

**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) The decision boundary between classes w_i and w_j for a minimum distance classifier is the _____ of the line segment joining the corresponding mean vectors m_i and m_j .
(a) first quartile (b) second part
(c) perpendicular bisector (d) circle locus
- (ii) The number of bits used to represent 512 shades of gray is
(a) 8 (b) 9 (c) A (d) B.
- (iii) 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.
- (iv) If a 10mm × 10mm image with highest resolution of 2 line pair/ mm is digitized then a minimum number of _____ × _____ pixels each of size _____ mm can handle it.
(a) 20, 20, 0.5 (b) 40, 40, 0.25
(c) 20, 40, 0.25 (d) 40, 20, 0.50.
- (v) Aliasing can be avoided by choosing a sampling rate $\geq 2 * \text{max frequency}$ in the image. This minimum sampling rate is called the _____ rate.
(a) Nyquist (b) Nyman
(c) Nyon (d) Nyquil.
- (vi) A monochromatic digital image is sampled in _____ dimensions, which are _____ and the _____.
(a) two, spatial, grayscale (b) two, color , grayscale
(c) two, spatial, color (d) three, spatial, grayscale.

- (vii) The inverse Fourier Transform of a low pass Gaussian Filter is also a Gaussian function implies no _____ effect after using this filter.
 (a) Salt and Pepper (b) Averaging
 (c) Ringing (d) Shading.
- (viii) Pattern arrangements for _____ description is in vector form, and for _____ description it is either in string or in tree form
 (a) quantitative, structural (b) behavioural, scientific
 (c) qualitative, quantitative (d) scientific, structural.
- (ix) In _____ learning, a teacher routine provides a category label or cost for each pattern in a training set. In _____ learning *there is no explicit teacher, and the system forms* clusters of the input patterns
 (a) Supervised, Unsupervised (b) Reinforced, Supervised
 (c) Unsupervised, Supervised (d) Unsupervised, Reinforced.
- (x) 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) undetected.

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.
- (b) Consider the image segment shown below.
 (i) Let $V=\{0, 1\}$ 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. (ii) Repeat for $V=\{1, 2\}$.

Image segment:

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

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

3. (a) What is Median value of the 3 x 3 Median Filter (in red) as shown on the given data set? Show steps.

102	123	122	145	156
154	135	143	142	234
214	145	160	123	125
164	131	163	129	165
187	234	175	153	104

Median filter 3 x 3

Data Set

- (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 $g(x,y)$.

- (c) What is histogram equalization? How is it used?

4 + 4 + 4 = 12

Group – C

4. (a) What is "dilation" and "erosion"? What are use of these operations? What is the function of a structural element?
- (b) Explain the morphological operation of "OPENING" and "CLOSING" with example. What are its use?
- (c) Explain the principle of boundary detection with morphological operators.

6 + 4 + 2 = 12

5. (a) Briefly explain what is inter-pixel redundancy, and psycho visual redundancy, and how they are related with compressing an image.
- (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

6 + 6 = 12

Group – D

6. (a) What are the different stages in the design of a classification system? Explain with a diagram.
- (b) Explain the role of a descriptor with a pattern class. What is the role of classifier?
- (c) What is supervised pattern recognition? What is a training set? How is a-priori information used?

4 + 3 + 5 = 12

7. (a) What is unsupervised learning explain with an example?
- (b) Two pattern classes w_1 and w_2 , using minimum distance classifiers, have sample mean vectors $m_1 = [4.3, 1.3]^T$, and $m_2 = [1.5, 0.3]^T$, respectively. Find the decision functions and the decision boundary.

6 + 6 = 12

Group – E

8. (a) What are the three conditions for the minimum distance classifier to be optimum in the Bayes sense?
- (b) What is the mathematical expression for the simplified Bayes decision function and what approximations are used to reach it?
- (c) Describe a "Perceptron" model for two training class.

3 + 4 + 5 = 12

9. (a) What is the function of a threshold element, and an activation element in a Perceptron model?
- (b) Write short notes on any two from the following topics.
- (i) SVM model
 - (ii) Principal component analysis
 - (iii) Parzen windows density estimation
 - (iv) Decision tree based classifiers.

4 + (4 + 4) = 12

Department & Section	Submission Link
ECE	https://classroom.google.com/w/MzAwODExMjU4NDg2/tc/MzY0NjIxNTQ3Njcx