1. Identidades vectoriales

1.1. Productos vectoriales y escalares

1.1.1. Producto escalar

Si $\overrightarrow{\mathbf{A}}$ y $\overrightarrow{\mathbf{B}}$ son vectores que en una base ortonormal $\{\overrightarrow{\mathbf{u}}_1, \overrightarrow{\mathbf{u}}_2, \overrightarrow{\mathbf{u}}_3\}$ se escriben como: $\overrightarrow{\mathbf{A}} = A_1\overrightarrow{\mathbf{u}}_1 + A_2\overrightarrow{\mathbf{u}}_2 + A_3\overrightarrow{\mathbf{u}}_3$ y $\overrightarrow{\mathbf{B}} = B_1\overrightarrow{\mathbf{u}}_1 + B_2\overrightarrow{\mathbf{u}}_2 + B_3\overrightarrow{\mathbf{u}}_3$, entonces su producto escalar se define:

$$\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{B}} = A_1B_1 + A_2B_2 + A_3B_3 \tag{1}$$

$$\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{B}} = \left|\overrightarrow{\mathbf{A}}\right|\left|\overrightarrow{\mathbf{B}}\right|\cos\theta \tag{2}$$

siendo θ el ángulo que forman dichos vectores.

Si $\overrightarrow{\mathbf{A}}$ es un vector unitario, entonces $\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{B}}$ se corresponde con la proyección de $\overrightarrow{\mathbf{B}}$ sobre la dirección definida por el vector unitario $\overrightarrow{\mathbf{A}}$.

$$\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{B}} = \overrightarrow{\mathbf{B}} \cdot \overrightarrow{\mathbf{A}} \tag{3}$$

$$\overrightarrow{\mathbf{A}} \cdot \left(\overrightarrow{\mathbf{B}} + \overrightarrow{\mathbf{C}}\right) = \overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{B}} + \overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{C}} \tag{4}$$

1.1.2. Producto vectorial

Si $\overrightarrow{\mathbf{A}}$ y $\overrightarrow{\mathbf{B}}$ son vectores que en una base ortonormal $\{\overrightarrow{\mathbf{u}}_1, \overrightarrow{\mathbf{u}}_2, \overrightarrow{\mathbf{u}}_3\}$ se escriben como: $\overrightarrow{\mathbf{A}} = A_1\overrightarrow{\mathbf{u}}_1 + A_2\overrightarrow{\mathbf{u}}_2 + A_3\overrightarrow{\mathbf{u}}_3$ y $\overrightarrow{\mathbf{B}} = B_1\overrightarrow{\mathbf{u}}_1 + B_2\overrightarrow{\mathbf{u}}_2 + B_3\overrightarrow{\mathbf{u}}_3$, entonces su producto vectorial se define:

$$
\begin{aligned}
\overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{B}} &= \begin{vmatrix} \overrightarrow{\mathbf{u}}_1 & \overrightarrow{\mathbf{u}}_2 & \overrightarrow{\mathbf{u}}_3 \\ A_1 & A_2 & A_3 \\ B_1 & B_2 & B_3 \end{vmatrix} = \\
&= (A_2B_3 - A_3B_2)\overrightarrow{\mathbf{u}}_1 + (A_3B_1 - A_1B_3)\overrightarrow{\mathbf{u}}_2 + \\
&+ (A_1B_2 - A_2B_1)\overrightarrow{\mathbf{u}}_3
\end{aligned}
\tag{5}
$$

$$\left|\overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{B}}\right| = \left|\overrightarrow{\mathbf{A}}\right|\left|\overrightarrow{\mathbf{B}}\right|\sin\theta \tag{6}$$

$\left|\overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{B}}\right|$ coincide con el área del paralelogramo definido por ambos vectores.

$$\overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{B}} = -\overrightarrow{\mathbf{B}} \times \overrightarrow{\mathbf{A}} \tag{7}$$

