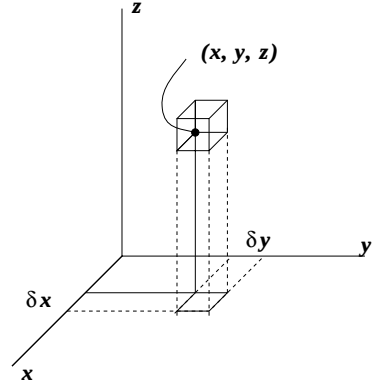


SISTEMAS DE COORDENADAS

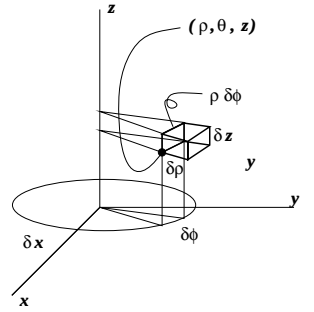
Rectangulares: $(x, y, z) \rightarrow (\hat{x}, \hat{y}, \hat{z})$

$$\begin{aligned}\vec{\nabla}\psi &= \left(\hat{x} \frac{\partial}{\partial x} + \hat{y} \frac{\partial}{\partial y} + \hat{z} \frac{\partial}{\partial z} \right) \psi \\ \nabla^2 \psi &= \left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} \right) \psi \\ \vec{\nabla} \cdot \vec{A} &= \frac{\partial}{\partial x} A_x + \frac{\partial}{\partial y} A_y + \frac{\partial}{\partial z} A_z \\ \vec{\nabla} \times \vec{A} &= \hat{x} \left(\frac{\partial}{\partial y} A_z - \frac{\partial}{\partial z} A_y \right) + \hat{y} \left(\frac{\partial}{\partial z} A_x - \frac{\partial}{\partial x} A_z \right) + \hat{z} \left(\frac{\partial}{\partial x} A_y - \frac{\partial}{\partial y} A_x \right)\end{aligned}$$

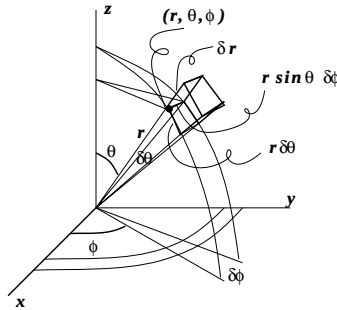


Cilíndricas: $(\rho, \phi, z) \rightarrow (\hat{\rho}, \hat{\phi}, \hat{z})$

$$\begin{aligned}\vec{\nabla}\psi &= \left(\hat{\rho} \frac{\partial}{\partial \rho} + \hat{\phi} \frac{1}{\rho} \frac{\partial}{\partial \phi} + \hat{z} \frac{\partial}{\partial z} \right) \psi \\ \nabla^2 \psi &= \left(\frac{1}{\rho} \frac{\partial}{\partial \rho} \rho \frac{\partial}{\partial \rho} + \frac{1}{\rho^2} \frac{\partial^2}{\partial \phi^2} + \frac{\partial^2}{\partial z^2} \right) \psi \\ \vec{\nabla} \cdot \vec{A} &= \frac{1}{\rho} \frac{\partial}{\partial \rho} (\rho A_\rho) + \frac{1}{\rho} \frac{\partial}{\partial \phi} (A_\phi) + \frac{\partial}{\partial z} A_z \\ \vec{\nabla} \times \vec{A} &= \hat{\rho} \left(\frac{1}{\rho} \frac{\partial}{\partial \phi} A_z - \frac{\partial}{\partial z} A_\phi \right) + \hat{\phi} \left(\frac{\partial}{\partial z} A_\rho - \frac{\partial}{\partial \rho} A_z \right) + \hat{z} \frac{1}{\rho} \left(\frac{\partial}{\partial \rho} (\rho A_\phi) - \frac{\partial}{\partial \phi} A_\rho \right)\end{aligned}$$



Esféricas: $(r, \theta, \phi) \rightarrow (\hat{r}, \hat{\theta}, \hat{\phi})$



$$\begin{aligned}\vec{\nabla}\psi &= \left(\hat{r} \frac{\partial}{\partial r} + \hat{\theta} \frac{1}{r} \frac{\partial}{\partial \theta} + \hat{\phi} \frac{1}{r \sin \theta} \frac{\partial}{\partial \phi} \right) \psi \\ \nabla^2 \psi &= \left(\frac{1}{r^2} \frac{\partial}{\partial r} r^2 \frac{\partial}{\partial r} + \frac{1}{r^2 \sin \theta} \frac{\partial}{\partial \theta} \sin \theta \frac{\partial}{\partial \theta} + \frac{1}{r^2 \sin^2 \theta} \frac{\partial^2}{\partial \phi^2} \right) \psi \\ \vec{\nabla} \cdot \vec{A} &= \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 A_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta A_\theta) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \phi} (A_\phi) \\ \vec{\nabla} \times \vec{A} &= \hat{r} \frac{1}{r \sin \theta} \left(\frac{\partial}{\partial \theta} (\sin \theta A_\phi) - \frac{\partial}{\partial \phi} A_\theta \right) + \hat{\theta} \frac{1}{r} \left(\frac{1}{\sin \theta} \frac{\partial}{\partial \phi} A_r - \frac{\partial}{\partial r} (r A_\phi) \right) + \hat{\phi} \frac{1}{r} \left(\frac{\partial}{\partial r} (r A_\theta) - \frac{\partial}{\partial \theta} A_r \right)\end{aligned}$$