

IMAGE PROCESSING
(MCAP 2260)

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 transform which is widely used to detect 'lines' in an image is
(a) Fourier transform (b) Hough transform
(c) Cosine transform (d) Haar transform.
 - (ii) An image of size 128 × 128 pixels with 64 intensity levels requires the storage space of
(a) 12 KB (b) 96 KB (c) 128 KB (d) 16 KB.
 - (iii) The Wiener filter behaves like an inverse filter
(a) in the presence of noise
(b) in the absence of noise
(c) in the presence of noise and degradation
(d) Wiener filter will not resemble inverse filter under any condition.
 - (iv) The initial step in any image processing technique is
(a) image normalization (b) masking
(c) image segmentation (d) image acquisition.
 - (v) The parameter that may change if all the pixels in an image are shuffled is
(a) mean (b) entropy
(c) histogram (d) covariance
 - (vi) In which type of image, the histogram covers broad range of the gray scale?
(a) Dark image (b) High contrast image
(c) Low contrast image (d) Bright image.
 - (vii) An example of a dictionary-based coding technique is
(a) Huffman coding (b) run-length coding
(c) LZW coding (d) predictive coding.

- (viii) Which one of the following is a lossy coding technique?
 (a) Run Length Coding (b) Uniform Quantizer
 (c) Huffman Coding (d) Arithmetic Coding.
- (ix) Sharpening in frequency domain is achieved by
 (a) low-pass filter (b) high-pass filter
 (c) both (a) and (b) (d) none of (a) or (b).
- (x) In an image compression system, 6686 bits are used to represent a 128×128 image with 256 intensity levels. What is the compression ratio for this system?
 (a) 0.4 (b) 2.45 (c) 19.6 (d) 0.05.

Group- B

2. (a) Explain the following terms with respect to digital image capturing:
 (i) Sampling, (ii) Quantization. [(CO1)(Understand/LOCQ)]
 (b) Discuss with relevant examples two application areas of digital image processing. [(CO1)(Remember/LOCQ)]
 (c) Differentiate among Euclidean distance, city-block distance and chessboard distance. [(CO2)(Analyze/LOCQ)]
4 + 4 + 4 = 12
3. (a) Explain the fundamental steps involved in digital image processing. [(CO1)(Understand/LOCQ)]
 (b) Explain the role of illuminance and reflectance in a simple image formation model. [(CO1)(Understand/LOCQ)]
8 + 4 = 12

Group - C

4. (a) Justify the statement “Median filter is an effective tool to minimise salt-and-pepper noise” through a suitable example. [(CO3)(Analyze/IOCQ)]
 (b) Suppose ‘ r ’ be the intensity level of an input image which has to be transformed to ‘ s ’ by linear stretching. Suppose for an 8-level image we have the following frequency table for the input intensity levels, where n_i is the no. of pixels having i -th intensity level. What will be the frequency table for the output intensity level? [(CO3)(Apply/IOCQ)]

i	0	1	2	3	4	5	6	7
n_i	0	20	26	34	10	6	4	0

- (c) Consider the following 4-bit image:

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

Calculate the value of the shaded pixel when the following enhancement techniques are applied with 3×3 mask size:

- (i) Mean filter
- (ii) Min filter
- (iii) Prewitt operator
- (iv) Sobel operator
- (v) Laplacian filter.

[[C03](Apply/IOCQ)]
3 + 4 + 5 = 12

5. (a) What purpose is served by image enhancement techniques? Differentiate between point-based transformation and neighbourhood-based transformation with respect to image enhancement. [[C03](Analyze/IOCQ)]
- (b) Explain ideal highpass filter (IHPF). What are its shortcomings? How these shortcomings are overcome in Butterworth highpass filter? [[C03](Analyze/IOCQ)]
- (c) Show that subtracting the Laplacian from an image is proportional to unsharp masking. [[C03](Apply/IOCQ)]
4 + 4 + 4 = 12

Group – D

6. (a) “The code created using Huffman’s procedure is itself an instantaneous uniquely decodable block code”. Provide arguments and/or examples to support the statement. [[C04](Evaluate/HOCQ)]
- (b) Explain Arithmetic coding with a suitable example. Show the compressed output and the compression achieved for the example that you have considered. [[C04](Apply/HOCQ)]
4 + 8 = 12
7. (a) How does image restoration differ from image enhancement? [[C03](Analyze/IOCQ)]
- (b) Explain the working of an adaptive local noise reduction filter. [[C03](Understand/LOCQ)]
- (c) Explain the role of the following filters in image restoration:
(i) Arithmetic mean filter
(ii) Median filter. [[C03](Understand/LOCQ)]
2 + 4 + 6 = 12

Group - E

8. (a) While trying to detect discontinuities in an image for the purpose of image segmentation, what are the properties to be satisfied by the first and second order derivatives? [[C05](Understand/LOCQ)]
- (b) Differentiate among a step, a ramp and a roof edge. [[C05](Analyze/IOCQ)]

- (c) Explain how edge linking algorithms based on Hough transform works.

[[C05](Apply/IOCQ)]

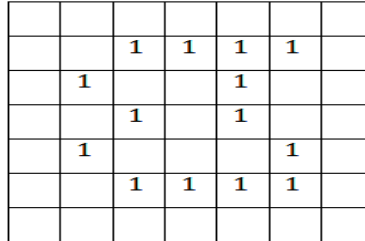
$$3 + 3 + 6 = 12$$

9. (a) Differentiate between global and local thresholding techniques for image segmentation.

[[C05](Analyze/IOCQ)]

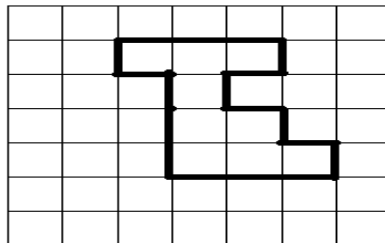
- (b) Illustrate the steps followed by Moore boundary tracing algorithm on the 1-valued region in the figure.

[[C06](Apply/IOCQ)]



- (c) Compute the 4-directional chain code and the shape number for the figure shown.

[[C06](Apply/IOCQ)]



$$4 + 4 + 4 = 12$$

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	38.54	48.95	12.51

Course Outcome (CO):

After the completion of the course students will be able to

CO1: Identify components, fundamental steps involved and application areas of digital image processing.

CO2: Apply basic mathematical concepts in determining the relationship between pixels in terms of adjacency and connectivity and distance measures.

CO3: Differentiate among various approaches to image enhancement and restoration.

CO4: Evaluate different methods for image compression.

CO5: Compare different image segmentation techniques.

CO6: Demonstrate different image representation techniques.

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