

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 D_8 distance (chessboard distance) between p and q with coordinates (x, y), (s, t) is defined as

(a) $ x - s + y - t $	(b) $\max(x - s , y - t)$
(c) $[(x - s)^2 + (y - t)^2]^{1/2}$	(d) $\min(x - s , y - t)$
 - (ii) For an 8-bit image $x[m, n]$, the transformation $y[m, n] = 255 - x[m, n]$ will yield a/an

(a) dark image	(b) bright image
(c) negative of the input image	(d) output image same as the input image.
 - (iii) The negative of an eight-bit image $f(m, n)$ is obtained using the relation $g(m, n) = 255 - f(m, n)$. This process is

(a) linear	(b) shift-invariant
(c) both linear and shift-invariant	(d) neither linear nor shift invariant.
 - (iv) Digitizing the intensity values of an image is called

(a) sampling	(b) quantization
(c) segmentation	(d) compression
 - (v) The effect of low pass filtering on an image is

(a) blurring	(b) sharpening
(c) contrast enhancement	(d) resizing.
 - (vi) Consider the two statements
 Statement 1: A histogram gives the frequency of occurrence of the intensity level.
 Statement 2: A histogram is invariant to rotation.

(a) Statements 1 and 2 are correct.	(b) Statement 1 is correct and Statement 2 is wrong.
(c) Statements 1 and 2 are wrong.	(d) Statement 2 is correct and Statement 1 is wrong.

- (vii) Permissible intensities of an 8-bit pixel image is
 - (a) 0 to 7
 - (b) 0 to 15
 - (c) 0 to 31
 - (d) 0 to 255.
- (viii) In global thresholding for image segmentation, the threshold value
 - (a) at any point (x, y) in an image depends on properties of a neighbourhood of (x, y) .
 - (b) is a constant applicable over an entire image.
 - (c) depends on the spatial coordinates (x, y) themselves.
 - (d) changes randomly over an image.
- (ix) Which of the following statements is FALSE for Moore boundary tracing algorithm?
 - (a) The algorithm cannot be extended to multiple, disjoint regions
 - (b) The algorithm works well for self intersecting boundaries
 - (c) Output is an ordered sequence of boundary points
 - (d) The algorithm works well with complex boundaries, such as a boundary with an attached branch.
- (x) The total amount of energy that flows from the light source and is usually measured in watts (W) is called
 - (a) Radiance
 - (b) Luminance
 - (c) Reflectance
 - (d) none of these.

Group - B

2.
 - (a) Illustrate the concept of neighbours of a pixel. Explain m-adjacency in this context.
[[CO2](Understand/LOCQ)]
 - (b) Briefly discuss the components of an image processing system.
[[CO1](Understand/LOCQ)]
 - (c) Explain the role of illuminance and reflectance in a simple image formation model.
[[CO1](Understand/LOCQ)]

4 + 4 + 4 = 12
3.
 - (a) Briefly explain the fundamental steps involved in digital image processing.
[[CO1](Understand/LOCQ)]
 - (b) Explain why the Fourier-transform phase of an image often captures most of the intelligibility of the image?
[[CO2](Understand/LOCQ)]
 - (c) Prove that if an image $f(m, n)$, $0 \leq m \leq M-1$ and $0 \leq n \leq N-1$ is multiplied by the checkerboard pattern $(-1)^{m+n}$, then its DFT is centred at $(M/2, N/2)$.
[[CO2](Apply/IOCQ)]

6 + 3 + 3 = 12

Group - C

4. (a) What is a histogram of an image? Is it possible, that two different images have the same histogram? Provide arguments and/or examples to support your answer.
- [[C03] (Evaluate/HOCQ)]*

- (b) Consider the following intensity level histogram of an input image of size 64×64 :

Intensity level	0	1	2	3	4	5	6	7
Frequency	1050	130	280	410	690	80	816	640

Find the intensity level histogram of the image enhanced by histogram equalization technique.

[[C03] (Apply/IOCQ)]

- (c) What is bit plane decomposition of an image? What would be the effect on the histogram of an image in general if the lower-order bit planes of the image are set to zero?

[[C03] (Analyze/IOCQ)]

$$3 + 5 + 4 = 12$$

5. (a) Why is it necessary for a differentiation kernel to have all its coefficients sum to zero?

[[C03] (Analyze/IOCQ)]

- (b) Explain image sharpening using a second order derivative operator.

[[C03] (Understand/LOCQ)]

- (c) Design a 3×3 kernel for performing unsharp masking in a single pass through an image. Assume that the average image is obtained using a box filter of size 3×3 .

[[C03] (Create/HOCQ)]

$$2 + 6 + 4 = 12$$

Group - D

6. (a) Can variable-length coding procedures be used to compress a histogram equalized image? Give reasons to support your answer.

[[C04] (Analyze/IOCQ)]

- (b) Consider the 4×8 , 8-bit image:

12	255	255	255	255	255	255	255
12	255	255	255	255	255	255	255
12	62	62	62	62	62	62	62
20	20	20	20	0	0	62	62

- (i) Compute the entropy of the image.
 (ii) Compress the image using Huffman coding.
 (iii) Compute the compression achieved and the effectiveness of the Huffman coding.

[[C04] (Apply/IOCQ)]

$$2 + (2 + 5 + 3) = 12$$

7. (a) State any three reasons for image degradation.

[[C03] (Remember/LOCQ)]

- (b) Describe how the degradation process is modelled with the help of degradation function.

[[C03] (Understand/LOCQ)]

- (c) Explain the role of the following filters in image restoration: (i) Arithmetic mean filter (ii) Geometric mean filter (iii) Harmonic mean filter.

[[C03] (Understand/LOCQ)]

$$3 + 3 + 6 = 12$$

Group - E

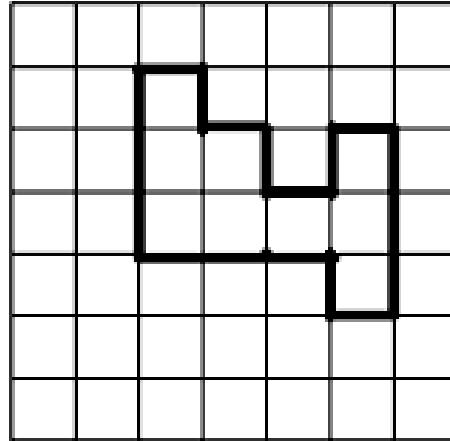
8. (a) Differentiate among an 'isolated point', a 'line' and an 'edge'.

[[C05] (Analyze/IOCQ)]

- (b) What is zero crossing? What is its role in edge detection? [[CO5](Understand/LOCQ)]
 (c) Explain with a suitable example the segmentation procedure by region splitting and merging. [[CO5](Apply/IOCQ)]

3 + 3 + 6 = 12

9. (a) Compare and contrast between Prewitt and Sobel masks for detecting edges. [[CO5](Analyze/IOCQ)]
 (b) What is a chain code? What is a shape number? Compute the 4-directional chain code and the shape number for the figure shown. [[CO6](Apply/IOCQ)]



6 + 6 = 12

<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	<i>40.63</i>	<i>48.95</i>	<i>10.42</i>

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.*