DIGITAL IMAGE PROCESSING
(AEIE 4242)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Which of the following is NOT a basic step in digital image processing?
(a) Image enhancement (b) Image acquisition
(c) Image compression (d) Image deletion.

(ii) Which image format is commonly used for lossless compression?
(a) JPEG (b) PNG
(c) GIF (d) BMP.

(iii) Which of the following is a commonly used measure of image quality?
(a) Bit rate (b) Signal-to-noise ratio
(c) Compression ratio (d) Sampling rate.

(iv) Which of the following transforms is used for image compression in JPEG standard?
(a) 2D DCT (b) Haar Transform
(c) Hadamard Transform (d) Radon Transform.

(v) Which of the following is a fundamental step in JPEG compression?
(a) Huffman Coding (b) Quantization
(c) Discrete Wavelet Transform (DWT) (d) Run-Length Encoding (RLE).

(vi) What is the purpose of image sampling?
(a) Enhancing image quality
(b) Reducing image resolution
(c) Converting continuous signals to discrete signals
(d) Storing images on digital devices.

(vii) Which of the following is the abbreviation of JPEG?
(a) Joint Photographic Experts Group
(b) Joint Photographs Expansion Group
(c) Joint Photographic Expanded Group
(d) Joint Photographic Expansion Group.

(viii) What does the total number of pixels in the region defines?
(a) Perimeter (b) Area
(c) Intensity (d) Brightness.

(ix) Canny edge detection algorithm is based on
(a) Ideal model (b) Step edge
(c) Real model (d) Smoothing model

(x) Points exceeding the threshold in output image are marked as
(a) 0 (b) 1
(c) 11 (d) X.

Fill in the blanks with the correct word

(xi) Discrete Cosine Transform (DCT) is commonly used in image compression to remove _____ redundancy.

(xii) The process of reducing the size of an image file without losing image quality is known as _____.

(xiii) The Histogram Equalization technique is used for _____ enhancement in images.

(xiv) Principal Component Analysis (PCA) is a technique used for _____ reduction in images.

(xv) The Laplacian operator is used for _____ enhancement in image processing.

Group - B

2. (a) Briefly discuss the components of an image processing system. *[(CO1)(Understand/LOCQ)]*

(b) What is pseudo colour image processing? *[(CO1)(Understand/LOCQ)]*

(c) How many number of bits required to store a 256×256 image with 32 gray levels? *[(CO1)(Remember/LOCQ)]*

(d) Consider the image segment shown below:

$$\begin{matrix} 3 & 1 & 2 & 1(q) \\ 2 & 2 & 0 & 2 \\ 1 & 2 & 1 & 1 \\ (p)1 & 0 & 1 & 2 \end{matrix}$$

Let $V = \{0,1\}$ be the set of intensity values used to define adjacency. Compute the lengths of the shortest$4-$, $8-$, and $m-$path between p and q. If a particular path does not exist between these two points, explain why. *[(CO1)(Analyze/IOCQ)]*

4 + 2 + 2 + 4 = 12

3. (a) What is Image Transform? What are the applications of transform? *[(CO2)(Understand/LOCQ)]*

(b) Find the $1D$ Walsh basis for the fourth-order system ($N = 4$). *[(CO2)(Analyze/IOCQ)]*

(c) Compute the 2D Hadamard transform of the signal $f(m.n) = \begin{bmatrix} 4 & -1 \\ 2 & 3 \end{bmatrix}$. *[(CO1)(Apply/IOCQ)]*

(1 + 2) + 6 + 3 = 12

Group - C

4. (a) The input image $f(m,n)$ is passed through a linear shift-invariant system $h(m,n)$. Determine the output image if $f(m,n)$ and $h(m,n)$ are given below:

$$f[m,n] = \begin{bmatrix} 12 & 10 & 8 & 4 \\ 8 & 14 & 6 & 9 \\ 5 & 9 & 13 & 8 \\ 14 & 5 & 7 & 9 \end{bmatrix} \text{ and } h[m,n] = \frac{1}{4}\begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}.$$

