# CHAPTER 7

# THE PLANE

# **TOPICS:**

**1.** Equations of a plane

2. Normal form

**3.**perpendicula distance from a point to a plane.

**3**.Intercept form

4. Angle between two planes

5. Distance between two parallel planes.

#### **PLANES**

### **Definition:**

A surface in space is said to be a plane surface or a plane if all the points of the straight line joining any two points of the surface lie on the surface.

### THEOREM

The equation of the plane passing through a point  $(x_1, y_1, z_1)$  and perpendicular to a line whose direction ratios are a, b, c is  $a(x-x_1)+b(y-y_1)+c(z-z_1)=0$ 

## THEOREM

The equation of the plane passing through a point  $(x_1, y_1, z_1)$  is  $a(x-x_1)+b(y-y_1)+c(z-z_1)=0$  where a,b,c are constants.

# THEOREM

The equation of the plane containing three points  $(x_1, y_1, z_1)$ ,  $(x_2, y_2, z_2)$ ,  $(x_3, y_3, z_3)$ 

is  $\begin{vmatrix} x - x_1 & y - y_1 & z - z_1 \\ x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ x_3 - x_1 & y_3 - y_1 & z_3 - z_1 \end{vmatrix} = 0$ 

# NORMAL FORM OF A PLANE THEOREM

The equation of the plane which is at a distance of p from the origin and whose normal has the direction cosines (l, m, n) is lx + my + nz = p (or)  $x \cos \alpha + y \cos \beta + z \cos \gamma = p$ .

NOTE. Equation of the plane through the origin is lx+my+nz=0Note: The equation of the plane ax +by+cz+d=0 in the normal form is

$$\frac{a}{\sqrt{\sum a^2}} x + \frac{b}{\sqrt{\sum a^2}} y + \frac{c}{\sqrt{\sum a^2}} z = \frac{-d}{\sqrt{\sum a^2}} \text{ if } d \le 0,$$
  
$$\frac{-a}{\sqrt{\sum a^2}} x + \frac{-b}{\sqrt{\sum a^2}} y + \frac{-c}{\sqrt{\sum a^2}} z = \frac{+d}{\sqrt{\sum a^2}} \text{ if } d > 0 \text{ where } \sum a^2 = a^2 + b^2 + c^2.$$

#### PERPENDICULAR DISTANCE FROM A POINT TO A PLALNE

The perpendicular distance from the origin to the plane ax + by + cz + d = 0 is  $\frac{|d|}{\sqrt{a^2 + b^2 + c^2}}$ 

#### THEOREM

The perpendicular distance from  $P(x_1, y_1, z_1)$  to the plane ax + by + cz + d = 0 is |ax + by + cz + d|

 $\frac{\left|ax_1+by_1+cz_1+d\right|}{\sqrt{a^2+b^2+c^2}}$ 

#### THEOREM

Intercept form of the plane

The equation of the plane having a,b,c as x,y,z- intercepts respectively is  $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$ 

#### THEOREM

The intercepts of the plane ax + by + cz + d = 0 are respectively  $\frac{-d}{a}, \frac{-d}{b}, \frac{-d}{c}$ 

#### ANGLE BETWEEN TWO PLANES

**Definition:** The angle between the normals to two planes is called the angle between the planes.

#### THEOREM

If  $\theta$  is the angle between the planes  $a_1x + b_1y + c_1z + d_1 = 0$ ,  $a_2x + b_2y + c_2z + d_2 = 0$ 

then 
$$\cos \theta = \frac{a_1 a_2 + b_1 b_1 + c_1 c_2}{\sqrt{a_1^2 + b_1^2 + c_1^2} \sqrt{a_2^2 + b_2^2 + c_2^2}}$$

#### Note

- 1. if  $\theta$  is acute then  $\cos \theta = \left| \frac{a_1 a_2 + b_1 b_1 + c_1 c_2}{\sqrt{a_1^2 + b_1^2 + c_1^2} \sqrt{a_2^2 + b_2^2 + c_2^2}} \right|$
- 2. The planes  $a_1x + b_1y + c_1z + d_1 = 0$ ,  $a_2x + b_2y + c_2z + d_2 = 0$  are
  - (i) parallel iff  $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

- (ii) Perpendicular iff .  $a_1a_2 + b_1b_2 + c_1c_2 = 0$
- 3. The given planes are perpendicular

$$\Leftrightarrow \theta = 90^0 \Leftrightarrow \cos \theta = 0 \Rightarrow a_1 a_2 + b_1 b_2 + c_1 c_2 = 0$$

### THEOREM

The equation of the plane parallel to the plane ax + by + cz + d = 0 is

ax + by + cz + k = 0 where k is a constant.

