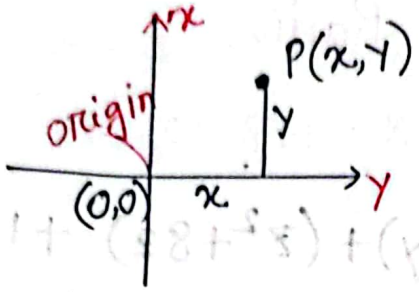
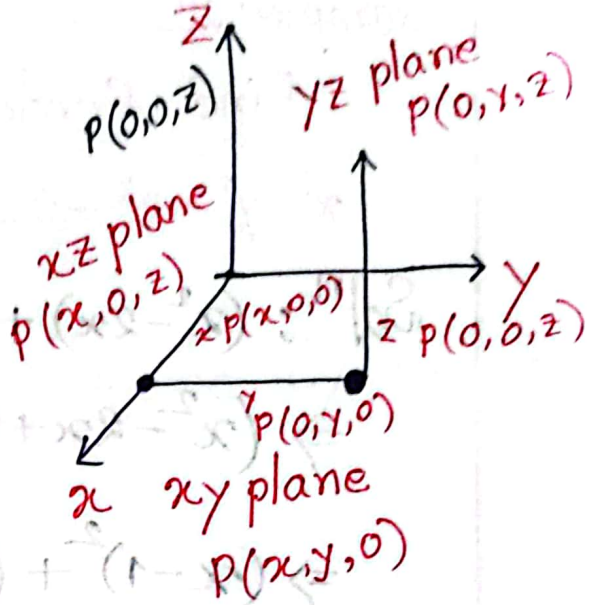
Chapter : 11

Three Dimensional Space ; Vector

Coordinate Geometry





2D Distance :

$P_1(x_1, y_1)$ and $P_2(x_2, y_2)$

$$\text{distance} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

3D Distance :

$P_1(x_1, y_1, z_1)$ and $P_2 = (x_2, y_2, z_2)$

$$\text{distance} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

Equation of Sphere :

center (x_1, y_1, z_1) radius r

$$\text{sphere} = (x - x_1)^2 + (y - y_1)^2 + (z - z_1)^2 = r^2$$

* $(x-3)^2 + (y-2)^2 + (z+1)^2 = 9 \longrightarrow 3^2$

  sphere with center $(3, 2, -1)$ $\Big\}$ radius $= 3$

* $x^2 + y^2 + z^2 = 1$

  center $(0,0,0)$ radius $= 1$

Example: 02

Find Center & Radius

$x^2+y^2+z^2-2x-4y+8z+17=0$

Sol^n: $(x^2-2x)+(y^2-4y)+(z^2+8z)+17=0$

$\Rightarrow (x^2-2x+1)+(y^2-4y+4)+(z^2+8z+16) = 21-17$

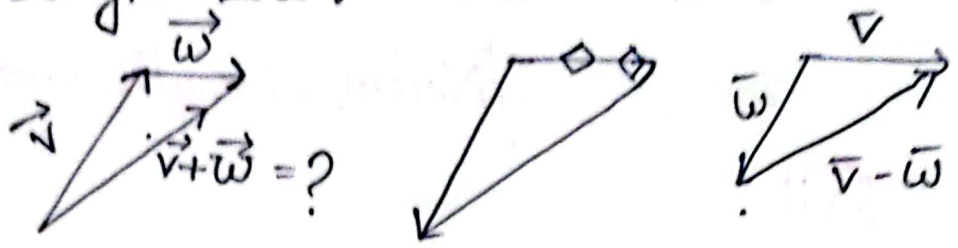
$\Rightarrow (x-1)^2+(y-2)^2+(z+4)^2 = 4 = 2^2$

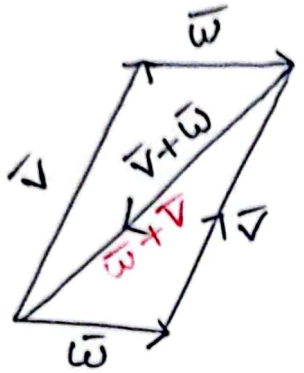
center $(1, 2, -4)$

radius $r = 2$

Chapter : 11.2

Triangle Low:





