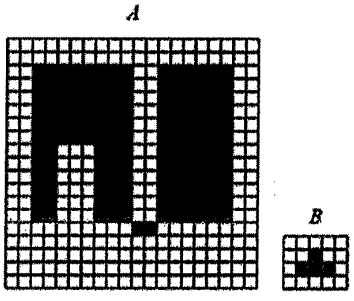

Figure for Q. 4.b.OR

58	45	29	27	24	19	17	20
62	52	42	41	38	30	22	18
48	47	49	44	40	36	31	25
59	78	49	32	28	31	31	31
98	138	116	78	39	24	25	27
115	160	143	97	48	27	24	21
99	137	127	84	42	25	24	20
74	95	82	67	40	25	25	19

Transformed image block

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

Quantization table

For Q.6.b.OR