# THEOREM

The distance between the parallel planes  $ax + by + cz + d_1 = 0$ ,  $ax + by + cz + d_2 = 0$  is  $\frac{|d_1 - d_2|}{|d_1 - d_2||}$ .

$$\frac{1}{\sqrt{a^2+b^2+c^2}}$$

#### EXERCISE 7

- I.
- 1. Find the equation of the plane if the foot of the perpendicular from origin to the plane is (1, 3, -5).
- **Sol.** Given point P = (1, 3, -5).
  - $\overrightarrow{op}$  is the normal to the plane
  - D. Rs of  $\overrightarrow{op}$  are 1, 3, -5.

The plane passes through P(1, 3, -5) equation of the plane is  $a(x-x_1)+b(y-y_1)+c(z-z_1)=0$ 

1(x-1) + 3(y-3) - 5(z+5) = 0

$$x - 1 + 3y - 9 - 5z - 25 = 0$$

x + 3y - 5z - 35 = 0



2. Reduce the equation x + 2y - 3z - 6 = 0 of the plane to the normal form.

# Sol. Equation of the plane is x + 2y - 3z - 6 = 0 i.e. x + 2y - 3z = 6

Dividing with 
$$\sqrt{1^2 + 2^2 + (-3)^2} = \sqrt{1 + 4 + 9} = \sqrt{14}$$
, we get

$$\left(\frac{1}{\sqrt{14}}\right)x + \left(\frac{2}{\sqrt{14}}\right)y + \left(\frac{-3}{\sqrt{14}}\right)z = \frac{6}{\sqrt{14}}$$
. Which is the normal form of the plane.

**3.** Find the equation of the plane. Whose intercepts on X, Y, Z-axis are 1, 2, 4 respectively.

Sol. Given X,Y,Z intercepts are a = 1, b = 2, c = 4

Equation of the plane in the intercept form is  $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$ 

The equation of the plane in the intercept form is

$$\frac{x}{1} + \frac{y}{2} + \frac{z}{4} = 1 \implies 4x + 2y + z = 4.$$

4. Find the intercepts of the plane 4x + 3y - 2z + 2 = 0 on the coordinate axes.

**Sol.** Equation of the plane is 4x + 3y - 2z + 2 = 0

$$-4x - 3y + 2z = 2 \Longrightarrow -\frac{4x}{2} - \frac{3y}{z} + \frac{2z}{2} = 1 \Longrightarrow \frac{x}{\left(-\frac{1}{2}\right)} + \frac{y}{\left(-\frac{2}{3}\right)} + \frac{z}{1} = 1$$

x-intercept = -1/2, y-intercept = -2/3, z-intercept = 1.

#### 5. Find the d.c.'s of the normal to the plane x + 2y + 2z - 4 = 0.

**Sol.** Equation of the plane is x + 2y + 2z - 4 = 0

d.r.'s of the normal are (1, 2, 2)

Dividing with  $\sqrt{1+4+4} = 3$ 

d.c.'s of the normal to the plane are  $\left(\frac{1}{3}, \frac{2}{3}, \frac{2}{3}\right)$ .

# 6. Find the equation of the plane passing through the point (-2, 1, 3) and having (3, -5, 4) as d.r.'s of its normal.

**Sol.** d.r.'s of the normal are (3, -5, 4) and the plane passes through (-2, 1, 3).

Equation of the plane is  $a(x-x_1)+b(y-y_1)+c(z-z_1)=0$ 

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

$$3x + 6 - 5y + 5 + 4z - 12 = 0$$
  

$$3x - 5y + 4z - 1 = 0.$$

#### 7. Write the equation of the plane 4x - 4y + 2z + 5 = 0 in the intercept form.

Sol. Equation of the plane is : 4x - 4y + 2z + 5 = 0-4x + 4y - 2z = 5 $-\frac{4x}{5} + \frac{4y}{5} - \frac{2z}{5} = 1$ 

