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## Uniform plane waves - free space

→ assumptions lead to  $\frac{\partial^2 E_x}{\partial z^2} = \mu_0 \epsilon_0 \frac{\partial^2 E_x}{\partial t^2}$

$$E_x(z,t) = \underbrace{E^+}_{\text{initial conditions}} \cos(\omega t - \underbrace{\beta_0 z}_{\text{direction of propagation}} + \underbrace{\phi^+}_{\text{phase constant}}) + E^- \cos(\omega t + \beta_0 z + \phi^-)$$

→ initial conditions

$$\omega = 2\pi f$$

$$T = \frac{1}{f}$$

→ phase constant

$$\beta_0 = \frac{2\pi}{\lambda}$$

$$= \omega \sqrt{\mu_0 \epsilon_0}$$

→ direction of propagation

→ phase velocity:  $v_p = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$

$$\nabla \times \vec{E}_s = -j\omega \mu_0 \vec{H}_s \Rightarrow$$

$$H_y(z,t) = \frac{E^+}{\underbrace{\eta_0}_{\text{intrinsic impedance}}} \cos(\omega t - \beta_0 z + \phi^+) - \frac{E^-}{\underbrace{\eta_0}_{\text{intrinsic impedance}}} \cos(\omega t + \beta_0 z + \phi^-)$$

$$\eta_0 = \sqrt{\frac{\mu_0}{\epsilon_0}} = 377 \Omega$$

