MMTE-004

ASSIGNMENT BOOKLET

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

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

COMPUTER GRAPHICS

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 :……

……

……

COURSE CODE: …….

COURSE TITLE : …….

ASSIGNMENT NO.: ……..…

STUDY CENTRE: ……..….. DATE: …….……...

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 year 2024 and submit it as per the instructions given in the programme guide.

8) **You cannot fill the exam form for this course** till you have submitted this assignment. So solve it and **submit it to your study centre at the earliest.**

We wish you good luck.

Assignment

Course Code: MMTE-004
Assignment Code: MMTE-004/TMA/2023
Maximum Marks: 100

1. a) What is the fraction of the total refresh time per frame spent in retrace of an electron beam for a non-interlaced raster system with a resolution of 1024×768, a refresh rate of $30\,\text{Hz}$, a horizontal retrace time of 4 microseconds and a vertical retrace time of 450 microseconds? (3)

   b) List two advantages of laser printers over dot matrix printers. (2)

   c) Describe the working procedure of a refresh cathode ray tube monitor. (5)

2. a) Compute pixel positions along the line path of the line joining the points $A(5, 2)$ and $B(8, 6)$ using the DDA Algorithm. Also display the actual line path and the scan-converted line path. (4)

   b) Rasterise the circle with centre $(2, 8)$ and radius 5, using the Midpoint Circle Drawing Algorithm. (6)

3. a) Explain the difference between the odd-even rule and the nonzero winding number rule with the help of an example. (4)

   b) Develop and implement the Flood Fill Algorithm. (6)

4. a) Show that rotation about an arbitrary pivot point (a, b) through an angle θ is equivalent to the rotation about the origin through θ followed by a translation through (a', b'), where $a' = a(1-\cos\theta) + b\sin\theta$ and $b' = b(1-\cos\theta) - a\sin\theta$. (4)

   b) Find the equation of the Bezier curve that passes through $(0, 0)$ and $(-4, 2)$ and controlled through $(14, 10)$ and $(4, 0)$. (6)

5. a) Let W be the window with corners at $(5, 5)$, $(10, 5)$, $(10, 8)$ and $(5, 8)$. Clip the triangle with vertices $(4, 6)$, $(12, 6)$ and $(6, 10)$ against W using
      i) Cohen-Sutherland Algorithm
      ii) Liang-Barsky Line Clipping Algorithm. (10)

6. a) A figure with vertices $A(10, 0)$, $B(0, 10)$, $C(-10, 0)$ and $D(0, -10)$ is scaled twice uniformly w.r.t. $O(0, 0)$ by the scaling factors 3 and $\frac{2}{5}$. Find the transformed coordinates of the corners of the figure and sketch it. (2)

   b) Prove that the reflection along the line $y = x$ is equivalent to reflection along the x-axis followed by a counter clockwise rotation by 90°. (3)

c) Show that the order in which transformations are performed is important by applying the transformations to the triangle A(1, 0), B(0, 1), C(1, 1) by

i) rotating by 45° about the origin and then translating in the direction of the vector $(1, 0)$.

ii) translating first and then rotating by 45° about the origin. (5)

7. Shear a unit square whose opposite vertices are at $(0, 0)$ and $(2, 2)$ by

i) 2 units along x-axis and reference line $y = 0$.

ii) 3 units along y-axis and reference line $x = 0$.

iii) 2 units along x-axis and 3 units along y-axis w.r.t. principal axis.

iv) 2 units along x-axis and reference line $y = -1$.

v) 3 units along y-axis and reference line $x = -1$. (10)

8. a) Determine the blending functions for uniform, periodic B-spline curves for $d = 5$ and $d = 6$. (6)

b) A Bezier curve of degree 4 has to be expressed as a Bezier curve of degree five. Find out the control points of the curve which make it a curve of degree 5. (4)

9. a) Determine a rotation matrix for rotation by an arbitrary angle θ about a fixed point (r_x, r_y) in homogeneous form. Use this matrix to rotate the square with vertices $(0, 0), (1, 0), (1,1)$ and $(0, 1)$ about the point $(1, 1)$ (4)

b) Suppose that a window has its lower-left corner at $(-2, -1)$ and its upper-right corner at $(3, 2)$. For each of the following line segments, state whether it will be totally visible, totally hidden, or partially visible; and for the partially visible-segments give the coordinates at which it is clipped.

i) $(-1, 0)$ to $(1, 1)$

ii) $(-3, 1)$ to $(4, 1)$

iii) $(-2, 3)$ to $(1, 4)$

iv) $(2, 3)$ to $(4, 1.5)$

v) $(0, 1.5)$ to $(2.5, 0)$. (6)

10. a) Modify the boundary-fill algorithm for a 4-connected region to avoid excessive stacking by incorporating scan line methods. (4)

b) Set up geometric data tables for a unit cube using only i) vertex and polygon tables and ii) a single polygon table. Compare the two methods for representing the unit cube with a representation using three data tables, and estimate storage requirements for each. (6)