1. Find the equation of plane through the points $A(2,2,-1)$, $B(3,4,2)$, and $C(7,0,6)$. $[5x + 2y - 3z = 17]$
2. Show that the four points $(0,-1,-1)$, $(-4,4,4)$, $(4,5,1)$and $(3,9,4)$ are coplanar. Find the equation of the plane containing them. $[5x - 7y + 11z + 4 = 0]$
3. A plane meets the coordinate axis in A,B,C such that the centroid of triangle ABC is the point (p,q,r). Show that the equation of the plane is $\frac{x}{p} + \frac{y}{q} + \frac{z}{r} = 3$.
4. A variable plane moves in such a way that the sum of the reciprocals of its intercepts on the three coordinate axes is constant. Show that the plane passes through a fixed point.
5. Find the vector equation of a plane passing through a point having position vector $2\hat{\imath} + 3\hat{\jmath} - 4\hat{k}$ and perpendicular to the vector $2\hat{\imath} - \hat{\jmath} + 2\hat{k}$. Also reduce it to Cartesian form. $[2x - y + 2z = -7]$
6. Find the equation in Cartesian form of the plane passing through the point $(3,-3,1)$ and normal to the line joining the point $(3,4,-1)$ and $(2,-1,5)$. $[x + 5y - 6z + 18 = 0]$
7. The foot of perpendicular drown from the origin to the plane is $(4,-2,-5)$. Find the equation of the plane. $[4x - 2y - 5z = 45]$
8. Find a normal vector to the plane $2x - y + 2z = 5$. Also find a unit vector normal to the plane. $\left[\frac{1}{3}\left(2\hat{\imath} - \hat{\jmath} + 2\hat{k}\right)\right]$
9. Find the equation of plane passes through the point $(1,-1,2)$ having 2,3,2 as direction ratio of the normal to the plane. $[2x + 3y + 2z = 3]$
10. Let $\vec{n}$ be a vector of magnitude $2\sqrt{3}$ such that it makes equal actual angles with coordinate axes. Find the vector and Cartesian for of the equation of the plane passing through $(1,-1,2)$ and normal to $\vec{n}$. $[x + y + z = 2]$
11. Find the angle between the normal to the plane $2x - y + z = 6$ and $x + y + 2z = 7$. $\left[\frac{\pi}{3}\right]$
12. Show that the normal to the planes $\vec{r}.\left(\hat{\imath} - \hat{\jmath} + \hat{k}\right) = 3$ and $\vec{r}.\left(3\hat{\imath} + 2\hat{\jmath} - \hat{k}\right) + 5 = 0$ are perpendicular to each other.
13. Find the angle at which the normal vector to the plane $4x + 8y + z = 5$ is inclined to the coordinate axes. $\left[\cos^{-1}\frac{4}{9}, \cos^{-1}\frac{8}{9}, \cos^{-1}\frac{1}{9}\right]$
14. A vector $\vec{n}$ of magnitude 8 unites is inclined to x-axis at 45°, y-axis at 60° and an acute angle with z-axis. If a plane passes through the point $\left(\sqrt{2},-1,1\right)$ and is normal to $\vec{n}$ find its equation in vector form. $\left[\vec{r}.\left(\sqrt{2}\hat{\imath} + \hat{\jmath} + \hat{k}\right) = 2\right]$
15. Reduce the equation of the plane $x - 2y - 2z = 12$ to normal form and hence find the length of the perpendicular form the origin to the plane. Also find the direction cosines of the normal to the plane. $\left[4, \quad \frac{1}{3}, -\frac{2}{3}, -\frac{2}{3}\right]$
16. Find the coordinate of the foot of the perpendicular drown from the origin to the plane $2x - 3y + 4z - 6 = 0$. $\left[\frac{12}{29}, -\frac{18}{29}, \frac{24}{29}\right]$
17. Find the equation of the plane passing through the point $(-1,2,1)$ and perpendicular to the line joining the points $(-3,1,2)$ and $(2,3,4)$. Find also the perpendicular distance of the origin from this plane. $\left[\vec{r}.\left(5\hat{\imath} + 2\hat{\jmath} + 2\hat{k}\right) = 1, \frac{1}{\sqrt{33}}\right]$
