CAD FAQ

CH:-1 Fundamentals of CAD

Q1) Define CAD. Give its advantages.

Q1) ☆ CAD:- The use of computer systems to assist in the creation, modification, analysis, or optimization of a design is known as computer Aided Design.

[*]

⇒ Advantages of CAD system:-

- customer modifications are easier to make.
- Improved accuracy of Design.
- Assistance in preparation of documentation.
- Designs have more standardization.
- Better Designs provided.
- Better knowledge of costs provided.
- Assistance in inspection of complicated parts.

Q2) Define Computer Graphics. State its Terminology.

* Computer Graphics:- "Computer graphics are the graphics created using computers and the representation of image data by a computer specifically with help from specialized graphic hardware & Software."

[*]

⇒ Computer graphics terminology:-

- 2D:- Two Dimensional.
- 3D:- Three Dimensional.
- Animation:- Any methods that can make an image appear to change over time.

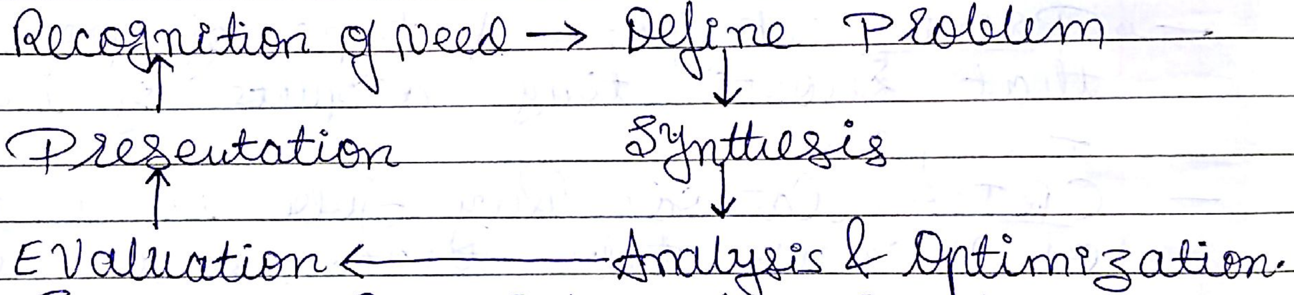
- **CSG**:- Constructive Solid geometry.
- **GIF**:- Graphics Interchange format is a file format for Storing images.
- **GUI**:- Graphical user interface.
- **HTML**:- Hyper Text Markup Language is the text formatting language used by documents on world wide web.
- **Image**:- A two dimensional array of pixels that together form a picture.
- **Origin**:- The point in the co-ordinate Space where all the co-ordinates are zero.
- **Pixel**:- The Smallest indivisible unit of a digital image.
- **Printer**:- Computer peripherals for producing hard copy on paper & other Similar media.
- **Printer, ink jet**:- A type of printer that Shoots tiny droplets of ink onto the page.
- **CRT**:- Cathode Ray Tube is a type of Vacuum tube that is commonly used as a computer graphics output device.
- **Raster Scan**:- The name for the pattern of the electron beam Sweeps out on a CRT face. The image is made of closely Spaced Scan lines, or horizontal Sweeps.
- **Rendering**:- The process of deriving a 2D image from the 3D Scene description.
- **TIFF**:- Tag Image file format.

⇒ **Use of Computer Graphics Terminology:**

- It is used for interpreting information, better and economical product design.
- user interfaces.
- Office Automation.
- computer Aided Design.
- Visualization.
- Medical. [Ultrasound, CT, MRI, PET].
- Education.
- Process Control.
- Simulation.
- Animated programs.

Q3] Explain CAD Process.

Ans] * CAD Process :-



Q4] Explain Co-ordinate System.

