CS 307 – COMPUTER GRAPHICS (2019/20)

Assignment 03

Submit the answers to **odd numbered questions** on or before 11.59 pm December 16th, 2020

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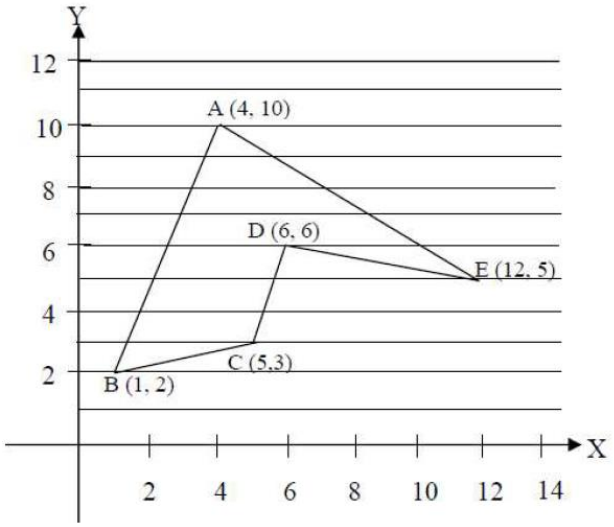
1. State the Odd Parity Rule in Scanline filling algorithm. Briefly explain the problem that may occur when using this rule.
2. The following 2D polygon area is needed to be filled using the Scanline filling algorithm. Create the Sorted Edge Table (SET) and derive the Active Edge Table (AET) from that. Show all the intermediate steps and calculations.



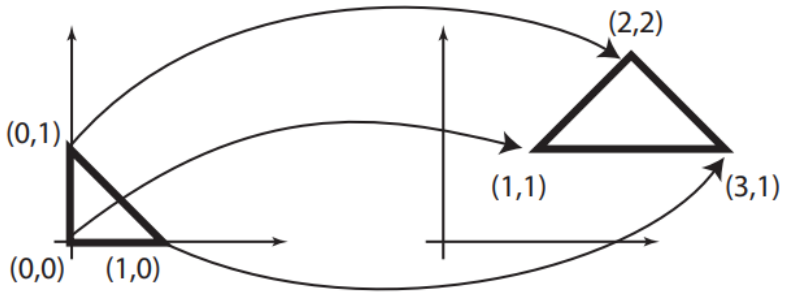
3. Write a pseudo-code for the Boundary Fill algorithm. Also compare boundary fill algorithm with scan line algorithm.
4. Write a boundary-fill procedure to fill an 8-connected region.
5. Modify the boundary-fill algorithm for a 4-connected region to avoid excessive stacking by incorporating scan-line methods.
6. Write a procedure for filling the interior of any specified set of fill-area vertices, including one with crossing edges, using the nonzero winding number rule to identify interior regions.
7. Show that the composition of two rotations is additive by concatenating the matrix representations for $R(\theta_1)$ and $R(\theta_2)$ to obtain,

$$R(\theta_1) \,.\, R(\theta_2) = R(\theta_1 + \theta_2)$$

8. Prove that the multiplication transformation matrices for each of the following sequences is commutative:
   i. Two successive rotations.
   ii. Two successive translations.
   iii. Two successive scalings.

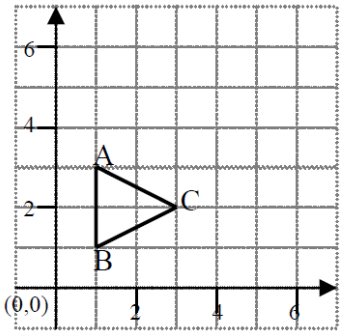
9. Prove that a uniform scaling and a rotation form a commutative pair of operations but that, in general, scaling and rotation are not commutative operations.
10. Determine the form of the 2D transformation matrix for a reflection about any line: $y = mx + b$.
11. Show that transformation matrix $\begin{bmatrix} 0 & -1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$, for a reflection about the line $y = -x$, is equivalent to a reflection relative to the y axis followed by a counterclockwise rotation of 90°.
12. Determine a sequence of basic transformations that is equivalent to the y-direction shearing matrix $\begin{bmatrix} 1 & 0 & 0 \\ sh_y & 1 & -sh_y . x_{ref} \\ 0 & 0 & 1 \end{bmatrix}$.

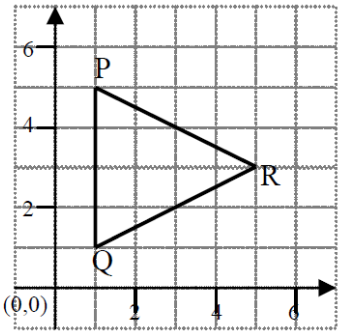
13. Suppose we have a unit triangle as shown on the left and we want to transform it into the triangle as shown on the right. Write a matrix that transforms the triangle in the desired way by giving all the entries in the matrix.



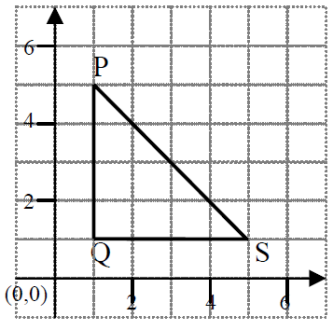
14.

i. Write down the composite transformation matrix that would scale ABC traingle to PQR triangle.

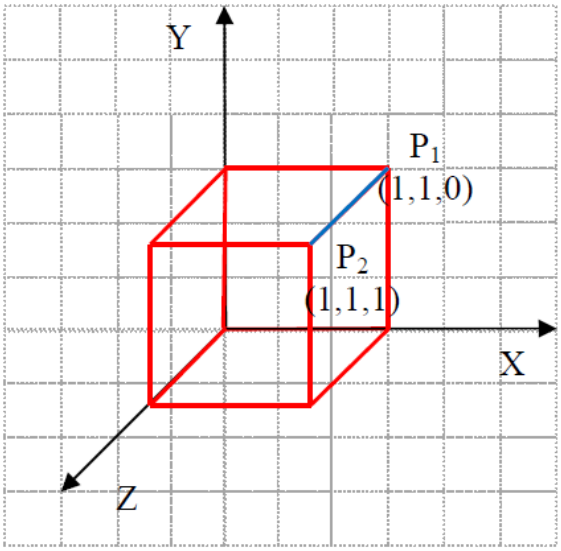




ii. Write down the transformation matrix that would transform the PQR triangle to the PQS right triangle.



15. Given a unit cube with one corner at (0, 0, 0) and the opposite corner at (1, 1, 1), derive the transformations necessary to rotate a cube by θ degrees about the edge from (1, 1, 0) to (1, 1, 1) in the counterclockwise direction when looking from point (1, 1, 1) towards the point (1, 1, 0). Clarify your answer by discussing every step of your transformations.



i. Translate the object so that the rotation axis passes through the coordinate origin.

ii. Perform the specified rotation about Z coordinate axis.

iii. Apply inverse translation to bring the rotation axis back to its original position.