

Consider a Vertical Slot Antenna

•From Ramo, Whinnery and Van Duzer, P 620

$$\overline{E} = \frac{E_0}{R} e^{j(\omega t - \beta R)} \frac{\cos\left(\frac{\pi}{2} \cos \theta\right)}{\sin \theta} \overline{a}_\Phi$$

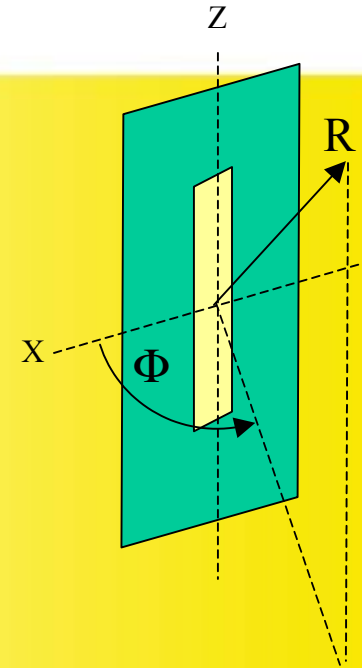
$$\overline{E} = \frac{E_s}{R} e^{-j\beta R} \frac{\cos\left(\frac{\pi}{2} \cos \theta\right)}{\sin \theta} \overline{a}_\Phi$$

$$\overline{a}_\Phi = -\sin \phi \overline{a}_x + \cos \phi \overline{a}_y = \frac{-y}{\sqrt{x^2 + y^2}} \overline{a}_x + \frac{x}{\sqrt{x^2 + y^2}} \overline{a}_y$$

$$R = \sqrt{x^2 + y^2 + z^2}$$

$$\cos \theta = \frac{z}{\sqrt{x^2 + y^2 + z^2}}$$

$$\sin \theta = \frac{\sqrt{x^2 + y^2}}{\sqrt{x^2 + y^2 + z^2}}$$



Where:

$\overline{E}$ =Electric field strength vector

R=radial distance from antenna

ω =radian frequency

β =Propagation constant

E_ϕ = Electric field component

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Expressing in Rectangular Coordinates

$$\bar{E} = \frac{E_s}{\sqrt{x^2 + y^2 + z^2}} e^{-j\beta \sqrt{x^2 + y^2 + z^2}} \frac{\cos\left(\frac{\pi}{2} \frac{z}{\sqrt{x^2 + y^2 + z^2}}\right)}{\frac{\sqrt{x^2 + y^2}}{\sqrt{x^2 + y^2 + z^2}}} \left(\frac{-y}{\sqrt{x^2 + y^2}} \bar{a}_x + \frac{x}{\sqrt{x^2 + y^2}} \bar{a}_y \right)$$

$$E_x = E_s e^{-j\beta \sqrt{x^2 + y^2 + z^2}} \frac{\cos\left(\frac{\pi}{2} \frac{z}{\sqrt{x^2 + y^2 + z^2}}\right)}{x^2 + y^2} (-y)$$

$$E_y = E_s e^{-j\beta \sqrt{x^2 + y^2 + z^2}} \frac{\cos\left(\frac{\pi}{2} \frac{z}{\sqrt{x^2 + y^2 + z^2}}\right)}{x^2 + y^2} (x)$$

$$E_z = 0$$

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Consider an arbitrarily location
 (x_n, y_n, z_n)

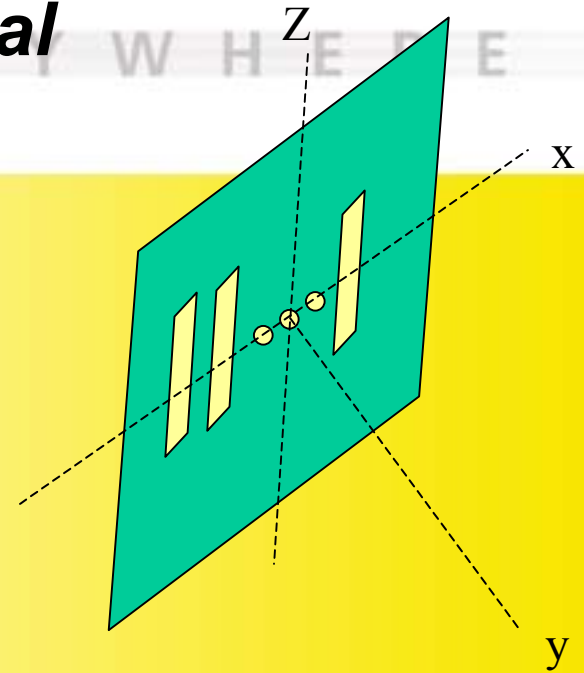
$$E_x = E_s e^{-j\beta \sqrt{(x-x_n)^2 + (y-y_n)^2 + (z-z_n)^2}} \frac{\cos\left(\frac{\pi}{2} \frac{z-z_n}{\sqrt{(x-x_n)^2 + (y-y_n)^2 + (z-z_n)^2}}\right)}{(x-x_n)^2 + (y-y_n)^2} (y_n - y)$$

$$E_y = E_s e^{-j\beta \sqrt{(x-x_n)^2 + (y-y_n)^2 + (z-z_n)^2}} \frac{\cos\left(\frac{\pi}{2} \frac{z-z_n}{\sqrt{(x-x_n)^2 + (y-y_n)^2 + (z-z_n)^2}}\right)}{(x-x_n)^2 + (y-y_n)^2} (x - x_n)$$

$$E_z = 0$$

An Array of Vertical Slot Antennas

Consider an array of vertical slot antennae located in positions $(X_n, 0, Z_n)$



$$E_x = \sum_n E_n e^{-j\beta \sqrt{(x-x_n)^2 + (y)^2 + (z-z_n)^2}} \frac{\cos\left(\frac{\pi}{2} \frac{z-z_n}{\sqrt{(x-x_n)^2 + (y)^2 + (z-z_n)^2}}\right)}{(x-x_n)^2 + (y)^2} (-y)$$

$$E_y = \sum_n E_n e^{-j\beta \sqrt{(x-x_n)^2 + (y)^2 + (z-z_n)^2}} \frac{\cos\left(\frac{\pi}{2} \frac{z-z_n}{\sqrt{(x-x_n)^2 + (y)^2 + (z-z_n)^2}}\right)}{(x-x_n)^2 + (y)^2} (x-x_n)$$

$$E_z = 0$$