NCERT Solutions for Class-XII Maths

Chapter-11.3

NCERT Maths Class 12

1. In each of the following cases, determine the direction cosines of the normal to the plane and the distance from the origin.

(a) z = 2

(b) x + y + z = 1

(c) 2x + 3y – z = 5

(d) 5y + 8 = 0

1. (a) The equation of the plane is z = 2 or 0x + 0y + z = 2 … (1) The direction ratios of normal are 0, 0, and 1.

$\therefore \sqrt{0^2+0^2+1^2}=1$

Dividing both sides of equation (1) by 1, we obtain

0.x + 0.y + 1.z = 2

This is of the form lx + my + nz = d, where l, m, n are the direction cosines of normal to the plane and d is the distance of the perpendicular drawn from the origin. Therefore, the direction cosines are 0, 0, and 1 and the distance of the plane from the origin is 2 units.

(b) x + y + z = 1 … (1)

The direction ratios of normal are 1, 1, and 1.

$\therefore \sqrt{(1)^2+(1)^2+(1)^2}=\sqrt{3}$

Dividing both sides of equation (1) by $\sqrt{3}$, we obtain

$\frac{1}{\sqrt{3}}x+\frac{1}{\sqrt{3}}y+\frac{1}{\sqrt{3}}z=\frac{1}{\sqrt{3}}$ …..(2)

This equation is of the form lx + my + nz = d, where l, m, n are the direction cosines of normal to the plane and d is the distance of normal from the origin.

Therefore, the direction cosines of the normal are $\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}}$ and $\frac{1}{\sqrt{3}}$ and the distance of normal from the origin is $\frac{1}{\sqrt{3}}$ units.

2. Find the vector equation of a plane which is at a distance of 7 units from the origin and normal to the vector $3\hat{i}+5\hat{j}-6\hat{k}$.

2. Vector eq.of the plane with position vector $\vec{r}$ is-

$\vec{r}.\hat{n} = d$

$\hat{n} = \frac{\vec{n}}{|\vec{n}|} - = \frac{3\hat{i}+5\hat{j}-6\hat{k}}{\sqrt{9+25+36}}$

$= \frac{3\hat{i}+5\hat{j}-6\hat{k}}{\sqrt{70}}$

$\vec{r}.\frac{3\hat{i}+5\hat{j}-6\hat{k}}{\sqrt{70}} = 7$

$\vec{r}.3\hat{i}+5\hat{j}-6\hat{k} = 7\sqrt{70}$

3. Find the Cartesian equation of the following planes:

(a) $\vec{r}.\left(\hat{r}+\hat{j}-\hat{k}=2\right)$

(b) $\vec{r}.\left(2\hat{i}+3\hat{j}-4\hat{k}\right)=1$

(c) $\vec{r}.\left[(s-2t)\hat{i}+(3-t)\hat{j}+(2s+t)\hat{k}\right]=15$

3. (a) It is given that equation of the plane is

$\vec{r}.\left(\hat{i}+\hat{j}-\hat{k}\right) = 2$ …(1)

For any arbitrary point P (x, y, z) on the plane, position vector $r^{\to}$ is given by,

$\vec{r} = x\hat{i}+y\hat{j}+z\hat{k}$

Substituting the value of $r^{\to}$ in equation (1), we obtain

$\left(x\hat{i}+y\hat{j}+z\hat{k}\right)\left(\hat{i}+\hat{j}-\hat{k}\right)=2$

$\Rightarrow x + y - z = 2$

This is the Cartesian equation of the plane.

(b) $\vec{r}.\left(2\hat{i}+3\hat{j}-4\hat{k}\right)=1$ ….(1)

For any arbitrary point P (x, y, z) on the plane, position vector $\vec{r}$ is given by,

$\vec{r} = x\hat{i}+y\hat{j}+z\hat{k}$

Substituting the value of $\vec{r}$ in equation (1), we obtain

$\left(x\hat{i}+y\hat{j}+z\hat{k}\right)\left(2\hat{i}+3\hat{j}-4\hat{k}\right)=1$

$\Rightarrow 2x + 3y - 4z = 2$

This is the Cartesian equation of the plane.

