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
<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)   Point Q is 8 adjacent to point P if
   (a) Q belongs to N4(p)   (b) Q belongs to ND(p)
   (c) both (a) and (b) is true   (d) none of the above.

   (ii)   What is the resolution of a printer in line pair per mm to properly print a image of size 2048 × 2048 pixels and to fit in a space of 5 × 5 cm?
   (a) 5   (b) 10   (c) 20   (d) 40.

   (iii)   The D8 distance between points A and B in an digital image is given by
   (a) City Block distance   (b) Euclidean distance
   (c) Chess board distance   (d) Texas distance.

   (iv)   The inverse Fourier Transform of a low pass Gaussian Filter is also a Gaussian function implies no _____ effect after using this filter.
   (a) Ringing   (b) Salt and Pepper   (c) Averaging   (d) Shading

   (v)   Morphological erosion followed by dilation is termed as morphological operation of
   (a) Open   (b) Close   (c) Skeletonization   (d) Boundary-detect.

   (vi)   The _____ reduces the dimensionality of a data set consisting of a large number of interrelated variables while retaining as much as possible of the variation present in the data set.
   (a) principal component analysis   (b) support vector machine
   (c) K-nearest Neighbors   (d) K-means clustering

   (vii)   In _____ pattern recognition or clustering the training data with known class labels are _____ _____.
   (a) unsupervised, not, available   (b) supervised, made, available
   (c) unsupervised, made, available   (d) both (a) and (b)

(viii) Minimum distance classifier computes a distance-based measure between an _____ pattern vector, and each of the class prototypes. It then assigns the unknown pattern to the class of its _____ prototypes.
(a) known, largest   (b) unknown, fastest
(c) farthest, known   (d) unknown, closest

(ix) A _____ takes the weighted sum of all its inputs and generates a logical output of +1 or -1.
(a) Jumbotron   (b) Trinitron   (c) PNPtron   (d) Perceptron

(x) In a process if the next state depends only on the current state, then such a process is said to follow _____ property.
(a) Madison   (b) Megan   (c) Markov   (d) Mega

Group - B

2. (a) State conditions when two set of pixels are called (i) 8 adjacent, (ii) m adjacent?
           [(CO2)(Remember/LOCQ)]
   (b) Explain what is (i) D4 distance, (ii) D8 distance.   [(CO2)(Understand/LOCQ)]
   (c) Consider two points P and Q. (i) State the conditions under which the D4 distance between P and Q is equal to the shortest 4 path between these points. (ii) Is this path unique?   [(CO2)(Apply/IOCQ)]
   4 + 4 + 4 = 12

3. (a) Explain with example the working of a 3×3 (i) low pass filter (ii) Median filter .
           [(CO2)(Remember/LOCQ)]
   (b) Assume transmission being 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 seconds would it take to transmit a sequence of 200 images of size of size 1280 × 960 pixels using a 3 Mbaud modem (3×10^6 bits/sec)?
   (ii) What would be the time by using a 30 G baud modem (30×10^9 bits/sec)?
           [(CO2)(Analyze/IOCQ)]
   6 + 6 = 12

Group - C

4. (a) Consider the simple 4×8, 8 bit image:
   21 21 21 95 169 243 243 243
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   (i) compute the entropy of the image
   (ii) compress the image using Huffmann coding.
   (iii) compute the compression achieved and the effectiveness of the Huffmann coding.   [(CO3)(Apply/IOCQ)]
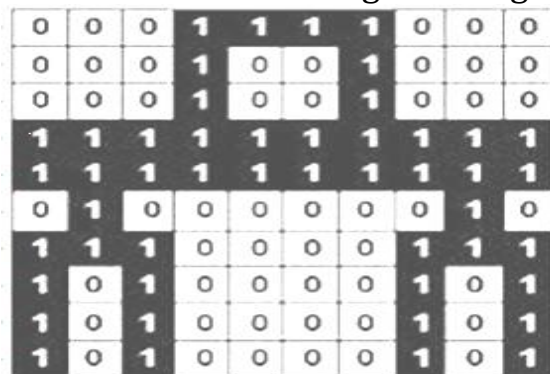
(b) Describe edge detection using
(i) 3 × 3 sobel mask
(ii) Morphology (subtraction after erosion).   [(CO2)(Remember/LOCQ)]
(2 + 4 + 2) + (2 + 2) = 12

5. (a) Given the image below form the run length coding for the rows 7 and 8.

[(CO4)(Creative/HOCQ)]

(b) 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 code2.

| 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) (Evaluate/HOCQ)]
6 + 6 = 12

Group - D

6. (a) What is working principle of a perceptron? What is an activation function? Why activation functions choose a smooth transition over a sharp cut-off? List two activation functions with diagram.   [(CO4) (Remember/LOCQ)]

(b) In the feed forward neural network calculate the output from the given matrix data given below:
[(CO4)(Evaluate/HOCQ)]

$$a(1) = x = \begin{bmatrix} 5 \\ 0 \\ 1 \end{bmatrix} \quad W(2) = \begin{bmatrix} 0.2 & 0.5 & 0.1 \\ 0.3 & 0.4 & 0.2 \end{bmatrix} \quad W(3) = \begin{bmatrix} 0.1 & 0.3 \\ 0.5 & 0.1 \end{bmatrix}$$

$$b(2) = \begin{bmatrix} 0.3 \\ 0.1 \end{bmatrix} \quad b(3) = \begin{bmatrix} 0.4 \\ 0.2 \end{bmatrix}$$
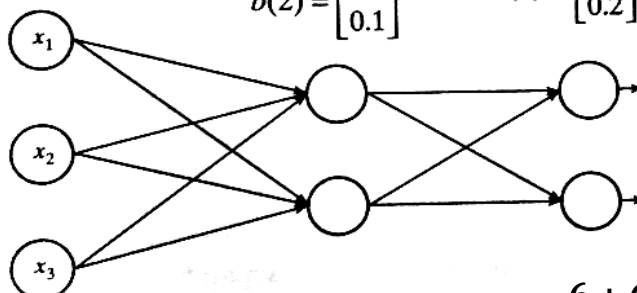
6 + 6 = 12

7. (a) Differentiate between Supervised, Unsupervised, and the Reinforced learning techniques? [(CO5)(Remember/LOCQ)]

   (b) Two pattern classes w1 and w2, using minimum distance classifiers, have sample mean vectors m1 = [5.3, 1.4] ^{T} and m2 = [1.6, 0.5] ^{T}, respectively. Find the decision functions and the decision boundary. [(CO5)(Evaluate/HOCQ)]

   (c) What are the conditions for the minimum distance classifier to be optimum in Bayes sense? [(CO5)(Analyze/IOCQ)]

   4 + 4 + 4 = 12

Group - E

8. (a) Explain the steps of K-nearest neighbour algorithm for classification. Is this method supervised or unsupervised? [(CO6)(Remember/LOCQ)]

   (b) Explain the steps of decision tree based classification.
   [(CO6)(Understand/LOCQ)]

   (c) State use of the Discrete Cosine Transform in feature selection.
   [(CO6)(Analyze/IOCQ)]

   4 + 4 + 4 = 12

9. (a) What is a threshold element, and an activation element in a Perceptron model?
   [(CO6)(Remember/LOCQ)]

   (b) Explain Hidden Markov Model and its role in the classifier design with example.
   [(CO6)(Understand/LOCQ)]

   (c) In Support Vector Machine technique, explain which are the support vectors?
   [(CO6)(Analyse/IOCQ)]

   4 + 6 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	47.9	29.17	22.92

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.