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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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 number of bits required to store a 256×256 digital image with 32 gray levels is
          (a) 256×256×8   (b) 256×256×5
          (c) 256×256×32   (d) None of the above.

    (ii) Cone vision is called
          (a) scotopic vision   (b) photopic vision
          (c) photogenic vision   (d) all of these.

    (iii) What is the tool used in tasks such as zooming, shrinking, rotating, etc.?
          (a) Sampling   (b) Interpolation
          (c) Filters   (d) None of the Mentioned.

    (iv) Digital images are displayed as a discrete set of
          (a) values   (b) numbers
          (c) frequencies   (d) intensities.

    (v)   Which of the following filters will in general have the best performance in enhancing edges in an image?
          (a) Mean filter   (b) Median filter
          (c) Laplacian filter   (d) Mode filter.

    (vi) The parameter that may change if all the pixels in an image are shuffled is
          (a) mean   (b) entropy
          (c) histogram   (d) covariance.

    (vii) Compressed image can be recovered back by
          (a) image enhancement   (b) image decompression
          (c) image contrast   (d) image equalization.

    (viii) Erosion followed by dilation is called
          (a) opening   (b) closing
          (c) open-close   (d) close-open.

(ix)   The effect of low pass filtering in an image is
        (a) contrast enhancement   (b) sharpening
        (c) blurring   (d) resizing.

(x)   Bayes approach to pattern recognition fits into the category of
        (a) structural approach   (b) statistical approach
        (c) template matching   (d) neural-network approach.

Group- B

2. (a)   Distinguish between monochrome and a gray scale image.
                                                [(CO1) (Remember/LOCQ)]
    (b)   What do you mean by the term image format? Mention some of the frequently
           used image file formats.   *[(CO1) (Remember/LOCQ)]*
    (c)   What are the different types of pixel connectivity? Explain with examples.
                                                [(CO1) (Understand/LOCQ)]
    (d)   Describe briefly the HSI colour model.   *[(CO1) (Remember/LOCQ)]*
                                                2 + 2 + 4 + 4 = 12

3. (a)   What is meant by image transform? Explain it's need in digital image processing.
                                                [(CO2) (Remember/LOCQ)]
    (b)   Define 2D-DCT and write it's properties.   *[(CO2) (Remember /LOCQ)]*
    (c)   Compute the inverse 2D-DFT of the transform coefficient given below.

$$F[k,l] = \begin{array}{|c|c|c|c|} \hline 16 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 \\ \hline \end{array}$$

                                                [(CO2)(Apply/IOCQ)]
                                                (2 + 1) + 4 + 5 = 12

Group - C

4. (a)   What is highboost filter? What is its application?   *[(CO4) (Remember/LOCQ)]*
    (b)   Perform histogram equalization of the following 3-bit gray scale image whose
           gray level distribution is given as follows:

Gray level	0	1	2	3	4	5	6	7
No. Of Pixels	8	10	10	2	12	16	4	2

                                                [(CO3) (Apply/IOCQ)]
    (c)   What is Homomorphic filtering? Explain with block diagram.
                                                [(CO3)(Remember/LOCQ)]
                                                3 + 6 + 3= 12

5. (a)   What is contrast stretching? Explain how it is performed on digital images.
                                                [(CO3) (Analyze/IOCQ)]

(b)   What is Laplacian sharpened image? Apply this technique on the image given below to determine the output image. Use pixel replication method for computation.   *[(CO3) (Apply/IOCQ)]*

6	9	14
12	10	15
8	7	9

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

4 + 6 + 2 = 12

Group - D

6.   (a)   Explain general image compression model with block diagram.   *[(CO4) (Understand/LOCQ)]*

(b)   Consider a 1st order lossless predictive coding model. Find out the encoder and decoder output for the following image segment along a line scan.

        110, 112, 114, 118, 115, 120, 116, 122, 125   *[(CO4) (Apply/IOCQ)]*

(c)   What is 'blocking artifacts' in DCT-based transformed image compression scheme?   *[(CO4)(Understand/LOCQ)]*

4 + 6 + 2 = 12

7.   (a)   Explain lossy and lossless predictive coding method.   *[(CO4) (Understand/LOCQ)]*

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

$$\begin{bmatrix} 1 & 8 & 6 & 6 \\ 6 & 3 & 11 & 8 \\ 8 & 8 & 9 & 10 \\ 9 & 10 & 10 & 7 \end{bmatrix} \qquad \begin{bmatrix} 2 & 8 & 8 & 7 \\ 6 & 3 & 12 & 8 \\ 5 & 4 & 9 & 1 \\ 15 & 9 & 11 & 9 \end{bmatrix}$$

        Original image   Reconstructed image

[(CO4) (Evaluate/HOCQ)]

4 + 8 = 12

Group - E

8.   (a)   Explain different shape features that can be extracted from 2D-images.   *[(CO6) (Remember/LOCQ)]*

(b)   Compute the decision functions of a minimum distance classifier for the three classes of patterns with the mean vectors $m_1 = \begin{bmatrix} 1.5 & 0.3 \end{bmatrix}^T$, $m_2 = \begin{bmatrix} 4.3 & 1.3 \end{bmatrix}^T$ and $m_3 = \begin{bmatrix} 5.5 & 2.1 \end{bmatrix}^T$, respectively. Sketch the decision surfaces implemented by the decision functions.   *[(CO6) (Understand/LOCQ)]*
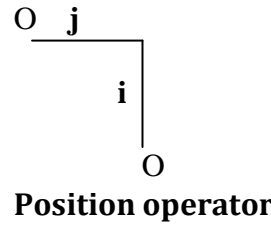
(c)   Name few measures used as simple descriptors in region description. Define length of a boundary and compactness of a region.   *[(CO6)(Understand/LOCQ)]*

3 + 5 + (2 + 2) = 12

9. (a)   Determine the gray level co-occurrence matrix (C_{ij}) for the image and position operator shown in figure below:

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

Image

O   **j**

     i

     O

Position operator

[(CO6) (Analyze/IOCQ)]

(b)   Using the obtained co-occurrence matrix in part (a), determine the element difference moment of order 2 using $\sum\sum(i-j)^2 C_{ij}$ and the entropy of this matrix (C_{ij}) using $-\sum\sum C_{ij}\log(C_{ij})$.   *[(CO6) (Apply/IOCQ)]*

(c)   What are supervised and unsupervised learning techniques?

[(CO6)(Understand/LOCQ)]

5 + (2 + 2) + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	54.17	37.5	8.33

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.