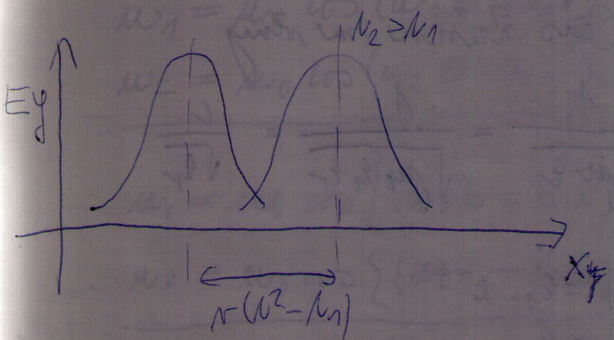
$\bar{B} = \frac{\bar{r} \times \bar{E}}{r^2}$ (alebo $\frac{\bar{K}}{K}) = \frac{\bar{r}}{r}$ $\quad \omega = k v$, $k = \frac{2\pi}{\lambda}$



(2) rovinná vlna v danom mieste

$\bar{E} = E_0 . \cos(\omega t) j$

$H = H . K \; H_0 \; \omega t$

$\frac{1}{H}$

$\bar{H} = \frac{\bar{r} \times \bar{E}}{\mu v r^2}$

$\bar{E} \times \bar{H} = \frac{1}{\mu v r^2} \left[\bar{r} . E - E \underbrace{\bar{r} . \bar{E}}_{0} \right] = \frac{1 . \bar{r} . \bar{E}}{\mu v r^2}$ $\qquad$ (*) $\bar{H} = \bar{I} . H . \cos \omega t \; \bar{k}$

$\bar{H} = \frac{\bar{r} \times E}{\mu} = \frac{r . v \times j \; E_0 . \cos \omega t}{\mu v r^2} = \frac{1}{\mu v} \bar{K} \; E_0 \cos \omega t = k . k^0 \cos \omega t$

$H_0 = \frac{E_0}{\mu v} \Rightarrow \mu v = \frac{E_0}{H_0} = \sqrt{\frac{\mu}{\varepsilon_0}}$

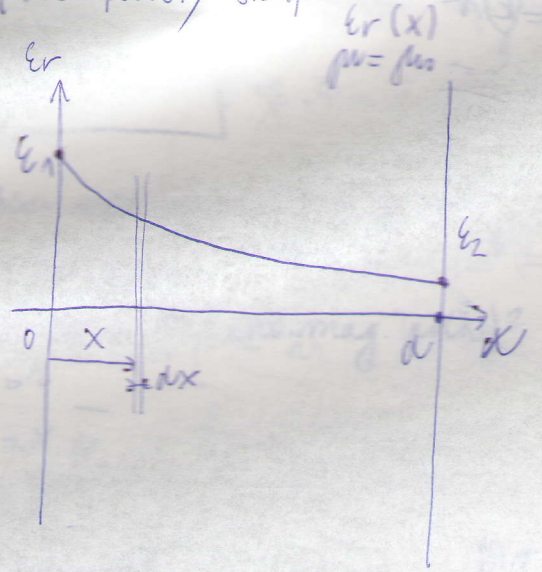
(3) pre $E_0 = 100 \, V/m$

$H_0 = 0{,}39 A . 10^{-6} \, m$

$\left(\frac{H_0}{E_0} \right)^2 = 3{,}9^2 . 10^{-6}$

(3)

4.50 Krempaský / skrip.



$T = ?$ (čas šírenia sa vlny)

$$v = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{1}{\sqrt{\mu_0 \varepsilon_0 \varepsilon_r}} = \frac{c}{\sqrt{\varepsilon_r}}$$

$$\varepsilon_r(x) = \varepsilon_1 \cdot e^{-\alpha x}$$

$$\varepsilon_r(0) = \varepsilon_1$$

$$\varepsilon_r(d) = \varepsilon_2 = \varepsilon_1 \cdot e^{-\alpha d} \Rightarrow e^{-\alpha} = \left(\frac{\varepsilon_2}{\varepsilon_1}\right)^{\frac{1}{d}}$$

$$\Rightarrow \boxed{\varepsilon_r(x) = \varepsilon_1 \cdot \left(\frac{\varepsilon_2}{\varepsilon_1}\right)^{\frac{x}{d}}}$$

$$v(x) = \frac{c}{\sqrt{\varepsilon_1 \left(\frac{\varepsilon_2}{\varepsilon_1}\right)^{\frac{x}{d}}}} = c \left(\frac{\varepsilon_1}{\varepsilon_2}\right)^{\frac{x}{2d}} \cdot \frac{1}{\sqrt{\varepsilon_1}}$$

