

**DIGITAL IMAGE PROCESSING & PATTERN RECOGNITION  
(ECEN 3231)**

**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) \_\_\_\_\_ level is generally used to describe the monochromatic intensity.  
(a) Color                      (b) Hue                      (c) RGB                      (d) Gray
  - (ii) Which of the following is the first and foremost step in Image Processing?  
(a) Image acquisition                      (b) Segmentation  
(c) Image enhancement                      (d) Image restoration.
  - (iii) If a 20mm × 20mm digital image has 1600 lines with square pixels, then each pixel has a width of \_\_\_\_\_ mm.  
(a) 0.025                      (b) 0.1225                      (c) 0.0321                      (d) 0.0125
  - (iv) The D4 distance between points P and Q in an digital image is given by  
(a) city block distance                      (b) euclidean distance  
(c) chess board distance                      (d) potential distance.
  - (v) Which of the following is the next step in image processing after compression?  
(a) Representation and description                      (b) Morphological processing  
(c) Segmentation                      (d) Wavelets.
  - (vi) \_\_\_\_\_ determines the quality of a digital image.  
(a) The discrete gray levels  
(b) The number of samples  
(c) Discrete gray levels & number of samples  
(d) None of the mentioned
  - (vii) The decision boundary between classes  $C_i$  and  $C_j$  for minimum distance classifier is the \_\_\_\_\_ of the line segment joining the corresponding mean vectors  $v_i$  and  $v_j$ .  
(a) closed, tuple                      (b) parallel, distance  
(c) perpendicular, bisector                      (d) circular, locus

- (viii) The \_\_\_\_\_ algorithm takes the unlabeled dataset as input, divides the dataset into k-number of clusters, and repeats the process till the best clusters is found. The value of k should be predetermined in this algorithm.
  - (a) K-Means Clustering
  - (b) K-Nearest Neighbor
  - (c) Principal Component
  - (d) Hierarchical Clustering
- (ix) In SVM (support vector machine), the support vectors are the data points that lie \_\_\_\_\_ to the decision surface.
  - (a) farthest
  - (b) closest
  - (c) unseen
  - (d) serial
- (x) \_\_\_\_\_ is the process of recognizing patterns by using machine learning algorithm.
  - (a) Processed Data
  - (b) Literate Statistical Programming
  - (c) Pattern Recognition
  - (d) Likelihood

**Group - B**

- 2. (a) Consider the image segment shown below. Let  $V=\{1, 2\}$  and compute the lengths of the shortest 4-, 8-, and m-path between p and q. If a particular path does not exist between these two points, explain why Image segment:

|     |   |   |      |   |
|-----|---|---|------|---|
|     | 1 | 3 | 1(q) | 2 |
|     | 2 | 0 | 2    | 0 |
|     | 1 | 1 | 2    | 2 |
| (p) | 1 | 0 | 2    | 3 |

[(CO2)(Understand/IOCQ)]

- (b) What is histogram equalization of an image? [(CO2)(Understand/LOCQ)]
- (c) What will be replaced by a 3x3 median filter mask (marked in red) at its center, when applied on the shown image data.

|     |     |     |     |     |
|-----|-----|-----|-----|-----|
| 152 | 123 | 122 | 145 | 156 |
| 124 | 125 | 133 | 124 | 234 |
| 214 | 154 | 106 | 132 | 125 |
| 164 | 175 | 133 | 192 | 165 |
| 157 | 234 | 175 | 153 | 144 |

Median filter  
 3 x 3  
 Data Set

[(CO2)(Analyse/IOCQ)]

$4 + 4 + 4 = 12$

- 3. (a) A CCD camera chip of dimensions 7\*7 mm, and having 1024\*1024 elements, is focused on a square, flat area, located 0.5 m away. How many line pairs per mm will this camera be able to resolve? The camera is equipped with a 35 mm lens. [(CO1)(Analyse/IOCQ)]
- (b) A common measure of transmission for digital data is the baud rate, defined as the number of bits transmitted per second. Generally, transmission is accomplished in packets consisting of a start bit, a byte (8 bits) of information, and a stop bit. Using these facts, answer the following:

