Dr. Keshav Sinha **Computer Graphics**

Assignment 1 **100 Marks**

Last Date: 07/10/2024

1. **Submit the assignment by given Date & Time. Late submissions are not allowed (considered as zero).**
2. **Show all steps clearly for each problem. Final answers without the necessary work will not receive full credit.**
3. **Start each new problem on a separate line. Number each problem as per the assignment sheet.**
4. **If you make a mistake, cross it out with a single line. Avoid using correction fluid (white-out).**

Questions: Each Question Carries 2.5 Marks, and every question is compulsory.

Q1). A laptop screen has a resolution of 3840 x 2160 pixels and is 15.6 inches wide. Determine the PPI (pixels per inch) of this display.

Q2). A display has a 1920 x 1080 pixels resolution and a refresh rate of 75 frames per second. Calculate the time taken to refresh one row of pixels.

Q3). A screen has a resolution of 1600 x 900 pixels. If the display dimensions are 17 inches wide and 10 inches high, determine the radius of each pixel.

Q4). For two raster systems with resolutions of 800 x 600 and 1600 x 1200, determine the size of the frame buffer (in bytes) required for each system if 16 bits per pixel are used.

Q5). Given an average execution time of 50 nanoseconds per instruction and a frame rate of 24 fps, find the maximum number of instructions in the display list.

Q6). Find the dimensions in inches for a 1280 x 720-pixel image displayed at 72 pixels per inch.

Q7). Given a screen size of 10 inches x 7 inches and a resolution of 120 pixels per inch, find the frame buffer size (in bytes) required to store 24 bits per pixel.

Q8). Use the DDA algorithm to find the pixel points for a horizontal line from G(3,4) to H(8,4).

Q9). Draw a line from I(0,4) to J(4,0) using the DDA algorithm.

Q10). Calculate the pixel points for a line from P(-3,7) to Q(4,-2).

Q11). Generate the points for a line from K(-3,5) to L(4,-2).

Q12). Generate the points for a line from K(-5,7) to L(6,-4).

Q13). Calculate the pixels of the circle using the parametric equation where the radius (r = 7) and the center is (15, 20).

Q14). Determine the pixel coordinates for a circle using the parametric equation with a radius of (r = 10) and center (0, 0).

Q15). Calculate the pixel points for a circle using Bresenham's Circle Drawing Algorithm where the radius (r = 6) and the center is at (12, 8).

Q16). Using the Mid-Point Circle Drawing Algorithm, calculate the pixels for a circle with radius (r = 5) and center at (7, -7).

Q17). Consider the scan conversion of a circle with center (3, 4) and radius 5. If the point P(6, 7) is already plotted on this circle, list the seven other points that can be generated using the symmetry of the circle.

Q18). Given a circle with center (-4, -3) and radius 6, if the point Q(-7, -3) is plotted on this circle, determine the coordinates of the seven other symmetric points that can be plotted using the properties of circle symmetry.

Q19). Using the Midpoint Ellipse Algorithm, calculate the pixel coordinates for an ellipse with the center at (5, 5), a major axis radius of 10, and a minor axis radius of 6.

Q20). Apply Bresenham's Ellipse Drawing Algorithm to determine the pixel points for an ellipse centered at (0, 0) with a horizontal radius of 8 and a vertical radius of 4.

Q21). Calculate the pixel positions using the Midpoint Ellipse Algorithm for an ellipse centered at (15, 10) with a major radius of 12 and a minor radius of 5.

Q22). Using the clipping window defined by (30, 30), (30, 100), (100, 30), and (100, 100), apply the Cohen-Sutherland algorithm to the line segment from (25, 25) to (75, 75). What is the outcome of the classification?

Q23). Using the Cohen-Sutherland algorithm, determine whether the line segment from (20, 30) to (40, 70) is clipped within a rectangle defined by the points (10, 20) and (50, 50). If it is clipped, what are the coordinates of the clipped segment?

Q24). Using the Liang-Barsky algorithm, determine the coordinates of the clipped line segment from (15, 25) to (70, 75) within a rectangular clipping window defined by (30, 30) and (60, 60). Show your calculations step by step.

