



SIGN CONVENTIONS FOR EM WAVES

EE 3321 Electromagnetic Field Theory

Pioneering 21st Century
Electromagnetics and Photonics



<http://emlab.utep.edu>

EQUATION(S)	ELECTRICAL ENGINEERING (Negative Sign Convention)	PHYSICS / SCIENCE (Positive Sign Convention)
Wave Propagating in +z Direction	$\cos(\omega t \mp kz)$ – forward wave $\exp(\mp jkz)$ + backward wave	$\cos(-\omega t \pm kz)$ – backward wave $\exp(\pm ikz)$ + forward wave
Maxwell's Equations	$\nabla \times \vec{E} = -j\omega\vec{B}$ $\nabla \cdot \vec{D} = \rho_v$ $\nabla \times \vec{H} = \vec{J} + j\omega\vec{D}$ $\nabla \cdot \vec{B} = 0$ $\vec{D} = \epsilon\vec{E}$ $\vec{B} = \mu\vec{H}$	$\nabla \times \vec{E} = i\omega\vec{B}$ $\nabla \cdot \vec{D} = \rho_v$ $\nabla \times \vec{H} = -\vec{J} - i\omega\vec{D}$ $\nabla \cdot \vec{B} = 0$ $\vec{D} = \epsilon\vec{E}$ $\vec{B} = \mu\vec{H}$
Wave Vector & Propagation Constant	$k = \beta - j\alpha$ $\gamma = jk = \alpha + j\beta$	$k = \beta + i\alpha$ $\gamma = ik = -\alpha + i\beta$
Permittivity, Permeability & Refractive Index	$\tilde{\epsilon} = \epsilon' - j\epsilon''$ $\tilde{\mu} = \mu' - j\mu''$ $\tilde{n} = n - j\kappa$	$\tilde{\epsilon} = \epsilon' + i\epsilon''$ $\tilde{\mu} = \mu' + i\mu''$ $\tilde{n} = n + i\kappa$
Lorentz Model	$\tilde{\epsilon}_r(\omega) = 1 + \frac{\omega_p^2}{\omega_0^2 - \omega^2 + j\omega\Gamma}$	$\tilde{\epsilon}_r(\omega) = 1 + \frac{\omega_p^2}{\omega_0^2 - \omega^2 - i\omega\Gamma}$

$-j \leftrightarrow i$

$\alpha < 0$ gain (grow) $\beta < 0$ backward
 $\alpha > 0$ loss (decay) $\beta > 0$ forward

$n < 0$ negative index $\kappa < 0$ gain (growth)
 $n > 0$ positive index $\kappa > 0$ loss (decay)

$\Gamma < 0$ gain (grow)
 $\Gamma > 0$ loss (decay)