Intercept form is  $\frac{x}{\left(-\frac{5}{4}\right)} + \frac{y}{\left(\frac{5}{4}\right)} + \frac{z}{\left(-\frac{5}{2}\right)} = 1$ 

x-intercept =  $-\frac{5}{4}$ , y-intercept =  $\frac{5}{4}$  z-intercept =  $-\frac{5}{2}$ 

8. Find the angle between the planes x + 2y + 2z - 5 = 0 and 3x + 3y + 2z - 8 = 0.

**Sol.** Equation of the plane are x + 2y + 2z - 5 = 0

$$3x + 3y + 2z - 8 = 0$$

Let  $\theta$  be the angle between the planes, then

$$\cos\theta = \frac{|a_1a_2 + b_1b_2 + c_1c_2|}{\sqrt{a_1^2 + b_1^2 + c_1^2}\sqrt{a_2^2 + b_2^2 + c_2^2}} = \frac{|1 - 3 + 2 - 3 + 2 - 2|}{\sqrt{1 + 4 + 4}\sqrt{9 + 9 + 4}} = \frac{13}{3\sqrt{22}}$$
$$\theta = \cos^{-1}\left(\frac{13}{3\sqrt{22}}\right)$$

II.

- 1. Find the equation of the plane passing through the point (1, 1, 1) and parallel to the plane x + 2y + 3z 7 = 0.
- Sol. Equation of the given plane is x + 2y + 3z 7 = 0Equation of the plane parallel to this plane is x + 2y + 3z = kThis plane passing through the point P(1, 1, 1)  $\Rightarrow 1 + 2 + 3 = k \Rightarrow k = -6$

Equation of the required plane is x + 2y + 3z = 6

- 2. Find the equation of the plane passing through (2, 3, 4) and perpendicular to X-axis.
- Sol. Since the plane is perpendicular to x-axis,
  - $\therefore$  x-axis is the normal to the plane
    - d.r.'s of x-axis are 1, 0, 0
  - : Equation of the required plane is  $a(x-x_1)+b(y-y_1)+c(z-z_1)=0$
  - $\Rightarrow 1(x-2) + 0 + 0 = 0 \Rightarrow x-2 = 0$

## 3. Show that 2x + 3y + 7 = 0 represents a plane perpendicular to XY-plane.

**Sol.** Equation of the given plane is 2x + 3y + 7 = 0

D,rs if normal to the plane are 2,3,0

Equation of xy-plane is : z = 0

d.rs of normal to the planes are 0,0,1

now  $a_1a_2 + b_1b_2 + c_1c_2 = 2 \Longrightarrow 2 \cdot 0 + 3 \cdot 0 + 0 \cdot 1 = 0$ 

The plane 2x + 3y + 7 = 0 is perpendicular to xy-plane.

4. Find the constant k so that the planes x - 2y + kz = 0 and 2x + 5y - z = 0 are at right angles. Find the equation of the plane through

## (1, -1, -1) and perpendicular to these planes.

**Sol.** Equations of the given planes are

x - 2y + kz = 0 and 2x + 5y - z = 0

since these planes are perpendicular, therefore

$$1 \cdot 2 - 2 \cdot 5 + k(-1) = 0$$

 $2-10 = k \Longrightarrow k = -8$ 

Equations of the planes are

$$x - 2y - 8z = 0$$
 ... (i)  
 $2x + 5y - z = 0$  ... (ii)

Let a,b,c be the drs of normal to the required plane.

This plane is perpendicular to the planes (i) and (ii).

The required plane passing through (1, -1, -1)

- :. Equation of the plane can be taken as a(x - 1) + b(y + 1) + c(z + 1) = 0 ...(iii) 42(x - 1) - 15(y + 1) + 9(z + 1) = 0 42x - 42 - 15t - 15 + 9z + 9 = 042x - 15y + 9z - 48 = 0.
- 5. Find the equation of the plane through (-1, 6, 2) and perpendicular to the join of (1, 2, 3) and (-2, 3, 4).