$$\overrightarrow{\mathbf{A}} \times \left(\overrightarrow{\mathbf{B}} + \overrightarrow{\mathbf{C}}\right) = \overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{B}} + \overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{C}} \tag{8}$$
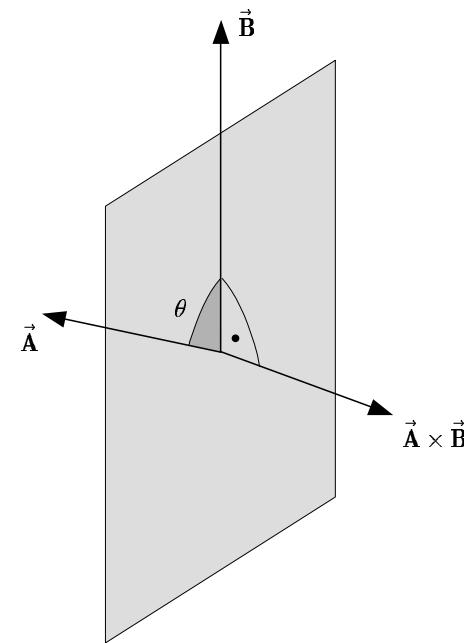
1.1.3. Identidades vectoriales

$$\overrightarrow{\mathbf{A}} \times \left(\overrightarrow{\mathbf{B}} \times \overrightarrow{\mathbf{C}}\right) = \overrightarrow{\mathbf{B}}\left(\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{C}}\right) - \overrightarrow{\mathbf{C}}\left(\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{B}}\right) \tag{9}$$

$$\left(\overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{B}}\right) \times \overrightarrow{\mathbf{C}} = \overrightarrow{\mathbf{B}}\left(\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{C}}\right) - \overrightarrow{\mathbf{A}}\left(\overrightarrow{\mathbf{B}} \cdot \overrightarrow{\mathbf{C}}\right) \tag{10}$$

$$\left(\overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{B}}\right) \cdot \left(\overrightarrow{\mathbf{C}} \times \overrightarrow{\mathbf{D}}\right) = \left(\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{C}}\right)\left(\overrightarrow{\mathbf{B}} \cdot \overrightarrow{\mathbf{D}}\right) - \left(\overrightarrow{\mathbf{A}} \cdot \overrightarrow{\mathbf{D}}\right)\left(\overrightarrow{\mathbf{B}} \cdot \overrightarrow{\mathbf{C}}\right) \tag{11}$$

$$
\begin{aligned}
\left(\overrightarrow{\mathbf{A}} \times \overrightarrow{\mathbf{B}}\right) &\times \left(\overrightarrow{\mathbf{C}} \times \overrightarrow{\mathbf{D}}\right) = \\
&= \overrightarrow{\mathbf{C}}\left[\overrightarrow{\mathbf{A}} \cdot \left(\overrightarrow{\mathbf{B}} \times \overrightarrow{\mathbf{D}}\right)\right] - \overrightarrow{\mathbf{D}}\left[\overrightarrow{\mathbf{A}} \cdot \left(\overrightarrow{\mathbf{B}} \times \overrightarrow{\mathbf{C}}\right)\right] = \\
&= \overrightarrow{\mathbf{B}}\left[\overrightarrow{\mathbf{A}} \cdot \left(\overrightarrow{\mathbf{C}} \times \overrightarrow{\mathbf{D}}\right)\right] - \overrightarrow{\mathbf{A}}\left[\overrightarrow{\mathbf{B}} \cdot \left(\overrightarrow{\mathbf{C}} \times \overrightarrow{\mathbf{D}}\right)\right]
\end{aligned}
\tag{12}
$$

2. Coordenadas Cartesianas

2.1. Transformación de Coordenadas

2.1.1. Desde Coordenadas Cilíndricas

$$
\begin{aligned}
x &= \rho \cos \varphi & (13) \\
y &= \rho \,\mathrm{sen}\, \varphi & (14) \\
z &= z & (15)
\end{aligned}
$$

2.1.2. Desde Coordenadas Esféricas

$$
\begin{aligned}
x &= r \,\mathrm{sen}\, \theta \cos \varphi & (16) \\
y &= r \,\mathrm{sen}\, \theta \,\mathrm{sen}\, \varphi & (17) \\
z &= r \cos \theta & (18)
\end{aligned}
$$

2.2. Transformación de Vectores

2.2.1. Desde Coordenadas Cilíndricas

$$
\begin{aligned}
A_x &= A_\rho \cos \varphi - A_\varphi \,\mathrm{sen}\, \varphi & (19) \\
A_y &= A_\rho \,\mathrm{sen}\, \varphi + A_\varphi \cos \varphi & (20) \\
A_z &= A_z & (21)
\end{aligned}
$$

