CSE423 - Computer Graphics

Midterm Practice Sheet [Spring 2025]

N.B. ***This is merely a reference to the problems inclusive and exclusive to the questions that will be set in the midterm. This practice sheet does not include all kinds of questions that may come into the examination.***

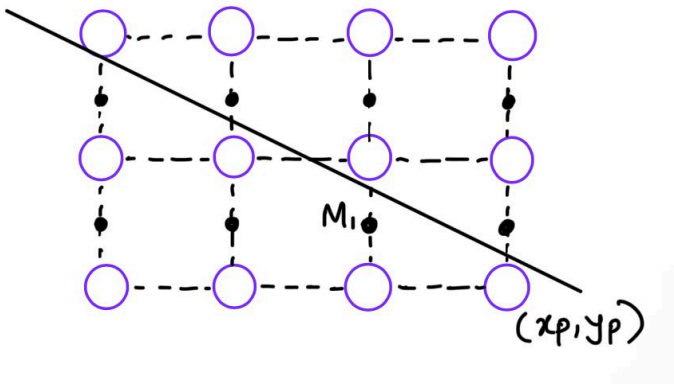
1. How does a computer transform a 3D model into 2D images? State each stage of this process.
2. A GPU can process 80,000 pixels per millisecond. If the frame time at 30 FPS is approximately 33.33 milliseconds, estimate the maximum number of pixels that can be rendered per frame.
3. Given a screen resolution of 2560 x 1440 and a frame rate of 45 FPS, calculate the total number of pixels processed per second.
4. Suppose a line segment starts at (120, 23) and ends at (423, 428). If we draw this problem using the DDA algorithm, determine the number of times x will be increased. How many pixels will be needed to draw this line?
5. Using the Digital Differential Analyzer (DDA) algorithm, find out the pixels between the lines whose endpoints are given:
   a. (5, 16) to (13, 10)
   b. (0, 0) to (4, 6)
   c. (4, -8) to (-1, 7)
   d. (14, -8) to (0, 14)
   e. (5, 6) to (8, 12)
6. Which problem persists in the DDA algorithm and how can it be solved?
7. Why is the value of y incremented/decremented by 1 instead of x, when the gradient is < -1 or > 1?
8. Suppose a line segment starts from P (s, r) and ends at Q (m, n). This line segment falls in Zone 1. Given that s < m and r < n, derive the formulas for determining the pixels' coordinates if DDA Algorithm is used.
9. Using the Slope Independent Line Drawing Algorithm, find the first 6 missing pixel values starting from: (Show the present value of d as well as $\triangle$s at each stage.)
   a. (20, 10) to (30, 18)
   b. (0, -14) to (-45, 11)
   c. (-1, -2) to (-15, 82)
   d. (-18, 11) to (0, -3)

e. (5, 10) to (-20, 5)

$$\frac{x}{7} - \frac{y}{12} = 5$$

10. Suppose a line segment has the equation above, and the starting point is at y = 12 and the ending point is at y = 0. Find the first 6 pixels using the Midpoint Line Algorithm.
11. Describe the significance of 8 Way Symmetry in the Midpoint Line Algorithm.
12. A line segment has the following orientation.

    Derive starting/initial deviation ('d') and its derivatives (△s)/decision parameters using mid-point line drawing algorithm.



13. Do you think the Mid Point Line Drawing Algorithm is better than DDA? Provide reasoning.
14. There is a line with the equation, y = -5x - 20. The line segment starts from where it cuts the y-axis and ends at where it cuts the x-axis. Find the first 8 pixels using the Midpoint Line Drawing Algorithm.
15. Given (-30, -30) and (30, 30) are the corners of the clip rectangle. The endpoints of a line are given as (35, 37) and (-38, -20). Using the Cohen-Sutherland line clipping algorithm, identify whether the lines are Accepted, Rejected, or Partial (partially accepted) only from the outcodes. Does Cyrus-Beck line clipping algorithm produce the same output?
16. Given (0, 0) and (400, 300) are the corners of the clip rectangle. The endpoints of a line are given as (−50, 350) and (450, 350). Using the Cohen-Sutherland line clipping algorithm, identify whether the lines are Accepted, Rejected, or Partial (partially accepted) only from the outcodes. Does Cyrus-Beck line clipping algorithm produce the same

output?