$$\boxed{dT = \frac{dx}{v(x)}} \quad ; \quad T = \int_0^d \frac{dx}{v(x)} = \frac{\sqrt{\varepsilon_1}}{c} \int_0^d \left(\frac{\varepsilon_2}{\varepsilon_1}\right)^{\frac{x}{2d}} dx =$$

$$T = \frac{\sqrt{\varepsilon_1}}{c} \int_0^d e^{\frac{x}{2d} \cdot \ln\left(\frac{\varepsilon_2}{\varepsilon_1}\right)} dx = \frac{\sqrt{\varepsilon_1}}{c} \cdot \frac{2d}{\ln\left(\frac{\varepsilon_2}{\varepsilon_1}\right)} \left[e^{\frac{x}{2d} \ln\left(\frac{\varepsilon_2}{\varepsilon_1}\right)} \right]_0^d$$

$$= \frac{\sqrt{\varepsilon_1}}{c} \cdot \frac{2d}{\ln\left(\frac{\varepsilon_2}{\varepsilon_1}\right)} \left[\sqrt{\frac{\varepsilon_2}{\varepsilon_1}} - 1 \right] = \frac{2d}{c} \cdot \frac{\sqrt{\varepsilon_2} - \sqrt{\varepsilon_1}}{\ln \varepsilon_2 - \ln \varepsilon_1}$$

$$T = \frac{d}{c} \cdot \frac{1}{\frac{\ln \sqrt{\varepsilon_2} - \ln \sqrt{\varepsilon_1}}{\sqrt{\varepsilon_2} - \sqrt{\varepsilon_1}}} \Rightarrow \text{derivácia: } \varepsilon_2 \to \varepsilon_1 : T \to \frac{d}{c}$$

4.51 Výpoč. prevencia vysielača, aby vlnová dĺžka vo vode bola $\frac{4}{5}$

(*) rýchl. grupová $v_g = \frac{d\omega}{dk}$

a) $n = \frac{1}{3} m$; $\varepsilon_r = 81$; $\mu_r = 1$

$$v = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{c}{\sqrt{\varepsilon_r}} = \lambda f \Rightarrow f = \frac{c}{\lambda \sqrt{\varepsilon_r}}$$

$c = 3 \cdot 10^8$, $\lambda = \frac{1}{3}$, $\sqrt{\varepsilon_r} = 9$

$$f = 10^8 \text{ Hz}$$

b) v akom pomere sú dĺžky vlnenia v rôznych prostr. $(\varepsilon_{r1} ; \varepsilon_{r2}) \Rightarrow \frac{\lambda_1}{\lambda_2}$

$$\lambda = \frac{v}{f} = \frac{\frac{c}{\sqrt{\varepsilon_r}}}{f} \Rightarrow$$

$$\frac{\lambda_1}{\lambda_2} = \frac{\frac{c}{\sqrt{\varepsilon_{r1}}}}{f} \cdot \frac{f}{\frac{c}{\sqrt{\varepsilon_{r2}}}} = \sqrt{\frac{\varepsilon_{r2}}{\varepsilon_{r1}}}$$

① 2 vlny (rovinné)

$u_1 = u_0 \cos(\omega_1 t - k_1 x)$
$u_2 = u_0 \cos(\omega_2 t - k_2 x)$

$\omega_1 \doteq \omega_2 \Rightarrow \omega_1 = \omega_0 - \Delta\omega$ a $\omega_2 = \omega_0 + \Delta\omega$
$k_1 \doteq k_2 \Rightarrow k_1 = k_0 + \Delta k$ a $k_2 = k_0 - \Delta k$

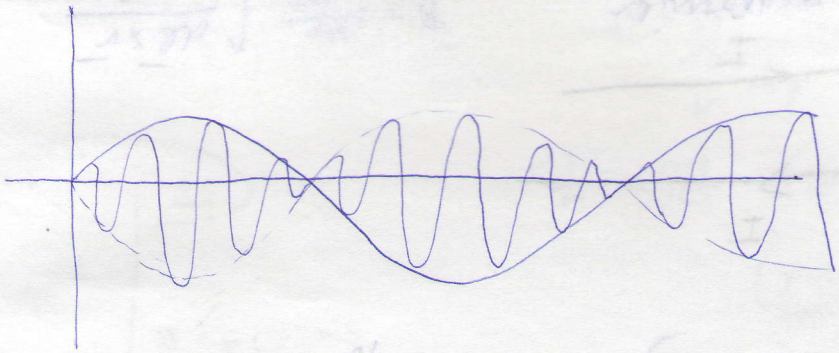
$u_1 = u_0 \cos[(\omega_0 t - k_0 x) - (\Delta\omega t + \Delta k x)]$
$u_2 = u_0 \cos\{(\omega_0 t - k_0 x) + (\Delta\omega t + \Delta k x)\}$

