Various forms of a Plane

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Plane - Introduction



A <u>plane</u> can be determined uniquely if anyone of the following is known:

- (i) The normal to the plane and its distance from origin is given.
- (ii) It passes through a point and is perpendicular to a given direction.
- (iii) It passes through three given non collinear points.

Equation of plane in normal form

Vector Form: If \bar{r} is the position vector of a point P in the plane, d is the perpendicular distance from origin and ? is the unit <u>normal</u> to the plane then its vector equation is given by

 \bar{r} . ? = d

Cartesian Form: If P(x, y, z) is a point in the plane, d is the perpendicular distance from origin and <l, m, n> are the direction cosines of ?, then the Cartesian form of the plane is given by

lx + my + nz = d

Note: If $\langle a, b, c \rangle$ are the direction ratios of the normal to the plane then the equation is ax + by + cz = d

Equation of a plane perpendicular to a given vector and passing through a given point

Vector Form: If \overline{a} is the position vector of a given point and \overline{N} is the perpendicular vector then its equation is given by $(\overline{r} - \overline{a})$. $\overline{N} = 0$

Cartesian Form: If A(x1, y1, z1) is the given point and P(x, y, z) is a general point in the plane and A, B and C are the direction ratios of \overline{N} then the Cartesian equation is given by

 $A(x-x_1)+B(y-y_1)+C(z-z_1)=0$

Equation of a plane passing through three non collinear points

Vector Form: If \overline{a} , \overline{b} and \overline{c} are the position vectors of three points and \overline{r} be any point in the plane, then the <u>equation of the plane</u> passing through three given points is

 $(\overline{r}, \overline{a}).[(\overline{b}, \overline{a}) X (\overline{c}, \overline{a})]=0$

Cartesian Form: If (x1, y1, z1), (x2, y2, z2) and (x3, y3, z3) are the three given points then equation of the plane is

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

Intercept Form of a plane



If the plane makes intercepts a, b and c on x, y and z axes respectively

then its equation in <u>intercept form</u> is given by $\mathbf{x} + \mathbf{y} + \mathbf{z} = \mathbf{1}$

Here coordinates of A, B and C are A(a,0,0), B(0,b,0) and C(0,0,c) respectively.

Intersection of two planes

b

а

С

Vector Form: If \bar{r} , $\bar{n}_1=d_1$ and \bar{r} , $\bar{n}_2=d_2$ are the vector equation of two planes then equation of the plane passing through the <u>intersection</u> of these two planes is given by

х

 $\bar{r}.(\bar{n}_1+?\bar{n}_2)=d_1+?d_2$

Cartesian Form: If $A_1x+B_1y+C_1z=d_1$ and $A_2x+B_2y+C_2z=d_2$ are the equations of two planes in the Cartesian form then the equation of the plane passing through the intersection of the given planes is

 $(A_1x+B_1y+C_1z-d_1)+?(A_2x+B_2y+C_2z-d_2)=0$

In general, if P_1 and P_2 are the equations of two planes then the equation of the plane passing through the intersection of P_1 and P_2 is given by

P1+?P2=0

Example: Find the equation of the plane through the intersection of the planes x+y+z-6=0 and 2x+3y+4z+5=0 ant the point (1, 1, 1)

Solution: Equation of the plane passing through x+y+z-6=0 and 2x+3y+4z+5=0 is given by (x+y+z-6) + ? (2x+3y+4z+5)=0(1)

Passes through (1, 1, 1) (1+1+1-6) + ? (2+3+4+5) = 0 ?=3/14

Substitute the value of ? in (1), so that the equation is (x+y+z-6)+3/14(2x+3y+4z+5) = 020x+23y+26z-69=0, which is the required equation. Now try it yourself! Should you still need any help, click here to schedule live online session with e Tutor!

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Reference links:

- http://en.wikipedia.org/wiki/Plane_%28geometry%29
- <u>http://en.wikipedia.org/wiki/Surface_normal</u>
- http://www.cs.fit.edu/~wds/classes/cse5255/thesis/planeEqn/planeEqn.html
- http://www.wikidoc.org/index.php/Plane_%28mathematics%29
- <u>http://mathworld.wolfram.com/Plane.html</u>

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