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Sol. Given points are
A(1, 2, 3) and B(-2, 3, 4).
d.r.'s of AB are 1 + 2, 2 - 3, 3 - 4
i.e. 3, -1, -1
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Since the plane is perpendicular to the line joining A(1, 2, 3) and B(-2, 3, 4), AB is normal to the plane and the plane passes through the point P(-1, 6, 2). Equation of the required plane is :

3(x + 1) - 1(y - 6) - 1(z - 2) = 0 3x + 3 - y + 6 - z + 2 = 03x - y - z + 11 = 0

6, Find the equation of the plane bisecting the line segment joining (2, 0, 6) and (-6, 2, 4) and perpendicular to it.

**Sol.** 
$$A(2, 0, 1), B(-6, 2, 4)$$
 are the given points

Let 'M' be the mid point of AB.

Coordinates of M are :

$$\left(\frac{2-6}{2}, \frac{0+2}{2}, \frac{6+4}{2}\right) = (-2, 1, 5)$$

Since the plane is perpendicular to AB, d.r.'s of the normal to the plane are

2+6, 0-2, 6-4 i.e., 8, -2, 2

Equation of the required plane is :

$$8(x + 2) - 2(y - 1) + 2(z - 5) = 0$$
  

$$\Rightarrow 8x + 16 - 2y + 2 + 2z - 10 = 0$$
  

$$\Rightarrow 8x - 2y + 2z + 8 = 0.$$
  

$$\Rightarrow 48x - y + z + 4 = 0$$

7. Find the equation of the plane passing through (0, 0, -4) and perpendicular to the line joining the point (1, -2, 2) and (-3, 1, -2).

**Sol.** Ans; 4x - 3y + 4z + 16 = 0.

- 8. Find the equation of the plane through (4, 4, 0) and perpendicular to the planes 2x + y + 2z + 3 = 0 and 3x + 3y + 2z 8 = 0.
- **Sol.** Equation of the plane passing through P(4,4,0) is :

$$a(x-4) + b(y-4) + c(z-0) = 0$$
 ...(i)  
This plane is perpendicular to

2x + y + 2z - 3 = 0

3x + 3y + 2z - 8 = 0

- $\therefore 2a + b + 2c = 0$  ...(ii)
  - 3a + 3b + 2c = 0 ...(iii)



a b c  

$$\frac{1}{3} \xrightarrow{2} \frac{2}{3} \xrightarrow{2} \frac{1}{3}$$

$$\frac{a}{2-6} = \frac{b}{6-4} = \frac{c}{6-3} \Rightarrow \frac{a}{-4} = \frac{b}{2} = \frac{c}{3}$$
Substituting in (i), equation of the

S he required plane is :

$$-4(x-4) + 2(y-4) + 3(z-0) = 0$$
  
$$\Rightarrow -4x + 16 + 2y - 8 + 3z = 0$$
  
$$\Rightarrow -4x + 2y + 3z + 8 = 0.$$

 $\Rightarrow$ 4x - 2y - 3z - 8 = 0

# III.

1. Find the equation of the plane through the points (2, 2, -1), (3, 4, 2), (7, 0, 6).

**Sol.** A(2, 2, 
$$-1$$
), B(3, 4, 2), C(7, 0, 6) are the given points.

Let a, b, c be the d. rs of normal to the plane.

Equation of the plane passing through

A(2, 2, -1) is 
$$a(x - 2) + b(y - 2) + c(z + 1) = 0$$
 ...(i)

This plane is passing through B(3, 4, 2) and C(7, 0, 6).

$$a(3-2) + b(4-2) + c(2+1) = 0 \implies a+2b+3c = 0$$
 ...(ii)

 $a(7-2) + b(0-2) + c(6+1) = 0 \implies 5a - 2b + 7c = 0$  ...(iii) From (ii) and (iii) :

a b c  
2 3 1 2  
-2 7 5 -2  

$$\frac{a}{14+6} = \frac{b}{15-7} = \frac{c}{-2-10}$$

$$\frac{a}{20} = \frac{b}{8} = \frac{c}{-12} \Rightarrow \frac{a}{5} = \frac{b}{2} = \frac{c}{-3}$$

Substituting in (i) equation of the required plane is

$$\begin{array}{l} 5(x-2) + 2(y-2) - 3(z+1) = 0 \Rightarrow 5x - 10 + 2y - 4 - 3z - 3 = 0 \\ \Rightarrow 5x + 2y - 3z - 17 = 0 \end{array}$$