(c) $\vec{r}.\left[(s-2t)\hat{i}+(3-t)\hat{i}+(2s+t)\hat{k}\right]=15$ …..(1)

For any arbitrary point P (x, y, z) on the plane, position vector $\vec{r}$ is given by,

$\vec{r} = x\hat{i}+y\hat{j}+z\hat{k}$ -

Substituting the value of $\vec{r}$ in equation (1), we obtain

$$\left(x\hat{i}+y\hat{j}+z\hat{k}\right)\left[(s-2t)\hat{i}+(3-t)\hat{j}+(2s+t)\hat{k}\right]=15$$

$\Rightarrow (s - 2t)\,x + (3 - t)y + (2s + t)z = 15$

This is the Cartesian equation of the plane.

4. In the following cases, find the coordinates of the foot of the perpendicular drawn from the origin.

(a) $2x + 3y + 4z - 12 = 0$

(b) $3y + 4z - 6 = 0$

(c) $x + y + z = 1$

(d) $5y + 8 = 0$

4. Let the coordinate of the foot of ⊥ P from the origin to the given plane be P(x,y,z).

$2x + 3y + 4z = 12$

Direction ratio (2, 3, 4)

$\therefore \sqrt{(2)^2+(3)^2+(4)^2}$

$=\sqrt{4+9+16}$

$=\sqrt{29}$

$$\frac{2}{\sqrt{29}}x+\frac{3}{\sqrt{29}}y+\frac{4}{\sqrt{29}}z=\frac{12}{\sqrt{29}}$$

This is the form of

$lx + my + nz = d$ ($\therefore$ d = Distance of the normal from the origin.)

Direction cosine(d) = $\frac{2}{\sqrt{29}},\frac{3}{\sqrt{29}},\frac{4}{\sqrt{29}}$

Coordinate of the foot (ld, md, nd) $=\frac{24}{29},\frac{36}{29},\frac{48}{29}$

(B) Let the coordinate of the foot of ⊥ P from the origin to the given plane be P(x, y, z).

$0x + 3y + 4z = 6$

Direction ratio (0, 3, 4)

$\therefore \sqrt{(0)^2+(3)^2+(4)^2}$

$=\sqrt{0+9+16}$

$=\sqrt{25}$

$= 5$

$$\frac{0}{5}x+\frac{3}{5}y+\frac{4}{5}z=\frac{6}{5}$$

This is the form of

$lx + my + nz = d$ ($\therefore$ d = Distance of the normal from the origin.)

Direction cosine (d) = $\frac{0}{5},\frac{3}{5},\frac{4}{5}$

Coordinate of the foot (ld, md, nd) = $0,\frac{18}{25},\frac{24}{25}$

(c) Let the coordinate of the foot of ⊥ P from the origin to the given plane be P(x, y, z).

$x + y + z = 1$

Direction ratio (1, 1, 1)

$\therefore \sqrt{(1)^2 + (1)^2 + (1)^2}$

$= \sqrt{1+1+1}$

$= \sqrt{3}$

$\frac{1}{\sqrt{3}}x + \frac{1}{\sqrt{3}}y + \frac{1}{\sqrt{3}}z = \frac{1}{\sqrt{3}}$

This is the form of

$lx + my + nz = d$ ($\therefore$ d = Distance of the normal from the origin.)

Direction cosine (d) = $\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}$

Coordinate of the foot (ld, md, nd) = $\frac{1}{3}, \frac{1}{3}, \frac{1}{3}$

(d) Let the coordinate of the foot of ⊥ P from the origin to the given plane be P(x,y,z).

$0x - 5y + 0z = 8$

Direction ratio (0, –5, 0)

$\therefore \sqrt{(0)^2 + (-5)^2 + (9)^2}$

$\sqrt{25}$

$= 5$

$\frac{0}{5}x - \frac{5}{5}y + \frac{0}{5}z = \frac{8}{5}$

This is the form of

$lx + my + nz = d$ ($\therefore$ d = Distance of the normal from the origin.)

