	$X_c = \frac{1}{j\omega C}$
	$X_L = j\omega L$
	$\omega = 2\pi f$
	$\beta = \frac{2\pi}{\lambda}$
	$v_p = f\lambda = \frac{\omega}{\beta}$
	$\tilde{V}(z) = V_o^+(e^{-\gamma z} + \Gamma e^{\gamma z})$
	$\tilde{I}(z) = \frac{V_o^+}{Z_o}(e^{-\gamma z} - \Gamma e^{\gamma z})$
	$\Gamma = \frac{V_o^-}{V_o^+} = -\frac{I_o^-}{I_o^+} = \frac{Z_L - Z_o}{Z_L + Z_o} = \|\Gamma\|e^{j\theta_r}$
	$l_{max} = \frac{\theta_r \lambda}{4\pi} + \frac{n\lambda}{2}, n = 0, 1, 2, 3, \ldots$
	$\gamma = \sqrt{(R' + jwL')(G' + jwC')} = \alpha + j\beta$
	$Z_o = \sqrt{\frac{R' + jwL'}{G' + jwC'}} = \frac{V_o^+}{I_o^+} = -\frac{V_o^-}{I_o^-}$
	$SWR = \frac{\|\tilde{V}\|_{max}}{\|\tilde{V}\|_{min}} = \frac{1 + \|\Gamma\|}{1 - \|\Gamma\|}$
	$Z_{in}(z) = Z_o \left[\frac{1 + \Gamma e^{j2\beta z}}{1 - \Gamma e^{j2\beta z}}\right]$ $Z_{in}(-l) = Z_o \left[\frac{Z_L + jZ_o \tan\beta l}{Z_o + jZ_L \tan\beta l}\right]$
	$V_o^+ = \left(\frac{\tilde{V}_g Z_{in}}{Z_g + Z_{in}}\right)\left(\frac{1}{e^{j\beta l} + \Gamma e^{-j\beta l}}\right)$
	$P_{avg} = \frac{1}{2} Re\left\{\tilde{V}\tilde{I}^*\right\}$

$\nabla \cdot \tilde{\mathbf{E}} = \tilde{\rho_V}/\epsilon$ $\nabla \times \tilde{\mathbf{E}} = -j\omega\mu\tilde{\mathbf{H}}$ $\nabla \cdot \tilde{\mathbf{H}} = 0$ $\nabla \times \tilde{\mathbf{H}} = \tilde{\mathbf{J}} + j\omega\epsilon\tilde{\mathbf{E}}$
$\nabla^2\tilde{\mathbf{E}} - \gamma^2\tilde{\mathbf{E}} = 0$ $\nabla^2\tilde{\mathbf{H}} - \gamma^2\tilde{\mathbf{H}} = 0$
$\gamma^2 = -\omega^2\mu\epsilon_c$ $k = \omega\sqrt{\mu\epsilon}$ $\epsilon = \epsilon_r\epsilon_o$ $\epsilon_c = \epsilon - j\sigma/\omega = \epsilon' - j\epsilon''$ $\mu = \mu_r\mu_o$ $\eta_c = \sqrt{\mu/\epsilon_c}$
$\tilde{\mathbf{H}} = \frac{1}{\eta_c}\hat{k} \times \tilde{\mathbf{E}}$ $\tilde{\mathbf{E}} = -\eta_c\hat{k} \times \tilde{\mathbf{H}}$
$\tan 2\gamma = (\tan 2\psi_o)\cos\delta \quad (-\pi/2 \leq \gamma \leq \pi/2)$ $\sin 2\chi = (\sin 2\psi_o)\sin\delta \quad (-\pi/4 \leq \chi \leq \pi/4)$ $\tan\psi_o = a_y/a_x \quad (0 \leq \psi_o \leq \pi/2)$ signe de γ = signe de $\cos\delta$
$\mathbf{S_{av}} = \frac{1}{2}Re[\tilde{\mathbf{E}} \times \tilde{\mathbf{H}}^*]$

