To get M, find the midpoint of a line

$M_x = \frac{x_1 + x_2}{2}$, $M_y = \frac{y_1 + y_2}{2}$

$M_x = \frac{-3+11}{2}$, $M_y = \frac{8-9}{2}$

$M_x = 4$ $M_y = -0.5$.

i) Translate & move to origin
ii) ~~move to origin~~ Apply rotation form
iii) ~~conve~~ move back to initial position

i) Translate

$t_x = -4$

$t_y = 0.5$

$$T_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -4 & 0.5 & 1 \end{bmatrix}$$

ii) Rotate $\theta = 90°$, clockwise

$$R = \begin{bmatrix} \cos(-90) & -\sin(-90) & 0 \\ \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Scanned with CamScanner

$$\begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

ii) Translate

$t_x = 4 \quad t_y = -0.5$

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 4 & -0.5 & 1 \end{bmatrix}.$$

$$T_R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -4 & 0.5 & 1 \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 4 & -0.5 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ -0.5 & -4 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 4 & -0.5 & 1 \end{bmatrix}$$

$$T_R = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 3.5 & -4.5 & 1 \end{bmatrix}$$

Scanned with CamScanner

Question 5

A triangle having vertices
A(3, 3); B(8, 5); C(5, 8)
is first translate 2 units in x direction.
Then it is scaled by two(2) units at
point (5, 6) and finally rotated
90° anticlockwise at point (2, 5).
Depict the initial and final position
of the triangle.

Understand application of computer
graphics

Sol^n (Q.5)

i) Translate

$tx = 2 \qquad ty = 0$

$$T_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 0 & 1 \end{bmatrix}$$

ii) Scale

T_a

$t_x = -5$, $t_y = -6$

$$T_a = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -5 & -6 & 1 \end{bmatrix}$$

S_b

$S_x = 2$, $S_y = 2$

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

T_b

$t_x = 5$, $t_y = 6$

$$T_b = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 5 & 6 & 1 \end{bmatrix}$$

$$T_R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -5 & -6 & 1 \end{bmatrix} \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 5 & 6 & 1 \end{bmatrix}$$

$$T_R = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ -10 & -12 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 5 & 6 & 1 \end{bmatrix}$$

$$T_R = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ -5 & -6 & 1 \end{bmatrix}$$

$$\therefore S = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ -5 & -6 & 1 \end{bmatrix}$$

(iii) Rotate.

T_a

$t_x = -2, \quad t_y = -5$

$$T_a = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -2 & -5 & 1 \end{bmatrix}$$

R_b

$\theta = 90°$, anticlockwise.

$$R_b = \begin{bmatrix} \cos 90 & -\sin 90 & 0 \\ \sin 90 & \cos 90 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Scanned with CamScanner

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

$\underline{T_b}$

$t_x = 2, \quad t_y = 5$

$$T_b = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 5 & 1 \end{bmatrix}$$

$$T_R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -2 & -5 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 5 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ -5 & 2 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 5 & 1 \end{bmatrix}$$

$$T_R = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ -3 & 7 & 1 \end{bmatrix}$$

$$\therefore R = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ -3 & 7 & 1 \end{bmatrix}$$

The resultant transformation is

$T_R = T1 \times S \times R$

$$T_R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ -5 & -6 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ -3 & 7 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ -1 & -6 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ -3 & 7 & 1 \end{bmatrix}$$

$$T_R = \begin{bmatrix} 0 & -2 & 0 \\ 2 & 0 & 0 \\ -9 & 8 & 1 \end{bmatrix}$$

$$\text{final Position} = \begin{bmatrix} 3 & 3 & 1 \\ 8 & 5 & 1 \\ 5 & 8 & 1 \end{bmatrix} \begin{bmatrix} 0 & -2 & 0 \\ 2 & 0 & 0 \\ -9 & 8 & 1 \end{bmatrix}$$

