

**Answer on Question #76429 – Math – Calculus  
Question**

Express the vector field  $\vec{F} = zx\vec{i} + (x^2 + y^2)\vec{j} + x/z \vec{k}$  in cylindrical polar coordinates.

**Solution**

Relation to convert a vector from rectangular to cylindrical

$$\begin{bmatrix} F_\rho \\ F_\theta \\ F_z \end{bmatrix} = \begin{bmatrix} \cos \theta & \sin \theta & 0 \\ -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} F_x \\ F_y \\ F_z \end{bmatrix}$$

$$\begin{bmatrix} F_\rho \\ F_\theta \\ F_z \end{bmatrix} = \begin{bmatrix} \cos \theta & \sin \theta & 0 \\ -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} zx \\ x^2 + y^2 \\ x/z \end{bmatrix} =$$

$$= \begin{bmatrix} \cos \theta & \sin \theta & 0 \\ -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} z\rho \cos \theta \\ (\rho \cos \theta)^2 + (\rho \sin \theta)^2 \\ \rho \cos \theta / z \end{bmatrix} =$$

$$= \begin{bmatrix} \cos \theta & \sin \theta & 0 \\ -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} z\rho \cos \theta \\ \rho^2 \\ \rho \cos \theta / z \end{bmatrix} =$$

$$= \begin{bmatrix} z\rho \cos^2 \theta + \rho^2 \sin \theta \\ -z\rho \sin \theta \cos \theta + \rho^2 \cos \theta \\ \rho \cos \theta / z \end{bmatrix}$$

$$\vec{F} = (z\rho \cos^2 \theta + \rho^2 \sin \theta)\vec{e}_\rho + (-z\rho \sin \theta \cos \theta + \rho^2 \cos \theta)\vec{e}_\theta + \left(\frac{\rho \cos \theta}{z}\right)\vec{e}_z$$