#### 2. Show that the points (0, -1, 0), (2, 1, -1), (1, 1, 1), (3, 3, 0) are coplanar.

**Sol.** Given points are A(0,-1,0) B(2,1,-1) c(1,1,1) and D(3,3,0)

The equation of the plane containing three points  $(x_1, y_1, z_1)$ ,  $(x_2, y_2, z_2)$ ,  $(x_3, y_3, z_3)$ 

is 
$$\begin{vmatrix} x - x_1 & y - y_1 & z - z_1 \\ x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ x_3 - x_1 & y_3 - y_1 & z_3 - z_1 \end{vmatrix} = 0$$

The equation of the plane through A,B,C is

$$\begin{vmatrix} x - 0 & y + 1 & z - 0 \\ 2 - 0 & 1 + 1 & -1 - 0 \\ 1 - 0 & 1 + 1 & 1 - 0 \end{vmatrix} = 0$$
  
$$\begin{vmatrix} x & y + 1 & z \\ 2 & 2 & -1 \\ 1 & 2 & 1 \end{vmatrix} = 0$$
  
$$\Rightarrow x(2+2) - (y+1)(2+1) + z(4-2) = 0$$
  
$$\Rightarrow 4x - 3y + 2z - 3 = 0$$

Substituting D(3,3,0),  $4.3 - 3.3 + 2.0 - 3 = 0 \implies 12 - 9 - 3 = 0 \implies 0 = 0$ .

Therefore D is a point of the plane ABC.

Hence given points are coplanar.

# 3. Find the equation of the plane through (6, -4, 3), (0, 4, -3) and cutting of intercepts whose sum is zero.

**Sol.** Suppose a, b, c are the intercepts of the plane.

Equation of the plane is  $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$ Given  $a + b + c = 0 \Rightarrow c = -(a + b)$ The plane is passing through P(6, -4, 3), Q(0, 4, -3)  $\Rightarrow \frac{6}{a} - \frac{4}{b} + \frac{3}{c} = 1$  and  $\frac{4}{b} - \frac{3}{c} = 1$ Adding these two  $\frac{6}{a} = 2 \Rightarrow a = \frac{6}{2} = 3$  $\frac{4}{b} - \frac{3}{c} = 1 \Rightarrow 4c - 3b = bc \Rightarrow$ 

$$c = -a - b = -3 - b \Longrightarrow 4(-3 - b) - 3b = b(-3 - b)$$
$$\Rightarrow -12 - 4b - 3b = -3b - b^{2} \Longrightarrow b^{2} - 4b - 12 = 0$$
$$\Rightarrow (b - 6)(b + 2) = 0 \Longrightarrow b = 6, -2$$

#### Case I :

 $b = 6 \Rightarrow c = -3 - b = -3 - 6 = -9$ Equation of the plane is :  $\frac{x}{3} + \frac{y}{6} - \frac{z}{9} = 1$ 6x + 3y - 2z = 18

#### Case II :

 $b = -2 \implies c = -3 - b = -3 + 2 = -1$ Equation of the plane is :  $\frac{x}{3} + \frac{y}{-2} + \frac{z}{-1} = 1$ 

4. A plane meets the coordinate axes in A, B, C. If the centroid of  $\triangle ABC$  is (a, b, c). Show that the equation of the plane is  $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 3$ .

**Sol.** let  $\alpha$ ,  $\beta$ ,  $\gamma$  be the intercepts of the plane ABC. Equation of the plane is  $\frac{x}{\alpha} + \frac{y}{\beta} + \frac{z}{\beta} = 1$  ...(i)



Coordinates of A are ( $\alpha$ , 0, 0), B are (0,  $\beta$ , 0) and C are (0, 0,  $\gamma$ ). Centroid of  $\triangle ABC$  is  $G = \left(\frac{\alpha}{3}, \frac{\beta}{3}, \frac{\gamma}{3}\right) = (a, b, c)$  $\frac{\alpha}{3} = a, \frac{\beta}{3} = b, \frac{\gamma}{3} = c \implies \alpha = 3a, \beta = 3b, \gamma = 3c$ 

Substituting in (i), equation of the plane ABC is :  $\frac{x}{3a} + \frac{y}{3b} + \frac{z}{3c} = 1 \Rightarrow \frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 3$ .

