DIGITAL IMAGE PROCESSING
(AEIE 4242)

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 visible spectrum ranges
(a) 300-600 nm (b) 400-700 nm
(c) 500-800 nm (d) 600-900 nm.

(ii) Which of the following is a common technique used in image enhancement?
(a) Median filtering (b) Edge detection
(c) Fourier transformation (d) All of (a), (b) & (c).

(iii) Which of the following correctly describes the slightest visible change in the level of intensity?
(a) Contour (b) Saturation
(c) Contrast (d) Intensity Resolution.

(iv) Which of the following is the application of Histogram Equalisation?
(a) Blurring (b) Contrast adjustment
(c) Image enhancement (d) None of (a), (b) & (c).

(v) Which of the following is an example of a spatial domain filter?
(a) Fourier Transform (b) Laplacian filter
(c) Haar Transform (d) Wavelet Transform.

(vi) What is the output of a smoothing, linear spatial filter?
(a) Median of pixels (b) Maximum of pixels
(c) Minimum of pixels (d) Average of pixels.

(vii) What is image restoration?
(a) Process of enhancing the visual appearance of an image
(b) Process of removing noise and distortions from an image
(c) Process of compressing an image
(d) Process of resizing an image.

(viii) Which of the following is a common method for image restoration?
(a) Median filtering (b) Histogram equalization
(c) Edge detection (d) Image segmentation.

(ix) Color model used for printers is
(a) CMYK (b) YIQ (c) RGB (d) HIS.

(x) Which of the following is a commonly used technique for image segmentation?
(a) Thresholding (b) Histogram equalization
(c) Edge detection (d) Denoising.

Group - B

2. (a) Write down some of the applications of Image processing. *[(CO1)(Remember/LOCQ)]*

(b) Explain the following terms with respect to digital image capturing:
(i) Sampling and (ii) Quantization. *[(CO1)(Understand/LOCQ)]*

(c) What do you mean by neighbours of a pixel? Define 4, 8 and m- adjacency of pixels in a gray scale image. *[(CO1)(Remember/LOCQ)]*

(d) Define Euclidean distance. *[(CO1)(Remember/LOCQ)]*

2 + (2 + 2) + (1 + 3) + 2 = 12

3. (a) If the DFT of $f(m,n)$ is $F(k,l)$ then prove that $F(k,l) = F^*(-k,-l)$. *[(CO2)(Analyze/IOCQ)]*

(b) Determine whether the matrix $A = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$ is unitary or not. *[(CO2)(Analyze/IOCQ)]*

(c) The discrete Fourier transform performed for the image $f(m,n)$ is given below. What will be the value of $F(0,0)$?

$$f(m,n) = \begin{bmatrix} 0 & 1 & 2 & 1 & 4 \\ 4 & 1 & 4 & 5 & 6 \\ 1 & 2 & 1 & 0 & 4 \\ 5 & 4 & 1 & 3 & 5 \\ 4 & 2 & 4 & 5 & 6 \end{bmatrix}$$

[(CO2)(Apply/IOCQ)]

(d) What is the goal of an image transform? *[(CO2)(Understand/LOCQ)]*

4 + 3 + 3 + 2 = 12

Group - C

4. (a) What is the difference between image restoration and image enhancement? What do they have in common? *[(CO3)(Understand/LOCQ)]*

(b) When will a constrained least square Filter (CLS) reduce to an inverse filter? *[(CO3)(Understand/LOCQ)]*

(c) What are the advantages of a Wiener filter over an inverse filter? *[(CO3)(Remember/LOCQ)]*

(d) A photograph is taken through the front window of a car moving at constant velocity on a flat road. Because of the movement of the car, the image is

distorted. State whether this image distortion is linear or non-linear. Also, find whether the point-spread function is space-invariant or not. *[(CO3)(Analyze/IOCQ)]*

