Digital Image Processing
(INFO 5101)

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 alternatives for the following: **10 x 1=10**

(i) When no priori model of the degradation model is available, the quality of an image is improved by
   (a) image compression   (b) image restoration
   (c) image normalization   (d) image enhancement.

(ii) The range for illumination is
   (a) $[0, \infty]$ (b) $[0, 255]$ (c) $[0, 1]$ (d) $[-255, 255]$.

(iii) Which one is used to detect the presence of an edge at a point in an image?
   (a) Sign of first derivative   (b) Magnitude of first derivative
   (c) Magnitude of second derivative   (d) Sign of second derivative.

(iv) How many shades of grey are there in a 9 bit image?
   (a) 511   (b) 256   (c) 512   (d) none of these.

(v) How much memory is needed to store a digital image of size 256 X 256 having 64 grey levels?
   (a) 256 x 8 x 6   (b) 256 x 256 x 64
   (c) 8 x 8 x 6   (d) 256 x 256 x 6.

(vi) Two pixels P and Q with values from V are 8-adjacent if Q is in the set _____
   (a) N4(P)   (b) ND(P)   (c) N8(P)   (d) N4(P) U N4(Q).

(vii) Image negative can be done using _____ operator.
   (a) AND   (b) NOT   (c) OR   (d) None of these.

(viii) Which is not the operator for edge detection for image segmentation?
   (a) Roberts   (b) Perwitt   (c) Sobel   (d) Butterworth.

(ix) The criteria for selection of an isolated point can be formulated as (T=Threshold, R=Response of the mask)
   (a) $|R| > T$ (b) $|R| < T$ (c) $|R| = T$ (d) $|R| \neq T$.

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(x) Which is not the property of 2-D Fourier Transform?

(a) Distributivity   (b) Scaling   (c) Rotation   (d) Linearity.

Group - B

2.(a) Consider a grayscale I image whose grayscale values $I(r, c)$ of rth row and c^{th} column is lying between 0 and 255. Let, for the range of all gray level values from 30 to 75, we want to stretch the range from 45 to 255. Obtain the equation for such type of stretching.

(b) It is desired to transform this image into a new image, using a transformation $z = H(r) = G^{-1}[T(r)]$, with histogram as specified below:

k	z_k	$p_{out}(z_k)$
0	0	0.00
1	1/7	0.00
2	2/7	0.00
3	3/7	0.15
4	4/7	0.20
5	5/7	0.30
6	6/7	0.20
7	1	0.15

Critically comment about the quality of the images with respect to following:

(i) Histogram clustered at the low end.

(ii) Histogram with a wide spread.

$$4 + (6+2) = 12$$

3.(a) Explain with an example, how a digital image is represented?

(b) How many minutes are required for a 512x512 image with 256 grey levels at 300 baud rate for transmission? The transmission is accomplished using packets consisting of a start bit, a byte (8 bits) of information and a stop bit. Baud rate means number of bits per second.

(c) An image is represented by the following table:

Graylevels	0	1	2	3	4	5	6	7
No. of pixels	1116	4513	5420	2149	1389	917	654	226

Find an image from this representation after histogram equalization.

$$4+3+5=12$$

Group – C

4.(a) Write Steps for Filtering in the Frequency Domain. Write down the significance of Fourier Transform in image processing.

(b) Write the expression for:

    i) 2D DFT and its inverse

    ii) Fourier Spectrum

    iii) Phase angle and Power Spectrum

$$6 + (2 \times 3) = 12$$

5.(a) Discuss how high pass filtering enhances an image? Discuss Contrast Stretching method for image enhancement.

(b) Explain the Median filter technique with an example .Write down the advantages and disadvantages of Median filter over the Mean filter technique.

$$(3+4) + 5 = 12$$

Group – D

6.(a) How the "salt and pepper" noise look like? How can it be removed?

(b) Why is image enhancement different from image restoration?

(c) With the help of degradation model explain the restoration process of an image.

$$(1 + 2) + 3 + 6 = 12$$

7.(a) What is image degradation? Specify different causes for it.

(b) Explain the action of the following spatial mask on an image.

0	-1	0
-1	4	-1
0	-1	0

(c) For what purpose smoothing filters are used in image enhancement phase?

$$(2+4) + 4 + 2 = 12$$

Group – E

8.(a) What is an edge? Explain with an example.

(b) Discuss the role of the Laplacian operator as an edge detector. What is the major shortcoming of the Laplacian operator?

(c) A Sobel operator uses two masks, Hx and Hy to process the image for edge detection. Explain what is measured by these masks and why two masks are required.

$$2 + (4 + 2) + 4 = 12$$

9.(a) Discuss Hough transform for line detection with example.

(b) What do you mean by global and local thresholding?

(c) What do you understand by region splitting and merging segmentation scheme?

$$8 + 2 + 2 = 12$$