Direction cosine(d)= 0, –1, 0

Coordinate of the foot (ld, md, nd) = $0, -\frac{8}{5}, 0$

5. Find the vector and Cartesian equation of the planes

(a) that passes through the point (1, 0, −2) and the normal to the plane is $\hat{i} + \hat{j} - \hat{k}$.

(b) that passes through the point (1, 4, 6) and the normal vector to the plane is $\hat{i} - 2\hat{j} + \hat{k}$.

5. The position vector of point (1, 0, −2) is $\vec{a} - = \hat{i} - 2\hat{k}$

The normal vector $\vec{N}$ perpendicular to the plane is $\vec{N} = \hat{i} + \hat{j} - \hat{k}$

The vector equation of the plane is given by, $(\vec{r} - \vec{a}).\vec{N} = 0$-

$\Rightarrow \left[\vec{r} - (\hat{i} - 2\hat{k})\right].(\hat{i} + \hat{j} - \hat{k}) = 0$ ….(1)

$\vec{r}$ is the position vector of any point P(x, y, z) in the plane.

$\therefore \vec{r} - = x\hat{i} + y\hat{j} + x\hat{k}$

Therefore, equation (1) becomes

$$\left[\left(x\hat{i}+y\hat{j}+z\hat{k}\right)-\left(\hat{i}-2\hat{k}\right)\right].\left(\hat{i}+\hat{j}-\hat{k}\right)=0$$

$$\Rightarrow \left[(x-1)\hat{i}+y\hat{j}+(z+2)\hat{k}\right].\left(\hat{i}+\hat{j}-\hat{k}\right)=0$$

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

$\Rightarrow x + y - z - 3 = 0$

$\Rightarrow x + y - 3 = 3$

This is the Cartesian equation of the required plane.

(a) The position vector of the point (1, 4, 6) is $\vec{a}=\hat{i}+4\hat{j}+6\hat{k}$

The normal vector $\vec{N}$ perpendicular to the plane is $\vec{N}=\hat{i}-2\hat{j}+\hat{k}$

The vector equation of the plane is given by, $(\vec{r}-\vec{a}).\vec{N}=0$

$$\Rightarrow \left[\vec{r}-\left(\hat{i}+4\hat{j}+6\hat{j}\right)\right].\left(\hat{i}-2\hat{j}+\hat{k}\right) \qquad ....(1)$$

$\vec{r}$ is the positive vector of any point P(x, y, z) in the plane.

$\therefore \vec{r}=x\hat{i}+y\hat{j}+z\hat{k}$

Therefore, equation (1) becomes

$$\left[\left(x\hat{i}+y\hat{j}+z\hat{k}\right)-\left(\hat{i}+4\hat{j}+6\hat{k}\right)\right].\left(\hat{i}-2\hat{j}+\hat{k}\right)=0$$

$$\Rightarrow\left[(x-1)\hat{i}(y-4)\hat{j}+(z-6)\hat{k}\right].\left(\hat{i}-2\hat{j}+\hat{k}\right)=0$$

$\Rightarrow (x - 1) -2(y - 4) + (z - 6) = 0$

$\Rightarrow x - 2y + z + 1 = 0$

6. Find the equations of the planes that passes through three points.

(a) (1, 1, −1), (6, 4, −5), (−4, −2, 3)

(b) (1, 1, 0), (1, 2, 1), (−2, 2, −1)

6. (a) The given points are (1, 1, –1),(6, 4, –5), (–4, –2, 3).

Let,

$$\Delta=\begin{vmatrix}1 & 1 & -1\\ 6 & 4 & -5\\ -4 & -2 & 3\end{vmatrix}$$

= 1(12 – 10) – 1(18 – 20) –1 (–12 + 16)

= 2 + 2 – 4

= 0

Since, the value of determinant is 0.

Therefore, these points are collinear as there will be infinite planes passing through the given 3 points.

(b) The given points are (1, 1, 0),(1, 2, 1),(–2, 2, –1).

Let,

$$\Delta = \begin{vmatrix} 1 & 1 & -1 \\ 1 & 2 & 1 \\ -2 & 2 & -1 \end{vmatrix}$$

$= 1(-2 - 2) - 1(-1 + 2)$

$= -4 - 1$

$= -5 \neq 0$

There passes a unique plane from the given 3 points.