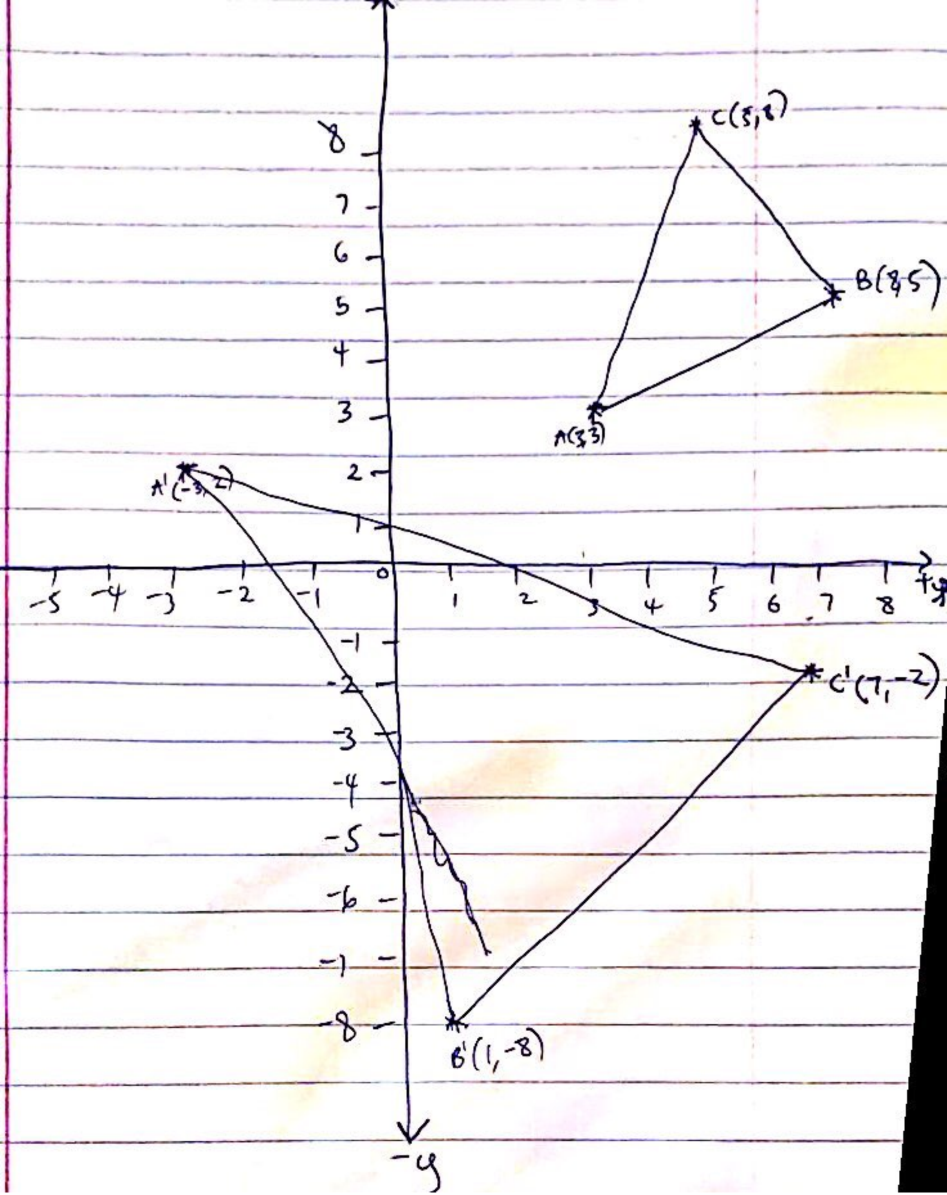
$$\begin{array}{c} A' \\ B' \\ C' \end{array} \begin{bmatrix} -3 & 2 & 1 \\ 1 & -8 & 1 \\ 7 & -2 & 1 \end{bmatrix}$$

converting to 2D coordinate:

$A' = (-3, 2)$

$B' = (1, -8)$

$C' = (7, -2)$.



Scanned with CamScanner