2.2.2. Desde Coordenadas Esféricas

$$
\begin{aligned}
A_x &= A_r \,\mathrm{sen}\, \theta \cos \varphi - A_\varphi \,\mathrm{sen}\, \varphi + A_\theta \cos \theta \cos \varphi & (22) \\
A_y &= A_r \,\mathrm{sen}\, \theta \cos \varphi + A_\varphi \cos \varphi + A_\theta \cos \theta \cos \varphi & (23) \\
A_z &= A_r \cos \theta - A_\theta \,\mathrm{sen}\, \theta & (24)
\end{aligned}
$$
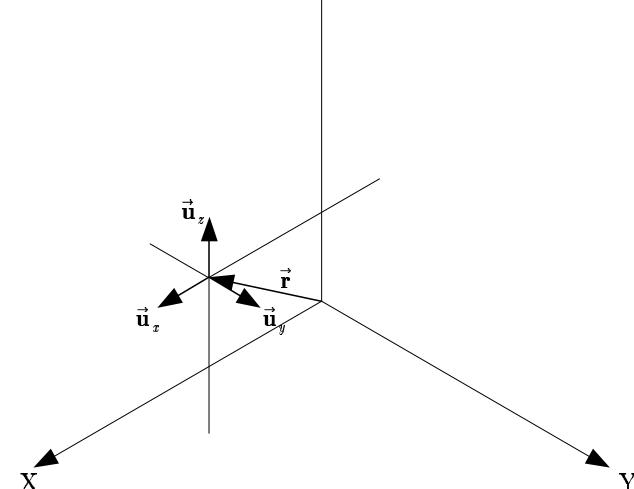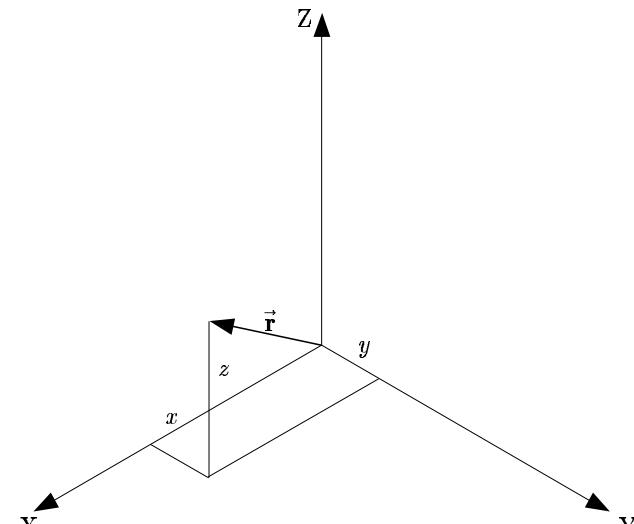
3. Coordenadas Cilíndricas

3.1. Transformación de Coordenadas

3.1.1. Desde Coordenadas Cartesianas

$$\rho = \sqrt{x^2 + y^2} \tag{25}$$

$$\operatorname{tg}\varphi = \frac{y}{x} \tag{26}$$

$$z = z \tag{27}$$

3.1.2. Desde Coordenadas Esféricas

$$\rho = r\operatorname{sen}\theta \tag{28}$$

$$\varphi = \varphi \tag{29}$$

$$z = r\cos\theta \tag{30}$$

3.2. Transformación de Vectores

3.2.1. Desde Coordenadas Cartesianas

$$A_\rho = A_x \frac{x}{\sqrt{x^2 + y^2}} + A_y \frac{y}{\sqrt{x^2 + y^2}} \tag{31}$$

$$A_\varphi = -A_x \frac{y}{\sqrt{x^2 + y^2}} + A_y \frac{x}{\sqrt{x^2 + y^2}} \tag{32}$$