	Tout matériel	Matériau sans perte ($\sigma = 0$)	Matériau à faibles pertes ($\epsilon''/\epsilon' \ll 1$)	Bon conducteur ($\epsilon''/\epsilon' \gg 1$)	unités
$\alpha =$	$\omega \left[\frac{\mu\epsilon'}{2}\left[\sqrt{1+\left(\frac{\epsilon''}{\epsilon'}\right)^2}-1\right]\right]^{1/2}$	0	$\frac{\sigma}{2}\sqrt{\frac{\mu}{\epsilon}}$	$\sqrt{\pi f \mu \sigma}$	Np/m
$\beta =$	$\omega \left[\frac{\mu\epsilon'}{2}\left[\sqrt{1+\left(\frac{\epsilon''}{\epsilon'}\right)^2}+1\right]\right]^{1/2}$	$\omega\sqrt{\mu\epsilon}$	$\omega\sqrt{\mu\epsilon}$	$\sqrt{\pi f \mu \sigma}$	rad/m
$\eta_c =$	$\sqrt{\frac{\mu}{\epsilon_c}} = \sqrt{\frac{\mu}{\epsilon'}}\left(1 - j\frac{\epsilon''}{\epsilon'}\right)^{1/2}$	$\sqrt{\frac{\mu}{\epsilon}}$	$\sqrt{\frac{\mu}{\epsilon}}$	$(1+j)\frac{\alpha}{\sigma}$	Ω
$v_p =$	ω/β	$1/\sqrt{\mu\epsilon}$	$1/\sqrt{\mu\epsilon}$	$\sqrt{4\pi f/\mu\sigma}$	m/s
$\lambda =$	$2\pi/\beta = v_p/f$				

Notes: $\epsilon' = \epsilon$; $\epsilon'' = \sigma/\omega$; dans le vide, $\epsilon = \epsilon_o$, $\mu = \mu_o$; en pratique un matériel est considéré à faibles pertes si ($\epsilon''/\epsilon' < 0.01$) et un bon conducteur si ($\epsilon''/\epsilon' > 100$).

Propriété	Incidence normale $\theta_i = \theta_t = 0$	Polarisation perpendiculaire	Polarisation parallèle
Coefficient de réflexion	$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1}$	$\Gamma_\perp = \frac{\eta_2\cos\theta_i - \eta_1\cos\theta_t}{\eta_2\cos\theta_i + \eta_1\cos\theta_t}$	$\Gamma_\parallel = \frac{\eta_2\cos\theta_t - \eta_1\cos\theta_i}{\eta_2\cos\theta_t + \eta_1\cos\theta_i}$
Coefficient de transmission	$\tau = \frac{2\eta_2}{\eta_2 + \eta_1}$	$\tau_\perp = \frac{2\eta_2\cos\theta_i}{\eta_2\cos\theta_i + \eta_1\cos\theta_t}$	$\tau_\parallel = \frac{2\eta_2\cos\theta_i}{\eta_2\cos\theta_t + \eta_1\cos\theta_i}$
relation Γ, τ	$\tau = 1 + \Gamma$	$\tau_\perp = 1 + \Gamma_\perp$	$\tau_\parallel = (1 + \Gamma_\parallel)\frac{\cos\theta_i}{\cos\theta_t}$
Réflectivité	$R = \lvert\Gamma\rvert^2$	$R_\perp = \lvert\Gamma_\perp\rvert^2$	$R_\parallel = \lvert\Gamma_\parallel\rvert^2$
Transmissivité	$T = \lvert\tau\rvert^2\frac{\eta_1}{\eta_2}$	$T_\perp = \lvert\tau_\perp\rvert^2\frac{\eta_1\cos\theta_t}{\eta_2\cos\theta_i}$	$T_\parallel = \lvert\tau_\parallel\rvert^2\frac{\eta_1\cos\theta_t}{\eta_2\cos\theta_i}$
Relation R, T	$R + T = 1$	$R_\perp + T_\perp = 1$	$R_\parallel + T_\parallel = 1$

Notes: $\sin\theta_t = \sqrt{\mu_1\epsilon_1/\mu_2\epsilon_2}\,\sin\theta_i$.
Pour un matériel non magnétique $\eta_2/\eta_1 = n_1/n_2$.