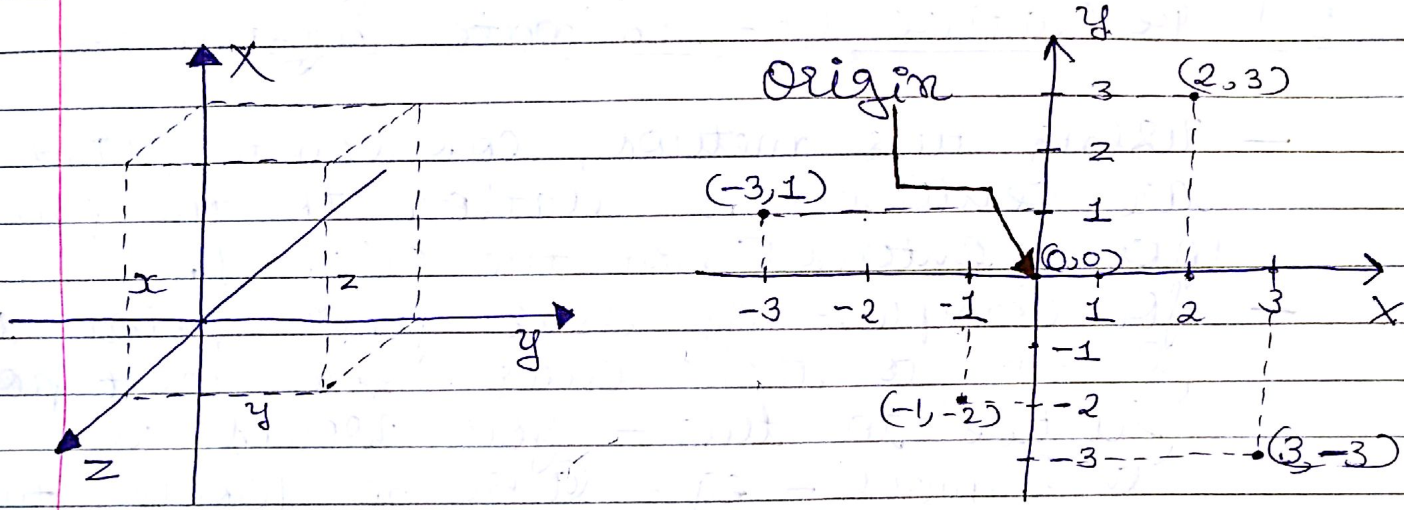
Ans] * Co-Ordinate Systems:-

1*] - A co-ordinate System is a system which uses one or more numbers, or co-ordinates, to uniquely determine the position of a point or other geometric element on the space.

⇒ Types Of Coordinate Systems:-

1) Absolute Coordinate System. [Cartesian System]
2) Relative coordinate System.
3) Polar coordinate System.
4) Relative Polar coordinate System.

1) Absolute Coordinate System:-



fig(A):- The cartesian Coordinate System in the plane:-

- using this method, the coordinate points are entered in direct relation to the origin (0,0).
- The prototypical example of a coordinate system is the Cartesian coordinate System.
- In the plane, two perpendicular lines are choosen & the coordinates of a point are taken to be signed distances to the lines.
- A specific point in a drawing is located by exact distances from the X & Y Axis. fig(B) shows its example.

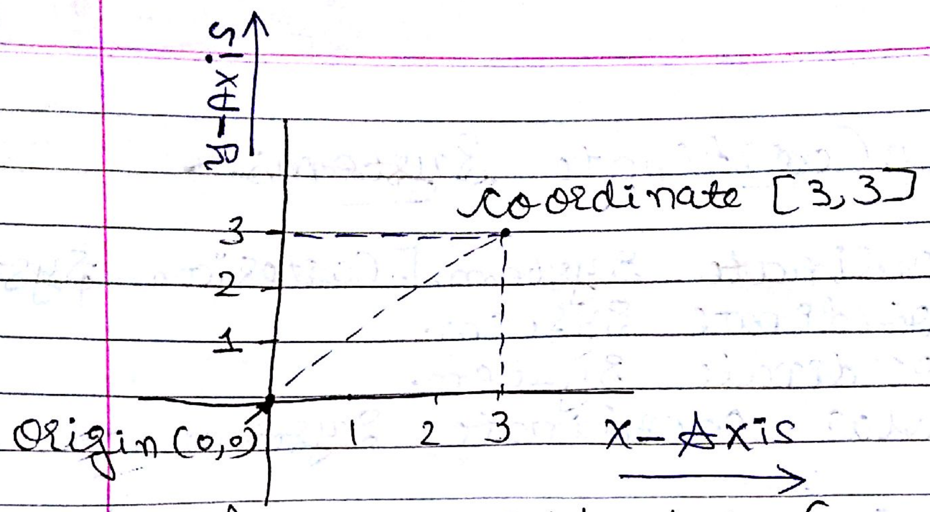


fig (B):- Absolute Coordinate System:-

2] Relative Co-ordinate System:-

- Using this method, coordinate points are entered in relation to the previous point entered [not the origin].
- For example:- If your first point is 20,45, to then enter your next point 'relative' to this - you would use the '@' symbol - eg:- @50,50 would then enter the second point 50 units horizontally along X-axis and 50 units vertically along the Y-axis to give this second point relative to your last point (20,45).
- fig (C) shows its example.

