COMSATS University Islamabad Lahore Campus

Sessional 2 Examination – Semester Spring 2021

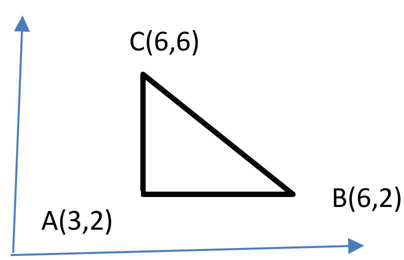
Course Title:	Computer Graphics		Course Code:	CSD304	Credit Hours:	3(2,1)
Course Instructor/s:	Aamer Mehmood		Programme Name:	BS Computer Sciences		
Semester:	5th,7th	Batch: SP18-SP19	Section:	A,B,C	Date:	
Time Allowed:	**1.5 Hours**		**Maximum Marks:**	**20**		
Student's Name:			Reg. No.	CIIT/SDP-SP( )-BCS- /LHR		

Important Instructions / Guidelines:

- Use proper indentation, comments, naming conventions and self-explanatory names if you want to secure better marks.

Question 1: Provide a 3x3 matrix that will compute the new vertices of a planner box after a rotation of 60 degrees and a scaling of factor S_x=S_y=0.5 about its center [4, 2]. (5 marks)

Question 2: (A) Rotate the triangle given in figure (a) by 90 degrees about the origin. (3 marks)

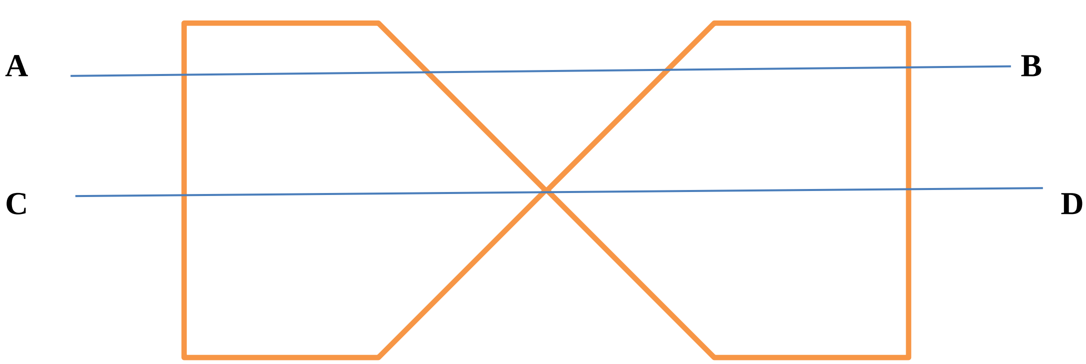


Figure(a).

(B) Write all the points which describe the rotation about arbitrary point other than the origin. (2 marks)

Question 3: Find a transformed point Q caused by rotating P (3, 5) about the origin through an angle of 60^o. (5 marks)

Question 4: What are the basic steps, performed to fill a polygon? Explain the algorithm with the given scenario. (5 marks)



Solutions

Question 1: Provide a 3x3 matrix that will compute the new vertices of a planner box after a rotation of 60 degrees and a scaling of factor S_x= 0.5 and S_y= 0.8 about its center [4, 2]. (5 marks)

Answer:

$$\begin{bmatrix}1 & 0 & 4\\0 & 1 & 2\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}1/2 & 0 & 0\\0 & 0.8 & 0\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}cos60 & -sin60 & 0\\sin60 & cos60 & 0\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}1 & 0 & -4\\0 & 1 & -2\\0 & 0 & 1\end{bmatrix}$$

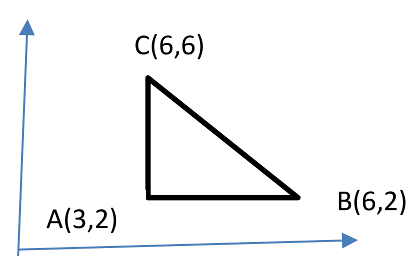
$$=\begin{bmatrix}1 & 0 & 4\\0 & 1 & 2\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}1/2 & 0 & 0\\0 & 0.8 & 0\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}0.5 & -0.866 & 0\\0.866 & 0.5 & 0\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}1 & 0 & -4\\0 & 1 & -2\\0 & 0 & 1\end{bmatrix}$$

$$=\begin{bmatrix}1 & 0 & 4\\0 & 1 & 2\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}1/2 & 0 & 0\\0 & 0.8 & 0\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}0.5 & -0.866 & -0.27\\0.866 & 0.5 & -5.44\\0 & 0 & 1\end{bmatrix}$$

$$=\begin{bmatrix}1 & 0 & 4\\0 & 1 & 2\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}0.25 & -0.433 & -0.135\\0.64 & 0.4 & -4.35\\0 & 0 & 1\end{bmatrix}$$

$$=\begin{bmatrix}0.25 & -0.433 & 3.865\\0.64 & 0.40 & -2.35\\0 & 0 & 1\end{bmatrix}$$

Question 2: (A) Rotate the triangle given in figure (a) by 90 degrees about the origin. (4 marks)



Figure(a).