$\vec{v}+\vec{w} = \vec{w}+\vec{v}$

Arithmetic Operation

$\vec{v} = (v_1, v_2)$ $\quad w = (w_1, w_2)$

$\vec{v}+\vec{w} = (v_1+w_1, v_2+w_2)$

$\vec{v}-\vec{w} = (v_1-w_1, v_2-w_2)$

$K \cdot \vec{v} = (Kv_1, Kv_2)$

↳ constant

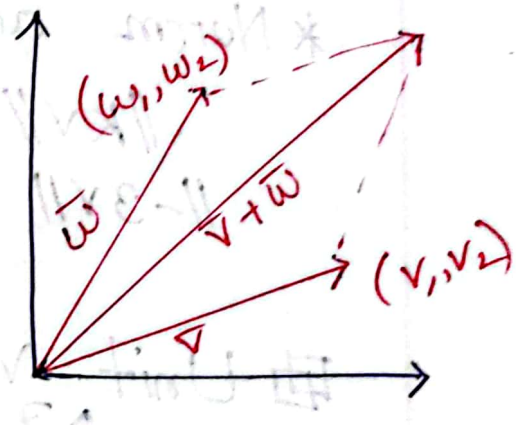
Ex: 1: $v = (-2, 0, 1)$
$w = (3, 5, -4)$

$\vec{v}+\vec{w} = (1, 5, -3)$

$3v = (-6, 0, 3)$

$-w = (-3, -5, 4)$

$w - 2v = (7, 5, -6)$



Vector With intial point not at The Origin :

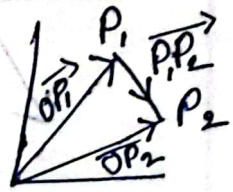
$P_1(x_1, y_1)$; $P_2(x_2, y_2)$ $\quad \overrightarrow{P_1P_2} = ?$

$\overrightarrow{P_1P_2} = \overrightarrow{OP_2} - \overrightarrow{OP_1}$

$= (x_2, y_2) - (x_1, y_1)$

$= (x_2 - x_1, y_2 - y_1)$

$\boxed{\text{terminal} - \text{initial}}$



Norm of a Vector

Norm = Length = magnitude

$\|\vec{v}\|$

2D : $\|\vec{v}\| = \sqrt{v_1^2 + v_2^2}$

3D : $\|\vec{v}\| = \sqrt{v_1^2 + v_2^2 + v_3^2}$

Ex: 3 $\quad w = (2, 3, 6)$

$$\|\vec{w}\| = \sqrt{2^2 + 3^2 + 6^2}$$
$$= \sqrt{49} = 7$$

* Norm always positive

$$\|kv\| = |k| \|v\|$$
$$\|-3v\| = |-3| \|v\| = 3\|v\|$$

$\vec{N} = (-2, 3)$

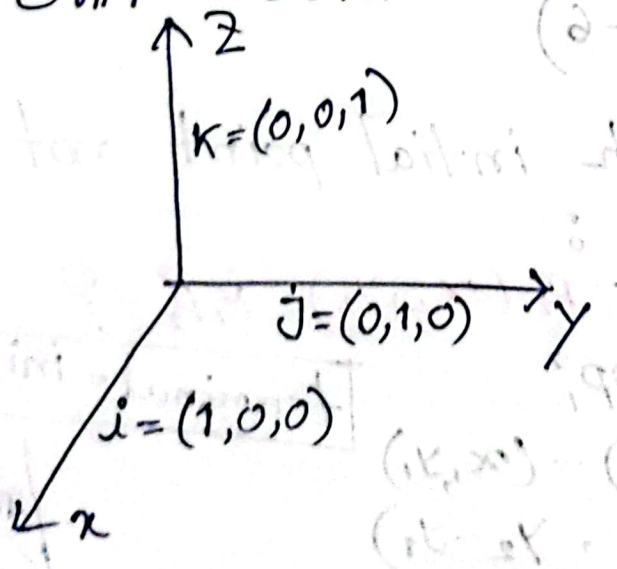
$\|-4v\| = ?$

$|-4| \|v\| = 4(\sqrt{4+9})$

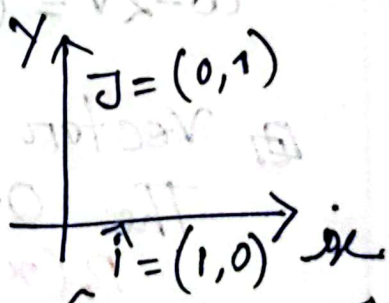
$= 4\sqrt{13}$

Unit Vector:

* 3D



* 2D



norm $= \|\hat{i}\|$
$= 1$

Length=1 norm

$$\bar{v} = (v_1, v_2)$$
$$= (v_1, 0) + (0, v_2)$$
$$= v_1(1,0) + v_2(0,1)$$
$$\boxed{= v_1\hat{i} + v_2\hat{j}} \quad (2D)$$

$$* \boxed{\vec{v} = v_1\hat{i} + v_2\hat{j} + v_3\hat{k}} \quad (3D)$$

Normalizing A Vector:

$$\vec{u} = \frac{1}{\|\bar{v}\|}\vec{v}$$

always unit vector

$$= \frac{\vec{v}}{\|v\|}$$

Same direction of $\vec{v}$

$\hookrightarrow$ Norm

Ex: 05 $\quad v = 2i + 2j - k$

$$\|\vec{v}\| = \sqrt{2^2 + 2^2 + (-1)^2} = \sqrt{4+4+1} = \sqrt{9} = 3$$

$$\vec{u} = \frac{1}{\|\vec{v}\|}\vec{v} = \frac{1}{3}(2i + 2j - k)$$

$$= \frac{2}{3}\hat{i} + \frac{2}{3}\hat{j} - \frac{1}{3}\hat{k}$$

$$= \left(\tfrac{2}{3}, \tfrac{2}{3}, -\tfrac{1}{3}\right) \quad \underline{\text{Ans}}$$

CamScanner

Vector Determind By Length and Angle :

$\vec{v} = ||v|| (\cos\theta, \sin\theta)$

or,

$\vec{v} = ||v|| \cos\theta \, \hat{i} + ||v|| \sin\theta \, \hat{j}$

$\frac{\vec{v}}{||v||} = \cos\theta \, \hat{i} + \sin\theta \, \hat{j}$

Example: 06

$||v|| = 2$

$\theta = \pi/4$

(a) $v = 2\cos\frac{\pi}{4} \hat{i} + 2\sin\frac{\pi}{4} \hat{j}$

$= \sqrt{2} \hat{i} + \sqrt{2} \hat{j}$

$= (\sqrt{2}, \sqrt{2})$

(b) $\frac{v}{||v||} = \frac{-\sqrt{3}\hat{i} + \hat{j}}{\sqrt{(-\sqrt{3})^2 + 1^2}} = -\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}$

$\therefore \cos\theta = -\frac{\sqrt{3}}{2} = 150^\circ = \frac{5\pi}{6}$

x-axis বললে তাই cosθ

$\sin\theta = \frac{1}{2}$ → y-axis বললে sinθ নিতে হবে।

*Vector যে quadant এ পড়ে Ans সেই Quadant -এ হবে।

* Vector determind by Length and a Vector in the same Direction:

$$v = \|v\| \vec{u}$$

└ unit vector

$$= \|v\| \cdot \text{unitvector of } (\vec{AB})$$

$$= \|v\| \cdot \underline{\frac{1}{\|AB\|} \vec{AB}}$$

└→ Normalizing Vect

example: 07

$$\vec{AB} = \cancel{(0,0,4)} \; (B - A)$$

$$= (2,5,0) - (0,0,4)$$

$$= (2-0,\ 5-0,\ 0-4)$$

$$= (2, 5, -4)$$

$$\|\vec{AB}\| = \sqrt{2^2 + 5^2 + (-4)^2} = \sqrt{45} = 3\sqrt{5}$$

$$v = \|\vec{AB}\| \vec{u}$$

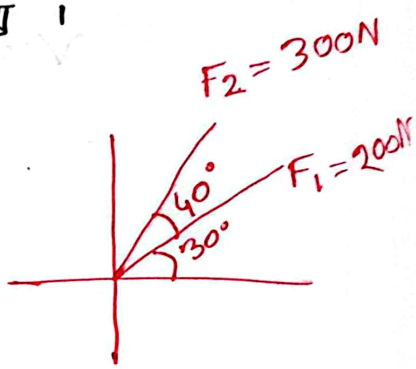
$$= \sqrt{5} \left(\frac{2}{3\sqrt{5}}, \frac{5}{3\sqrt{5}}, -\frac{4}{3\sqrt{5}} \right)$$

$$= \left(\frac{2}{3}, \frac{5}{3}, \frac{-4}{3} \right)$$

CS CamScanner

Resultant of Two concurrent Force :

* দুটি Force এর লব্ধি টা কি হবে তারা same impact create করে।



Example: 08

$$F_1 = 200\cos 30\hat{i} + 200\sin\hat{j}$$

$$F_2 = 300\cos 70\hat{i} + 300\sin 70\hat{j}$$

$$F_1 + F_2 = (100\sqrt{3} + 300\cos 70^\circ, 100 + 300\sin 70^\circ)$$

$$= 100(\sqrt{3} + 3\cos 70^\circ, 1 + 3\sin 70^\circ)$$

$$= (275.8, 381.9)$$

$$\|F_1 + F_2\| = \sqrt{(275.8)^2 + (381.9)^2}$$

$$= 471 \text{ N}$$

$$\theta = \cos^{-1}\frac{275.8}{471} \qquad \theta = \sin^{-1}\frac{381.9}{471}$$

$$= 54.162 \qquad = 53.95.$$

Chapter : 11.3

Dot Product

* Dot Product always Scallar Value যেমন—।

$$u \cdot v = (u_1 \cdot u_2 \cdot u_3)(v_1 \cdot v_2 \cdot v_3)$$
$$= u_1 \cdot v_1 + u_2 \cdot v_2 + u_3 \cdot v_3$$
$$u \cdot v = v \cdot u$$