17. Given (-30, -30) and (30, 30) are the corners of the clip rectangle. The endpoints of a line are given as (-80, 35) and (35, -80). Using the Cohen-Sutherland line clipping algorithm, identify whether the lines are Accepted, Rejected, or Partial (partially accepted) only from the outcodes. Does Cyrus-Beck line clipping algorithm produce the same output?
18. The top-right corner of a clipping rectangle is (20, 60). The window is 60 units wide and 40 units tall. The endpoints of a line segment are (7, 16) and (85, 75). Apply Cohen-Sutherland Algorithm, and identify whether the line is "partially inside", "completely inside", or "completely outside". If it is the first case, run the algorithm to calculate new endpoints for the line segment so that it is inside the clipping window. Does Cyrus-Beck line clipping algorithm produce the same output?
19. A clipping window is 70 units wide and 30 units tall, and has its center at (0, 35). The endpoints of a line segment are (-45, 65) and (23, -10). Apply Cohen-Sutherland Algorithm, and identify whether the line is "partially inside", "completely inside", or "completely outside". If it is the first case, run the algorithm to calculate new endpoints for the line segment so that it is inside the clipping window. Does Cyrus-Beck line clipping algorithm produce the same output?
20. What is 2D Region Outcode and 3D Region Outcode?
21. What are the disadvantages of the Cohen-Sutherland line clipping algorithm?
22. Which algorithm is suitable for polygonal or circular clipping region?
23. Given a line segment from (10, 60) to (25, 30). Construct the parametric equation P(t) of the line. Using the parametric equation, determine the coordinates of the point where t = 3/5.
24. Does Cyrus-Beck algorithm work for both Concave and Convex polygonal regions? Explain why or why not with a figure.
25. For the following value of t_E and t_L, comment whether the following lines are accepted, rejected or partially clipped:

t_E	t_L	Comments
0.3	0.7	
-0.3	1.2	
-0.3	-0.33	
-0.5	0.5	

1.1	2.4	
0.3	1.3	

26. Define a homogeneous coordinate system. Why does computer graphics prefer a homogeneous coordinate system?
27. Make a simple classification tree of transformations/motions.
28. Derive |4x4| rotation matrix for a 3D point while;
    a. Rotation across the X-axis and the center of rotation (a, b, c).
    b. Rotation across the Y-axis and the center of rotation (a, b, c).
    c. Rotation across the Z-axis and the center of rotation (a, b, c).
29. Derive |3x3| transformation matrix for reflection about any line L.
30. Determine the coordinate of a 3D point P(100, -60, 80)
    a. After rotating 60^0 across the Y-axis, given that the center of rotation is (50, 20, 45).
    b. After rotating 60^0 across the X-axis, given that the center of rotation is (50, 20, 45).
    c. After rotating 60^0 across the Z-axis, given that the center of rotation is (50, 20, 45).
31. Find the following composite transformation matrices as instructed:
    a. A 3D rotation of 90^0 clockwise about the y-axis with respect to the point (a, b, c) followed by a translation of (a, b, c).
    b. A reflection about the line ax - by + c = 0 followed by a scaling “e” times with respect to the point (a, b).
    c. A 3D rotation of 45° counterclockwise about the z-axis with respect to point (d, e, f) followed by a uniform scaling of factor 3 with respect to point (d, e, f) and lastly followed by a translation of (a, b, c). [Here a, b, c, d, e, f are arbitrary values]
32. Arya drew a triangle on a coordinate plane with vertices A(3, 2), B(5, 1), and C(4, 3). She performed the following transformations in sequence: At first, she translated the triangle by (−2, 3). Then, rotate the triangle 90^0 counterclockwise about the origin. After that, she reflected the triangle on the x-axis. Finally, she scaled the triangle uniformly by a factor of 2 about the point (1, −1). After applying these transformations, the new location of one vertex was found to be (a, b).
    a. Now, identify the position of the vertices before only the reflection is applied. (That means only translation and rotation are applied to each of the vertices).
    b. Write the composite matrix formulation for all transformations applied to the triangle. (You do not need to perform matrix multiplication.)
    c. Which geometric properties are preserved after each

transformation?

33. A 3D composite transformation is defined by a shearing along the X axis by a shearing factor of (2, 4) about point (423, 0, 0), followed by a uniform scaling by factor 3 again, followed by a 30-degree counterclockwise rotation on the X axis about point (2, 10, 12) and finally followed by a translation of (-4, -2, -3). A point P is transformed into P' with the above transformation.
    a. Now, write down the composite transformation matrix representation for P' in the correct sequence of matrix multiplications. [N.B. the shearing factor will be $Sh_{y=2}$ and $Sh_{z=4}$. Go sequentially if it is not mentioned]
    b. Also, find out the inverse composite transformation matrix representation for P' in the correct sequence of matrix multiplications.
34. A 3D point M is transformed to M' applying shearing along the Y Axis by a shearing factor of (12, 21) with respect to a point (-33, 44, -55). If the coordinate of M' is (125, 255, -674). What was the original coordinate of M?
35. A composite transformation is defined by a scaling on the X-axis and Y-axis (first transformation) followed by a second transformation, via the following equations:

$$x' = 5x - 11$$

$$y' = 10y + 22$$

$$z' = 33 + z$$

    a. Find the composite transformation matrix. What was the second transformation after scaling?
    b. Write down the scaling matrix from the above composite transformation.
    c. If a 3D point M has the coordinate (4, 2, 3), what is the new coordinate of the point, M' after the transformation defined by the equations?