$$A_z = A_z \tag{33}$$

3.2.2. Desde Coordenadas Esféricas

$$A_\rho = A_r \operatorname{sen}\theta + A_\theta \cos\theta \tag{34}$$

$$A_\varphi = A_\varphi \tag{35}$$

$$A_z = A_r \cos\theta - A_\theta \operatorname{sen}\theta \tag{36}$$

3
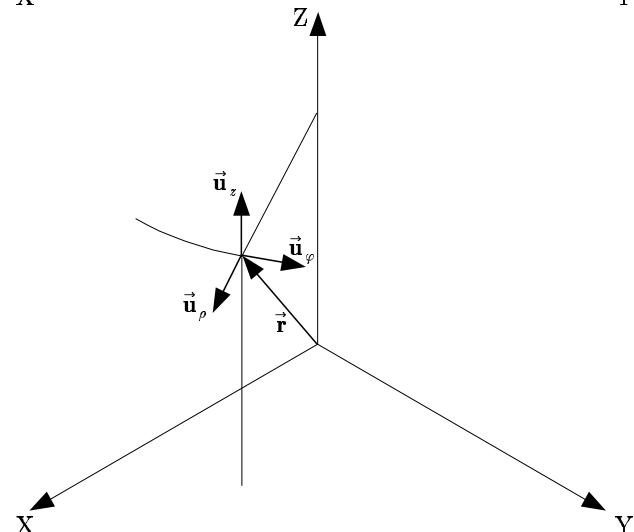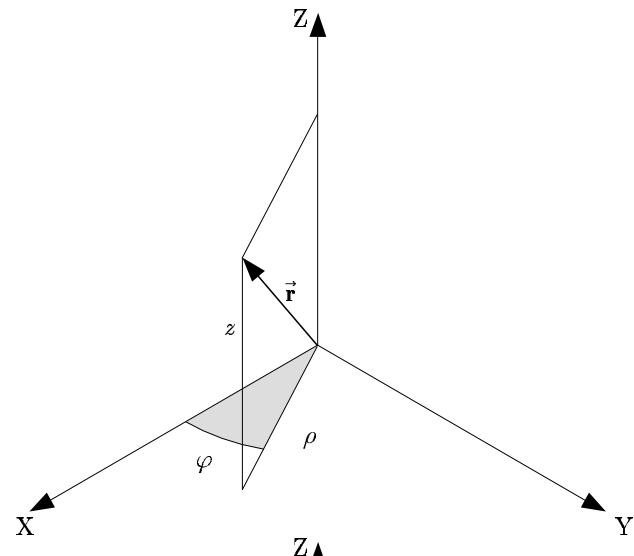
4. Coordenadas Esféricas

4.1. Transformación de Coordenadas

4.1.1. Desde Coordenadas Cartesianas

$$r = \sqrt{x^2 + y^2 + z^2} \tag{37}$$

$$\operatorname{tg}\theta = \frac{\sqrt{x^2 + y^2}}{z} \tag{38}$$

$$\operatorname{tg}\varphi = \frac{y}{x} \tag{39}$$

4.1.2. Desde Coordenadas Cilíndricas

$$r = \sqrt{\rho^2 + z^2} \tag{40}$$

$$\operatorname{tg}\theta = \frac{\rho}{z} \tag{41}$$

$$\varphi = \varphi \tag{42}$$

4.2. Transformación de Vectores

4.2.1. Desde Coordenadas Cartesianas

$$A_r = A_x \frac{x}{\sqrt{x^2 + y^2 + z^2}} + \tag{43}$$

$$+ \quad A_y \frac{y}{\sqrt{x^2 + y^2 + z^2}} + A_z \frac{z}{\sqrt{x^2 + y^2 + z^2}}$$

$$A_\varphi = -A_x \frac{y}{\sqrt{x^2 + y^2}} + A_y \frac{x}{\sqrt{x^2 + y^2}} \tag{44}$$

$$A_\theta = A_x \frac{xz}{\sqrt{(x^2 + y^2 + z^2)(x^2 + y^2)}} + \tag{45}$$

$$+ \quad A_y \frac{yz}{\sqrt{(x^2 + y^2 + z^2)(x^2 + y^2)}} - A_z \frac{\sqrt{x^2 + y^2}}{\sqrt{x^2 + y^2 + z^2}}$$