Assume zero padding of the original image. *[(CO3)(Apply/LOCQ)]*

(b) What are the major effects in the erosion process? *[(CO3)(Remember/LOCQ)]*

(c) What is a hit-or-miss transformation? *[(CO3)(Remember/LOCQ)]*

7 + 3 + 2 = 12

5. (a) Compute the median value of the marked pixel shown in the figure using a, 3 × 3 mask.

$$\begin{bmatrix} 1 & 5 & 7 \\ 2 & \boxed{4} & 6 \\ 3 & 2 & 1 \end{bmatrix}$$

[(CO3)(Apply/IOCQ)]

(b) Filter the following image using 3 × 3 neighbourhood averaging by assuming zero padding.

$$\begin{vmatrix} 1 & 2 & 3 & 2 \\ 4 & 2 & 5 & 1 \\ 1 & 2 & 6 & 3 \\ 2 & 6 & 4 & 7 \end{vmatrix}$$

[(CO3)(Apply/IOCQ)]

(c) Can two different images have the same histogram? Justify your answer. *[(CO3)(Analyze/IOCQ)]*

3 + 7 + 2 = 12

Group - D

6. (a) Consider an image strip of size 100×100, as shown in below Fig.. The image consists of four vertical stripes. The gray levels of the stripes from left to right are 64, 32, 16 and 8. The corresponding widths of the stripes are 40, 30, 20 and 10 pixels. For this striped image, compute the entropy in bits per pixel.

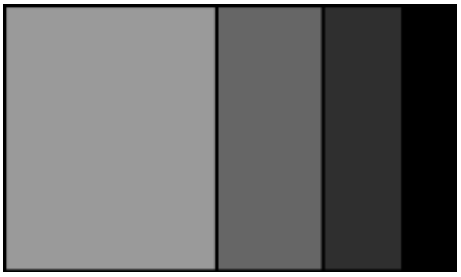

Fig. Image strip

[(CO4)(Analyze/IOCQ)]

(b) Explain run length coding scheme. *[(CO4)(Remember/LOCQ)]*

(c) What are the drawbacks of run length coding? *[(CO4)(Remember/LOCQ)]*

8 + 2 + 2 = 12

7. (a) Explain transform-based image coding scheme with block diagram. *[(CO4)(Remember/LOCQ)]*

(b) What are the basic steps involving in JPEG compression? Explain with a block diagram. *[(CO4)(Remember/LOCQ)]*

(c) Distinguish between scalar and vector quantisation? *[(CO4)(Remember/LOCQ)]*

4 + 4 + 4 = 12

Group - E

8. (a) Distinguish between local and global thresholding techniques for image segmentation. What is the difference between region splitting and region merging techniques of image segmentation? *[(CO5)(Remember/LOCQ)]*

(b) Explain split and merge algorithm for image segmentation? *[(CO5)(Understand/LOCQ)]*

(4 + 2) + 6 = 12

9. (a) What are the advantages/disadvantages if we use more than one seed in a region-growing technique? *[(CO6)(Understand/LOCQ)]*

(b) What are the roles of feature selection in machine learning? *[(CO6) (Understand/LOCQ)]*

(c) Compute the covariance matrix of the data given by $X_1 = [2 \quad 1]^T$, $X_2 = [3 \quad 2]^T$, $X_3 = [2 \quad 3]^T$ and $X_4 = [1 \quad 2]^T$. *[(CO6)(Apply/IOCQ)]*

2 + 2 + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	55	45	0

Course Outcome (CO):

After the completion of the course students will be able to

1. Understand how gray level and colour images are formed, sampled, quantized and represented digitally and processed by discrete, linear, time-invariant systems.
2. Apply transformation algorithms such as DFT, DCT, Walsh, Hadamard, Haar, KLT and Wavelet transform to any given image.
3. Perform image enhancement, restoration and morphological operations on images.
4. Compress a given image by applying lossy and loss less image coding techniques.
5. Evaluate the methodologies of image segmentation, representation and description.
6. Learn feature extraction techniques for image analysis and recognition.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*