Equation of the plane passes through the points, (x_1, y_1, z_1), (x_2, y_2, z_2) and (x_3, y_3, z_3), i.e.,

$$= \begin{vmatrix} x - x_1 & y - 1 & z \\ x_2 - 1 & y_2 - 1 & z_2 \\ x_3 - 1 & y_3 - 1 & z_3 \end{vmatrix}$$

$$= \begin{vmatrix} x - 1 & y - 1 & z \\ x_2 - 1 & y_2 - 1 & z_2 \\ x_3 - 1 & y_3 - 1 & z_3 \end{vmatrix}$$

$$= \begin{vmatrix} x - 1 & y - 1 & z \\ 1 - 1 & 2 - 1 & 1 \\ -2 - 1 & 2 - 1 & -1 \end{vmatrix}$$

$$= \begin{vmatrix} x - 1 & y - 1 & z \\ 0 & 1 & 1 \\ -3 & 1 & -1 \end{vmatrix}$$

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

$\Rightarrow -2x + 2 - 3y + 3 + 3z = 0$

$\Rightarrow 2x + 3y - 3z = 5$

This is the required eq. of the plane.

7. Find the intercepts cut off by the plane $2x + y - z = 5$

7. $2x + y - z = 5$ …(1)

Dividing both sides of equation (1) by 5, we obtain

$$\frac{2}{5}x + \frac{y}{5} - \frac{z}{5} = 1$$

$$\Rightarrow \frac{x}{\frac{5}{2}} + \frac{y}{5} + \frac{z}{-5} = 1 \quad \text{….(2)}$$

It is known that the equation of a plane in intercept form is $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$, where a, b, c are the intercepts cut off by the plane at x, y, and z axes respectively.

Therefore, for the given equation,

$a = \frac{5}{2}$, b = 5 and c = –5

Thus, the intercepts cut off by the plane are $\frac{5}{2}$, 5 and –5

8. Find the equation of the plane with intercept 3 on the y-axis and parallel to ZOX plane.

8. We know that the eq. of the plane ZOX is
y = 0
Eq. of plane parallel to it is of the form, y = a
Hence, the required eq. of the plane is
y = 3

9. Find the equation of the plane through the intersection of the planes
3x – y + 2z – 4 = 0 and x + y + z – 2 = 0 and the point (2, 2, 1)

9. The equation of any plane through the intersection of the planes,
3x − y + 2z − 4 = 0 and x + y + z − 2 = 0, is
$(3x – y + 2z – 4) +\alpha (x + y + z – 2) = 0$, where $\alpha \in R$ …(1)
The plane passes through the point (2, 2, 1).
Therefore, this point will satisfy equation (1).
$\therefore (3 \times 2 – 2 + 2 \times 1 – 4) + \alpha(2 + 2 + 1 – 2) = 0$
$\Rightarrow 2 + 3\alpha = 0$
$\Rightarrow \alpha = -\frac{2}{3}$

Substituting $\Rightarrow \alpha = -\frac{2}{3}$ in equation (1), we obtain

$(3x - y + 2z - 4) - \frac{2}{3}(x + y + z - 2) = 0$
$\Rightarrow 3(3x - y + 2z - 4) - 2(x + y + z - 2) = 0$
$\Rightarrow (9x - 3y + 6z - 12) - 2(x + y + z - 2) = 0$
$\Rightarrow 7x - 5y + 4z - 8 = 0$
This is the required equation of the plane.

