

DIGITAL IMAGE PROCESSING & PATTERN RECOGNITION (ECEN 3231)

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) How does picture formation in the eye vary from image formation in a camera?
 - (a) Fixed focal length
 - (b) Varying distance between lens and imaging plane
 - (c) No difference
 - (d) Length Variable focal.
- (ii) Which of the following correctly describes the slightest visible in the level of intensity?
 - (a) Contour (b) Saturation (c) Contrast (d) Intensity resolution.
- (iii) At what points, a continuous image is digitized?
 - (a) Sampling (b) Vertex (c) Contour (d) Random
- (iv) In linear spatial filtering, what is the pixel of the image under mask corresponding to the mask coefficient $w(1, -1)$, assuming a 3×3 mask?
 - (a) $f(x, -y)$ (b) $f(x + 1, y)$ (c) $f(x, y - 1)$ (d) $f(x + 1, y - 1)$.
- (v) In neighbourhood operations working is being done with the value of image pixel in the neighbourhood and the corresponding value of a sub image that has same dimension as neighbourhood. The sub image is referred as _____.
 - (a) filter (b) mask (c) template (d) all of the mentioned
- (vi) Which of the following algorithms is commonly used for pattern recognition tasks that involve classifying data into multiple categories?
 - (a) K-means clustering (b) Linear regression
 - (c) Decision tree (d) Support Vector Machines (SVM).
- (vii) Which of the following is/are used as basic function in nonlinear filter for noise reduction?
 - (a) Computation of variance (b) Computation of median
 - (c) All of the mentioned (d) None of the mentioned.
- (viii) In general, which of the following assures of no ringing in the output?
 - (a) Gaussian Low pass Filter (b) Ideal Low pass Filter
 - (c) Butterworth Low pass Filter (d) All of the mentioned.

- (ix) What is the relation of the frequencies to a circle of radius D_0 , where D_0 is the cutoff distance measured from origin of frequency rectangle, for an Ideal Highpass filter?
 (a) IHPF sets all frequencies inside circle to zero
 (b) IHPF allows all frequencies, without attenuating, outside the circle
 (c) All of the mentioned
 (d) None of the mentioned.
- (x) The low pass filtering process can be applied in which of the following area(s)?
 (a) The field of machine perception, with application of character recognition
 (b) In field of printing and publishing industry
 (c) In field of processing satellite and aerial images
 (d) All of the mentioned.

Fill in the blanks with the correct word

- (xi) The effect caused by the use of an insufficient number of intensity levels in smooth areas of a digital image _____
- (xii) A frequency domain filter of the corresponding filter in spatial domain can be obtained by applying _____.
- (xiii) Region of Interest (ROI) operations is generally known as _____
- (xiv) Methods which are used for padding the image _____
- (xv) Histogram of an image is changed according to the histogram is known as _____.

Group - B

2. (a) A CCD camera chip of dimensions 8×8 mm, and having 2048×2048 elements, is focused on a square, flat area, located 0.4 m away. How many line pairs, per mm will this camera be able to resolve? The camera is equipped with a 32-mm lens. [[CO3](Analyse/HOCQ)]
- (b) In an image, a pixel group of size 3×3 is processed using a 3×3 averaging filter. The pixel values in the group are as follows:
- | | | |
|---|---|---|
| 4 | 5 | 3 |
| 1 | 2 | 6 |
| 7 | 8 | 9 |
- Calculate the average value of the pixels after applying the filter. [[CO2](Apply/HOCQ)]
- $6 + 6 = 12$**
3. (a) Explain the following image processing operations with example
 (i) Thresholding
 (ii) Clipping
 (iii) Digital negative
 (iv) Power law transformation. [[CO3](Remembering/LOCQ)]
- (b) Perform the contrast stretching operation for the given image and display the output image.
 Two reference point as given below with the image A:

$$A = \begin{bmatrix} 4 & 3 & 5 & 2 \\ 3 & 6 & 4 & 6 \\ 2 & 2 & 6 & 5 \\ 7 & 6 & 4 & 1 \end{bmatrix}$$

(i) $r_1=3$ & $s_1=2$ (ii) $r_2=5$ & $s_2=6$.

