

DIGITAL IMAGE PROCESSING
(AEIE 5241)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group - A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

- (i) Dynamic range of imaging system is a ratio where the upper limit is determined by
 - (a) saturation
 - (b) noise
 - (c) brightness
 - (d) contrast
- (ii) The colour model which is more suitable for printing purposes is the
 - (a) RGB model
 - (b) CMY model
 - (c) HSI model
 - (d) YIQ model
- (iii) The procedure done on a digital image to alter the values of its individual pixels is
 - (a) neighbourhood operations
 - (b) image registration
 - (c) geometric spatial transformation
 - (d) single pixel operation
- (iv) In formula $g(x,y) = T[f(x,y)]$, T is the
 - (a) transformed image
 - (b) transformation vector
 - (c) transformation theorem
 - (d) transformation function
- (v) For an 8-bit image $f(m,n)$ the transformation $g(m,n) = 255 - f(m,n)$ will yield a/an
 - (a) dark image
 - (b) bright image
 - (c) negative of the input image
 - (d) output image same as the input image
- (vi) Huffman coding is used to reduce
 - (a) coding redundancy
 - (b) psycho visual redundancy
 - (c) inter pixel redundancy
 - (d) all of the above
- (vii) Compression ratio of an image is defined by
 - (a) Original size/Compressed size: 1
 - (b) 1: Original size/Compressed size
 - (c) Compressed size/ Original size: 1
 - (d) 1: Compressed size/ Original size
- (viii) In an image compression system, 16384 bits are used to represent a 128×128 image with 256 gray levels. What is the compression ratio for this system?
 - (a) 4
 - (b) 8
 - (c) 12
 - (d) 16
- (ix) An example of an unsupervised neural network is
 - (a) perceptron
 - (b) back-propagation network
 - (c) self-organizing feature map
 - (d) counter propagation network

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

Fill in the blanks with the correct word

- (xi) Approaches to image processing that work directly on the pixels of incoming image is called _____ domain approach.
- (xii) A pixel p at coordinates (x, y) has neighbours whose coordinates are given by: $(x+1, y)$, $(x-1, y)$, $(x, y+1)$, $(x, y-1)$. This set of pixels is called _____ of p .
- (xiii) The operator which can be used to detect edges in an image is _____.
- (xiv) In _____ image we notice that the components of histogram are concentrated on the low side on intensity scale.
- (xv) Impulse noise in Order-statistic filter is also called as _____.

Group - B

2. (a) What is a digital image? State the major fields of application of digital image processing. *[(CO1)(Remember/LOCQ)]*

(b) Distinguish between monochrome and a gray scale image. What do you mean by the term image format? Mention some of the frequently used image file formats. *[(CO1)(Understand/LOCQ)]*

(c) Compute the inverse 2D-DFT of the transform coefficient given below:

$F[k, l] =$	16	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0

[(CO2)(Apply/IOCQ)]

$$(1 + 2) + (2 + 1 + 1) + 5 = 12$$

3. (a) Define D4 distance and D8 distance measure between any two pixels in an image.
[(CO1)(Remember/LOCQ)]

(b) Consider the image segment shown in fig. below. (i) Let $V = \{0,1\}$ and compute the lengths of the shortest 4-path, 8-path and m-path between p and q. If a particular path does not exist between these two points, explain why. (ii) Repeat the problem considering $V = \{1,2\}$.
[(CO1)(Analyze/IOCQ)]

3	1	2	1(q)
2	2	0	2
1	2	1	1
0	1	0	2

(c) Compute the 2D linear convolution between two signals $x(m, n)$ and $h(m, n)$ as shown in figure below:

$ \begin{array}{ccc} n \uparrow & & \\ & 2 & 1 & 0 \\ & 3 & 2 & 1 \\ \hline & x(m, n) & \end{array} $	$ \begin{array}{ccc} n \uparrow & & \\ & 1 & 1 \\ & 1 & -1 \\ \hline & h(m, n) & \end{array} $
----------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------

$$\begin{aligned}
 & [(CO2)(Apply/IOCQ)] \\
 & 2 + (3 + 3) + 4 = 12
 \end{aligned}$$