4.2.2. Desde Coordenadas Cilíndricas

$$A_r = A_\rho \frac{\rho}{\sqrt{\rho^2 + z^2}} + A_z \frac{z}{\sqrt{\rho^2 + z^2}} \tag{46}$$
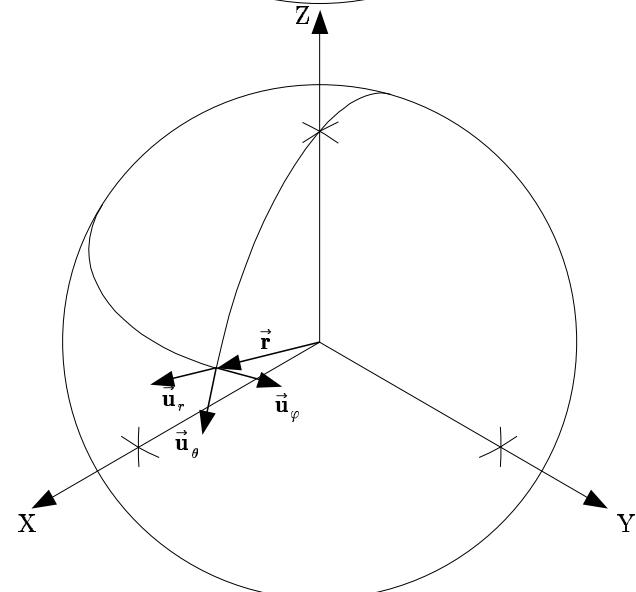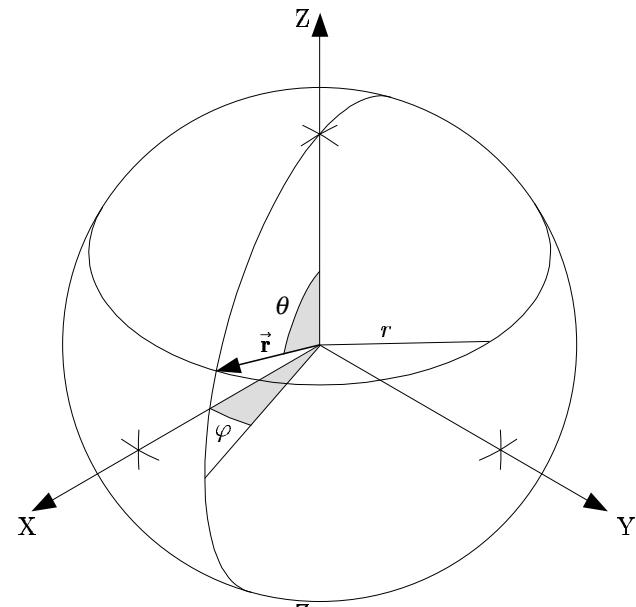
$$A_\varphi = A_\varphi \tag{47}$$
$$A_\theta = A_\rho \frac{z}{\sqrt{\rho^2 + z^2}} - A_z \frac{\rho}{\sqrt{\rho^2 + z^2}} \tag{48}$$
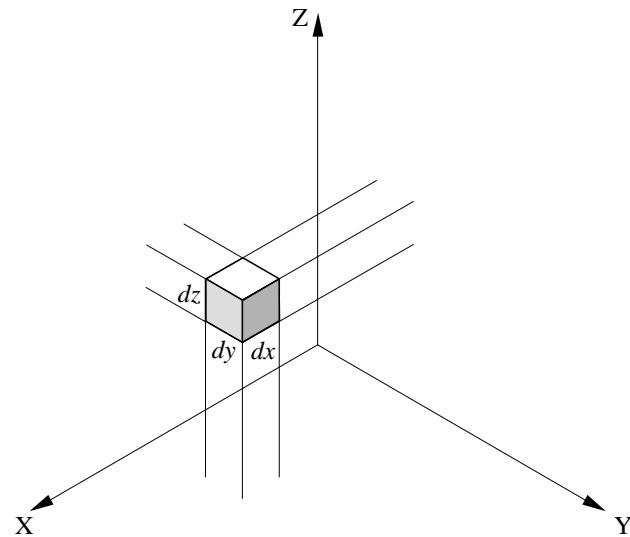
5. Fórmulas de análisis vectorial

5.1. Coordenadas Cartesianas

5.1.1. Elemento de longitud

$$d\vec{\mathbf{r}} = dx\,\vec{\mathbf{u}}_x + dy\,\vec{\mathbf{u}}_y + dz\,\vec{\mathbf{u}}_z \tag{49}$$
$$dr = \sqrt{dx^2 + dy^2 + dz^2} \tag{50}$$

5.1.2. Elementos de superficie

$$d\vec{\mathbf{s}}_x = dydz\,\vec{\mathbf{u}}_x \tag{51}$$
$$d\vec{\mathbf{s}}_y = dzdx\,\vec{\mathbf{u}}_y \tag{52}$$
$$d\vec{\mathbf{s}}_z = dxdy\,\vec{\mathbf{u}}_z \tag{53}$$

5.1.3. Elemento de volumen

$$dv = dxdydz \tag{54}$$
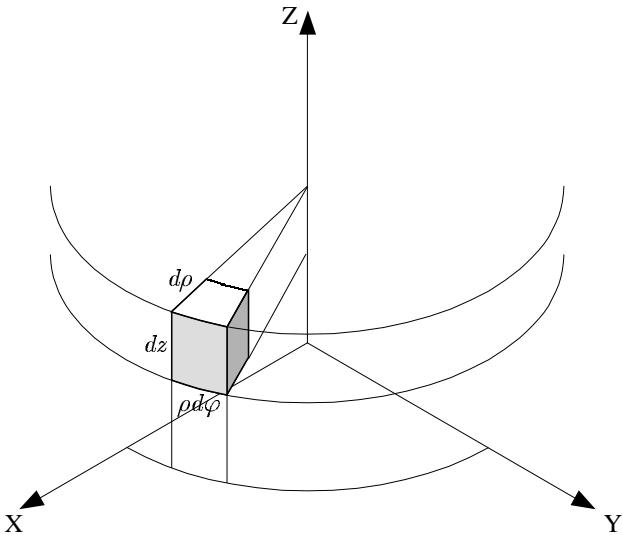
5.2. Coordenadas Cilíndricas