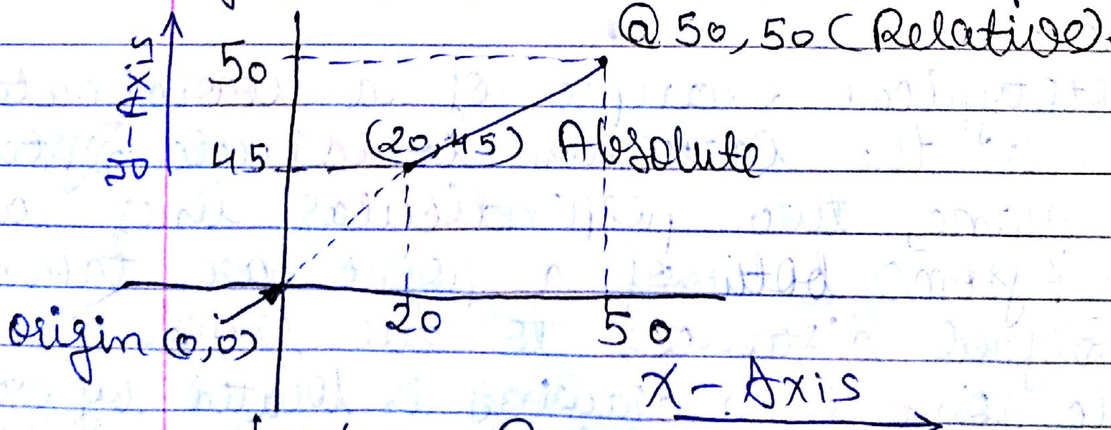


fig (C):- Relative Coordinate System:-

3) Polar coordinate System:-

- The polar coordinate system uses one angle to define a point in ample of point in a drawing could be 50<45, so 50 units long and at an angle of 45 degrees.
- NOTE:- The "<" sign is used for angle.
- fig (D) shows its example.

