$\nabla \times \bar{H} = j\omega \underline{\varepsilon} \bar{E}$

$\nabla \times \bar{E} = -j\omega \mu \bar{H}$

$\nabla \cdot \bar{E} = 0$

$\nabla \cdot \bar{H} = 0$

$\nabla^2 \bar{E} = \omega^2 \mu \underline{\varepsilon} \bar{E} = 0$

sans pertes $\nabla^2 \bar{E} + \beta^2 \bar{E} = 0$

$\beta^2 = \omega^2 \mu \varepsilon$

$\bar{E} = \bar{A} e^{-j\bar{K}\cdot\bar{r}} + \bar{B} e^{+j\bar{K}\cdot\bar{r}}$

$\|\bar{K}\| = \beta \qquad \bar{K} = \beta \hat{n}$

$\beta = \frac{2\pi}{\lambda} = \omega\sqrt{LC} = \frac{\omega}{V_p}$

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

$V_p = \lambda f = \frac{\lambda \omega}{2\pi} = \frac{\omega}{\beta} = \frac{1}{\sqrt{\mu\varepsilon}}$

$\mu_0 = \frac{4\pi}{10^7} \ H/m$

$\varepsilon_0 = 8.85 \times 10^{-12} \ F/m$

$\eta = \sqrt{\frac{\mu}{\varepsilon}} = \frac{j\omega\mu}{\gamma} = \sqrt{\frac{j\omega\mu}{\sigma + j\omega\varepsilon}}$

$P_{moy} = \frac{1}{2} Re\{\bar{E} \times \bar{H}^*\}$

$P_{moy} = \hat{n} \frac{|A_x|^2 + |A_y|^2 + |A_z|^2}{2\eta} = \hat{n} \frac{\|A\|^2}{2\eta}$

$P_{moy} = \frac{\|\bar{E}\|^2}{2\eta} = \frac{\eta \|\bar{H}\|^2}{2}$

$E : V/m$

$H : A/m$

$\eta : \Omega$

$\Gamma_V = \frac{V^-}{V^+} = \frac{R_L - Z_0}{R_L + Z_0} = \frac{z-1}{z+1} = -\Gamma_I$

$\Gamma_I = \frac{I^-}{I^+} = \frac{y-1}{y+1} \qquad y = \frac{Y}{Y_0}$

$Z_1 \ \Gamma_\Delta \ Z_2 \qquad \Gamma = \frac{Z_2 - Z_1}{Z_2 + Z_1}$

$\gamma = \alpha + j\beta \qquad \gamma^2 = -\omega^2 LC$ → si pas de pertes

$\alpha = \frac{\text{nepper}}{\lambda} = \frac{\sqrt{LC}}{2}\left(\frac{R}{L} + \frac{G}{C}\right)$

$Z_0 = \sqrt{\frac{L}{C}}$

$TOS = \frac{1 + |\Gamma_L|}{1 - |\Gamma_L|} = \frac{V_{max}}{V_{min}}$

$|\Gamma| = \frac{TOS - 1}{TOS + 1}$

Ondes Planes

$\alpha = Re\left(\sqrt{j\omega\mu(\sigma + j\omega\varepsilon)}\right) \ Np/m$

$\beta = Im\left(\sqrt{j\omega\mu(\sigma + j\omega\varepsilon)}\right) \ 1/m$

$K = \sqrt{-j\omega\mu(\sigma + j\omega\varepsilon)} \ 1/m$

$\gamma = jK = \sqrt{j\omega\mu(\sigma + j\omega\varepsilon)} \ 1/m$

$\gamma = \alpha + j\beta$

angle de la charge

$\Gamma(d) = \Gamma_L e^{-2\gamma d}$ ($\gamma = \alpha + j\beta$)

$Z(d) = Z_0 \frac{1 + \Gamma(d)}{1 - \Gamma(d)} = Z_0 \frac{Z_L + jZ_0 \tan\beta d}{Z_0 + jZ_L \tan\beta d}$

$\Gamma(d) = \frac{Z(d) - Z_0}{Z(d) + Z_0}$

$Z(0) = Z_L = Z_0 \frac{1 + \Gamma_L}{1 - \Gamma_L}$

$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{z - 1}{z + 1}$

$z(d) = \frac{z_L + j\tan\beta d}{1 + jz_L \tan\beta d}$

$V = V^+ e^{j\beta d}\left(1 + |\Gamma| e^{j\angle\Gamma} e^{-j\beta d}\right)$

$Z_L \ \ \lambda/4 \ \ Z_0 \ Z_1 \qquad Z_0 = \sqrt{Z_1 Z_2} \qquad d = \lambda$ vers axe R

$C = \frac{-b Y_0}{\omega} \qquad d = \lambda(y \to b) \qquad C = \frac{1}{\omega Z_0 x} \qquad d = \lambda(z \to x)$

$L = \frac{1}{\omega Y_0 b} \qquad L = \frac{-x Z_0}{\omega}$

Bon conducteur : $P > 100 \Rightarrow \frac{\varepsilon''}{\varepsilon'} > 100$

$E \to \bar{E}_1, \bar{E}_2 \qquad \hat{n} \times \bar{E}_1 = \begin{cases} +j\bar{E}_2 & Pcd \\ -j\bar{E}_2 & Pcg \end{cases}$

$\sin(x) = \cos(x - \frac{\pi}{2})$

$E_x = A_x e^{-j\bar{K}\cdot\bar{r}}$ Phaseur

$E_x = A_x e^{j\omega t} e^{-j\bar{K}\cdot\bar{r}}$ complexe

$E_x = Re\{E_x\} = |A_x| \cos(\omega t - \bar{K}\cdot\bar{r} + \theta_A) \qquad \theta_A = \angle A_x$ Réel