DIGITAL IMAGE PROCESSING
(INFO 3211)

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) How much storage space is required to store 1000 medical images whose resolutions are 1024 × 1024 × 24 bits?
(a) 25165824 KB (b) 4145768 KB
(c) 3145728 KB (d) 1048576 KB.

(ii) Median filter belongs to which of the following categories?
(a) Linear spatial filter (b) Laplacian filter
(c) Frequency domain filter (d) Order statistic filter.

(iii) The D4-distance between the pixels (1, 1) and (3, 4) is
(a) $\sqrt{13}$ (b) 4 (c) 5 (d) 3.

(iv) The maximum compression is achieved in
(a) P frame (b) B frame
(c) I frame (d) all will get same compression ratio.

(v) Inverse transformation plays an important role in which of the following Histogram Processing Techniques?
(a) Histogram Linearization (b) Histogram Equalization
(c) Histogram Matching (d) None of the mentioned.

(vi) In digital image of M rows and N columns and K discrete gray levels, the bits required to store a digitized image for M=N=32 and K=16 is
(a) 16384 (b) 4096
(c) 8192 (d) 512.

(vii) Example of lossy compression is
(a) Motion Compensation (b) Frame Replenishment
(c) Quantization (d) Huffman Encoding.

(viii) For an 8-bit image x[m,n,] the transform y[m,n] = 255 – x[m,n] will give
(a) dark image (b) bright image
(c) negative image (d) output same as input image.

(ix) Which technique is used for solving tasks such as zooming, shrinking, etc.?
(a) Sampling (b) Quantization
(c) Interpolation (d) Filter.

(x) Which of the following is the valid response when we apply a first order derivative?
(a) Non-zero at flat segm (b) Zero in flat segments
(c) Zero along ramp (d) Zero at the onset of gray level step.

Group- B

2. (a) How image can be zoomed by using replication and linear interpolation method? [(CO1)(Remember/LOCQ)]

(b) Consider an image $I = \begin{bmatrix} 0 & 1 & 1 \\ 2 & 0 & 3 \\ 1 & 0 & 2 \end{bmatrix}$ of size 3 × 3. Apply replication and nearest neighbourhood interpolation techniques to resize the image I to 6 × 6. Will these results be identical? [(CO1)(Apply/IOCQ)]

4 + (3 + 3 + 2) = 12

3. (a) Define the condition(s) under which the D4 distance between two points p and q is equal to the shortest 4-path between these points. Is this path unique? [(CO1)(Remember/LOCQ)]

(b) Costruct histogram equalization on the following image which has 8 discrete pixel levels (0-7).

1 1 1 1 1 1 1 1
0 2 5 5 5 5 2 0
0 3 2 6 7 2 3 0
0 3 3 2 2 3 3 0
0 2 3 2 2 3 3 0
0 3 2 4 6 2 4 0
0 2 6 4 4 4 2 0
1 1 1 1 1 1 1 1

[(CO2)(Create/HOCQ)]

(3 + 1) + 8 = 12

Group – C

4.

120	134	150	170	110
100	0	150	170	100
130	150	255	170	130
145	130	150	160	50
140	155	130	140	50

Find the output image by applying a low pass filter, high pass filter, MAX filter and median filter of size 3 × 3. [(CO2)(Apply/IOCQ)]

(3 + 3 + 3 + 3) = 12

5. (a) Evaluate 2D DFT of the following image segment. [(CO4) (Evaluate/HOCQ)]

$$I = \begin{bmatrix} 2 & 4 \\ 3 & 8 \end{bmatrix}$$

(b) (i) What is the difference between image restoration and image enhancement? [(CO3) (Remember/LOCQ)]

(ii) Explain any four properties of 2-D Fourier transforms. [(CO4) (Remember/LOCQ)]

6 + (2 + 4) = 12

Group - D

6. (a) Develop Huffman Code for the following data: [(CO5)(Create/HOCQ)]

Gray Level	Probability
a1	0.1
a2	0.4
a3	0.06
a4	0.1
a5	0.4
a6	0.3

(b) Describe Dictionary Based Compression Algorithm. Give two examples. [(CO5)(Understand/LOCQ)]

(c) With proper block diagram, state whether JPEG compression loses image data permanently or not. [(CO5)(Analyze/IOCQ)]

4 + 4 + 4 = 12

7. (a) "Removal of Psycho-visual Redundancy incurs better compression ratio compared to removal of Statistical Redundancy" – Justify the effectiveness of this statement. [(CO5)(Evaluate/HOCQ)]

(b) Write down the encoding algorithm of LZW. [(CO5)(Remember/LOCQ)]

(c) Consider the string ADBBADBB. Encode the string by using LZW algorithm. [(CO5)(Apply/IOCQ)]

3 + 4 + 5 = 12

Group - E

8. (a) Explain first and second order derivatives of an image. [(CO6) (Understand/LOCQ)]

(b) Consider a 1-D image f(x) = [5, 5, 4, 3, 2, 1, 0, 0, 0, 6, 0, 0, 0, 0, 1, 3, 1, 0, 0, 0, 0, 7, 7, 7, 7]. Apply the first and second order derivatives and locate the position of edges. [(CO6)(Analyze/IOCQ)]

4 + 8 = 12

9. (a) State the steps to develop an algorithm for Hough edge linking algorithm. [(CO6)(Understand/LOCQ)]

(b) Using Hough edge linking algorithm, justify that points (0, 0), (1, 1), (2, 2) and (3, 3) are on the same line. [(CO6)(Evaluate/HOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.33	38.54	28.13

Course Outcome (CO):

After successfully completing this course the students will be able to:

1. Review the fundamental concepts of a digital image processing system.
2. Apply different techniques employ for the enhancement of images in spatial domain.
3. Explain different causes for image degradation and apply image restoration techniques.
4. Apply different techniques employ for the enhancement of images in frequency domain.
5. Understand the need for image compression and explain different techniques of image compression.
6. Apply different feature extraction techniques for image analysis and recognition.

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