MMTE-003

ASSIGNMENT BOOKLET

(Valid from 1st January, 2023 to 31st December, 2023)

M.Sc. (Mathematics with Applications in Computer Science)

Pattern Recognition and Image Processing

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THE PEOPLE'S
UNIVERSITY

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2023)

Dear Student,

Please read the section on assignments and evaluation in the Programme Guide for Elective courses that we sent you after your enrolment. A weightage of 20 per cent, as you are aware, has been assigned for continuous evaluation of this course, **which would consist of one tutor-marked assignment**. The assignment is in this booklet.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully.

1) On top of the first page of your answer sheet, please write the details exactly in the following format:

ROLL NO :……………………………………………

NAME :……………………………………………

ADDRESS :……………………………………………

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COURSE CODE: …………………………….

COURSE TITLE : …………………………….

ASSIGNMENT NO. …………………………..…

STUDY CENTRE: ………………………..….. DATE:

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PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise.

5) While solving problems, clearly indicate which part of which question is being solved.

6) This assignment is to be submitted to the Programme Centre as per the schedule made by the programme centre. Answer sheets received after the due date shall not be accepted.
   We strongly suggest that you retain a copy of your answer sheets.

7) This assignment is valid only upto December, 2023. For submission schedule please read the section on assignments in the programme guide. If you have failed in this assignment or fail to submit it by December, 2023, then you need to get the assignment for the session 2024 and submit it as per the instructions given in the programme guide.

We wish you good luck.

Assignment

Course Code: MMTE-003
Assignment Code: MMTE-003/TMA/2023
Maximum Marks: 100

1. a) Perform Histogram Equalization for the 8×8 image shown below: (5)

Image Grey Level Distribution

Grey Levels (r_k)	Number of pixels (p_k)
0	8
1	10
2	10
3	2
4	12
5	16
6	4
7	2

b) Determine the binary output for the image $f = \begin{bmatrix} 1 & 2 \\ 5 & 4 \end{bmatrix}$, if the threshold is given by

i) 3

ii) $\begin{bmatrix} 2 & 2 \\ 2 & 1 \end{bmatrix}$. (3)

c) Differentiate between supervised and un-supervised learning. Give an example of each. (2)

2. a) Perform multiplication and division operations on the following two images: (5)

$$f_1 = \begin{bmatrix} 1 & 3 & 7 \\ 5 & 15 & 75 \\ 200 & 50 & 150 \end{bmatrix}$$

$$f_2 = \begin{bmatrix} 50 & 150 & 125 \\ 45 & 55 & 155 \\ 200 & 50 & 75 \end{bmatrix}.$$

b) Determine the DC component of the following image: (2)

$$f = \begin{bmatrix} 1 & 3 & 4 \\ 5 & 6 & 7 \\ 8 & 9 & 11 \end{bmatrix}.$$

c) Apply Discrete Cosine Transform (DCT) to the following image: (3)

$$\begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix}.$$

3. a) Apply Discrete Fourier Transform (DFT) to the sequence (x) given below:

$$x = \{1\ 2\ 8\ 9\}.$$

Verify whether the original sequence can be determined without any loss of information after Inverse Fourier Transform. (4)

b) Explain the following (give example for each):

i) Gamma Correction

ii) Wiener Filter

iii) Adaptive Mean Filter. (6)

4. a) Show that subtracting the Laplacian of an image from the image itself is proportional to the Unsharp Masking. (3)

b) Compute Mean Square Error (MSE) and Signal to Noise Ration (SNR) for the reference image $f(x, y) = \begin{bmatrix} 3 & 2 & 1 \\ 1 & 2 & 1 \\ 3 & 2 & 2 \end{bmatrix}$, and the processed image $\hat{f}(x, y) = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$. (5)

c) Give examples of string matching and matching shape numbers. (2)

5. a) The following pattern classes have Gaussian probability functions:

$$w_1 : \{(1, 1)^T, (3, 1)^T, (3, 3)^T, (1,3)^T\} \text{ and}$$

$$w_2 : \{(5, 5)^T, (7, 5)^T, (7, 7)^T, (5, 7)^T\}$$

Assuming that $P(w_1) = P(w_2) = \frac{1}{2}$, obtain the equation of the Bayes' decision boundary between these two classes. (5)

b) Calculate the following for the data given below: (5)

i) Entropy

ii) Coding redundancy of Binary code

iii) Coding redundancy of Huffman code

Symbol:	1	2	3	4	5	6
Huffman code:	0	10	110	1110	11110	111111
Binary code:	000	001	010	011	100	101
Probability:	0.4	0.2	0.2	0.1	0.05	0.05

[Given, $\log_2 0.05 = -4.32$].

6. a) Given a four-symbol source {a, b, c, } with source probabilities {0.1, 0.4, 0.3, 0.2}, arithmetically encode the sequence b b a d c. (6)

b) Let the salt and pepper noise have the following pdf:

$$f(z) = \begin{cases} p_a; & z = -255 \\ p_b; & z = 255 \\ 1-(p_a + p_b); & z = 0 \end{cases}$$

Obtain the mean and variance of this distribution. (4)

7. Write short notes on the following: (10)

a) Principal Component Analysis

b) Digital Watermarking and its Applications

c) MPP Algorithm

d) Image segmentation.

8. a) Define the following intensity transformation functions, with suitable examples: (4)

i) Log Transformations

ii) Power-Law (Gamma) Transformations.

b) What is Histogram Equalization? Why is it performed? Perform histogram equalization of the following image: (6)

$$\begin{bmatrix} 1 & 3 & 5 \\ 4 & 4 & 3 \\ 5 & 2 & 2 \end{bmatrix}.$$

9. a) Compute the degree of compression that can be achieved using (i) Huffman coding, and (ii) Run length coding, assuming two-bits to represent the pixel value and two-bits to represent the run length. (6)

$$I = \begin{bmatrix} 3 & 3 & 3 & 2 \\ 2 & 3 & 3 & 3 \\ 3 & 2 & 2 & 2 \\ 2 & 1 & 1 & 0 \end{bmatrix}$$

b) Find the entropy of the image (4)

$$\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 1 & 2 & 2 \\ 0 & 1 & 2 & 3 \\ 1 & 2 & 2 & 3 \end{bmatrix}.$$

10. a) Two images $g_1(x, y)$ and $g_2(x, y)$ have histograms hg_1 and hg_2, respectively. Give the condition under which the histograms of the following can be determined:

i) $g_1(x, y) + g_2(x, y)$

ii) $g_1(x, y) - g_2(x, y)$

iii) $g_1(x, y) \times g_2(x, y)$

iv) $g_1(x, y) \div g_2(x, y)$

Hence, obtain the histogram in each case in terms of hg_1 and hg_2. (4)

b) Construct a 4-directional and 8-directional chain code for the shape of the alphabet 'C'. Hence, obtain its difference code and shape number. (6)