DIGITAL IMAGE PROCESSING
(AEIE 5241)

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) The number of shades in a six-bit image is
(a) 256 (b) 128
(c) 64 (d) 32

(ii) In 4-neighbours of a pixel p, how far are each of the neighbours located from p?
(a) One pixel apart (b) Two pixels apart
(c) Four pixels apart (d) None of these.

(iii) Which of the following is the first and foremost step in Image Processing?
(a) Image acquisition (b) Segmentation
(c) Image restoration (d) Image enhancement.

(iv) The quality of a digital image is determined by
(a) The discrete gray levels
(b) The number of samples
(c) Discrete gray levels & number of samples
(d) None of the mentioned

(v) Which of the following is the abbreviation of JPEG?
(a) Joint Photographic Experts Group
(b) Joint Photographic Expansion Group
(c) Joint Photographic Extension Group
(d) None of the above.

(vi) Step edge transition is between the pixels over the distance of
(a) 1 pixel (b) 2 pixels
(c) 3 pixels (d) 4 pixels

(vii) The city block distance between the points (2, 4) and (7, 7) is
(a) 5 (b) $\sqrt{34}$
(c) 8 (d) None of the above

(viii) Operator which can be used to detect edges of an image is
(a) Logarithm (b) Gradient
(c) Exponential (d) Average

(ix) Dilation followed by erosion is called
(a) Opening (b) Blurring
(c) Closing (d) Translation

(x) An example of unsupervised classifier is
(a) Perceptron (b) Back propagation network
(c) Support vector machine (d) Self-organizing feature map.

Fill in the blanks with the correct word

(xi) A RGB image comprises of _____ number of bits for 8-bit monochrome.

(xii) _____filter is known as averaging filter.

(xiii) The photosensitive 'detector' of human eye is _____.

(xiv) The selection of the real plane spanned by the coordinates of an image is called the _____ domain.

(xv) The best example of an order-statistic filter is _____.

Group - B

2. (a) What is hue and saturation? Describe the HSI colour model. *[(CO1)(Remember/LOCQ)]*
(b) Define Euclidean distance, D4 distance and D8 distance measure between any two pixels in an image. *[(CO1)(Remember/LOCQ)]*
(c) List the components required in digital image processing. Mention some advantages and limitations of digital image processing. *[(CO1)(Understand/LOCQ)]*

(2 + 3) + 3 + (2 + 2) = 12

3. (a) What is the need for image transform? State the properties of 2D discrete cosine transform. *[(CO2)(Remember/LOCQ)]*
(b) Find the 2D Hadamard transform of the image shown in Fig. below.

$$F = \begin{bmatrix} 1 & 2 & 1 & 3 \\ 2 & 3 & 0 & 2 \\ 3 & 1 & 2 & 1 \\ 1 & 0 & 3 & 2 \end{bmatrix}$$

[(CO2)(Apply/IOCQ)]

(c) What is energy compaction of a unitary transform? Compare the energy compaction of DCT with respect to DFT. *[(CO2)(Understand/LOCQ)]*

(2 + 2) + 6 + (1 + 1) = 12

Group - C

4. (a) Show how noise can be eliminated by image averaging. *[(CO3)(Understand/LOCQ)]*

(b) What are contrast stretching and zooming operations? *[(CO3)(Understand/LOCQ)]*

(c) Consider the sub-image image shown in figure below. Compute the output of MIN, MAX, median, mean and high pass filter output if it is operated by a 3×3 box fitter mask centred on the circled pixel.

1	2	3
2	(4)	5
3	4	3

[(CO3)(Apply/IOCQ)]

(d) Explain the approach of image enhancement in frequency domain with block diagram. *[(CO3)(Understand/LOCQ)]*

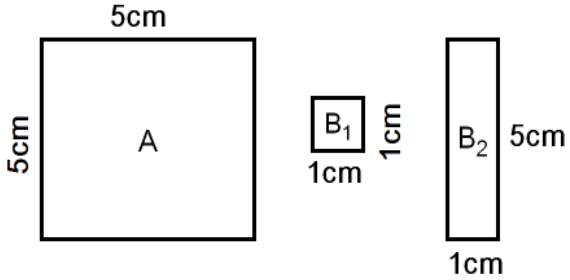
3 + 3 + 3 + 3 = 12

5. (a) Perform histogram equalization of the image given in figure below and show the output image.

5	4	4	4	5
3	2	3	5	2
5	4	3	6	2
3	5	6	4	2
2	4	5	6	3

[(CO3)(Apply/IOCQ)]

(b) Sketch the output image in the following cases considering the objects shown in figure below. (i) $A \oplus B_1$ and (ii) $A \oplus B_2$.



[(CO3)(Apply/IOCQ)]

8 + 4 = 12

Group - D

6. (a) What are coding and psychovisual redundancy. *[(CO4)(Understand/LOCQ)]*

(b) Consider an image with the following pixel distribution and two different coding scheme.

Pixel values (r_k)	Probability [$P_r(r_k)$]	Code1	Code2
87	0.25	01010111	01
128	0.47	10000000	1
186	0.25	11000100	000
255	0.03	11111111	001
$r_k$for k ≠ 87, 128,186, 255	0	-	-

Find the average bit length of code1 and code2 and hence compression ratio and data redundancy and entropy of the image. *[(CO4)(Apply/IOCQ)]*

2 + 10 = 12

7. (a) What is run length coding? Explain with example. *[(CO4)(Understand/LOCQ)]*

(b) For the image shown in below and compute the degree of compression that can be achieved using (i) Huffman coding of pixel values, (ii) run-length coding, assuming 2 bits to represent the pixel value and 2 bits to represent run length?

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

[(CO4)(Apply/IOCQ)]

(c) Explain the 'fidelity criterion' for lossy image compression. *[(CO4)(Understand/LOCQ)]*

2 + 8 + 2 = 12

Group - E

8. (a) Distinguish between local and global thresholding techniques for image segmentation. *[(CO5)(Understand/LOCQ)]*

(b) Explain different types of shape features that can be extracted from images. *[(CO6)(Analyze/IOCQ)]*

(c) What is clustering? Describe K-means clustering algorithm. *[(CO6)(Apply/IOCQ)]*

3 + 3 + 6 = 12

9. (a) Distinguish between supervised and unsupervised classification. *[(CO6)(Understand/LOCQ)]*

(b) Define signature, eccentricity, compactness and circularity of an object. *[(CO6)(Remember/LOCQ)]*

(c) What is texture of an image? What are the three approachs to describe texture of an image? Explain the useful statistical features for texture classification *[(CO2)(Understand/LOCQ)]*

2 + 4 + (1 + 1 + 4) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	50	50	0

Course Outcome (CO):

After the completion of the course students will be able to

1. Learn how 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. Learn segmentation of a given image by line, edge and boundary detection and thresholding and region based techniques.
6. Gain concept of analyzing an image by features extraction and object recognition techniques.

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