IMAGE PROCESSING
(MCAP 3160)

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)   An image of size 1024 × 1024 pixels, in which the intensity of each pixel is an 8-bit quantity, requires the storage space of
    (a) 1 KB   (b) 1 MB   (c) 2 KB   (d) 2 MB

    (ii)   The D_8 distance (chessboard distance) between pixels with coordinates (x, y), (s, t) is defined as
    (a) $| x - s | + | y - t |$ (b) $\max(| x - s |, | y - t |)$
    (c) $[(x - s)^2 + (y - t)^2]^{\frac{1}{2}}$ (d) $\min(| x - s |, | y - t |)$

    (iii)   The effect, caused by the use of an insufficient number of gray levels in smooth areas of a digital image is called
    (a) true contouring   (b) false contouring
    (c) thickening   (d) thinning.

    (iv)   Which among the following is a linear operation?
    (a) Median filtering   (b) Min filtering
    (c) Max filtering   (d) Mean filtering.

    (v)   The transformation to generate the negative of an image with L intensity levels, where r and s are the input and output intensities respectively, is given by
    (a) $s = - r$ (b) $s = L - r$
    (c) $s = r - L - 1$ (d) $s = L - 1 - r$

    (vi)   Histogram related techniques can be used for
    (a) image enhancement   (b) image compression
    (c) image segmentation   (d) all of (a), (b) and (c).

    (vii)   Which one of the following is a lossy coding technique?
    (a) Run Length Coding   (b) Uniform Quantizer
    (c) Huffman Coding   (d) Arithmetic Coding.

(viii) Digitizing the coordinate values of an image is called
(a) sampling   (b) quantization
(c) zooming   (d) compression.

(ix) Segmentation is a process that partitions image into
(a) blocks   (b) vertices   (c) regions   (d) lines.

(x) In an image compression system, 6686 bits are used to represent a 128x128 image with 256 intensity levels. What is the compression ratio for this system?
(a) 19.6   (b) 2.45   (c) 0.41   (d) 0.05.

Group – B

2. (a) Explain the fundamental steps involved in digital image processing.
[(CO1), Understand/LOCQ)]

(b) Elucidate the role of illuminance and reflectance in a simple image formation model. [(CO6)(Understand/LOCQ)]

8 + 4 = 12

3. (a) Illustrate the concept of neighbours of a pixel. Explain m-adjacency in this context. [(CO2) (Understand/LOCQ)]

(b) Consider the image segment shown.

$$
\begin{array}{cccc}
3 & 1 & 2 & 1\,(q) \\
2 & 2 & 0 & 2 \\
1 & 2 & 1 & 1 \\
(p)\,1 & 0 & 1 & 2
\end{array}
$$

Let V = {1, 2} be the set of intensity values used to define adjacency. Compute the lengths of the shortest 8- and m-path between p and q.
[(CO2) (Evaluate/HOCQ)]

(c) A waveform g(x) defined at equally spaced set of points x = 0, 1, 2, 3, 4 is given by 1, 2, 4, 5, 5. Compute the discrete Fourier transform of g(x). Also compute the amplitude spectrum of g(x). [(CO6) (Apply/IOCQ)]

3 + 3 + 6 = 12

Group – C

4. (a) "An intensity histogram of an image gives some useful clues about the shape of the objects in the image". Can you agree with this statement? Give your reasons.
[(CO3) (Analyze/IOCQ)]

(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	130	80	280	410	640	1050	816	690

Find the intensity level histogram of the image enhanced by histogram equalization technique. [(CO3) (Apply/IOCQ)]

(c) Find all the bit-plane images for the following 3-bit image:
[(CO3) (Evaluate/HOCQ)]

0	3	6
2	3	7
1	5	4

(d) 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? [(CO3) (Analyze/IOCQ)]

2 + 5 + 3 + 2 = 12

5. (a) Why is it necessary for a differentiation kernel to have all its coefficients sum to zero? [(CO3) (Analyze/IOCQ)]
   (b) Explain the techniques of unsharp masking and highboost filtering.
   [(CO3) (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. [(CO3) (Create/HOCQ)]

2 + 6 + 4 = 12

Group – D

6. (a) Explain Entropy and analyse its role in image compression.
   [(CO4) (Analyze/IOCQ)]
   (b) Consider the 4 × 8, 8-bit image:

19	19	19	80	80	240	240	240
19	19	19	80	80	240	240	240
19	19	19	80	155	155	240	240
19	19	19	80	155	155	240	240

   (i) Compute the entropy of the image. [(CO4) (Apply/IOCQ)]
   (ii) Compress the image using Huffman coding. [(CO4) (Apply/IOCQ)]
   (iii) Compute the compression achieved and the effectiveness of the Huffman coding. [(CO4) (Evaluate/HOCQ)]

3 + (2 + 5 + 2) = 12

7. (a) How does image restoration differ from image enhancement?
   [(CO3) (Analyze/IOCQ)]
   (b) Describe how the degradation process is modelled with the help of degradation function. [(CO3) (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. [(CO3) (Understand/LOCQ)]

3 + 3 + 6 = 12

Group – E

8. (a) The segmentation process subdivides an image region R into R_1, R_2, ... R_n. State the conditions that these R_i s should satisfy for a proper segmentation. Explain the significance of each of them. [(CO5)(Understand/LOCQ)]
    (b) Explain edge linking by Hough Transform. [(CO5)(Understand/LOCQ)]
    (c) What is the problem associated with Hough transform when slope intercept form of straight line is considered? How is that problem solved?
    [(CO5)(Analyze/IOCQ)]

$$4 + 6 + 2 = 12$$

9. (a) Explain with neat diagram(s) the segmentation procedure by region splitting and merging. [(CO5) (Understand/LOCQ)]
    (b) With the help of an example show the steps followed by Moore boundary tracing algorithm. [(CO6) (Apply/IOCQ)]

$$6 + 6 = 12$$

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	47.92	39.58	12.50

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

Department & Section	Submission Link
MCA	https://classroom.google.com/c/NDA1MTU3MzMyNDU2/a/NDU3MzUzMTE5NDg2/details