The Curl

The curl of a vector function is the vector product of the del operator with a vector function:

$$\nabla \times E = \left(\frac{\partial E_z}{\partial y} - \frac{\partial E_y}{\partial z} \right) i + \left(\frac{\partial E_x}{\partial z} - \frac{\partial E_z}{\partial x} \right) j + \left(\frac{\partial E_y}{\partial x} - \frac{\partial E_x}{\partial y} \right) k$$

where i,j,k are unit vectors in the x, y, z directions. It can also be expressed in determinant form:

$$\begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_x & E_y & E_z \end{vmatrix}$$

Curl in cylindrical and sphericalcoordinate systems

Applications:	London equation for superconductors

Index

Vector calculus

HyperPhysics*****HyperMath*****Calculus

R Nave

Go Back

Curl, Cylindrical

The curl in cylindrical polar coordinates, expressed in determinant form is:

$$\nabla \times E = \begin{vmatrix} \frac{1_r}{r} & 1_\theta & \frac{k}{r} \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial z} \\ E_r & rE_\theta & E_z \end{vmatrix}$$

Index

Vector calculus

R Nave

Go Back

Curl, Spherical

The curl in spherical polar coordinates, expressed in determinant form is:

$$\nabla \times E = \begin{vmatrix} \dfrac{1_r}{r^2 \sin\theta} & \dfrac{1_\theta}{r \sin\theta} & \dfrac{1_\phi}{r} \\ \dfrac{\partial}{\partial r} & \dfrac{\partial}{\partial \theta} & \dfrac{\partial}{\partial \phi} \\ E_r & rE_\theta & r \sin\theta E_\phi \end{vmatrix}$$

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