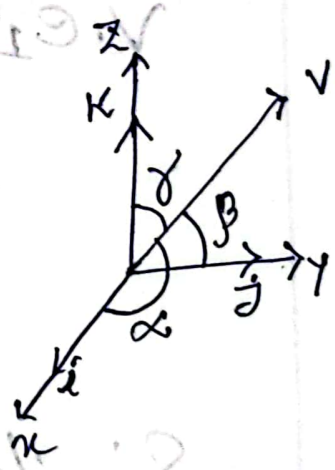
$$\boxed{\|v\| = \sqrt{v \cdot v}}$$

Angle between Vector

$$\vec{u}\vec{v} = \|u\| \, \|v\| \cos\theta$$

$$\therefore \cos\theta = \frac{\vec{u} \cdot \vec{v}}{\|u\| \, \|v\|}$$

$$\theta = \cos^{-1} \frac{\vec{u} \cdot \vec{v}}{\|u\| \, \|v\|}$$



Direction Angles :

* $\cos\alpha = \dfrac{\vec{v} \cdot \vec{i}}{\|v\| \, \|i\|} = \dfrac{v_1}{\|v\|}$

* $\cos\beta = \dfrac{\vec{v} \cdot \vec{j}}{\|v\| \, \|j\|} = \dfrac{v_2}{\|v\|}$

* $\cos\gamma = \dfrac{\vec{v} \cdot \vec{k}}{\|v\| \, \|k\|} = \dfrac{v_3}{\|v\|}$

Decomposing Vector into Orthogonal Components :

একটা vector কে দুটা vector এর sum হিসেবে calculation

$\boxed{90^\circ}$

$$V = W_1 + W_2$$
$$W_1 = K_1 e_1$$
$$W_2 = K_2 e_2$$

$$V \cdot e_1 = (W_1 + W_2) e_1$$
$$= (K_1 \cdot e_1 + K_2 e_2) e_1$$
$$\Rightarrow K_1 \underbrace{(e_1 \cdot e_2)}_{1} + K_2 \underbrace{(e_1 \cdot e_2)}_{0}$$
$$\Rightarrow K_1 + 0$$
$$= K_1$$

Similarly, $V \cdot e_2 = K_2$

$$V = K_1 \cdot e_1 + K_2 e_2$$
$$V = (V \cdot e_1) e_1 + (V \cdot e_2) e_2 \quad \left[\begin{array}{l} K_1 = V e_1 \\ K_2 = V e_2 \end{array} \right.$$

* Scaler Component →
  $V \cdot e_1$, $V \cdot e_2$
* Vector component →
  $(V \cdot e_1) e_1$, $(\vec{V} \cdot \vec{e}_2) \vec{e}_2$

Ex: 05

Scaler component

$$v \cdot e_1 = 2\frac{1}{\sqrt{2}} + 3\frac{1}{\sqrt{2}} = \frac{5}{\sqrt{2}}$$

$$v \cdot e_2 = 2\left(-\frac{1}{\sqrt{2}}\right) + 3\frac{1}{\sqrt{2}} = \frac{1}{\sqrt{2}}$$

Vector Component →

$$(v \cdot e_1)e_1 = \frac{5}{\sqrt{2}}\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right) = \left(\frac{5}{2}, \frac{5}{2}\right)$$

$$(v \cdot e_2)e_2 = \frac{1}{\sqrt{2}}\left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right) = \left(-\frac{1}{2}, \frac{1}{2}\right)$$

Orthogonal Projection:

$\text{Proj}_{e_1} v = (v \cdot e_1) e_1$

$\text{Proj}_{e_2} v = (v \cdot e_2) e_2$

$$\boxed{\text{Proj}_e v = (v \cdot e) e}$$

unit vector

If e is not a unit vector

$$\text{Proj}_e v = \left(v \cdot \frac{\vec{e}}{\|e\|}\right)\left(\frac{\vec{e}}{\|e\|}\right)$$

$$\boxed{\text{Proj}\, v = \frac{v \cdot \vec{e}}{\|e\|^2}\, \vec{e}}$$

not a unit vec.