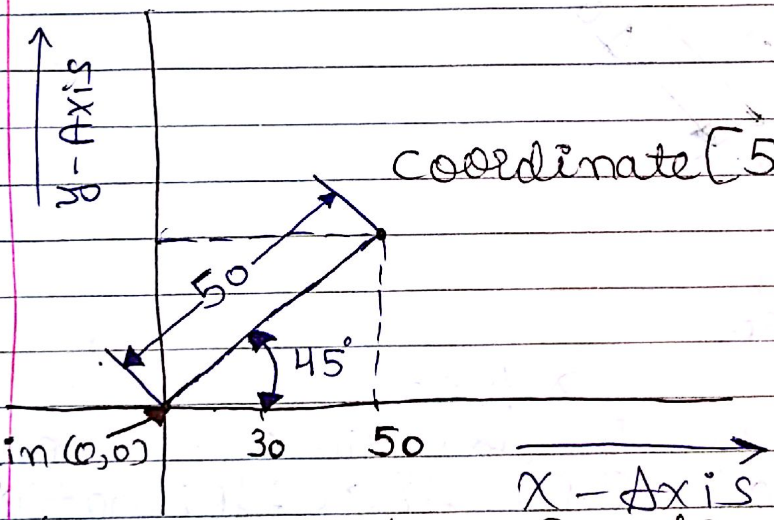


fig (D):- Polar Coordinate System:-

4) Relative Polar Coordinate System:-

- This is very useful way of drawing entities of which you know the exact length and angle.
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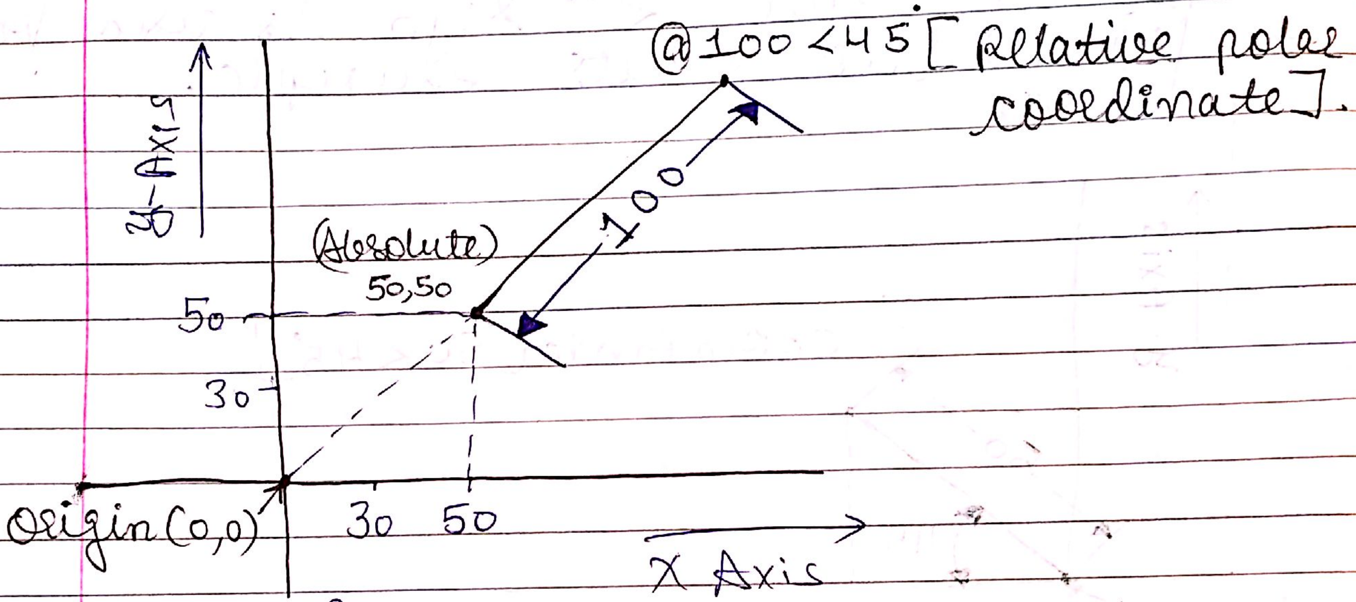
- for example, you could draw a 100mm long line from start point 50, 50 (absolute coordinate) and specify your second point at 100 < 45. (Relative 'polar' coordinate).
- fig E shows its example.



Q5/ Explain Geometric Transformation & its types.

Ans/ * Geometrical 2-D Transformation :-

- As a part of a process of displaying an object on the screen, it is often necessary to transform a whole group of picture features, points, lines or planes and for that various types of transformations are available with CAD Systems.

|*|

- Types of Transformations:-
  i) 2 D Transformation.
  ii) 3 D Transformation.

⇒ 2D Transformation & its types:-

1] Translation.
2] Scaling.
3] Rotation.
4] Mirroring.
5] Shearing.

1] 2-D Translation:-

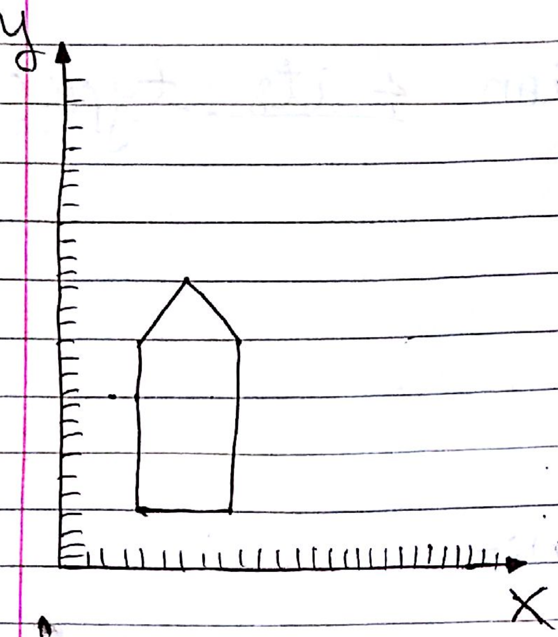
- During translation process, element is moved from one location to the another location.
- Repositioning an object along a straight line path from one coordinate location to another.
- Adding translation distances t_x & t_y to the original coordinate position.
- Here, object is moving without deformation.

- Let
x, y :- Initial location of the element.
x', y' :- Location of element after translation.
t_x, t_y :- Translation movement of x & y.
$x' = x + t_x$ & $y' = y + t_y$.