[[CO4](Apply/IOCQ)]

6 + 6 = 12

Group - C

4. (a) What is "dilation" and "erosion"? What are uses of these operations? What is the function of a structural element? [[CO2](Remembering/LOCQ)]
- (b) Explain the morphological operation of "OPENING" and "CLOSING" with example. What are their uses? [[CO3](Remembering/LOCQ)]
- (c) Explain the principle of boundary detection with morphological operators. [[CO3](Remembering/LOCQ)]

6 + 4 + 2 = 12

5. (a) Find out Filter function $H(u,b)$ to apply on a gray scale image of size 4 by 4 using butterworth low pass filter with order $n = 1$ and the cut-off frequency $D_0 = 1.44$. [[CO3](Analyse/HOCQ)]
- (b) Find out the Fourier transform of a given image A. Use reparability property.

$$A = \begin{bmatrix} 4 & 4 & 4 & 4 \\ 4 & 4 & 4 & 4 \\ 4 & 4 & 4 & 4 \\ 4 & 4 & 4 & 4 \end{bmatrix}$$

[[CO2](Apply/IOCQ)]

8 + 4 = 12

Group - D

6. (a) Mention few differences between traditional programming and machine learning. What do you mean by supervised, unsupervised and reinforced or semi-supervised learning? [[CO3](Analyse/LOCQ)]
- (b) Observe the following data set and answer it accordingly. [[CO3](Analyse/IOCQ)]

Given the following training instances (see table), each having two attributes (x_1 and x_2). Compute the class label for test instance $t_1 = (3,7)$ using three-nearest neighbors ($k=3$).

Training Instance	x_1	x_2	Output
I_1	7	7	0
I_2	7	4	0
I_3	3	4	1
I_4	1	4	1

6 + 6 = 12

7. (a) Describe a typical pattern recognition system with a standard block diagram. Explain the functions of each block. [[CO3](Analyse/IOCQ)]
- (b) Based on the given data set classify the data whether it is diabetic or not. Apply k nearest neighbor classifier to predict the diabetic patient with the given features BMI, Age and Sugar. Assume $K = 3$, test example BMI = 43.6, Age = 40, S Sugar?

BMI	Age	Sugar
33.6	50	1
26.6	30	0
23.4	40	0
43.1	67	0
35.3	23	1
35.9	67	1
36.7	45	1
25.7	46	0
23.3	29	0
31	56	1

[[CO4](Apply/IOCQ)]

4 + 8 = 12

Group - E

8. (a) What do you mean by classification and clustering in data analysis? Explain with example. [[CO3](Remembering/LOCQ)]

- (b) Draw an optimal hyper plane using SVM to classify the points.

Suppose we are given the following positively labeled data points,

$$\left\{ \begin{pmatrix} 3 \\ 1 \end{pmatrix}, \begin{pmatrix} 3 \\ -1 \end{pmatrix}, \begin{pmatrix} 6 \\ 1 \end{pmatrix}, \begin{pmatrix} 6 \\ -1 \end{pmatrix} \right\}$$

and the following negatively labeled data points,

$$\left\{ \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ -1 \end{pmatrix}, \begin{pmatrix} -1 \\ 0 \end{pmatrix} \right\}$$

[[CO4](Apply/HOCQ)]

4 + 8 = 12

9. (a) Explain how support vector machine algorithm works to classify linear and nonlinear data sets. [[CO3](Analyse/LOCQ)]

- (b) The points (4, 1), (4, -1) and (6,0) belong to positive class and points (1, 0), (0, 1) and (0,-1) belong to negative class. Draw an optimal hyper plane using SVM to classify the points. [[CO4](Apply/HOCQ)]

4 + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.34	29.16	37.5

Course Outcomes (CO):

After completing the course the student will be able to:

1. Gain a working knowledge about the mathematical tools needed for Image Processing and Pattern Recognition.
2. Understand the need for different types of digital image transforms their properties and application.
3. Evaluates the technique for morphological operations and image compression.
4. Gain knowledge about the fundamentals of Pattern Recognition like recognition, decision making and statistical learning problems.
5. Identify parametric and non-parametric techniques, supervised and unsupervised learning of pattern recognition.
6. Design systems and algorithms for Image Processing and Pattern Recognition

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