Q25). Given a polygon defined by the vertices (1, 1), (5, 1), (5, 4), and (1, 4), determine whether the point (3, 2) is inside or outside this polygon using the ray-casting algorithm.

Q26). A polygon is defined by the vertices (2, 2), (6, 2), (6, 5), (2, 5). Use the winding number algorithm to determine whether the point (4, 3) is inside or outside the polygon. What are the steps involved in your calculation?

Q27). Given a polygon defined by the vertices A(2, 1), B(5, 5), C(6, 2), and D(3, 0) and a clipping window defined by the coordinates (1, 1), (1, 4), (4, 4), and (4, 1), apply the Sutherland-Hodgman algorithm to find the clipped polygon. Show all the steps.

Q28). Given a non-convex polygon with vertices (1, 1), (5, 2), (3, 4), (0, 3), and (1, 5), determine how the Sutherland-Hodgman algorithm clips this polygon against a clipping window defined by (2, 2) and (4, 4). What challenges does the algorithm face with this polygon?

Q29). For a polygon defined by the vertices (2, 2), (6, 2), (6, 6), (2, 6), and a clipping window defined by (4, 4), apply the Weiler-Atherton algorithm and determine how the clipped polygon is affected by the window's position.

Q30). Given a line segment defined by the endpoints A(2, 3) and B(6, 5) and a clipping window defined by the vertices (1, 1), (1, 4), (4, 4), and (4, 1), apply the Cyrus-Beck algorithm to find the clipped line segment. Show all necessary calculations.

Q31). Given a line segment defined by the endpoints (1, 1) and (10, 10), apply the Cyrus-Beck algorithm against a non-convex clipping polygon defined by the vertices (3, 2), (5, 5), (4, 7), and (1, 6). Discuss the steps involved in determining the resulting clipped line segment.

Q32). Given a point P(2, 3), apply the following transformations in sequence: a scaling transformation that doubles the size, a translation of (3, -1), and a rotation of 90 degrees counterclockwise about the origin. What are the final coordinates of the point?

Q33). Consider a rectangle defined by the vertices A(1, 1), B(4, 1), C(4, 3), and D(1, 3). Apply a shearing transformation with a shear factor of 2 in the x-direction. What are the new coordinates of the rectangle's vertices after the transformation?

Q34). A triangle has vertices at (1, 2), (3, 4), and (5, 2). If you reflect this triangle over the line y = x, what are the coordinates of the reflected triangle?

Q35). Describe how to combine multiple transformations into a single transformation matrix. For example, how would you represent a transformation that scales by a factor of 2, then translates by (3, 4), and finally rotates by 45 degrees? Provide the resulting transformation matrix.

Q36). A point P(2,3) undergoes a sequence of transformations: it is first rotated 45° counterclockwise about the origin, then translated by (5,−2), and finally reflected across the line y=x. What are the coordinates of the final position of the point P?

Q37). Consider a triangle with vertices at A(1,2), B(4,5), and C(3,1). Perform the following composite transformation:

- Rotate the triangle 30° clockwise around point A.
- Scale the triangle by a factor of 2 relative to point B.
- Reflect the resulting triangle across the x-axis.
- What are the coordinates of the vertices of the transformed triangle?

Q38). A rectangle has vertices at P(1,1), Q(1,4), R(5,4), and S(5,1). The rectangle undergoes a composite transformation consisting of:

- A rotation of 90° counterclockwise about the origin.
- A translation by (−3,2).
- A reflection across the y-axis.
- What are the coordinates of the vertices after the composite transformation?

Q39). A pentagon with vertices A(−2,3), B(1,4), C(3,2), D(1,0), and E(−2,1) are subjected to the following transformations:

- Rotate the pentagon 60° counterclockwise around the point (1,1).
- Reflect the result across the line y=−x.
- Translate by (4,−3).
- What are the pentagon’s new coordinates?

Q40). Given point M(−3,2), apply the following composite transformations:

- Translate by (4,5).
- Reflect the translated point across the line y=−1.
- Rotate the result 90° clockwise around the origin.
- Scale the final point by a factor of 0.5 with respect to the origin.
- Find the final coordinates of the point M.