5.2.1. Elemento de longitud

$$
\begin{aligned}
d\overrightarrow{\mathbf{r}} &= d\rho\,\overrightarrow{\mathbf{u}}_\rho + \rho d\varphi\,\overrightarrow{\mathbf{u}}_\varphi + dz\,\overrightarrow{\mathbf{u}}_z & (55) \\
dr &= \sqrt{d\rho^2 + \rho^2 d\varphi^2 + dz^2} & (56)
\end{aligned}
$$

5.2.2. Elementos de superficie

$$
\begin{aligned}
d\overrightarrow{\mathbf{s}}_\rho &= \rho d\varphi dz\,\overrightarrow{\mathbf{u}}_\rho & (57) \\
d\overrightarrow{\mathbf{s}}_\varphi &= d\rho dz\,\overrightarrow{\mathbf{u}}_\varphi & (58) \\
d\overrightarrow{\mathbf{s}}_z &= \rho d\rho d\varphi\,\overrightarrow{\mathbf{u}}_z & (59)
\end{aligned}
$$

5.2.3. Elemento de volumen

$$
dv = \rho d\rho d\varphi dz \qquad (60)
$$
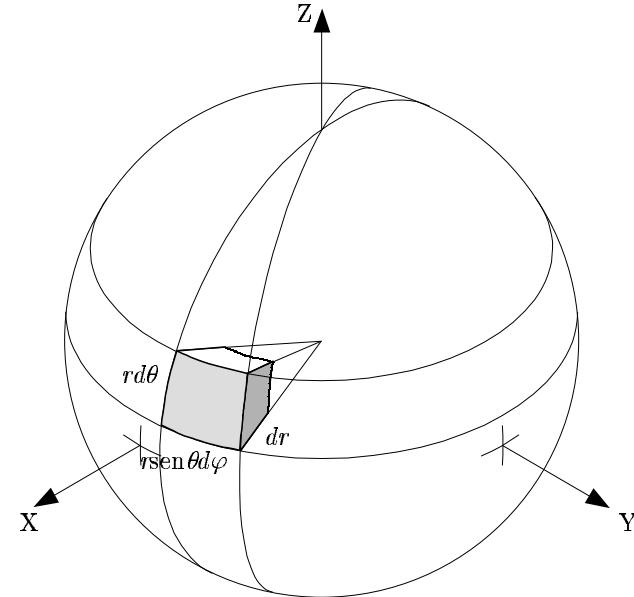
5.3. Coordenadas Esféricas

5.3.1. Elemento de longitud

$$
\begin{aligned}
d\overrightarrow{\mathbf{r}} &= dr\,\overrightarrow{\mathbf{u}}_r + r\,\mathrm{sen}\,\theta d\varphi\,\overrightarrow{\mathbf{u}}_\varphi + rd\theta\,\overrightarrow{\mathbf{u}}_\theta & (61) \\
dr &= \sqrt{dr^2 + r^2\,\mathrm{sen}^2\,\theta d\varphi^2 + r^2 d\theta^2} & (62)
\end{aligned}
$$

5.3.2. Elementos de superficie

$$
\begin{aligned}
d\overrightarrow{\mathbf{s}}_r &= r^2\,\mathrm{sen}\,\theta d\varphi d\theta\,\overrightarrow{\mathbf{u}}_r & (63) \\
d\overrightarrow{\mathbf{s}}_\theta &= r\,\mathrm{sen}\,\theta dr d\varphi\,\overrightarrow{\mathbf{u}}_\theta & (64) \\
d\overrightarrow{\mathbf{s}}_\varphi &= rdr d\theta\,\overrightarrow{\mathbf{u}}_\varphi & (65)
\end{aligned}
$$