3 + 3 + 3 + 3 = 12

5. (a) Given an image of size 3×3 as $f(m,n) = \begin{bmatrix} 128 & 212 & 255 \\ 54 & 62 & 124 \\ 140 & 152 & 156 \end{bmatrix}$. Determine the output image $g(m,n)$ using logarithmic transformation $g(m,n) = \lfloor c \log_{10}(1 + f_{m,n}$ where $c=1$. *[(CO3)(Apply/IOCQ)]*

(b) List three properties of median filter. *[(CO3)(Remember/LOCQ)]*

(c) What are the effects of the dilation process? *[(CO3)(Understand/LOCQ)]*

6 + 3 + 3 = 12

Group - D

6. (a) Determine whether the code {0, 01, 11} is uniquely decodable or not. *[(CO1)(Remember/LOCQ)]*

(b) Explain how zonal coding is different from threshold coding. *[(CO3)(Understand/LOCQ)]*

(c) One of the objective measures of image compression is Peak Signal-to-Noise Ratio (PSNR). The original and the reconstructed image are given below. Calculate the PSNR expressed in decibels.

$$Original\ image = \begin{bmatrix} 1 & 8 & 6 & 6 \\ 6 & 3 & 11 & 8 \\ 8 & 8 & 9 & 10 \\ 9 & 10 & 10 & 7 \end{bmatrix}$$

$$Reconstructed\ image = \begin{bmatrix} 2 & 8 & 8 & 7 \\ 6 & 3 & 12 & 8 \\ 5 & 4 & 9 & 1 \\ 15 & 9 & 11 & 9 \end{bmatrix}$$

[(CO1)(Evaluate/HOCQ)]

2 + 3 + 7 = 12

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

(b) Apply the run length coding to the following image segment:
44444222222777777333333388888822255555555 *[(CO4)(Apply/IOCQ)]*

(c) What is predictive coding? Describe loss-less predictive scheme with schematic block diagram. *[(CO4)(Understand/LOCQ)]*

(d) Why is zig-zag scanning preferred in JPEG standard? *[(CO4)(Understand/LOCQ)]*

3 + 2 + 4 + 3 = 12

Group - E

8. (a) What are supervised and unsupervised classification techniques? *[(CO6)(Remember/LOCQ)]*

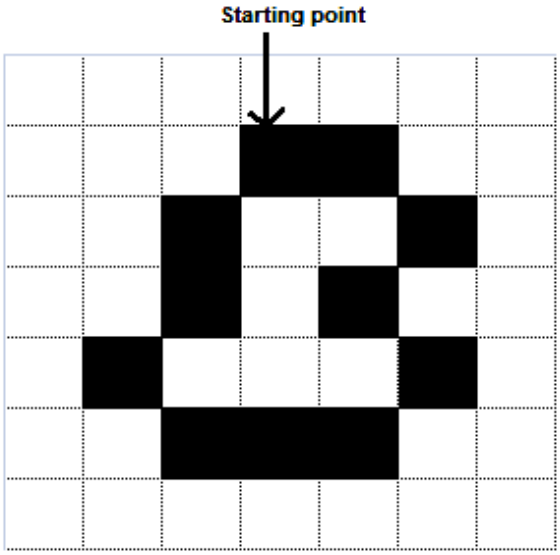
(b) Describe the states involved in k-means clustering. *[(CO6)(Understand/LOCQ)]*

(c) Name few measures used as simple descriptors in region description. Define length of a boundary and compactness of a region. *[(CO6)(Understand/LOCQ)]*

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

9. (a) What are the three stages of the Canny edge detector? Briefly explain each phase. *[(CO6)(Remember/LOCQ)]*

(b) Obtain the 8-directional chain code, difference code and the shape number for the arbitrary-shape shown in figure below.



[(CO5)(Evaluate/HOCQ)]

(c) Explain different shape features that can be extracted from 2D images. *[(CO6)(Analyze/IOCQ)]*

3 + 6 + 3 = 12

Cognition Level	*LOCQ*	*IOCQ*	*HOCQ*
Percentage distribution	*61.46*	*25.00*	*13.54*

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.*