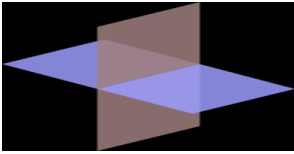


Angle between two planes

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Angle between two planes - Introduction



The [angle](#) between two planes is defined as the angle between their normals. If θ is the angle between two planes, then so is $180 - \theta$. We shall take the acute angle as the [angle between two planes](#).

Vector Form: If $\vec{r} \cdot \vec{n}_1 = d_1$ and $\vec{r} \cdot \vec{n}_2 = d_2$ are the equations of two planes then angle between them is given by the equation

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

$$\theta = \cos^{-1} \left[\frac{\vec{n}_1 \cdot \vec{n}_2}{|\vec{n}_1| |\vec{n}_2|} \right]$$

Cartesian Form: If $A_1x + B_1y + C_1z + D_1 = 0$ and $A_2x + B_2y + C_2z + D_2 = 0$ are the Cartesian equations of two planes and θ is the angle between them then

$$\cos \theta = \left| \frac{A_1A_2 + B_1B_2 + C_1C_2}{\sqrt{A_1^2 + B_1^2 + C_1^2} \sqrt{A_2^2 + B_2^2 + C_2^2}} \right|$$

Condition for parallelism and perpendicularity

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

1. If the planes are parallel then $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$
2. If the planes are perpendicular then $A_1A_2 + B_1B_2 + C_1C_2 = 0$

Coplanarity of Two Lines

Vector Form: If $\vec{r} = \vec{a}_1 + \lambda \vec{b}_1$ and $\vec{r} = \vec{a}_2 + \mu \vec{b}_2$ are the equations of two lines then they are said to be coplanar if $(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2) = 0$

Cartesian Form: If $A(x_1, y_1, z_1)$ and $B(x_2, y_2, z_2)$ are two points with the direction ratios of parallel [vectors](#) $\langle a_1, b_1, c_1 \rangle$ and $\langle a_2, b_2, c_2 \rangle$, then the lines are said to be coplanar if

$$\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$$

Distance of a point from a plane

Vector Form: If the equation of the plane is in the form $\vec{r} \cdot \vec{N} = d$, where \vec{N} is normal to the plane, then the perpendicular [distance](#) is $\frac{|\vec{a} \cdot \vec{N} - d|}{|\vec{N}|}$

The length of perpendicular from origin O to the plane $\vec{r} \cdot \vec{N} = d$ is $|d|/|\vec{N}|$

Cartesian Form: If $P(x_1, y_1, z_1)$ be the given point with position vector \vec{a} and $Ax + By + Cz = D$ be the equation of the plane then the perpendicular distance from P to the plane is given by $d = \left| \frac{Ax_1 + By_1 + Cz_1 - D}{\sqrt{A^2 + B^2 + C^2}} \right|$

Angle between a Line and a Plane

If $\vec{r} = \vec{a} + \lambda \vec{b}$ be the equation of the line and $\vec{r} \cdot \vec{n} = d$ be the equation of the plane the angle between them is given by

$$\sin \Phi = \left| \frac{\vec{b} \cdot \vec{n}}{|\vec{b}| |\vec{n}|} \right|$$

$$\Phi = \sin^{-1} \left(\left| \frac{\vec{b} \cdot \vec{n}}{|\vec{b}| |\vec{n}|} \right| \right)$$

Example: Find the distance of a point (2, 5, -3) from the plane $6x - 3y + 2z - 4 = 0$

$$d = \frac{|6 \times 2 - 3 \times 5 + 2 \times (-3) - 4|}{\sqrt{36 + 9 + 4}}$$

Solution: Distance

$$= \frac{|12 - 15 - 6 - 4|}{\sqrt{49}}$$

$$= 13/7$$

Now try it yourself! Should you still need any help, [click here](#) to schedule live online session with e Tutor!

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Links:

- http://en.wikipedia.org/wiki/Angle#Angles_between_curves
- http://schools-wikipedia.org/wp/p/Plane_%2528mathematics%2529.htm
- <http://www.netcomuk.co.uk/~jenolive/vect>
- <http://en.wikiversity.org/wiki/Vectors>

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