$u = u_1 + u_2 = 2u_0 \cos(\omega_0 t - k_0 x)\cos(\Delta\omega t + \Delta k x)$

max: $\Delta\omega t + \Delta k x = 0 \Rightarrow$

$x = -\frac{\Delta\omega t}{\Delta k}$

grupová rychlost



② vlnový balík (? Bátos)

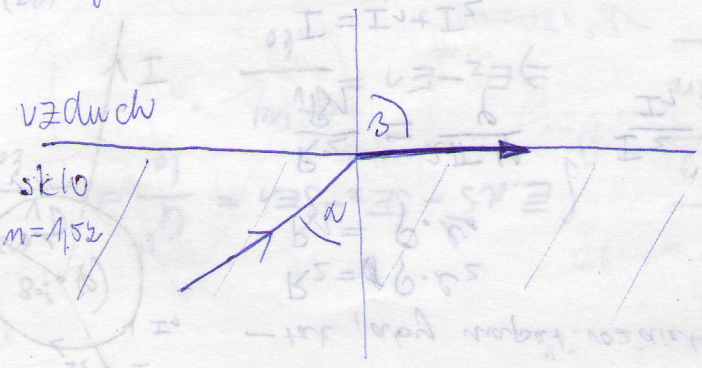
③ Intenzita el. pola elektromagnet. vlny je daná vzťahom:

4.52 $E(x,t) = 10^3 \sin\pi(9\cdot10^{14}t - 3\cdot10^6 x)$

$E_0 = 10^3$ V/m
$f = 4{,}5 \cdot 10^4$ Hz
$\lambda =$
$T = \frac{1}{f}$
$k = 3\cdot10^6\pi$
$\vec{k} = \vec{i}\cdot k$

④ Opísať (Hajko) 7.7.8

Pod akým α musí ľúč dopadnúť na rozhranie sklo-vzduch, aby už nevnikol do vzduchu

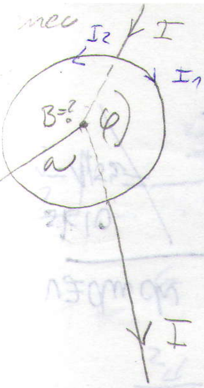


$\frac{\sin\alpha}{\sin\beta} = \frac{1}{n} \Rightarrow \sin\alpha = \frac{1}{1{,}52}$

$\sin\frac{\pi}{2} = 1$

$\alpha = \arcsin\left(\frac{1}{1{,}52}\right)$

$\alpha = 41°8'$



— tak, aby napät. rozdiel bol rovnaký $\Rightarrow$ $I_2 R_2 = I_1 R_1$

$R_2 = \rho \cdot l_2$

$R_1 = \rho \cdot l_1$

$\frac{R_2}{R_1} = \frac{2\pi - \varphi}{\varphi}$ $\qquad \frac{I_2}{I_1} = \frac{R_1}{R_2} = \frac{\varphi}{2\pi - \varphi}$

$I = I_1 + I_2$

$I = I_1 + I_1 \cdot \frac{\varphi}{2\pi - \varphi} = I_1 \cdot \frac{2\pi}{2\pi - \varphi} \Rightarrow I_1 = I \cdot \frac{2\pi - \varphi}{2\pi}$

$I_2 = \frac{\varphi}{2\pi}$

$B = B_1 + B_2$

$\frac{\mu_0}{2a} I_1 \frac{\varphi}{2\pi} - \frac{\mu_0 I_2}{2a} \cdot \frac{2\pi - \varphi}{2\pi}$

$\frac{m v^2}{r} = q v B$

$m_e ; -e$

$m_p ; +e$

$\omega_p = ?$

$v = \omega r$

$m \omega^2 r = q \omega r B$

$\omega = \frac{q \cdot B}{m} \longrightarrow \omega_e = -\frac{eB}{m_e}$, $\omega_p = +\frac{eB}{m_p}$ $\Bigg\} \Rightarrow \frac{\omega_e}{\omega_p} = -\frac{m_p}{m_e}$

783(H) Na sklenený hranol s $n = \sqrt{2}$ dopadá lúč v rovine prednej zámernej steny.