MATHS

BOOKS - NAVBODH MATHS (HINGLISH)

PLANE

Solve Examples

1. Find the vector equation of the plane passing through a point having position vector $3\hat{i} - 2\hat{j} + 3\hat{k}$ and perpendicular to the vector $4\hat{i} + 3\hat{j} + 2\hat{k}$.

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2. Equation of the plane is $\bar{r} \cdot \left(3\hat{i} - 4\hat{j} + 12\hat{k}\right) = 8$

Find the length of the perpendicular from the origin to the plane.

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

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4. Let a plane passing through point $(-1, 1, 1)$ is parallel to the vector $2\hat{i} + 3\hat{j} - 7\hat{k}$ and the line $\bar{r} = \left(\hat{i} - 2\hat{j} - \hat{k}\right) + \lambda\left(3\hat{i} - 8\hat{j} + 2\hat{k}\right)$. The vector equation of plane is

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5. A plane meets the coordinate axes in A, B, C such that eh centroid of triangle ABC is the point (p, q, r). Show that the equation of the plane is $\frac{x}{p} + \frac{y}{q} + \frac{z}{r} = 3.$

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6. Find the vector and cartesian equation of the plane passing through the point A(1, 1, -2), B(1,2,1) and C (2, -1,1).

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7. Parametric form of the equation of the plane is $\bar{r} = \left(2\hat{i} + \hat{k}\right) + \lambda\hat{i} + \mu\left(\hat{i} + 2\hat{i} - 3\hat{k}\right)\lambda$ and μ are parameters. Find normal to the plane and hence equation of the plane in normal form. Write its Cartesion form.

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8. The equation of plane passing through the line of intersection of planes $2x - y + z = 3, 4x - 3y - 5z + 9 = 0$ and parallel to the line $\frac{x+1}{2} = \frac{y+3}{4} = \frac{z-3}{5}$ is

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9. The vector equation of the plane passing tgrough the intersection of planes $\bar{r}.\left(2\hat{i} - 3\hat{j} + 4\hat{k}\right) = 1$ and $\bar{r}.\left(\hat{i} - \hat{j}\right) + 4 = 0$ and perpendicular to the plane $\bar{r}.\left(2\bar{i} - \hat{j} + \hat{k}\right) = -5$ is

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10. Find the equations of the plane parallel to the plane $x + 2y + 2z + 8 = 0$ which are at a distance of 2 units from the point (1, 1, 2).

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11. Show that the lines $\frac{x+1}{-3} = \frac{y-3}{2} = \frac{z+2}{1}$ and $\frac{x}{1} = \frac{y-7}{-3} = \frac{z+7}{2}$ are coplanar. Also, find the equation of the plane containing them.

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12. Show that the lines

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

$\vec{r} = \left(2\hat{i} + 6\hat{j} + 3\hat{k}\right) + \mu\left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)$

are coplanar. Also the find the equation of the plane passing through these lines.

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13. Find the acute angle between the planes $\bar{r} \cdot \left(2\hat{i} + \hat{j} - \hat{k}\right) = 3$ and $\bar{r} \cdot \left(\hat{i} + 2\hat{j} + \hat{k}\right) = 1.$

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14. Find the angle between the line $\frac{x-1}{3}=\frac{y+1}{2}=\frac{z+2}{4}$ and the plane $2x+y-3z+4=0$.

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15. Find the distance of the point $\hat{i}+2\hat{j}-\hat{k}$ from the plane $\bar{r}\cdot\left(\hat{i}-2\hat{j}+4\hat{k}\right)=10.$

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Example For Practice

1. Find the vector equation of the plane passing through the point having position vector $2\hat{i} + 3\hat{j} + 4\hat{k}$ and perpendicular to the vector $2\hat{i} + \hat{j} - 2\hat{k}$.

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

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3. Find the vector and cartesian equations of the plane that passes through the point $(0, 1, -2)$ and normal to the plane is $hti + \hat{j} + \hat{k}$.

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4. Reduce the equation $\bar{r} \cdot \left(3\hat{i} - 4\hat{j} + 12\hat{k}\right) = 3$ to the normal form and hence find the length of perpendicular from the origin to the plane.

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5. Find the direction cosines of perpendicular from the origin to the plane. $\bar{r} \cdot \left(2\hat{i} + 3\hat{j} + 6\hat{k}\right) = 0.$

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6. The coordinates of the foot of a perpendicular drawn from the origin to the plane are (2, 3, 1). Find the equation of the plane in vector form.