- (i) How many minutes would it take to transmit a 1024\*1024 image with 256 gray levels using a 56K baud modem?
- (ii) What would the time be at 750K baud, a representative speed of a phone DSL (digital subscriber line) connection?      [[CO1,C02](Analyze/IOCQ)]  
**5 + 7 = 12**

**Group - C**

- 4. (a) Explain the principle of vertical and horizontal edge detection with 3 × 3 sobel edge detector. Explain how to detect edges set at various angles.      [[CO3](Remember/LOCQ)]
- (b) If f(x,y) be a monochromatic gray scale 8 bit image and g(x,y) be its corresponding negative transformation (reverse video effect) of f(x,y), then plot the transform curve between f(x,y) and g(x,y).      [[CO3](Analyze/LOCQ)]
- (c) Describe the Notch filter principle of operation.      [[CO2](Understand/IOCQ)]  
**4 + 4 + 4 = 12**

- 5. (a) Explain morphological operations OPEN and CLOSE with example.      [[CO3](Understand/LOCQ)]
- (b) Explain the operation of a laplacian filter to find edges with 3 × 3 example.      [[CO3](Understand/LOCQ)]
- (c) An image with 8 gray level is represented by Code 1 with 3 bits. It is also represented with variable length Code 2 as shown below. Determine the redundancy and compression ratio with code 2.

| Gray shades | probability of Occurrence | Code1 | L1(rk1) | Code 2 | L2(rk2) |
|-------------|---------------------------|-------|---------|--------|---------|
| r0 = 0      | 0.19                      | 000   | 3       | 11     | 2       |
| r1 = 1/7    | 0.25                      | 001   | 3       | 01     | 2       |
| r2 = 2/7    | 0.21                      | 010   | 3       | 10     | 2       |
| r3 = 3/7    | 0.16                      | 011   | 3       | 001    | 3       |
| r4 = 4/7    | 0.08                      | 100   | 3       | 0001   | 4       |
| r5 = 5/7    | 0.06                      | 101   | 3       | 00001  | 5       |
| r6 = 6/7    | 0.03                      | 110   | 3       | 000001 | 6       |
| r7 = 1      | 0.02                      | 111   | 3       | 000000 | 6       |

[[CO3](Analyze/HOCQ)]  
**4 + 4 + 4 = 12**

**Group - D**

- 6. (a) What is the working principle of a Perceptron?      [[CO5](Remember/LOCQ)]
- (b) Differentiate between Supervised, Unsupervised, and Reinforced learning techniques.      [[CO5](Remember/IOCQ)]
- (c) Two pattern classes w1 and w2, using minimum distance classifiers, have sample mean vectors m1 = [4.3, 1.3]<sup>T</sup>, and m2 = [1.5, 0.3]<sup>T</sup>, respectively. Find the decision functions and the decision boundary.      [[CO6](Analyze/HOCQ)]  
**4 + 4 + 4 = 12**

7. (a) Explain Hidden Markov model and its role in the classifier design. [(CO5)(Remember/LOCQ)]  
(b) Compare supervised, unsupervised and reinforcement learning techniques. [(CO5)(Remember/LOCQ)]  
**6 + 6 = 12**

**Group - E**

8. (a) Explain KNN method for classification? Is this method supervised or unsupervised? [(CO5)(Remember/LOCQ)]  
(b) What are the three conditions for the minimum distance classifier to be optimum in the Bayes sense? [(CO5)(Understand/LOCQ)]  
(c) What are Decision tree based classifiers? [(CO5)(Analyse/IOCQ)]
9. (a) Formulate SVM as an optimization problem. How support vector machines can be used for classification of data which are not linearly separable? [(CO6)(Analyse/IOCQ)]  
(b) What is the function of a threshold element, and an activation element in a Perceptron model? [(CO6)(Remember/LOCQ)]  
**7 + 5 = 12**

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| Cognition Level         | LOCQ  | IOCQ  | HOCQ |
|-------------------------|-------|-------|------|
| Percentage distribution | 51.04 | 40.63 | 8.33 |

**Course Outcome (CO):**

After the completion of the course students 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