SIGN CONVENTIONS FOR EM WAVES

EE 3321 Electromagnetic Field Theory

Pioneering 21st Century Electromagnetics and Photonics

http://emlab.utep.edu

EQUATION(S)	ENGINEERING (Negative Sign Convention)	$-j \leftrightarrow i$	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	$\nabla \times \vec{E} = -j\omega\vec{B}$ $\nabla \bullet \vec{D} = \rho_v$ $\vec{D} = \varepsilon\vec{E}$ $\nabla \times \vec{H} = \vec{J} + j\omega\vec{D}$ $\nabla \bullet \vec{B} = 0$ $\vec{B} = \mu\vec{H}$		$\nabla \times \vec{E} = i\omega\vec{B}$ $\nabla \bullet \vec{D} = \rho_v$ $\vec{D} = \varepsilon\vec{E}$ $\nabla \times \vec{H} = -\vec{J} - i\omega\vec{D}$ $\nabla \bullet \vec{B} = 0$ $\vec{B} = \mu\vec{H}$
Wave Vector & Propagation Constant	$k = \beta - j\alpha$ $\gamma = jk = \alpha + j\beta$	$\alpha < 0$ gain (grow) $\beta < 0$ backward $\alpha > 0$ loss (decay) $\beta > 0$ forward	$k = \beta + i\alpha$ $\gamma = ik = -\alpha + i\beta$
Complex μ, ε, and n	$\tilde{\varepsilon} = \varepsilon' - j\varepsilon''$ $\tilde{\mu} = \mu' - j\mu''$ $\tilde{n} = n - j\kappa$	$n < 0$ negative index $\kappa < 0$ gain (growth) $n > 0$ positive index $\kappa > 0$ loss (decay)	$\tilde{n} = n + i\kappa$ $\tilde{\varepsilon} = \varepsilon' + i\varepsilon''$ $\tilde{\mu} = \mu' + i\mu''$
Lorentz Model	$\tilde{\varepsilon}_{\mathrm{r}}(\omega) = 1 + \frac{\omega_{\mathrm{p}}^2}{\omega_0^2 - \omega^2 + j\omega\Gamma}$	$\Gamma < 0$ gain (grow) $\Gamma > 0$ loss (decay)	$\tilde{\varepsilon}_{\mathrm{r}}(\omega) = 1 + \frac{\omega_{\mathrm{p}}^2}{\omega_0^2 - \omega^2 - i\omega\Gamma}$
Fourier Transform	Temporal $F(\omega) = \frac{1}{2\pi}\int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt$ $f(t) = \int_{-\infty}^{\infty} F(\omega)e^{j\omega t}d\omega$ Spatial $F(k) = \frac{1}{2\pi}\int_{-\infty}^{\infty} f(x)e^{jkx}dx$ $f(x) = \int_{-\infty}^{\infty} F(k)e^{-jkx}dk$		Temporal $F(\omega) = \frac{1}{2\pi}\int_{-\infty}^{\infty} f(t)e^{i\omega t}dt$ $f(t) = \int_{-\infty}^{\infty} F(\omega)e^{-i\omega t}d\omega$ Spatial $F(k) = \frac{1}{2\pi}\int_{-\infty}^{\infty} f(x)e^{-ikx}dx$ $f(x) = \int_{-\infty}^{\infty} F(k)e^{ikx}dk$
Fourier Series	Temporal $a_n = \frac{1}{\tau}\int_{-\tau/2}^{\tau/2} f(t)e^{-j\omega t}dt$ $f(t) = \sum_{n=-\infty}^{\infty} a_n e^{j\omega t}$ Spatial $a_n = \frac{1}{\Lambda}\int_{-\Lambda/2}^{\Lambda/2} f(x)e^{j\frac{2\pi nx}{\Lambda}}dx$ $f(x) = \sum_{n=-\infty}^{\infty} a_n e^{-j\frac{2\pi nx}{\Lambda}}$		Temporal $a_n = \frac{1}{\tau}\int_{-\tau/2}^{\tau/2} f(t)e^{i\omega t}dt$ $f(t) = \sum_{n=-\infty}^{\infty} a_n e^{-i\omega t}$ Spatial $a_n = \frac{1}{\Lambda}\int_{-\Lambda/2}^{\Lambda/2} f(x)e^{-i\frac{2\pi nx}{\Lambda}}dx$ $f(x) = \sum_{n=-\infty}^{\infty} a_n e^{i\frac{2\pi nx}{\Lambda}}$