$\sin\theta_c = n_2/n_1 = \sqrt{\frac{\epsilon_{r2}}{\epsilon_{r1}}}$ (si $\mu_1 = \mu_2$)
$\tan\theta_{B\parallel} = \sqrt{\epsilon_2/\epsilon_1}$ (si $\mu_1 = \mu_2$)

$$H_z = A_{nm}\cos(K_x x)\cos(K_y y)e^{-j\beta z}$$
$$H_x = \frac{j\beta K_x}{K_c^2}A_{nm}\sin(K_x x)\cos(K_y y)e^{-j\beta z}$$
$$H_y = \frac{j\beta K_y}{K_c^2}A_{nm}\cos(K_x x)\sin(K_y y)e^{-j\beta z}$$
$$E_x = \frac{j\omega\mu K_y}{K_c^2}A_{nm}\cos(K_x x)\sin(K_y y)e^{-j\beta z}$$
$$E_y = \frac{-j\omega\mu K_x}{K_c^2}A_{nm}\sin(K_x x)\cos(K_y y)e^{-j\beta z}$$

$$E_z = B_{nm}\sin(K_x x)\sin(K_y y)e^{-j\beta z}$$
$$H_x = \frac{j\omega\epsilon K_y}{K_c^2}B_{nm}\sin(K_x x)\cos(K_y y)e^{-j\beta z}$$
$$H_y = \frac{-j\omega\epsilon K_x}{K_c^2}B_{nm}\cos(K_x x)\sin(K_y y)e^{-j\beta z}$$
$$E_x = \frac{-j\beta K_x}{K_c^2}B_{nm}\cos(K_x x)\sin(K_y y)e^{-j\beta z}$$
$$E_y = \frac{-j\beta K_y}{K_c^2}B_{nm}\sin(K_x x)\cos(K_y y)e^{-j\beta z}$$

$$K_c^2 = K_x^2 + K_y^2 = \left(\frac{n\pi}{a}\right)^2 + \left(\frac{m\pi}{b}\right)^2 = \omega^2\mu\epsilon - \beta^2$$

$$H_z = \text{solution de l'équation d'onde}$$
$$H_x = -\frac{j\beta}{K_c^2}\frac{dH_z}{dx}$$
$$E_y = \frac{j\omega\mu}{K_c^2}\frac{dH_z}{dx}$$

$$E_z = \text{solution de l'équation d'onde}$$
$$E_x = -\frac{j\beta}{K_c^2}\frac{dE_z}{dx}$$
$$H_y = -\frac{j\omega\epsilon}{K_c^2}\frac{dE_z}{dx}$$

TE PAIR dans le coeur

$U^2 = n_1^2 k_o^2 - \beta^2$

$H_z = A' \sin(Ux)$

$H_x = -\frac{j\beta}{U} A' \cos(Ux)$

$E_y = \frac{j\omega\mu}{U} A' \cos(Ux)$

TE PAIR dans la gaine

$W^2 = \beta^2 - n_2^2 k_o^2$

$H_z = Be^{-W|x|}$

$H_x = -\frac{j\beta}{W} Be^{-W|x|}$

$E_y = \frac{j\omega\mu}{W} Be^{-W|x|}$

$V^2 = (U^2 + W^2)d^2 = (n_1^2 - n_2^2)\omega^2 d^2 / c^2$

TE pair : $\tan(Ud) = W/U$

TE impair : $\tan(Ud) = -U/W$

TM pair : $\tan(Ud) = (n_1/n_2)^2 W/U$

TM impair : $\tan(Ud) = -(n_2/n_1)^2 U/W$

$F(\theta, \phi) = \frac{S(R, \theta, \phi)}{S_{max}}$

$d\Omega = \frac{dA}{R^2} = \sin\theta d\theta d\phi$

$dP_{rad} = R^2 S(R, \theta, \phi) d\Omega$

$\Omega_p = \int\int F(\theta, \phi) d\Omega$

$D = \frac{F_{max}}{F_{av}} = \frac{4\pi}{\Omega_p} = \frac{4\pi R^2 S_{max}}{P_{rad}} = \frac{S_{max}}{S_{av}}$

$G = \xi D$

$\xi = \frac{P_{rad}}{P_t} = \frac{R_{rad}}{(R_{rad} + R_{loss})}$

$A_e = \frac{P_{int}}{S_i} = \frac{\lambda^2 D}{4\pi}$

$\frac{P_{rec}}{P_t} = G_t G_r \left(\frac{\lambda}{4\pi R}\right)^2$