10. Find the vector equation of the plane passing through the intersection of the planes
$\vec{r}.\left(2\hat{i} + 2\hat{j} - 3\hat{k}\right)$-= 7, $\vec{r}.\left(2\hat{i} + 5\hat{j} + 3\hat{k}\right) = 9$ and through the point (2, 1, 3)

10. Let the vector eq. of the plane passing through the intersection of the planes
$\vec{r}.\left(2\hat{i} + 2\hat{j} - 3\hat{k}\right) = 7$ and $\vec{r}.\left(2\hat{i} + 5\hat{j} + 3\hat{k}\right) = 9$

Here, $\vec{r}.\left(2\hat{i} + 2\hat{j} - 3\hat{k}\right) - 7 = 0$

$\vec{r}.\left(2\hat{i}+5\hat{j}+3\hat{k}\right)-9=0$

$\therefore\ \left[\vec{r}.\left(2\hat{i}+2\hat{j}-3\hat{k}\right)-7\right]\times\lambda\left[\vec{r}.\left(2\hat{i}+5\hat{j}+3\hat{k}\right)-9\right]=0$

$\vec{r}\left[\left(2\hat{i}+2\hat{j}-3\hat{k}\right)+\left(2\lambda\hat{i}+5\lambda\hat{j}+3\lambda\hat{k}\right)\right]-7-9\lambda=0$

$\vec{r}.\left[(2+2\lambda)\hat{i}+(2+5\lambda)\hat{j}+(-3+3\lambda)\hat{k}\right]-7-9\lambda=0$

$\because$ Plane passes through points (2, 1, 3)

$\left(2\hat{i}+\hat{j}+3\hat{k}\right).\left[(2+2\lambda)\hat{i}+(2+5\lambda)\hat{j}+(-3+3\lambda)\hat{k}\right]-7-9\lambda=0$

$4+4\lambda+2+5\lambda-9+9\lambda-7-9\lambda=0$

$9\lambda=10$

$\lambda=\frac{10}{9}$

$\vec{r}.\left[\left(2+\frac{20}{9}\right)\hat{i}+\left(2+\frac{50}{9}\right)\hat{j}+\left(-3+\frac{30}{9}\right)\hat{k}\right]-7-9\frac{10}{9}=0$

$\vec{r}.\left[\left(2+\frac{20}{9}\right)\hat{i}+\left(2+\frac{50}{9}\right)\hat{j}+\left(-3+\frac{30}{9}\right)\hat{k}\right]-17=0$

$\vec{r}.\left[\left(2+\frac{20}{9}\right)\hat{i}+\left(2+\frac{50}{9}\right)\hat{j}+\left(-3+\frac{30}{9}\right)\hat{k}\right]=17$

$\vec{r}\left[\frac{38}{9}\hat{i}+\frac{68}{9}\hat{j}+\frac{3}{9}\hat{k}\right]=17$

$\vec{r}\left[38\hat{i}+68\hat{j}+3\hat{k}\right]=153$

This is the required vector eq. of the plane.

11. Find the equation of the plane through the line of intersection of the planes x + y + z = 1 and 2x + 3y + 4z = 5 which is perpendicular to the plane x – y + z = 0

11. The equation of the plane through the intersection of the planes, x + y + z = 1 and 2x + 3y + 4z = 5, is

(x + y + z – 1) +λ(2x + 3y + 4z – 5) = 0

⇒ (2λ + 1) x + (3λ + 1) y + (4λ + 1) z–(5λ + 1) = 0 ….(1)

The direction ratios, a_1, b_1, c_1, of this plane are (2λ + 1), (3λ + 1), and (4λ + 1).

The plane in equation (1) is perpendicular to x – y + z = 0

Its direction ratios, a_2, b_2, c_2, are 1, −1, and 1.

Since the planes are perpendicular,

$a_1a_2 + b_1b_2 + c_1c_2 = 0$

⇒ (2λ + 1) – (3λ + 1) + (4λ + 1) = 0

⇒ 3λ + 1 = 0

$\Rightarrow \lambda = -\frac{1}{3}$

Substituting $\lambda = -\frac{1}{3}$ in equation (1), we obtain

This is the required equation of the plane.