5.3.3. Elemento de volumen

$$
dv = r^2\,\mathrm{sen}\,\theta dr d\theta d\varphi \qquad (66)
$$

5.4. Gradiente, Divergencia y Rotacional

5.4.1. Coordenadas Cartesianas

$$\overrightarrow{\nabla}\Phi \;=\; \frac{\partial\Phi}{\partial x}\overrightarrow{\mathbf{u}}_x + \frac{\partial\Phi}{\partial y}\overrightarrow{\mathbf{u}}_y + \frac{\partial\Phi}{\partial z}\overrightarrow{\mathbf{u}}_z \tag{67}$$

$$\overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{A}} \;=\; \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z} \tag{68}$$

$$\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}} \;=\; \left(\frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z}\right)\overrightarrow{\mathbf{u}}_x + \tag{69}$$
$$+\; \left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right)\overrightarrow{\mathbf{u}}_y + \left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right)\overrightarrow{\mathbf{u}}_z$$

5.4.2. Coordenadas Cilíndricas

$$\overrightarrow{\nabla}\Phi \;=\; \frac{\partial\Phi}{\partial\rho}\overrightarrow{\mathbf{u}}_\rho + \frac{1}{\rho}\frac{\partial\Phi}{\partial\varphi}\overrightarrow{\mathbf{u}}_\varphi + \frac{\partial\Phi}{\partial z}\overrightarrow{\mathbf{u}}_z \tag{70}$$

$$\overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{A}} \;=\; \frac{1}{\rho}\frac{\partial(\rho A_\rho)}{\partial\rho} + \frac{1}{\rho}\frac{\partial A_\varphi}{\partial\varphi} + \frac{\partial A_z}{\partial z} \tag{71}$$

$$\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}} \;=\; \left(\frac{1}{\rho}\frac{\partial A_z}{\partial\varphi} - \frac{\partial A_\varphi}{\partial z}\right)\overrightarrow{\mathbf{u}}_\rho + \tag{72}$$
$$+\; \left(\frac{\partial A_\rho}{\partial z} - \frac{\partial A_z}{\partial\rho}\right)\overrightarrow{\mathbf{u}}_\varphi + \left[\frac{1}{\rho}\frac{\partial(\rho A_\varphi)}{\partial\rho} - \frac{1}{\rho}\frac{\partial A_\rho}{\partial\varphi}\right]\overrightarrow{\mathbf{u}}_z$$

5.4.3. Coordenadas Esféricas

$$\overrightarrow{\nabla}\Phi \;=\; \frac{\partial\Phi}{\partial r}\overrightarrow{\mathbf{u}}_r + \frac{1}{r}\frac{\partial\Phi}{\partial\theta}\overrightarrow{\mathbf{u}}_\theta + \frac{1}{r\,\mathrm{sen}\,\theta}\frac{\partial\Phi}{\partial\varphi}\overrightarrow{\mathbf{u}}_\varphi \tag{73}$$

$$\overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{A}} \;=\; \frac{1}{r^2}\frac{\partial\left(r^2 A_r\right)}{\partial r} + \frac{1}{r\,\mathrm{sen}\,\theta}\frac{\partial\left(\mathrm{sen}\,\theta A_\theta\right)}{\partial\theta} + \frac{1}{r\,\mathrm{sen}\,\theta}\frac{\partial A_\phi}{\partial\varphi} \tag{74}$$

$$\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}} \;=\; \left\{\frac{1}{r\,\mathrm{sen}\,\theta}\left[\frac{\partial\left(\mathrm{sen}\,\theta A_\varphi\right)}{\partial\theta} - \frac{\partial A_\theta}{\partial\varphi}\right]\right\}\overrightarrow{\mathbf{u}}_r + \tag{75}$$
$$+\; \left[\frac{1}{r\,\mathrm{sen}\,\theta}\frac{\partial A_r}{\partial\varphi} - \frac{1}{r}\frac{\partial\left(r A_\varphi\right)}{\partial r}\right]\overrightarrow{\mathbf{u}}_\theta +$$
$$+\; \left\{\frac{1}{r}\left[\frac{\partial\left(r A_\theta\right)}{\partial r} - \frac{\partial A_r}{\partial\theta}\right]\right\}\overrightarrow{\mathbf{u}}_\varphi$$