18. Find the vector equation of the plane passing through the point $A(2,2,-1)$ $B(3,4,2)$ $C(7,0,6)$. Also find the Cartesian equation of the plane. $\left[\vec{r}.\left(5\hat{\imath} + 2\hat{\jmath} - 3\hat{k}\right) = 17, 5x + 2y - 2z = 17\right]$
19. If form a point $P(a,b,c)$ perpendiculars to PA and PB are drawn to yz and zx-plane. Find the vector equation of the plane. $\left[\vec{r}.\left(bc\hat{\imath} + ca\hat{\jmath} - ab\hat{k}\right) = 0\right]$
20. Find the angle between the plane $\vec{r}.\left(2\hat{\imath} - \hat{\jmath} + \hat{k}\right) = 6$ and $\vec{r}.\left(\hat{\imath} + \hat{\jmath} + 2\hat{k}\right) = 5$. $[\pi/3]$
21. If the plane $\vec{r}.\left(2\hat{\imath} - \hat{\jmath} + \lambda\hat{k}\right) = 5$ and $\vec{r}.\left(3\hat{\imath} + 2\hat{\jmath} + 2\hat{k}\right) = 4$ are perpendicular. Find the value of λ. $[-2]$
22. Find the equation of the plane passing through the point $(1,1,-1)$ and perpendicular to the planes $2x + 2y + 3z - 7 = 0$ and $2x - 3y + 4z = 0$. $[17x + 2y - 7z = 26]$
23. Find the equation of the plane through the points $(2,1,-1)$ and $(-1,3,4)$ and perpendicular to the plane $x - 2y + 4z = 10$. $[18x + 17y + 4z = 49]$
24. Find the equation of the plane passing through the point $(-1,-1,2)$ and perpendicular to the planes $3x + 2y - 3z = 1$ and $2x - 4y + z = 5$. $[5x + 9y + 11z - 8 = 0]$
25. Find the equation of the plane through the points $(2,2,1)$ and $(9,3,6)$ and perpendicular to the plane $2x + 6y + 6z = 1$. $[3x + 4y - 5z = 9]$
26. Find the vector equation of the following plane in scalar product form: $\vec{r} = (\hat{\imath} - \hat{\jmath}) + \lambda\left(\hat{\imath} + \hat{\jmath} + \hat{k}\right) + \mu\left(\hat{\imath} - 2\hat{\jmath} + 3\hat{k}\right)$. $\left[\vec{r}.\left(5\hat{\imath} - 2\hat{\jmath} - 3\hat{k}\right) = 7\right]$
27. Find the Cartesian form of the equation of the plane $\vec{r} = (s - 2t)\hat{\imath} + (3 - t)\hat{\jmath} + (2s + t)\hat{k}$. $[2x - 5y - z = -15]$
28. Find the vector equation of the plane passing through the points $\hat{\imath} + \hat{\jmath} - 2\hat{k}, 2\hat{\imath} - \hat{\jmath} + \hat{k}$ and $\hat{\imath} + 2\hat{\jmath} + \hat{k}$. $\left[\vec{r}.\left(9\hat{\imath} + 3\hat{\jmath} - \hat{k}\right) = 14\right]$
29. Find the equation of the plane containing the line of intersection of the plane $x + y + z - 6 = 0$ and $2x + 3y + 4z + 5 = 0$ and passing through the point $(1,1,1)$. $[20x + 23y + 26z - 69 = 0]$
30. Find the equation of the plane which is perpendicular to the plane $2x + 3y + 6z + 8 = 0$ and which contains the line of intersection of the planes $x + 2y + 3z - 4 = 0$ and $2x + y - z + 5 = 0$ $[51x + 15y - 50z + 173 = 0]$
31. Find the Cartesian as well as vector equation of the plane through the intersection of the plane $\vec{r}.(2\hat{\imath} + 6\hat{\jmath}) + 12 = 0$ and $\vec{r}.\left(3\hat{\imath} - \hat{\jmath} + 4\hat{k}\right) = 0$. Which are at unit distance from the origin. $\left[\vec{r}.\left(8\hat{\imath} + 4\hat{\jmath} + 8\hat{k}\right) = 12 \text{ and } \vec{r}.\left(-\hat{\imath} + 2 - 2\hat{k}\right) + 3 = 0\right]$

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