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7. Find the vector and cartesian equations of the plane that passes through the point $(0, 1, -2)$ and

normal to the vector $\hat{i} + \hat{j} + \hat{k}$.

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8. Find the vector and cartesian equation of the plane passing through the point $(2, 3, 1)$ & $(4, -5, 3)$ and parallel to the Y-axis.

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9. Find the vector equation of the plane passing through the point $A(1, 0, 1), B(1, -1, 1)$ and $C(4, -3, 2)$

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10. Find the vector equation of the plane passing through the point $\hat{i}+\hat{j}-2\hat{k}$ and $\hat{i}+2\hat{j}+\hat{k}, 2\hat{i}-\hat{j}+\hat{k}$.

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11. Line $\bar{r}=\left(\hat{i}-\hat{j}+\hat{k}\right)+\lambda\left(2\hat{i}-\hat{j}+\hat{k}\right)$ contained in a plane to which vector $\bar{n}=3\hat{i}-2\hat{j}+\lambda\hat{k}$ is normal. Find the value of λ. Also find the vector equation of the plane.

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12. Find the equations of the planes parallel to the plane $x - 2y + 2z - 4 = 0$, which are at a unit distance from the point (1, 2, 3).

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13. If from a point $P(a, b, c)$ perpendiculars $PAandPB$ are drawn to $YZandZX - planes$ find the vectors equation of the plane OAB.

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14. Find the cartesian form of the equation of the plane.

$$\bar{r} = \left(\hat{i} + \hat{j}\right) + s\left(\hat{i} - \hat{j} + 2\hat{k}\right) + t\left(\hat{i} + 2\hat{j} + \hat{k}\right).$$

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15. Find the vector equation of the plane passing through the intersection of the planes

$$\bar{r} \cdot \left(2\hat{i} + 2\hat{j} - 3\hat{k}\right) = 8, \bar{r} \cdot \left(2\hat{i} + 4\hat{j} + 3\hat{k}\right) = 7$$

and through the point (2, 1, 3).

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16. Find the equation of the plane passing through the intersection of the planes

$3x + 2y - z + 1 = 0$ and $x + y + z - 2 = 0$ and the point (2, 2, 1).

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17. Prove that the lines $\frac{x-2}{1} = \frac{y-4}{4} = \frac{z-6}{7}$ and $\frac{x+1}{3} = \frac{y+3}{5} = \frac{z+5}{3}$ are coplanar. Also find the equation of the plane containing these lines.

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18. A variable plane which remains at a constant distance 3p from the origin cuts the coordinate axes at A, B, C. Show that the locus of the centroid of triangle ABC is $\frac{1}{x^2}+\frac{1}{y^2}+\frac{1}{z^2}=\frac{1}{p^2}$.

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

$\bar{r}\cdot\left(2\hat{i}+2\hat{j}-3\hat{k}\right)=5$ and $\bar{r}\cdot\left(\hat{i}-2\hat{j}+\hat{k}\right)=7.$

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20. If the line $\bar{r} = \left(\hat{i} - 2\hat{j} + 3\hat{k}\right) + \lambda\left(2\hat{i} + \hat{j} + 2\hat{k}\right)$ is parallel to the plane $\bar{r} \cdot \left(3\hat{i} - 2\hat{j} + p\hat{k}\right)$ find the value of p.

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21. The planes $\bar{r} \cdot \left(3\hat{i} - 2\hat{j} + p\hat{k}\right) = 1$ and $\bar{r} \cdot \left(-2\hat{i} + p\hat{j} + 4\hat{k}\right) = 2$ are perpendicular to each other. Find the value of p.

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22. Find the value of p, if the planes $\bar{r} \cdot \left(p\hat{i} - \hat{j} + 2\hat{k}\right) + 3 = 0$ and $\bar{r} \cdot \left(2\hat{i} - p\hat{j} - \hat{k}\right) - 5 = 0$ include an angle of $\frac{\pi}{3}$.

