

Ex. 2 : Find the equation of the sphere passing through the points (1, 0, -1), (2, 1, 0), (1, 1, -1) and (1, 1, 1).

Sol. : Let (a, b, c) be the centre of the sphere.

All the points on sphere are equidistant from the centre.

$$\begin{aligned} \therefore (a-1)^2 + b^2 + (c+1)^2 &= (a-2)^2 + (b-1)^2 + c^2 \\ &= (a-1)^2 + (b-1)^2 + (c+1)^2 \\ &= (a-1)^2 + (b-1)^2 + (c-1)^2 \end{aligned} \quad \dots (1)$$

This gives us three equations as

$$2a + 2b + 2c - 3 = 0, \quad 2b - 1 = 0, \quad 2b + 4c - 1 = 0$$

Solving these equations, we get $a = 1$, $b = \frac{1}{2}$, $c = 0$

Radius of the sphere = Distance of centre (a, b, c) from any one point, say (1, 1, -1) on the sphere

$$\begin{aligned} &= \sqrt{(a-1)^2 + (b-1)^2 + (c-1)^2} \\ &= \sqrt{\frac{1}{4} + 1} = \frac{\sqrt{5}}{2} \end{aligned} \quad \dots (2)$$

From (1) and (2), equation of the sphere is,

$$(x-1)^2 + \left(y-\frac{1}{2}\right)^2 + z^2 = \frac{5}{4}$$

or $x^2 - 2x + 1 + y^2 - y + \frac{1}{4} + z^2 = \frac{5}{4}$

or $x^2 + y^2 + z^2 - 2x - y = 0$

which is the required equation of the sphere.

Ex. 3 : Find the equation of the sphere through the points (4, -1, 2), (0, -2, 3), (1, 5, -1), (2, 0, 1).

Sol. : We can solve this problem by the above method. However, another method of solving this problem is as follows :

Let the required equation of the sphere be

$$x^2 + y^2 + z^2 + 2ux + 2vy + 2wz + d = 0 \quad \dots (1)$$

\therefore It passes through (4, -1, 2),

$$16 + 1 + 4 + 8u - 2v + 4w + d = 0$$

or $21 + 8u - 2v + 4w + d = 0$

Similarly, as the sphere passes through (0, -2, 3), (1, 5, -1), (2, 0, 1)

$$13 - 4v + 6w + d = 0$$

and $27 + 2u + 10v - 2w + d = 0$

and $5 + 4u + 2w + d = 0$

Subtracting (5) from each of (2), (3) and (4) (to eliminate d), we get

$$16 + 4u - 2v + 2w = 0 \text{ or } 8 + 2u - v + w = 0 \quad \dots (6)$$

$$8 - 4u - 4v + 4w = 0 \text{ or } 2 - u - v + w = 0 \quad \dots (7)$$

$$22 - 2u + 10v - 4w = 0 \text{ or } 11 - u + 5v - 2w = 0 \quad \dots (8)$$

Solving (6), (7) and (8), we get $u = -2$, $v = -7$, $w = -11$. Also from (3), $d = 25$.

Substituting these values in (1), the required equation of the sphere is

$$x^2 + y^2 + z^2 - 4x - 14y - 22z + 25 = 0$$

Ex. 4 : Find the equation of the sphere which passes through the points (1, -4, 3), (1, -5, 2), (1, -3, 0) and whose centre lies on the plane $x + y + z = 0$. (May 2014)

Sol. : Let the equation of the sphere be

$$x^2 + y^2 + z^2 + 2ux + 2vy + 2wz + d = 0 \quad \dots (1)$$

\therefore It passes through (1, -4, 3), (1, -5, 2), (1, -3, 0)

$\therefore 1 + 16 + 9 + 2u - 8v + 6w + d = 0$ or $26 + 2u - 8v + 6w + d = 0$

and $1 + 25 + 4 + 2u - 10v + 4w + d = 0$ or $30 + 2u - 10v + 4w + d = 0$

Engineering Maths 2 Notes

Camilla Rothe



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