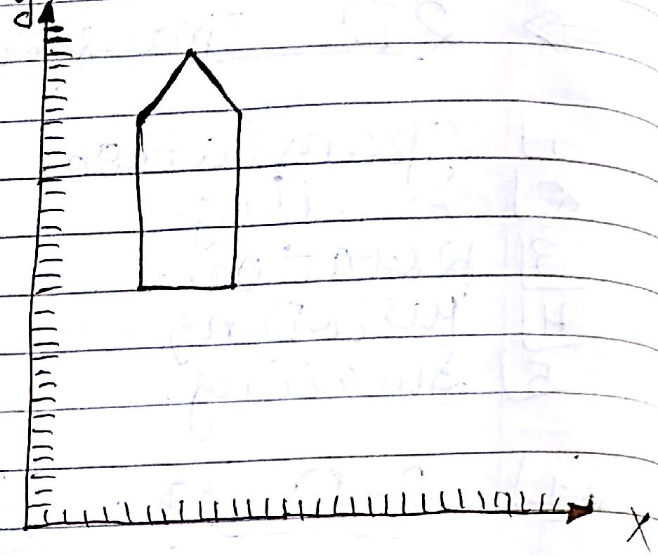
i.e $\boxed{(x', y') = (x, y) + T.}$ where, T = Translation Matrix.

~ Matrix form:-

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix}.$$



fig(A):- Before Translation



fig(B):- After Translation

2) 2-D Scaling:-

- Scaling of an element is used to enlarge or reduce its size. i.e Scaling is used to change the size of the element.
- By Scaling, we can change the size of an element in X & Y direction.
- Scaling alters the size of an object and the object is scalled by multiplying the coordinated (x, y) of each Vertex by a Scaling factor S_x & S_y.
- $x' = x . S_x$ & $y' = y . S_y$

Scaling matrix is given by

$(x', y') = (x, y)\ S$, where, S= Scaling Matrix.

Where, S_x = Scaling in X-direction.
S_y = Scaling in Y-direction.

~. Matrix form:-

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

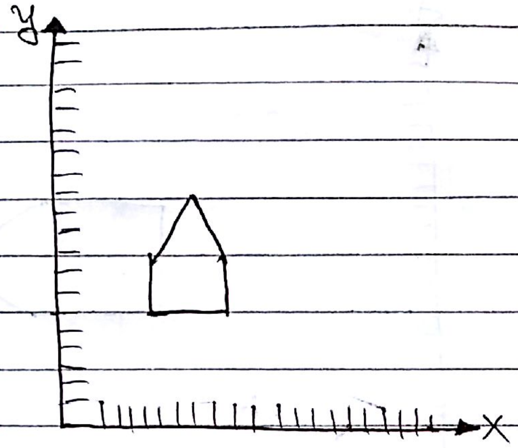


fig (C):- Before Scaling:

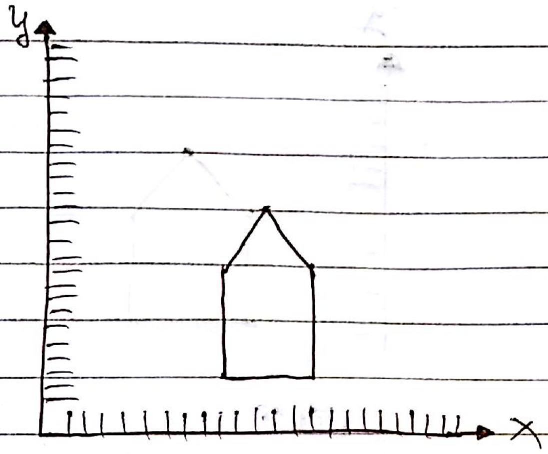


Fig (D):- After Scaling:

3] 2-D Rotation:-

- By rotation, the points of the object are rotated about the origin by an angle (θ).
- The angle is positive, when the rotation is in counter-clockwise directn.
- The angle is negative, when the rotation is in clockwise direction.
- In rotation, object is repositioning along a circular path.
- Need a rotation angle (θ) and the position (x_r, y_r) of the pivot point which the object is to be rotated about.