* Vector component of $\bar{v}$ orthogonal to $\bar{b}$

$$\boxed{v - \text{proj}\, v}$$

Chapter: 11.4

Cross Product

$$u \times v = \begin{vmatrix} i & j & k \\ u_1 & u_2 & u_3 \\ v_1 & v_2 & v_3 \end{vmatrix}$$

$$u \times v = (u_2 v_3 - u_3 v_2) i - (u_1 v_3 - u_3 v_1) j + (u_1 v_2 - u_2 v_1) k$$

$i \times j = k$ $\quad$ $j \times i = -k$

$j \times k = i$ $\quad$ $k \times j = -i$

$k \times i = j$ $\quad$ $i \times k = -j$

$u \cdot (u \times v) = 0$

$v \cdot (u \times v) = 0$

Q: Example: 3 Find a Vector that is orthogonal $u(2, -1, 3)$ $v = (-7, 2, -1)$

$$u \times v = \begin{vmatrix} i & j & k \\ 2 & -1 & 3 \\ -7 & 2 & -1 \end{vmatrix}$$

parallelogram: $A = \| u \times v \|$
আয়তক্ষেত্র

Triangle: $\frac{1}{2} \| \overrightarrow{P_1P_2} \times \overrightarrow{P_1P_3} \|$

Scaler Triple Product: $\vec{u} \cdot (\vec{v} \times \vec{w})$

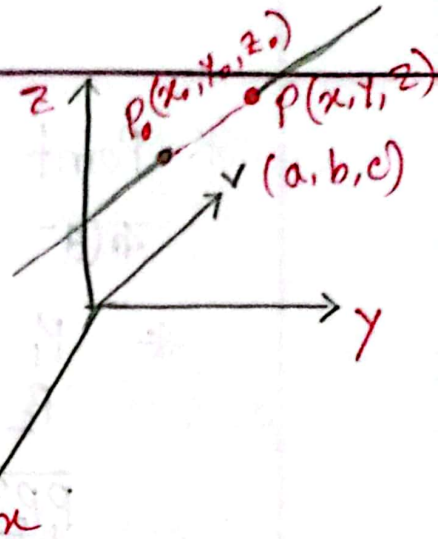
$$= \begin{vmatrix} u_1 & u_2 & u_3 \\ v_1 & v_2 & v_3 \\ w_1 & w_2 & w_3 \end{vmatrix}$$

* $V = |u \cdot (v \times w)|$ Parallelepiped

* $u \cdot (v \times w) = 0$ হলে same plane

Chapter : 11.5

Lines Determind By a Point and a Vector:



$$\overrightarrow{P_0P} = t\vec{v}$$

Scaler

Eq.

$$(x - x_0,\ y - y_0,\ z - z_0) = (ta, tb, tc)$$

$$x - x_0 = at,\quad y - y_0 = bt,\quad z - z_0 = ct$$

Parametric Equation of Straight Line:

$$\boxed{x = x_0 + at,\ y = y_0 + bt,\ z = z_0 + ct}$$

Ex-01: Find Parametric Eq—

(b) $(1, 2, -3)$ $\vec{v} = 4\hat{i} + 5\hat{j} - 7\hat{k}$

(c) the origin is 3 space $\vec{v} = (1, 1, 1)$

Sol^n b: $x = 1 + 4t$ $\quad x_0 = 1 \quad a = 4$

$y = 2 + 5t$ $\quad y_0 = 2 \quad b = 5$

$z = -3 - 7t$ $\quad z_0 = -3 \quad c = -7$

Sol^n c: Here, $x_0 = 0 \quad a = 1$

$y_0 = 0 \quad b = 1$

$z_0 = 0 \quad c = 1$

$\therefore x = 0 + 1t \quad y = t \quad z = t$

$= t$

Ans

* Point দেওয়া থাকলে Point গুলো connect করে Vector পাওয়া যায়।

* $P_1(x_1, y_1, z_1)$
  $P_2(x_2, y_2, z_2)$
  $\overrightarrow{P_1P_2}\ (x_2-x_1,\ y_2-y_1,\ z_2-z_1)$

Ex-02 (a) Find Parametric Eq.s $P_1(2, 4, -1)$ & $P_2(5, 0, 7)$
(b) Where does the Line intersect xy plane