$\frac{1}{3}x - \frac{1}{3}z + \frac{2}{3} = 0$

$\Rightarrow x - z + 2 = 0$

12. Find the angle between the planes whose vector equations are

$\vec{r}.\left(2\hat{i} + 2\hat{j} - 3\hat{k}\right) = 5$ and $\vec{r}.\left(3\hat{i} - 3\hat{j} + 5\hat{k}\right) = 3$

12. The eq. of the given planes are

$\vec{r}\left(2\hat{i} + 2\hat{j} - 3\hat{k}\right) = 5$ and $\vec{r}\left(3\hat{i} - 3\hat{j} + 5\hat{k}\right) = 5$

If n_1 and n_2 are normal to the planes, $\vec{r}_1.\vec{n}_1 = d_2$ and $\vec{r}_2.\vec{n}_2 = d_2$

Angle between two planes

$$\cos\theta = \left|\frac{\vec{n}_1.\vec{n}_2}{\left|\vec{n}_1.\vec{n}_2\right|}\right|$$

$$= \left|\frac{6 - 6 - 15}{\sqrt{4+4+9}\sqrt{9+9+25}}\right|$$

$$= \left|\frac{-15}{\sqrt{17}\sqrt{43}}\right|$$

$$\theta = \cos^{-1}\left(\frac{15}{\sqrt{17}\sqrt{43}}\right)$$

$$= \cos^{-1}\left(\frac{15}{\sqrt{731}}\right)$$

13. In the following cases, determine whether the given planes are parallel or perpendicular, and in case they are neither, find the angles between them.

(a) $7x + 5y + 6z + 30 = 0$ and $3x - y - 10z + 4 = 0$

(b) $2x + y + 3z - 2 = 0$ and $x - 2y + 5 = 0$

(c) $2x - 2y + 4z + 5 = 0$ and $3x - 3y + 6z - 1 = 0$

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

(e) $4x + 8y + z - 8 = 0$ and $y + z - 4 = 0$

13. The direction ratios of normal to the plane, $L_1 : a_1x + b_1y + c_1z = 0$, are a_1, b_1, c_1 and $L_2 : a_1x + b_2y + c_2z = 0$ are a_2, b_2, c_2

$L_1 \parallel L_2$, if $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

$L_1 \perp L_2$, if $a_1a_2 + b_1b_2 + c_1c_2 = 0$

The angle between L_1 and L_2 is given by,

$$Q = \cos^{-1}\left|\frac{a_1a_2 + b_1b_2 + c_1c_2}{\sqrt{a_1^2 + b_1^2 + c_1^2}.\sqrt{a_2^2 + b_2^2 + c_2^2}}\right|$$

(a) The equations of the planes are $7x + 5y + 6z + 30 = 0$ and $3x - y - 10z + 4 = 0$

Here, $a_1 = 7$, $b_1 = 5$, $c1 = 6$

$a_2 = 3$, $b_2 = -1$, $c_2 = -10$

$a_1a_2 + b_1b_2 + c_1c_2 = 7 \times 3 + 5 \times (-1) + 6 \times (-10) = -44 \neq 0$

Therefore, the given planes are not perpendicular.

$$\frac{a_1}{a_2} = \frac{7}{3}, \frac{b_1}{b_2} = \frac{5}{-1} = -5, \frac{c_1}{c_2} = \frac{6}{-10} = \frac{-3}{5}$$

It can be seen that, $\frac{a_1}{a_2} \neq \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$

Therefore, the given planes are not parallel.

The angle between them is given by,

$$Q = \cos^{-1}\left|\frac{7\times 3 + 5\times(-1) + 6\times(-10)}{\sqrt{(7)^2 + (5)^2 + (6)^2} \times \sqrt{(3)^2 + (-1)^2 + (-10)^2}}\right|$$

$$= \cos^{-1}\left|\frac{21 - 5 - 60}{\sqrt{110}\times\sqrt{110}}\right|$$

$$= \cos^{-1}\frac{44}{110}$$

$$= \cos^{-1}\frac{2}{5}$$

(b) The equations of the planes are $2x + y + 3z - 2 = 0$ and $x - 2y + 5 = 0$

Here, $a_1 = 2$, $b_1 = 1$, $c_1 = 3$ and $a_2 = 1$, $b_2 = -2$, $c_2 = 0$

$\therefore\ a_1a_2 + b_1b_2 + c_1c_2 = 2 \times 1 + 1 \times (-2) + 3 \times 0 = 0$

Thus, the given planes are perpendicular to each other.