~ Matrix form:-

$$(x', y') = (x\ y) \begin{vmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{vmatrix}.$$

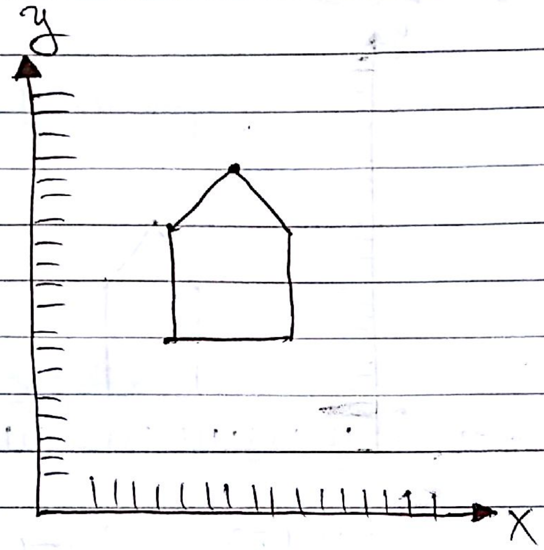


fig:-(E) Before Rotation

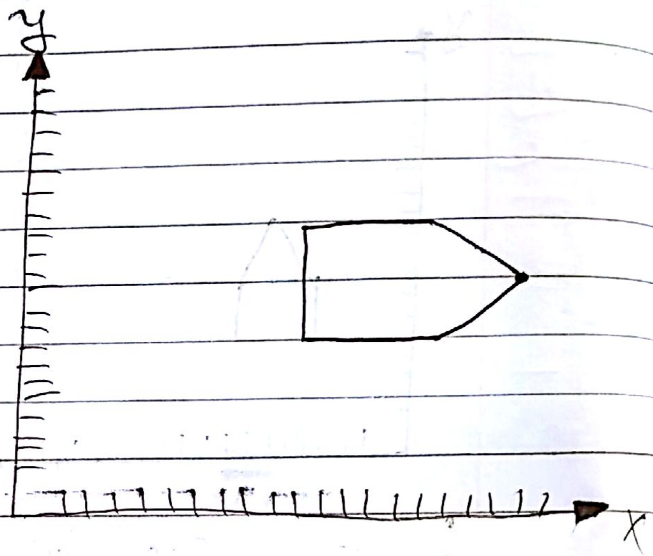


fig (f):- After Rotation

* Geometric Transformations with Numerical:-

Q6) ⟹ A line AB having end coordinates A(2, 2) and B(3, 5). Translate the line 2 units in X-Axis and 1 unit in Y-Axis.

Ans) A(2, 2) $\quad \therefore X_1 = X + t_x$ & $Y_1 = Y + t_y$

B(3, 5) $\quad \therefore (x_1, y_1) = (x, y) + T$

$$\therefore \begin{bmatrix} x_1 \\ y_1 \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix}.$$

$$= \begin{bmatrix}2 & 2\\3 & 5\end{bmatrix} + \begin{bmatrix}2 & 1\\2 & 1\end{bmatrix} = \begin{bmatrix}4 & 3\\5 & 6\end{bmatrix}$$

∴ New Translated Coordinates are :-

$\boxed{A'(4,3) \ \& \ B'(5,6).}$

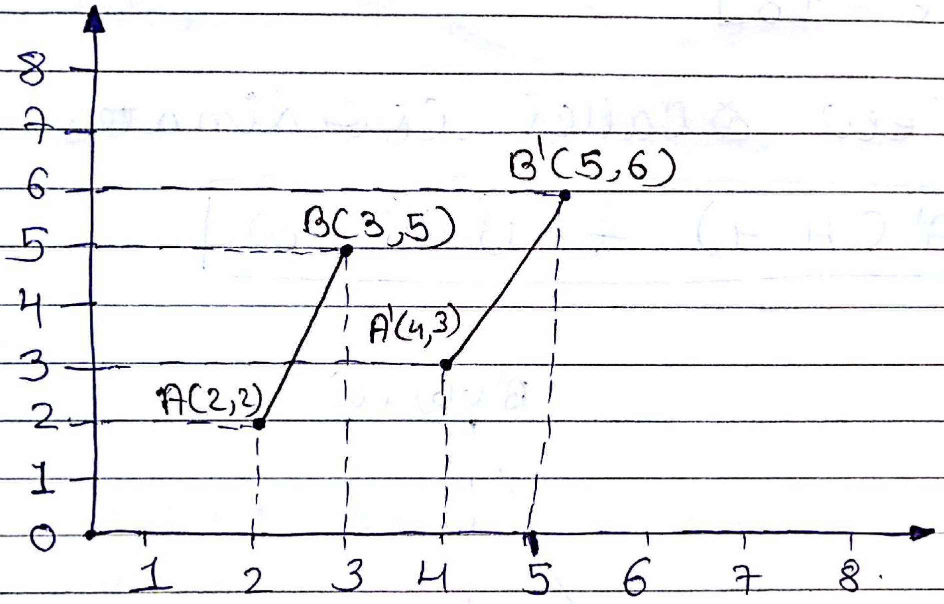


fig (A) :- Translation

Q7) ⇒ A line AB having end coordinates A(2,2) and B(3,5). Scale the line twice.