Sol^n a:

$$\overrightarrow{P_1P_2} = (5-2, 0-4, 7+1)$$
$$= (3, -4, 8)$$

$P_1(2,4,-1)$ Parametric Eq. →

$$x = 2+3t$$
$$y = 4-4t$$
$$z = -1+8t$$

$P_2 \rightarrow$
$$x = 5+3t$$
$$y = -4t$$
$$z = 7+8t$$

Sol^n b: xy plane G intersect করলে $z=0$

$\therefore$ $z = -1+8t = 0$
$\Rightarrow 8t = 1$
$\therefore t = 1/8$

$x = 2+3\times\frac{1}{8}$
$= 19/8$

$y = 4-4\frac{1}{8}$
$= \frac{7}{2}$

$\therefore (x, y, z) = (19/8,\ 7/2,\ 0)$ Ans

Ex-03 L_1: $x_1 = 1+4t$ $y = 5-4t$ $z = -1+5t$

$x = 2+8t$ $y = 4-3t$ $z = 5+t$

ⓐ Are the Line parallel?

ⓑ Do the Line intersect?

Sol^n a: $x = x_0 + a\vec{t}$ → Vector

* দুটি Vector এর scaler multiple হলে Line parallel হয়।

L_1 is parallel to the Vector $= 4\hat{i} - 4\hat{j} + 5\hat{k}$

L_2 is parallel to the Vector $= 8\hat{i} - 3\hat{j} + \hat{k}$

Scaler multiple:

$$\frac{4}{8} \neq \frac{-4}{-3} \neq \frac{5}{1}$$

Thus, the Line are not parallel.

Sol^n b: L_1: $x_0 = 1+4t_1$, $y_0 = 5-4t_1$, $z_0 = -1+5t_1$

L_2: $x_0 = 2+8t_2$, $y_0 = 4-3t_2$, $z_0 = 5+t_2$

$1+4t_1 = 2+8t_2$ --- (i)

$5-4t_1 = 4-3t_2$ --- (ii)

$-1+5t_1 = 5+t_2$ --- (iii)

from (i) & (ii) ⇒

(i)+(ii) ⇒ $6 = 6+5t_2$

$\therefore t_2 = 0$

from (i) ⇒ $1+4t_1 = 2+8\times 0$

⇒ $t_1 = 1/4$

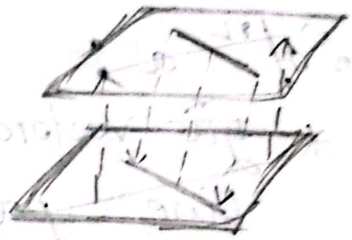
from (iii) ⇒

$-1+5\times\frac{1}{4} = 5+0$

⇒

* দুটি লাইন যদি parallel নাহয় and intersect না করে তাকে skew Line বলে

Example-3 skew line



Vector Eq. of Line:

$$(x, y, z) = (x_0 + at,\ y_0 + bt,\ z_0 + ct)$$

$$= (x_0, y_0, z_0) + (at, bt, ct)$$

$$= (x_0, y_0, z_0) + t(a, b, c)$$

r $\quad$ P.P $\quad$ vector

r_0

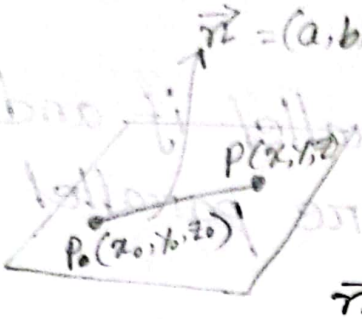
$$\boxed{\vec{r} = \vec{r_0} + t\vec{v}}$$

Chapter : 11.6

Planes in 3-SPACE

Planes Determind by a Point & Normal Vect:

Perpendicular = लम्ब
↓
orthogonal
↓
Normal Vect.



Plane — P.P
Plane — Normal

$\vec{n} = (a,b,c)$

$\overrightarrow{PP_0} = (x-x_0, y-y_0, z-z_0)$

$\vec{n} \cdot \overrightarrow{PP_0} = a(x-x_0) + b(y-y_0) + c(z-z_0) = 0$

pq^n of plane
point-normal of from

$\Rightarrow ax - ax_0 + by - by_0 + cz - cz_0 = 0$

$\Rightarrow ax + by + cz + (-ax_0 - by_0 - cz_0) = 0$

$\Rightarrow ax + by + cz + d = 0$

* vector $\vec{n}$ (a,b,c) / point (x_0, y_0, z_0)

Ex-01 : point $(3,-1,7)$, vect. $\vec{n} = (4,2,-5)$

Sol^n: Eq. of plane:

$a(x-x_0) + b(y-y_0) + c(z-z_0) = 0$

$\Rightarrow 4(x-3) + 2(y+1) + (-5)(z-7) = 0$

$\Rightarrow 4x - 12 + 2y + 2 - 5z + 35 = 0$

$\Rightarrow \underbrace{4x}_{ax} + \underbrace{2y}_{by} - \underbrace{5z}_{cz} + \underbrace{25}_{d} = 0$

Ans

Ex-02 $3x-4y+5z=0$ $\quad -6x+8y-10z-4=0$
planes are parallel?