5. Show that the plane through (1, 1, 1), (1, -1, 1) and (-7, -3, -5) is parallel to y-axis.

Sol. Equation of the plane through (1, 1, 1), (1, -1, 1) and (-7, -3, -5) is  $\begin{vmatrix} x - x_1 & y - y_1 & z - z_1 \\ x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ x_3 - x_1 & y_3 - y_1 & z_3 - z_1 \end{vmatrix} = 0 \implies \begin{vmatrix} x - 1 & y - 1 & z - 1 \\ 0 & -2 & 0 \\ -8 & -4 & -6 \end{vmatrix} = 0 \implies 3x - 4z + 1 = 0$ 

D.rs of normal to the plane aer 3, 0, -4

d.rs of y axis are  $0,1,0 \Rightarrow a_1a_2 + b_1b_2 + c_1c_2 = 3.0 + 0.1 - 4.0 = 0$ 

Normal to the plane is perpendicular to the y-axis. hence plnae is parallel to Y-axis.

# 6. Show that the equations ax + by + r = 0, by + cz + p = 0, cz + ax + q = 0 represent planes perpendicular to XY, YZ, ZX planes respectively.

**Sol.** Given plane is : ax + by + c = 0

d.r.'s of the normal are (a, b, 0)

Equation of XY-plane is z = 0

d.r.'s of the normal are (0, 0, 1)

 $\Rightarrow a_1a_2 + b_1b_2 + c_1c_2 = \mathbf{a} \cdot \mathbf{b} + \mathbf{b} \cdot \mathbf{0} + \mathbf{0} \cdot \mathbf{1} = \mathbf{0}$ 

 $\therefore$  ax + by + r = 0 is perpendicular to xy-plane. Similarly we can show that by + cz + p = 0 is perpendicular to yz-plane and cz + ax + q = 0 is perpendicular to zx-plane.

# 7. Find the equation of the plane passing through (2, 0, 1) and (3, -3, 4) and perpendicular to x - 2y + z = 6.

Sol. Equation of the plane passing through (2, 0, 1) is a(x - 2) + by + c(z - 1) = 0 ...(i) where a,b,c are d.rs of normal to the plane. This plane passes through B(3, -3, 4)  $\Rightarrow a - 3b + 3c = 0$  ...(ii) The plane (i) is perpendicular to x - 2y + z = 6

 $\Rightarrow a - 2b + c = 0$  ... (iii)

Solving (ii) and (iii)



Substituting in (i), equation of the required plane is :

$$3(x-2) + 2y + 1(z-1) = 0$$
  

$$3x - 6 + 2y + z - 1 = 0$$
  

$$3x + 2y + z - 7 = 0.$$

#### **Problems for practice**

1. Find the equation of the plane if the foot of the perpendicular from origin to the plane is (2, 3, -5).

**Ans**: 2x + 3y - 5z - 38 = 0.

Find the equation to the plane through the points (0, -1, -1), (4, 5, 1) and (3, 9, 4).

**Ans.** 5x - 7y + 11z + 4 = 0

3. Find the equation to the plane parallel to the ZX plane and passing through (0, 4, 4).

Ans. y = 4

4. Find the equation of the plane through the point  $(\alpha, \beta, \gamma)$  and parallel to the plane ax + by + cz = 0.

Sol. Equation of the given plane is ax + by + cz = 0Equation of the parallel plane is ax+by+cz = kThis plane passes through  $P(\alpha, \beta, \gamma) \Rightarrow a\alpha + b\beta + c\gamma = K$  $\therefore$  Equation of the required plane is :  $ax + by + cz = a\alpha + b\beta + c\gamma$ i.e.  $a(x - \alpha) + b(y - \beta) + c(z - \gamma) = 0$ .

# 5. Find the angle between the plane 2x - y + z = 6 and x + y + 2z = 7.

Ans.  $\theta = \pi/3$ 

6. Find the equation of the plane passing through (2, 0, 1) and (3, -3, 4) and perpendicular to x - 2y + z = 6.

**Ans.** 3x + 2y + z - 7 = 0