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23. Find the angle between the line $\bar{r} = \left(\hat{i} + 2\hat{j} + \hat{k}\right) + \lambda\left(\hat{i} + \hat{j} + \hat{k}\right)$ and the plane $\bar{r} \cdot \left(2\hat{i} - \hat{j} + \hat{k}\right) = 5.$

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24. Find the angle between the line $\frac{x+1}{2} = \frac{y}{3} = \frac{z-3}{6}$ and the plane $10x + 2y11z = 3.$

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25. Find the distance of the point $2\hat{i} + \hat{j} + \hat{k}\Big)$ from the plane $\bar{r} \cdot \left(\hat{i} + 2\hat{j} + 4\hat{k}\right) = 13.$

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26. Find the distance of the point $(1, 2 - 1)$ from the plane $x - 2y + 4z - 10 = 0.$

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27. Show that the points (1, 1, 1) and $(-3, 0, 1)$ are equidistant from the plane $\bar{r} \cdot \left(3\hat{i} + 4\hat{j} - 12\hat{k}\right) + 13 = 0$

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28. Show that the points $(1, -1, 3)$ and $(3, 4, 3)$ are equidistant from the plane $5x + 2y + -7z + 8 = 0.$

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Multiple Choice Questions

1. The equation of the plane passing through the point $(2, -1, 3)$ and perpendicular to the vector $3\hat{i} + 2\hat{j} - \hat{k}$ is

A. $\bar{r} \cdot \left(3\hat{i} + 2\hat{j} - \hat{k}\right) = 1$

B. $\bar{r} \cdot \left(3\hat{i} + 2\hat{j} - \hat{k}\right) + 1 = 0$

C. $\bar{r} \cdot \left(3\hat{i} + 2\hat{j} - \hat{k}\right) = 0$

D. $\bar{r} \cdot \left(3\hat{i} + 2\hat{j} + \hat{k}\right) = 1$

Answer: A

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2. The vector form of the equation of the plane which is at a distance of 3 units from the origin and has $\hat{i}+\hat{j}-3\hat{k}$ as a normal vector, is

A. $\bar{r}\cdot\left(\hat{i}+\hat{j}-3\hat{k}\right)=3$

B. $\bar{r}\cdot\left(\hat{i}+\hat{j}-3\hat{k}\right)=3\sqrt{11}$

C. $\bar{r}\cdot\left(\hat{i}+\hat{j}-3\hat{k}\right)=\sqrt{11}$

D. $\bar{r}\cdot\left(\hat{i}+\hat{j}-3\hat{k}\right)+3\sqrt{11}=0.$

Answer: B

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3. The equation of the plane bisecting perpendicularly the segment joining the points (2, -1, 3) and (0, -2, 1) is

A. $4x + 2y + 4z + 9 = 0$

B. $4x + 2y + z = 9$

C. $4x + 2y + 4z = 9$

D. $4x + 2y + 4z = 0.$

Answer: C

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4. A plane makes intercepts 1,2, 3 on the coordinate axes. If the distance from the origin is p, then the value of p is

A. $\frac{7}{6}$,

B. $\frac{6}{7}$

C. $\frac{3}{7}$

D. $\frac{1}{7}$.

Answer: B

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5. The angle between the planes $\bar{r} \cdot \left(\hat{i} - 2\hat{j} + 3\hat{k}\right) + 4 = 0$ and $\bar{r} \cdot \left(2\hat{i} + \hat{j} - 3\hat{k}\right) = 0$ is

A. $\frac{\pi}{2}$

B. $\cos^{-1}\left(\frac{3}{4}\right)$

C. $\cos^{-1}\left(\frac{9}{14}\right)$

D. $\frac{\pi}{3}$

Answer: C

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6. If the line $\bar{r} = \left(\hat{i} - 2\hat{j} + \hat{k}\right) + \lambda\left(2\hat{i} + \hat{j} + 2\hat{k}\right)$ is parallel to the plane $\bar{r} \cdot \left(3\hat{i} - 2\hat{j} + m\hat{k}\right) = 14$, then the value of m is

A. 2

B. -2

C. $\frac{2}{3}$

D. $-\frac{1}{2}$

Answer: B

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7. The acute angle between the line $\frac{x+1}{2} = \frac{y}{3} = \frac{z-3}{6}$ and the plane $10x + 2y - 11z = 8$ is

A. $\sin^{-1}\left(\frac{8}{21}\right)$

B. $\cos^{-1}\left(\frac{8}{21}\right)$

C. $\sin^{-1}\left(\frac{1}{8}\right)$

D. $\sin^{-1}\left(\frac{1}{8}\right)$

Answer: A

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8. If p_1 and p_2 are the lengths of perpendiculars from the points $\hat{i} - \hat{j} + 3\hat{k}$ and $3\hat{i} + 4\hat{j} + 3\hat{k}$ to the plane $\bar{r} \cdot \left(5\hat{i} + 2\hat{j} - 7\hat{k}\right) + 8 = 0$, then

A. $p_1 = p_2$

B. $2p_1 = p_2$

C. $p_1 = 2p_2$

D. $p_1 + p_2 = \dfrac{32}{\sqrt{78}}$

Answer: A

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