Sol^n: Two planes are parallel if and only if their normals are parallel vectors.

Scaler multiple:

$$\frac{3}{-6} = \frac{-4}{8} = \frac{5}{-10} = -\frac{1}{2}$$

$\therefore$ So, the planes are parallel.

Ex-03 Find equation $\rightarrow$ $P_1(1,2,-1)$
$P_2(2,3,1)$
$P_3(3,-1,2)$

Sol^n: $\overrightarrow{P_1P_2} = (2-1, 3-2, 1+1)$
$= (1,1,2)$

$\overrightarrow{P_1P_3} = (3-1, -1-2, 2+1)$
$= (2,-3,3)$

$$\overrightarrow{P_1P_2} \times \overrightarrow{P_1P_3} = \begin{vmatrix} i & j & k \\ 1 & 1 & 2 \\ 2 & -3 & 3 \end{vmatrix} = i(3+6) - j(3-4) + k(-3-2)$$
$$= 9\hat{i} + \hat{j} - 5\hat{k}$$

Eq. of plane:
$P_1(1,2,-1)$

$$9(x-1) + 1(y-1) - 5(z+1) = 0$$
$$= 9x - 9 + y - 2 - 5z - 5 = 0$$
$$\Rightarrow 9x + y - 5z - 16 = 0$$

CamScanner

Ex-04 : $x = 3 + 8t$, $y = 4 + 5t$, $z = -3 - t$ is parallel $x - 3y + 5z = 12$

Sol^n: $v = (8, 5, -1)$

$n = (1, -3, 5)$

$\vec{v} \cdot \vec{n} = 0$ হলে parallel হবে।

$\vec{v} \cdot \vec{n} = 8(1) + 5 \times (-3) + (-1) \times 5$

$= -12$

$\therefore$ Line and plane are not parallel.

Ex-05: Find intersection of line & plane Ex-

Let, (x_0, y_0, z_0) be the intersecting point

$x_0 - 3y_0 + 5z_0 = 12$ ---- (i)

$x_0 = 3 + 8t_0$, $y_0 = 4 + 5t_0$, $z_0 = -3 - t_0$ --- (ii)

Substituting (ii) $\Rightarrow$ (i)

$(3 + 8t_0) - 3(4 + 5t_0) + 5(-3 - t_0) = 12$

$\Rightarrow -24 - 12t_0 = 12$

$\Rightarrow -12t_0 = 36$

$t_0 = -3$

$t_0 = -3 \Rightarrow$ (ii)

$x_0 = -21$

$y_0 = -11$

$z_0 = 0$

$\therefore (x_0, y_0, z_0) = (-21, -11, 0)$ Ans

Intersecting Plane :

$$\cos\theta = \frac{|\bar{n}_1 \cdot \bar{n}_2|}{\|n_1\| \, \|n_2\|}$$

Ex-06 $2x - 4y + 4z = 6$
$6x + 2y - 3z = 4$

Sol^n: $n_1 = (2, -4, 4)$
$n_2 = (6, 2, -3)$

$$\cos\theta = \frac{|12 - 8 - 12|}{\sqrt{36}\,\sqrt{49}} = \frac{4}{21}$$

$$\theta = \cos^{-1}\left(\frac{4}{21}\right) \approx 79^\circ$$ Ans

Ex-07 $\vec{n}_1 = (2, -4, 4)$
$\vec{n}_1 = (6, 2, -3)$

$\vec{v} = \vec{n}_1 \times \vec{n}_2 = (4, 30, 28)$

3 variable, 2 eq^n $\Big\}$ 1 free variable. $z = t$

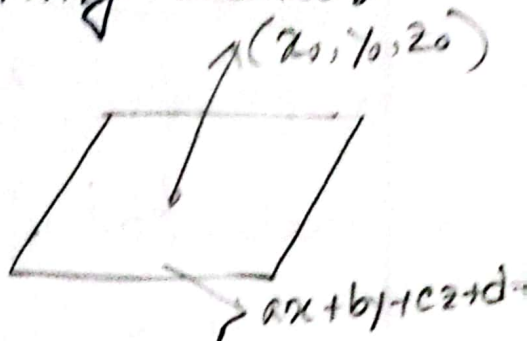
$2x - 4y = 6$
$6x + 2y = 4$ $\Big\}$

$(x, y, z) = (1, -1, 0)$

Distance Problem Involving Planes:

