## INTRODUCTION TO THREE DIMENSIONAL GEOMETRY

1. **Coordinates- axes, planes, points in 3D**
2. **Distance between Two Points**
3. **Section Formula**

- **Coordinate axes**: In three dimensions, the coordinate axes of a rectangular Cartesian coordinate system are three mutually perpendicular lines. The axes are called the x-axis, y-axis and z-axis.
- **Planes**: The three planes determined by the pair of axes are the coordinate planes, called XY, YZ and ZX planes.

$xy-$plane i.e., $z = 0$

$yz-$plane i.e., $x = 0$

$zx-$plane i.e., $y = 0$

- **Octants**: The three coordinate planes divide the space into eight parts known as octants.
- **Points in 3D**: The coordinates of a point P in three dimensional geometry is always written in the form of triplet like (x, y, z). Here x, y and z are the distances from the YZ, ZX and XY

$\text{Any point on XY} \rightarrow \text{plane} \quad (\text{x}, \text{y}, 0)$

$\text{Any point on YZ} \rightarrow \text{plane} \quad (0, \text{y}, \text{z})$

$\text{Any point on ZX} \rightarrow \text{plane} \quad (\text{x}, 0, \text{z})$

- **Distance formula between two points**: Distance between two points $\mathrm{P}\ (\ \mathrm{x}_1\ ,\ \mathrm{y}_1,\ \mathrm{z}_1\ )$ and $\mathrm{Q}\ (\ \mathrm{x}_2\ ,\ \mathrm{y}_2\ ,\mathrm{z}_2\ )$ is

$$|\mathrm{PQ}|\ =\ \sqrt{(\ x_2 - x_1\ )^2 + \ \left(\ y_2 - y_1)^2\right) + \ (\ z_2 - z_1)^2}$$

**Section Formula**: The co-ordinates of R which divides a line segment joining the points $\mathrm{P}\ (\ \mathrm{x}_1\ ,\ \mathrm{y}_1,\ \mathrm{z}_1\ )$ and $\mathrm{Q}\ (\ \mathrm{x}_2\ ,\ \mathrm{y}_2,\ \mathrm{z}_2\ )$

Internally and externally in the ratio m : n respectively

Internally: $R\left(\frac{mx_2+nx_1}{m+n}, \frac{my_2+ny_1}{m+n}, \frac{mz_2+nz_1}{m+n}\right)$

Externally: $S\left(\frac{mx_2-nx_1}{m-n}, \frac{my_2-ny_1}{m-n}, \frac{mz_2-nz_1}{m-n}\right)$

**Centroid**: The coordinates of the centroid of the trinagle whose vertices are $(\ \mathrm{x}_1\ ,\ \mathrm{y}_1,\ \mathrm{z}_1\ )$

$(\ \mathrm{x}_2\ ,\ \mathrm{y}_2,\ \mathrm{z}_2\ )$ $\quad and \quad$ $(x_3,\ y_3, z_3)$ is

$\left(\frac{x_1+x_2+x_3}{3}, \frac{y_1+y_2+y_3}{3}, \frac{z_1+z_2+z_3}{3}\right)$