Group - C

4. (a) What is image subtraction? State an example where it is useful in practical application. [(CO3)(Remember/LOCQ)]

(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)]

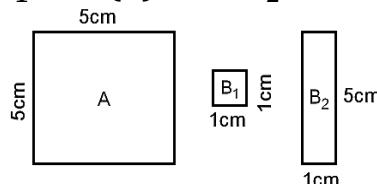
6 9 14 12 10 15 8 7 9

(c) Elaborate the two basic approaches of image enhancement techniques. [(CO3)(Understand/LOCQ)]

$$\begin{aligned}
 & [(CO3)(Understand/LOCQ)] \\
 & (2 + 1) + 6 + 3 = 12
 \end{aligned}$$

5. (a) What is high boost filtering? Derive an expression of it. [(CO3)(Analyse/LOCQ)]

(b) Sketch the output image in the following cases considering the objects shown in figure below: (i) $A \oplus B_1$ and (ii) $A \oplus B_2$. [(CO3)(Evaluate/HOCQ)]



(c) What is image negative? Explain how an image negative can be formed. [(CO3)(Apply/IOCQ)]

$$\begin{aligned}
 & [(CO3)(Apply/IOCQ)] \\
 & (1 + 4) + 4 + (1 + 2) = 12
 \end{aligned}$$

Group - D

6. (a) What are coding and psychovisual redundancy? [(CO4)(Understand/LOCQ)]

(b) Consider an image with the following pixel distribution and two different coding schemes. Find the average bit length of code1 and code2 and hence calculate compression ratio, data redundancy and entropy of the image?

Pixel values (r_k)	Probability $P_r(r_k)$	Code1	Code2
87	0.25	01010111	01
128	0.47	10000000	1
186	0.25	11000100	000
255	0.03	11111111	001
r_k for $k \neq 87, 128, 186, 255$	0	-	-

$$\begin{aligned}
 & [(CO4)(Analyse/IOCQ)] \\
 & 2 + 10 = 12
 \end{aligned}$$

7. (a) What are lossy and lossless predictive coding? [(CO4)(Remember /LOCQ)]
 (b) Using a 2nd order linear predictor model with appropriate coefficients, find the compressed and decompressed pixel sequence of following given image: 115, 118, 125, 120, 123, 126, 130, 137? [(CO4)(Apply/IOCQ)]
 (c) Find out the entropy and redundancy of the following image shown in figure below. Consider that each pixel is 8-bits in length.

$$\begin{bmatrix} 20 & 0 & 20 & 0 \\ 40 & 0 & 40 & 0 \\ 0 & 20 & 0 & 20 \\ 0 & 40 & 0 & 40 \end{bmatrix}$$

[(CO4)(Apply/IOCQ)]
2 + 6 + 4 = 12

Group - E

8. (a) Describe the region growing technique for image segmentation and mention the problems associated with it. [(CO5)(Remember/LOCQ)]
 (b) What is meant by object description? Explain 4-chain code descriptor with example. [(CO5)(Remember/LOCQ)]
 (c) What is an edge? Describe Laplacian edge detector. [(CO5)(Apply/IOCQ)]
4 + 4 + 4 = 12

9. (a) Define signature, eccentricity, compactness and circularity of an object. [(CO6)(Remember/LOCQ)]
 (b) Consider an 8×8 image with gray levels ranging from 0 to 7 as shown in figure below. Find out the segmented image obtained by split and merge technique considering a threshold value $th=3$ of the property:

$$\text{Prop}(R): \max_{(r,c) \in R} \{g(r,c)\} - \min_{(r,c) \in R} \{g(r,c)\} \leq th$$

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

[(CO5)(Evaluate/HOCQ)]
4 + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.5	50	12.5