(c) The equations of the given planes are $2x - 2y + 4z + 5 = 0$ and $3x - 3y + 6z - 1 = 0$

Here, $a_1 = 2$, $b_1 - 2$, $c_1 = 4$ and $a_2 = 3$, $b_2 = -3$, $c_2 = 6$

$a_1a_2 + b_1b_2 + c_1c_2 = 2 \times 3 + (-2)(-3) + 4 \times 6 = 6 + 6 + 24 = 36 \neq 0$

Thus, the given planes are not perpendicular to each other.

$$\frac{a_1}{a_2} = \frac{2}{3}, \frac{b_1}{b_2} = \frac{-2}{-3} = \frac{2}{3} \text{ and } \frac{c_1}{c_2} = \frac{4}{6} = \frac{2}{3}$$

$$\therefore \frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

Thus, the given planes are parallel to each other.

(d) The equations of the planes are $2x - y + 3z - 1 = 0$ and $2x - y + 3z + 3 = 0$

$a_1 = 2, b_1 = -1, c_1 = 3$ and $a_2 = 2, b_2 = -1, c_2 = 3$

Here,

$$\frac{a_1}{a_2} = \frac{2}{2} = 1, \frac{b_1}{b_2} = \frac{-1}{-1} \text{ and } \frac{c_1}{c_2} = \frac{3}{3} = 1$$

$$\therefore \frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

Thus, the given lines are parallel to each other.

(e) The equations of the given planes are $4x + 8y + z - 8 = 0$ and $y + z - 4 = 0$

$a_1 = 4, b_1 = 8, c_1 = 1$ and $a_2 = 0, b_2 = 1, c_2 = 1$

Here,

$$a_1a_2 + b_1b_2 + c_1c_2 = 4 \times 0 + 8 \times 1 + 1 = 9 \neq 0$$

Therefore, the given lines are not perpendicular to each other.

$$\frac{a_1}{a_2} = \frac{4}{0}, \frac{b_1}{b_2} = \frac{8}{1} = 8, \frac{c_1}{c_2} = \frac{1}{1} = 1$$

$$\frac{a_1}{a_2} \neq \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

Therefore, the given lines are not parallel to each other.

The angle between the planes is given by,

$$Q = \cos^{-1}\left|\frac{4\times0+8\times1+1\times1}{\sqrt{4^2+8^2+1^2}\times\sqrt{0^2+1^2+1^2}}\right| = \cos^{-1}\left|\frac{9}{9\times\sqrt{2}}\right| = \cos^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45°$$

14. In the following cases, find the distance of each of the given points from the corresponding given plane.

(a) (0, 0, 0) $3x - 4y + 12z = 3$

(b) (3, –2, 1) $2x - y + 2z + 3 = 0$

(c) (2, 3, –5) $x + 2y - 2z = 9$

(d) (–6, 0, 0) $2x - 3y + 6z - 2 = 0$

14. Distance of point $P(x_1, y_1, z_1)$ from the plane $Ax + By + Cz - D = 0$ is

$$d = \left|\frac{0+0+0+3}{\sqrt{9+16+144}}\right|$$

$$= \left|\frac{3}{\sqrt{169}}\right|$$

$$= \frac{3}{13}$$

(b) Given point is (3, –2, 1) and the plane is $2x - y + 2z + 3 = 0$

$$d = \left|\frac{6+2+2+3}{\sqrt{4+1+4}}\right|$$

$$= \left|\frac{13}{\sqrt{9}}\right|$$

$$= \frac{13}{3}$$

(c) Given point is (2, 3, –5) and the plane is x + 2y – 2z = 9

$$d = \left|\frac{2+6+10-9}{\sqrt{1+4+4}}\right|$$

$$= \left|\frac{9}{\sqrt{9}}\right|$$

$$= \frac{9}{3}$$

= 3

(d) Given point is (-6,0,0) and the plane is 2x – 3y + 6z – 2 = 0

$$d = \left|\frac{-12-0+0-2}{\sqrt{4+9+36}}\right|$$

$$= \left|\frac{14}{\sqrt{49}}\right| = \frac{14}{7} = 2$$