Distance

Point — Plane



$$\text{distance, } D = \frac{|ax_0 + by_0 + cz_0 + d|}{\sqrt{a^2+b^2+c^2}}$$

Ex-08:

$a=2,\ b=-3,\ c=6,\ d=1$ | $x_0=1$, $y_0=-4$, $z_0=-3$

$$D = \frac{|2\times 1 + (-3)\times(-4) + 6\times(-3) + 1|}{\sqrt{2^2+(-3)^2+6^2}}$$

$$= \frac{|-3|}{7} = \frac{3}{7}$$ Ans

Ex-09: $x+2y-2z=3$ & $2x+4y-4z=7$

$x+2y-2z=3$ --- point

equation $\rightarrow 1$
variable $\rightarrow 3$ } free variable 2 $\left(\begin{matrix} y=s \\ z=t \end{matrix}\right)$

$s=0,\ t=0 \therefore (x,y,z) = (3,0,0)$

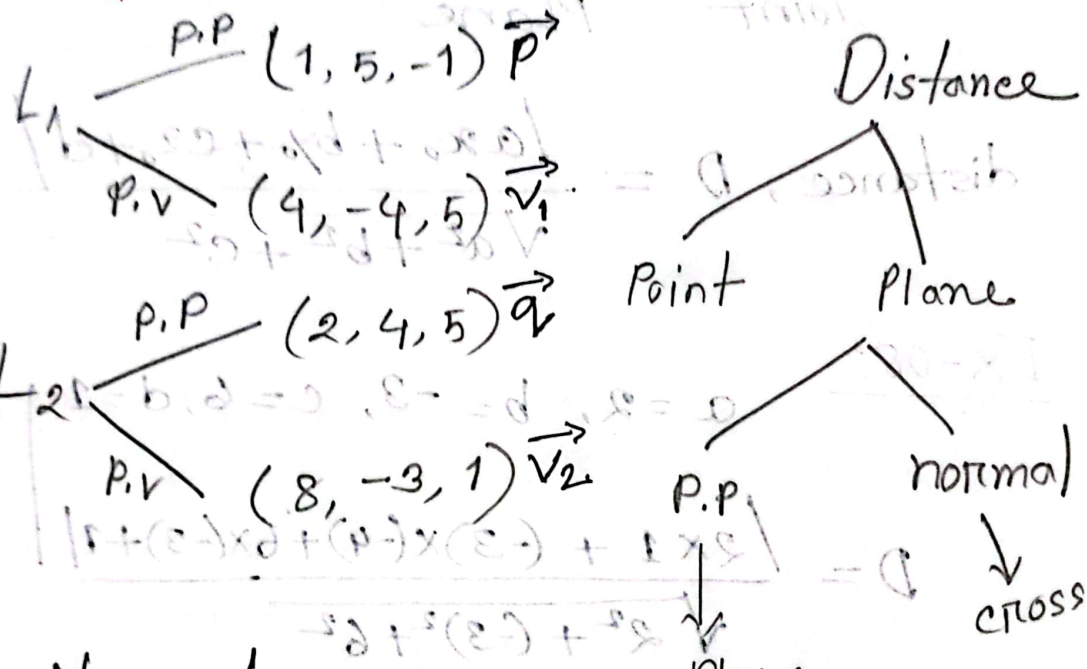
$(a,b,c,d) = (2,4,-4,-7)$

$D =$

Ex-10

L_1 : $x = 1+4t$, $y = 5-4t$, $z = -1+5t$

L_2 : $x = 2+8t$, $y = 4-3t$, $z = 5+t$



for Normal vector $\vec{n} = \vec{v_1} \times \vec{v_2}$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 4 & -4 & 5 \\ 8 & -3 & 1 \end{vmatrix}$$

$$= 11\hat{i} + 36\hat{j} + 20\hat{k}$$

$$= (11, 36, 20)$$

Eq. of Plane: $Q(2, 4, 5)$

$$11(x-2) + 36(y-4) + 20(z-5) = 0$$

$$\Rightarrow 11x - 22 + 36y - 36\times(-4) + 20z - 20\times 5 = 0$$

$$= \underset{a}{11x} + \underset{b}{36y} + \underset{c}{20z} - \underset{d}{266} = 0$$

$$\vec{P} = (1, 5, -1)$$

$$D = \frac{|11\times 1 + 36\times 5 + 20\times(-1) + (-266)|}{\sqrt{11^2 + 36^2 + 20^2}} = 0$$

$$= \frac{95}{\sqrt{1817}}$$

$\therefore$ Distance $D = \dfrac{95}{\sqrt{1817}}$

Ans