

**MMTE-003**

**ASSIGNMENT BOOKLET**  
(Valid from 1<sup>st</sup> January, 2019 to 31<sup>st</sup> December, 2019)

**M.Sc. (Mathematics with Applications in Computer Science)**  
**Pattern Recognition and Image Processing**



**School of Sciences**  
**Indira Gandhi National Open University**  
**Maidan Garhi, New Delhi-110068**

**2019**

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:

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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, 2019. 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, 2019, then you need to get the assignment for the session 2020 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/2019

Maximum Marks: 100

1. a) 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  $1024 \times 1024$  image with 256 intensity levels using a 56 k baud modem?
  - ii) What would the time be at 3000K baud, a representative medium speed of a phone DSL (Digital Subscriber Line) connection? (6)
- b) Develop an algorithm for converting a one-pixel-thick 8-path to a 4-path. (4)
2. a) Give a single intensity transformation function for spreading the intensities of an image so the lowest intensity is 0 and the highest is  $L - 1$ , where  $L$  is the number of intensity levels in the image. (5)
- b) Two images,  $f(x, y)$  and  $g(x, y)$ , have histograms  $h_f$  and  $h_g$ . Give the conditions under which the histograms of the following can be determined.
  - i)  $f(x, y) + g(x, y)$
  - ii)  $f(x, y) - g(x, y)$
  - iii)  $f(x, y) \times g(x, y)$
  - iv)  $f(x, y) \div g(x, y)$  (5)
3. Consider the continuous function  $f(t) = \sin(2\pi nt)$ .
  - i) What is the period of  $f(t)$ ?
  - ii) What is the frequency of  $f(t)$ ?

The Fourier transform,  $F(\mu)$ , of  $f(t)$  is purely imaginary, and because the transform of the sampled data consists of periodic copies of  $F(\mu)$ , the transform of the sampled data,  $F(\mu)$ , will also be purely imaginary. Draw a diagram of Fourier transform of the function and answer the following question based on your diagram (assume that sampling starts at  $t = 0$ ).

- iii) What would the sampled function and its Fourier transform look like in general if  $f(t)$  is sampled at a rate higher than the Nyquist rate?

- iv) What would the sample function look like in general if  $f(t)$  is sampled at a rate lower than the Nyquist rate?
- v) What would the sample function look like if  $f(t)$  is sampled at the Nyquist rate with samples taken at  $t = 0, \Delta T, 2\Delta T, \dots$ ? (10)
4. a) Consider a linear, position-invariant image degradation system with impulse response
- $$h(x - \alpha, y - \beta) = e^{-[(x-\alpha)^2 + (y-\beta)^2]}$$
- Suppose that the input to the system is an image consisting of a line of infinitesimal width located at  $x = a$ , and modeled by  $f(x, y) = \delta(x - a)$ , where  $\delta$  is an impulse. Assuming no noise, what is the output image  $g(x, y)$ ? (6)
- b) Write a general procedure for decoding exponential Golomb code  $G_{\text{exp}}^k(n)$ . (4)
5. Consider Huffman encoding pairs of pixels rather than individual pixels. That is, consider the image to be produced by the second extension of the zero-memory source that produced the original image. What is the entropy of the image when looked at as pairs of pixels? (10)
6. a) The compass gradient operators of size  $3 \times 3$  are designed to measure gradients of edges oriented in eight directions: E, NE, N, NW, W, SW, S, and SE.
- i) Give the form of these eight operators using coefficients valued 0, 1 or  $-1$ .
- ii) Specify the gradient vector direction of each mask, keeping in mind that the gradient direction is orthogonal to the edge direction. (6)
- b) Using the Hough transform
- i) Develop a general procedure for obtaining the normal representation of a line from its slope-intercept form,  $y = ax + b$ .
- ii) Find the normal representation of the line  $y = -2x + 1$ . (4)
7. a) Given a four symbol source  $\{\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}\}$  with some probabilities  $\{0.1, 0.4, 0.3, 0.2\}$ , obtain encoded sequence corresponding to **bbadc**.
- i) Using Huffman coding.
- ii) Using arithmetic coding. (6)
- b) What is the entropy of this source? Compare it with the data rate obtained using the two encoding schemes and comment on the result. (4)
8. a) Draw the block diagram of a typical motion compensated video encoder. (4)

- b) How many computations are required to find the optimal motion vector of  $8 \times 8$  macro block, with maximum allowable displacement of 8 pixels using
- i) Single pixel precision.
  - ii)  $\frac{1}{4}$  pixel precision. (6)
9. Given a  $8 \times 16$ , 3-bit image with the following histogram [32, 32, 32, 32, 0, 0, 0, 0].
- i) Apply histogram equalization and obtain the equalized histogram.
  - ii) Apply histogram specification to obtain the following histogram [0, 2, 2, 4, 8, 16, 32, 64]. What is the resulting histogram? (10)
10. a) A  $50 \times 50$  image (binary) contains a  $10 \times 10$  white block in the center against a black background. Following distortion occurs in the image:
- The four vertices of the white block become  $(15, 28), (22, 35), (22, 21), (29, 28)$ . Obtain the parameters of the affine transformation that caused this geometric spatial transformation. (6)
- b) Explain the difference between forward and reverse map in Affine Transformation. (4)