Ans) A(2,2) ∴ $x' = x \cdot S_x$ & $y' = y \cdot S_y$.
B(3,5) ∴ $(x', y') = (x, y) \cdot S$.

$$\therefore (x', y') = \begin{bmatrix}x\\y\end{bmatrix} \begin{bmatrix}S_x & 0\\0 & S_y\end{bmatrix}.$$

$$= \begin{bmatrix} 2 & 2 \\ 3 & 5 \end{bmatrix} + \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 2\times2+2\times0 & 2\times0+2\times2 \\ 3\times2+5\times0 & 3\times0+5\times2 \end{bmatrix}$$

$$= \begin{bmatrix} 4 & 4 \\ 6 & 10 \end{bmatrix}$$

∴ New Scalled coordinates are :-

$\boxed{A'(4,4) \ \& \ B'(6,10).}$

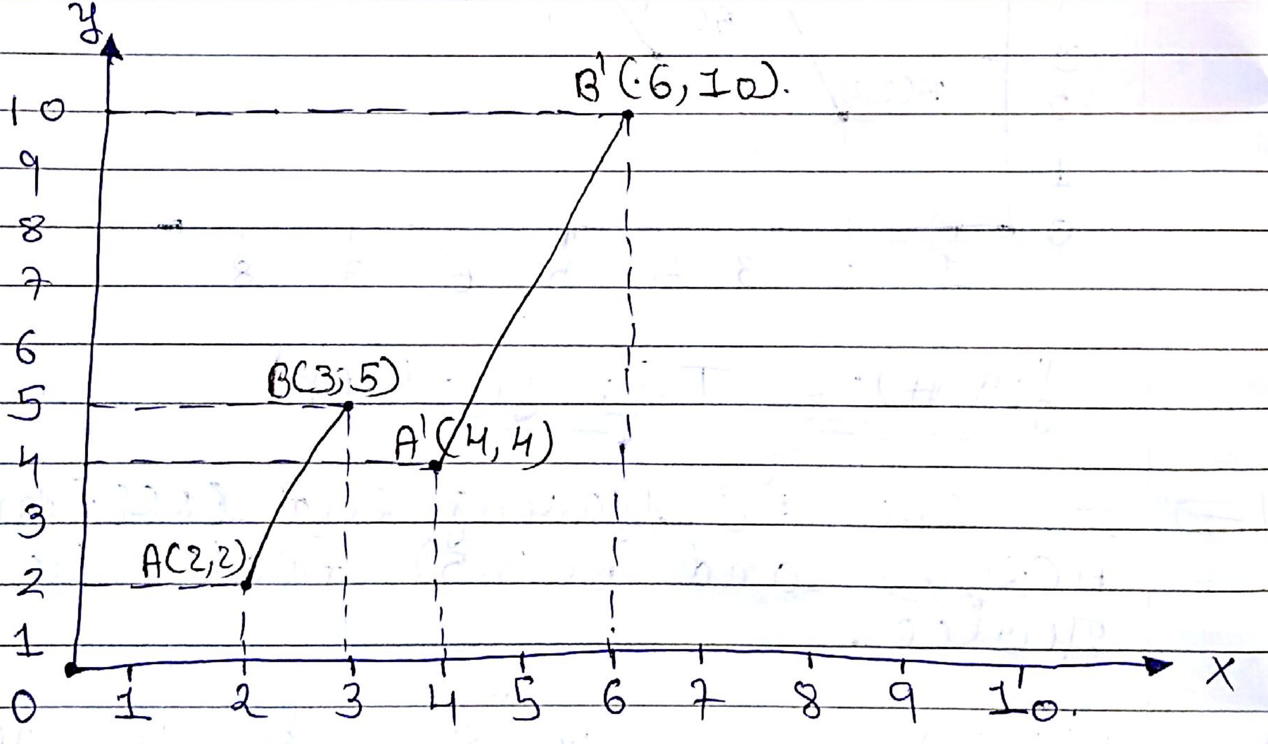


fig (B):- Scaling

Q8 ⟹ A line AB having end coordinated A(2,2) and B(3,5). Rotate the line 30 degree with respect to origin.

