3. You are given a rectangle. This rectangle is sheared 30 degree in the direction of x axis. You are given a point (20, 5). Find out the new co-ordinates of the point (20,5) after the transformation. [**hint** : First, move the object to the origin , then apply the shearing, then move the object the actual position. So, there will be total 3 steps.] (10)

translate
to origin :-
$$\begin{bmatrix} 1 & 0 & -10 \\ 0 & 1 & -10.0 \\ 0 & 0 & 1 \end{bmatrix}$$

A(10,5) ↘ A'   B(20,5) ↘ B'

30

sheer :-
$$\begin{bmatrix} 1 & \tan\theta & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

translate back :-
$$\begin{bmatrix} 1 & 0 & 10 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$
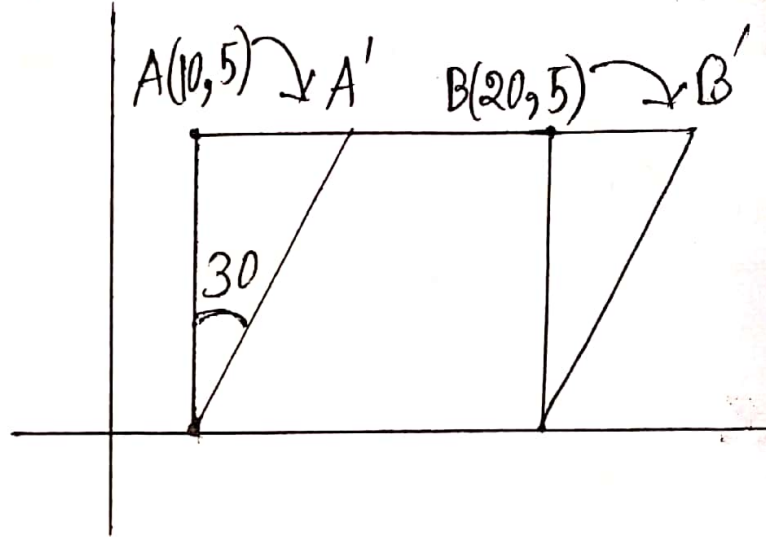
$$= \begin{bmatrix} 1 & 0 & +10 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & \tan 30 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -10 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 20 \\ 5 \\ 1 \end{bmatrix}$$

$$\doteq \begin{bmatrix} 1 & \frac{1}{\sqrt{3}} & 10 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -10 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 20 \\ 5 \\ 1 \end{bmatrix}$$

Nice

$$= \begin{bmatrix} 1 & \frac{1}{\sqrt{3}} & -10+10 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 20 \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} 20 + \frac{5}{\sqrt{3}} \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} 22.89 \\ 5 \\ 1 \end{bmatrix}$$
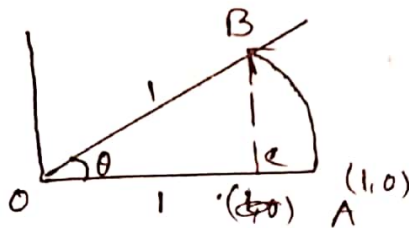
$$B = (22.89, 5)$$

1. Between solid and shell modeling which one calculates faster? (3)

— Shell model because it only calculates the surface

3

2. Suppose, you rotated an object θ degree anti-clockwise. Now derive the rotation matrix for this case. [You have to clearly show each steps of your derivation] (7)
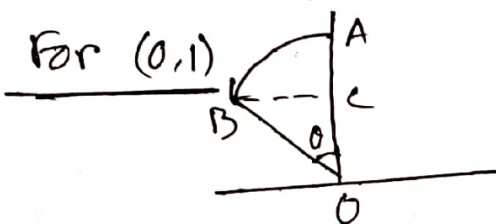
Given θ degree anti-clockwise rotation.

For (1,0)

$OA = OB = 1$

$\therefore OC = OB\cos\theta = \cos\theta$

$CB = OB\sin\theta = \sin\theta$

$\therefore T(1,0) \rightarrow (\cos\theta, \sin\theta)$

For (0,1)

$OA = OB = 1$

$OC = OB\cos\theta = \cos\theta$

$BC = -OB\sin\theta = -\sin\theta$

$\therefore T(0,1) \rightarrow (-\sin\theta, \cos\theta)$