DIGITAL IMAGE PROCESSING
(AEIE 5241)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The transition between continuous values of the image function and its digital equivalent is called
(a) quantization (b) sampling
(c) rasterisation (d) none of the mentioned.

(ii) Filter that replaces the pixel value with the medians of intensity levels is
(a) arithmetic mean filter (b) geometric mean filter
(c) median filter (d) sequence mean filter.

(iii) The procedure done on a digital image to alter the values of its individual pixels is
(a) neighbourhood operations (b) image registration
(c) geometric spatial transformation (d) single pixel operation.

(iv) Huffman coding is used to reduce
(a) coding redundancy (b) psycho visual redundancy
(c) inter pixel redundancy (d) all of the above.

(v) The transform which is recommended in JPEG2000 standard is
(a) radon transform (b) discrete cosine transform
(c) walsh transform (d) wavelet transform.

(vi) For line detection we use mask that is
(a) Gaussian (b) Laplacian (c) Ideal (d) Butterworth.

(vii) Which of the following is the useful descriptor of a boundary, whose value is given by the ratio of length of the major axis to the minor axis?
(a) Radius (b) Perimeter (c) Area (d) Eccentricity.

(viii) Gradient magnitude images are more useful in
(a) point detection (b) line detection
(c) area detection (d) edge detection.

(ix) An example of an unsupervised neural network is
(a) perceptron (b) back-propagation network
(c) self-organizing feature map (d) counter propagation network.

(x) The process of embedding one image into another image is known as
(a) dithering (b) demosicing (c) watermarking (d) beamforming.

Group- B

2. (a) What is hue and saturation? Describe the RGB colour model. [(CO1)(Remember/LOCQ)]

(b) Define Euclidean distance, D4 distance and D8 distance measure between any two pixels in an image. [(CO1)(Understand/LOCQ)]

(c) Consider the image segment shown in Fig.1. (i) Let $V = \{0,1\}$ and and 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. (ii) Repeat the problem considering $V = \{1,2\}$. [(CO1)(Analyze/LOCQ)]

3	1	2	1(q)
2	2	0	2
1	2	1	1
(p)1	0	1	2

Fig.1

(2 + 3) + 3 + 4 = 12

3. (a) What is image transform? List the application of image transform. [(CO2)(Remember/LOCQ)]

(b) Compute the 2D linear convolution between two signals $x(m,n)$ and $h(m,n)$ as shown in Fig.2 below. [(CO1)(Apply/IOCQ)]

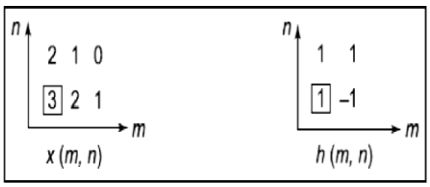

Fig.2

(c) State the properties of two dimensional DFT. [(CO2)(Remember/LOCQ)]

(d) A 4 × 4 image is shown below in Fig.3. Compute the 2D-DFT of the image.

1	2	2	1
2	0	0	2
2	0	0	2
1	2	2	1

Fig. 3

[(CO2)(Apply/IOCQ)]

2 + 4 + 2 + 4 = 12

Group - C

4. (a) Show how noise can be eliminated by image averaging. [(CO3)(Analyze/IOCQ)]

(b) A 3 × 3 image having 8 gray levels is shown below in Fig.4. Compute the output pixel value corresponding to the marked pixel obtained by a 3 × 3 (i) high pass

filter (ii) low pass filter (iii) median filter (iv) MIN filter (v) MAX filter and (vi) high boost filter mask. [(CO3)(Apply/IOCQ)]

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

Fig.4

(c) Explain gray level slicing of image and write its application. [(CO3)(Understand/LOCQ)]

3 + 6 + 3 = 12

5. (a) What are the purposes of edge detection? [(CO4)(Remember/LOCQ)]

(b) A 4 × 4 image is given in Fig.5a. Compute the output image using a median filter with the filter mask as given in Fig.5b. [(CO3)(Analyze/LOCQ)]

3	2	2	4
6	2	3	5
1	4	7	6
5	6	4	3

Fig.5a: Image

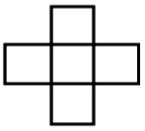

Fig.5b: Filter mask

(c) What is image restoration? Describe the constrained least square error approach of image restoration technique. [(CO3)(Remember/LOCQ)]

2 + 5 + 5 = 12

Group - D

6. (a) What is the need for image compression? What are the two main types of data compression? [(CO4)(Remember/LOCQ)]

(b) What is transform coding? Explain transformed-based image-coding scheme with block diagram. [(CO4)(Understand/LOCQ)]

(c) Apply block truncation coding procedure to the image shown in the Fig.6 below to find the compressed image and reconstructed image. [(CO4)(Apply/IOCQ)]

$$f(m,n) = \begin{bmatrix} 45 & 55 & 60 & 40 \\ 32 & 55 & 62 & 58 \\ 64 & 52 & 55 & 45 \\ 60 & 35 & 45 & 58 \end{bmatrix}$$

Fig.6

(2 + 1) + 3 + 6 = 12

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

(b) Formulate a set of code words and compute average word length using Huffman coding scheme for a set of input gray levels from 0 to 7 with probabilities as given in table 1 below. Estimate the compression ratio using Huffman coding and data redundancy of original representation. [(CO4)(Evaluate/HOCQ)]

Table-1

Gray level	0	1	2	3	4	5	6	7
Probabilities	0.03	0.10	0.06	0.16	0.05	0.17	0.13	0.30

3 + 9 = 12

Group - E

8. (a) What is region growing technique of image segmentation? What is its drawback? [(CO5)(Remember/LOCQ)]
   (b) What is the purpose of shape representation? [(CO5)(Remember/LOCQ)]
   (c) Explain 4-directional and 8-directional chain code approaches of shape representation. [(CO5)(Understand/LOCQ)]
   (d) Obtain the 4-directional chain code and the shape number for the arbitrary-shape shown in the Fig.7 below. [(CO5)(Apply/IOCQ)]

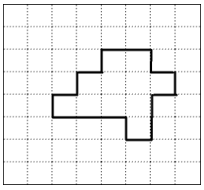

Fig.7

3 + 2+ 3 + 4 = 12

9. (a) State the differences between supervised and unsupervised classification. [(CO6)(Remember/LOCQ)]
   (b) Describe the k-means clustering algorithm. [(CO6)(Understand/LOCQ)]
   (c) What do you understand by texture analysis? What are the approaches to analyse texture? Define Energy, Entropy and Contrast features to quantify spatial variation of pixel gray level or intensity that forms the textural patterns. [(CO6)(Understand/LOCQ)]

2 + 4 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	62.5	28.12	9.38

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