Find the circulation of the vector field F(x, y, z) = langle y + z, x - z, x - y rangle around...

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Question:

Find the circulation of the vector field

$\mathrm{F}(x, y, z) = \langle y + z, x - z, x - y \rangle$ around the ellipse formed by the intersection of the cylinder $x^2 + y^2 = 4$ with the plane $x + 2y + 4z = 8$.

Stokes theorem:-

Strokes integral is defined as the line integral of a vector field over a surface or an loop is always equal to the flux produced upon an curl throughout the surface integral.

✓ Answer and Explanation:

Given:

- The given vector field is, $F\left(x, y, z\right) = \left(2xz + 2yz, -2xz, x^2 + y^2\right)$.
- Given cylinder is $x^2 + y^2 = 1$

between the plane $z = 0$ and $z = 2$.

Now we differentiate F with respect tox ,

$$\begin{aligned} F &= \frac{d}{dx}(2xz + 2yz) + \frac{d}{dy}(-2xz) + \frac{d}{dz}\left(x^2 + y^2\right) \\ &= 2z + 0 \\ &= 2z \end{aligned}$$

Using Stokes theorem,

$$\begin{aligned} \int\int_c F \cdot ds &= \int\int\int_R F \cdot dv \\ &= \int\int\int_R 2z \cdot dv \end{aligned}$$

Now we change the coordinates into cylindrical coordinates,

$$\iint_A \int_0^2 2z\,dz\,dA = \iint_A \left[z^2\right]_0^2 dA$$
$$= 4\int_0^{2\pi}\int_0^1 r\,dr\,d\theta$$
$$= 4\int_0^{2\pi} d\theta \left[\frac{r^2}{2}\right]_0^1$$
$$= 4\left(2\pi\right)\left(\frac{1}{2}\right)$$
$$= 4\pi$$

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The required value of surface integral by using stokes theorem is 4π.

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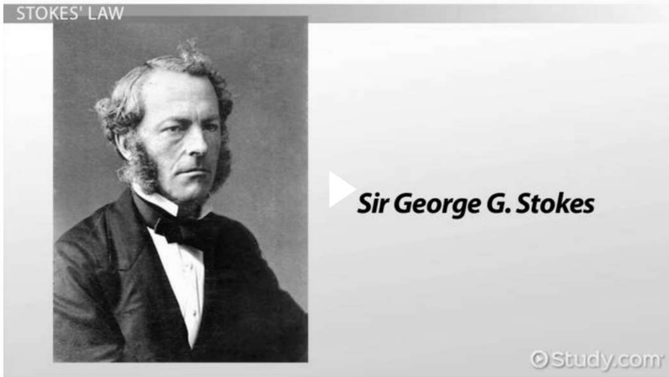

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