5.4.4. Identidades

$$\overrightarrow{\nabla}\times\overrightarrow{\nabla}\Phi \;=\; \overrightarrow{\mathbf{0}} \tag{76}$$

$$\overrightarrow{\nabla}\cdot\left(\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}}\right) \;=\; 0 \tag{77}$$

$$\overrightarrow{\nabla}\cdot\left(\overrightarrow{\nabla}\Phi\right) \;=\; \nabla^2\Phi \tag{78}$$

$$\overrightarrow{\nabla}\times\left(\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}}\right) \;=\; \overrightarrow{\nabla}\left(\overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{A}}\right) - \nabla^2\overrightarrow{\mathbf{A}} \tag{79}$$

$$\overrightarrow{\nabla}\left(\Phi + \Psi\right) \;=\; \overrightarrow{\nabla}\Phi + \overrightarrow{\nabla}\Psi \tag{80}$$

$$\overrightarrow{\nabla}\cdot\left(\overrightarrow{\mathbf{A}} + \overrightarrow{\mathbf{B}}\right) \;=\; \overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{A}} + \overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{B}} \tag{81}$$

$$\overrightarrow{\nabla}\times\left(\overrightarrow{\mathbf{A}} + \overrightarrow{\mathbf{B}}\right) \;=\; \overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}} + \overrightarrow{\nabla}\times\overrightarrow{\mathbf{B}} \tag{82}$$

$$\overrightarrow{\nabla}\left(\Phi\Psi\right) \;=\; \Psi\overrightarrow{\nabla}\Phi + \Phi\overrightarrow{\nabla}\Psi \tag{83}$$

$$\overrightarrow{\nabla}\cdot\left(\Phi\overrightarrow{\mathbf{A}}\right) \;=\; \overrightarrow{\mathbf{A}}\cdot\overrightarrow{\nabla}\Phi + \Phi\overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{A}} \tag{84}$$

$$\overrightarrow{\nabla}\left(\overrightarrow{\mathbf{A}}\cdot\overrightarrow{\mathbf{B}}\right) \;=\; \left(\overrightarrow{\mathbf{A}}\cdot\overrightarrow{\nabla}\right)\overrightarrow{\mathbf{B}} + \left(\overrightarrow{\mathbf{B}}\cdot\overrightarrow{\nabla}\right)\overrightarrow{\mathbf{A}} + \tag{85}$$
$$+\; \overrightarrow{\mathbf{A}}\times\left(\overrightarrow{\nabla}\times\overrightarrow{\mathbf{B}}\right) + \overrightarrow{\mathbf{B}}\times\left(\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}}\right)$$

$$\overrightarrow{\nabla}\cdot\left(\overrightarrow{\mathbf{A}}\times\overrightarrow{\mathbf{B}}\right) \;=\; \overrightarrow{\mathbf{B}}\,\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}} + \overrightarrow{\mathbf{A}}\,\overrightarrow{\nabla}\times\overrightarrow{\mathbf{B}} \tag{86}$$

$$\overrightarrow{\nabla}\times\left(\Phi\overrightarrow{\mathbf{A}}\right) \;=\; \overrightarrow{\nabla}\Phi\times\overrightarrow{\mathbf{A}} + \Phi\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}} \tag{87}$$

$$\overrightarrow{\nabla}\times\left(\overrightarrow{\mathbf{A}}\times\overrightarrow{\mathbf{B}}\right) \;=\; \overrightarrow{\mathbf{A}}\,\overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{B}} - \overrightarrow{\mathbf{B}}\,\overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{A}} + \tag{88}$$
$$+\; \left(\overrightarrow{\mathbf{B}}\cdot\overrightarrow{\nabla}\right)\overrightarrow{\mathbf{A}} - \left(\overrightarrow{\mathbf{A}}\cdot\overrightarrow{\nabla}\right)\overrightarrow{\mathbf{B}}$$

5.4.5. Teoremas

$$\int_v \left(\overrightarrow{\nabla}\cdot\overrightarrow{\mathbf{A}}\right) dv \;=\; \oint_s \overrightarrow{\mathbf{A}}\cdot d\overrightarrow{\mathbf{s}} \tag{89}$$

$$\int_s \left(\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}}\right) d\overrightarrow{\mathbf{s}} \;=\; \oint_c \overrightarrow{\mathbf{A}}\cdot d\overrightarrow{\mathbf{r}} \tag{90}$$

$$\int_v \left(\overrightarrow{\nabla}\times\overrightarrow{\mathbf{A}}\right) dv \;=\; \oint_s d\overrightarrow{\mathbf{s}}\times\overrightarrow{\mathbf{A}} \tag{91}$$

$$\int_s d\overrightarrow{\mathbf{s}}\times\overrightarrow{\nabla}\Phi \;=\; \oint_c \Phi\, d\overrightarrow{\mathbf{r}} \tag{92}$$