Answer: Applying the homogenous co-ordinate system for rotation.

For co-ordinate A (3, 2),

$$\begin{bmatrix}x`\\y`\\1\end{bmatrix}=\begin{bmatrix}cos90 & -sin90 & 0\\sin90 & cos90 & 0\\0 & 0 & 1\end{bmatrix}\begin{bmatrix}x\\y\\1\end{bmatrix}$$

$$=\begin{bmatrix}0 & -1 & 0\\ 1 & 0 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}3\\2\\1\end{bmatrix}$$

$$=\begin{bmatrix}-2\\3\\1\end{bmatrix}$$

For co-ordinate B (6, 2),

$$\begin{bmatrix}x`\\y`\\1\end{bmatrix}=\begin{bmatrix}cos90 & -sin90 & 0\\ sin90 & cos90 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}x\\y\\1\end{bmatrix}$$

$$=\begin{bmatrix}0 & -1 & 0\\ 1 & 0 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}6\\2\\1\end{bmatrix}$$

$$=\begin{bmatrix}-2\\6\\1\end{bmatrix}$$

For co-ordinate C(3,2),

$$\begin{bmatrix}x`\\y`\\1\end{bmatrix}=\begin{bmatrix}cos90 & -sin90 & 0\\ sin90 & cos90 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}x\\y\\1\end{bmatrix}$$

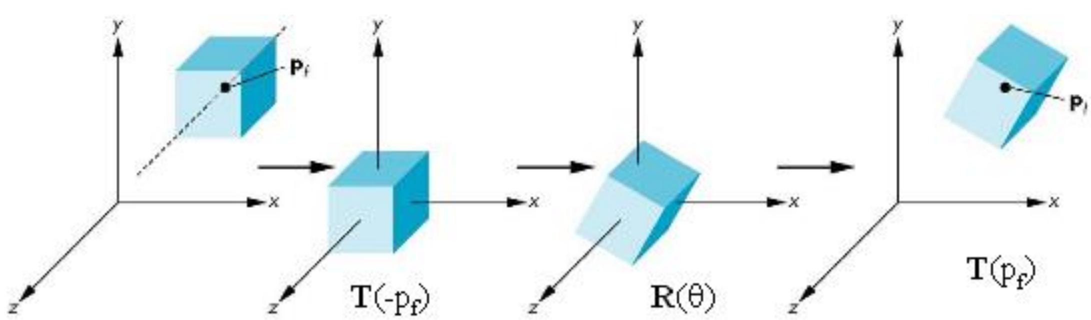
$$=\begin{bmatrix}0 & -1 & 0\\ 1 & 0 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}6\\6\\1\end{bmatrix}$$

$$=\begin{bmatrix}-6\\6\\1\end{bmatrix}$$

(B) Write all the points which describe the rotation about arbitrary point other than the origin. (2 marks)
As we know the default rotation matrix is about origin.so for arbitrary point,

- Move fixed point to origin T ($-p_f$)
- Rotate R (α)
- Move fixed point back T (p_f)

So M = T($-p_f$) R (α) T(p_f)



Question 3: Find a transformed point Q caused by rotating P (3, 5) about the origin through an angle of 60^o. (5 marks)

Answer: x` = xcosø-sinø
y`=xsinø+ycosø
x`=3(0.5)-5(0.866)=1.5-4.33 = -2.83
y`= 3(0.866)+ 5(0.5)=2.598 + 2.5 = 5.098

Question 4: What are the basic steps, performed to fill a polygon? Explain the algorithm with the given scenario.

Answer: To fill a polygon, we have to keep these points in mind,

1. Number of scan lines passing through the polygon, (scan line passes the polygon from left to right in a raster system).

2. Calculate the size of the polygon with the given formula,
   Size= $Y_{max} – Y_{min}$ +1

3. Check the scan line which is passing through the polygon and apply these conditions.
   If the scan line is passing through just the edges of the polygon then consider only 1 intersection at each cutting point.
   If the scan line is passing through the vertex of the polygon then apply these conditions.
   If the edges of that particular vertex is on the same side then make two intersecting points on that vertex else just make only one intersection point.

4. After assigning the intersection points, Start from left and make line from 2 consecutive intersection points. Don't use intersection point for making line, which is already used, and color that point to fill the polygon.

For the scenario given in Fig, for the scan line AB, it is only passing through the edges of the polygon, so we will assign four intersections x_1 , x_2 , x_3 and x_4 and make line from x_1 and x_2 and x_3 and x_4 and color those lines.
For the scan line CD, as it is passing through the vertex and the edges of the vertex are on the same side, therefore 2 intersections will be made at vertex with total 4. Starting from left, we will draw two lines and color them.