Ans) A(2,2) $(x', y') = (x, y) \cdot R$
B(3,5)

$$\therefore (x', y') = (x, y) \begin{vmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{vmatrix}$$

$$= \begin{bmatrix} 2 & 2 \\ 3 & 5 \end{bmatrix} \begin{bmatrix} \cos 30^\circ & -\sin 30^\circ \\ \sin 30^\circ & \cos 30^\circ \end{bmatrix}$$

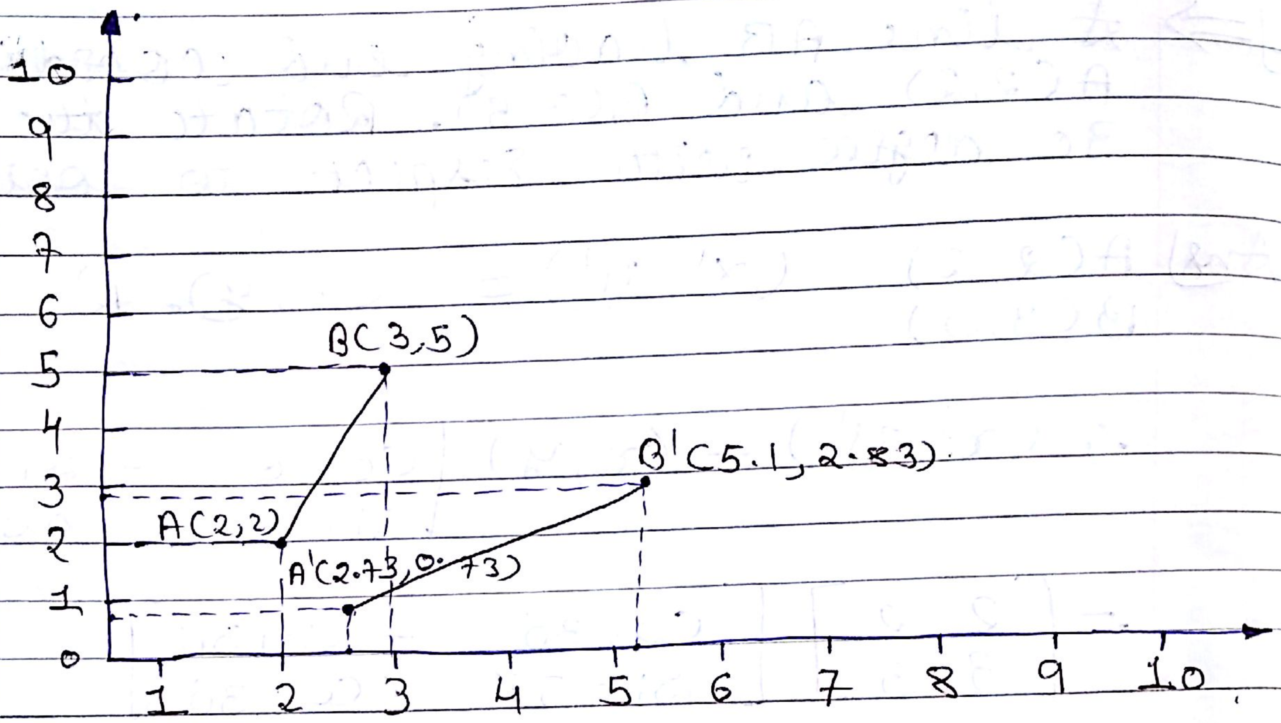
$$= \begin{bmatrix} 2 & 2 \\ 3 & 5 \end{bmatrix} \begin{bmatrix} 0.866 & -0.5 \\ 0.5 & 0.866 \end{bmatrix}$$

$$= \begin{bmatrix} 2\times 0.866 + 2\times 0.5 & 2\times(-0.5) + 2\times 0.866 \\ 3\times 0.866 + 5\times 0.5 & 3\times(-0.5) + 5\times 0.866 \end{bmatrix}$$

$$= \begin{bmatrix} 2.73 & 0.73 \\ 5.1 & 2.83 \end{bmatrix}$$

∴ New coordinates after 30° rotation are :-

$$\boxed{A'(2.73, 0.73) \ \& \ B'(5.1, 2.83).}$$



fig(c):- Rotation