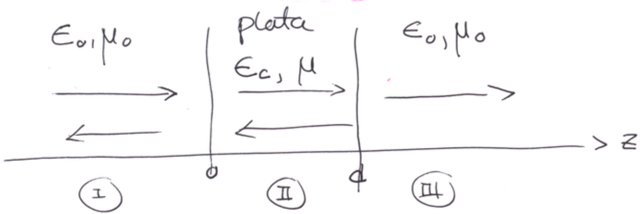
Flöt rafsegulbylgja með bylgjulengd λ fellur á stóra velleiðandi plötu með þykkt d.



$$\beta_0 = \frac{2\pi}{\lambda}$$

Veljum eins og í kafla 8-9 í bók

$$\bar{E}_1 = \hat{a}_x \left\{ E_{i0} e^{i\beta_0 z} + E_{r0} e^{-i\beta_0 z} \right\}$$

$$\bar{H}_1 = \hat{a}_y \frac{1}{\eta_0} \left\{ E_{i0} e^{i\beta_0 z} - E_{r0} e^{-i\beta_0 z} \right\}$$

Ég nota i í stað $-j$, ég veit að ég hef ekki passað vel upp á það í fyrirlestrum

$$\bar{E}_2 = \hat{a}_x \left[E_2^+ e^{ik_2 z} + E_2^- e^{-ik_2 z} \right], \quad k_2 = \beta_2 + i\alpha_2$$

$$\bar{H}_2 = \frac{\hat{a}_y}{\eta_2} \left[E_2^+ e^{ik_2 z} - E_2^- e^{-ik_2 z} \right]$$

$$\bar{E}_3 = \hat{a}_x \left[E_{t0} e^{i\beta_0 z} \right], \quad \bar{H}_3 = \hat{a}_y \frac{1}{\eta_0} E_{t0} e^{i\beta_0 z}$$

Engin seguluirkni → notum jaðarskilyrði

$$E_{1t} = E_{2t} \quad \text{og} \quad \hat{a}_{n2} \times (\bar{H}_1 - \bar{H}_2) = \bar{J}_s = 0$$

því verður

$$\boxed{\begin{aligned} \bar{E}_1(0) &= \bar{E}_2(0) \\ \bar{H}_1(0) &= \bar{H}_2(0) \end{aligned}} \qquad \boxed{\begin{aligned} \bar{E}_2(d) &= \bar{E}_3(d) \\ \bar{H}_2(d) &= \bar{H}_3(d) \end{aligned}}$$

$z = 0$ $\qquad\qquad$ $z = d$

Skilyrðin eru því

$$E_{i0} + E_{r0} = E_2^+ + E_2^-$$

$$\frac{E_{i0} - E_{r0}}{\eta_0} = \frac{E_2^+ - E_2^-}{\eta_2}$$

$$E_2^+ e^{ik_2 d} + E_2^- e^{-ik_2 d} = E_{t0} e^{i\beta_0 d}$$

$$\frac{E_2^+ e^{ik_2 d} - E_2^- e^{-ik_2 d}}{\eta_2} = \frac{E_{t0}}{\eta_0} e^{i\beta_0 d}$$

Fjórar jöfnur línulegar og fjórar óþekktar stærðir því við getum fest E_{i0} eða miðað hinar allar við E_{i0}

$$E_{r0} - E_2^+ - E_2^- = -E_{i0}$$

$$-E_{r0} - \frac{\eta_0}{\eta_2} E_2^+ + \frac{\eta_0}{\eta_2} E_2^- = -E_{i0}$$

$$E_2^+ e^{ik_2 d} + E_2^- e^{-ik_2 d} - E_{t0} e^{i\beta_0 d} = 0$$

$$E_2^+ e^{ik_2 d} - E_2^- e^{-ik_2 d} - \frac{\eta_2}{\eta_0} E_{t0} e^{i\beta_0 d} = 0$$

Jöfnurnar má umrita sem

$$\begin{pmatrix} 1 & -1 & -1 & 0 \\ -1 & -C & +C & 0 \\ 0 & A & 1/A & -B \\ 0 & A & -1/A & -B/C \end{pmatrix} \begin{pmatrix} E_{r0} \\ E_2^+ \\ E_2^- \\ E_{t0} \end{pmatrix} = \begin{pmatrix} -E_{i0} \\ -E_{i0} \\ 0 \\ 0 \end{pmatrix}$$

þar sem $C = \frac{\eta_0}{\eta_2}$

$$A = e^{ik_2 d}$$

$$B = e^{i\beta_0 d}$$

Setjum

$$F = (A^2-1)C^2 - 2(A^2+1)C + A^2-1$$
$$= (C^2+1)(A^2-1) - 2C(A^2+1)$$

þá fæst

$$\frac{E_{ro}}{E_{io}} = - \frac{\left\{(A^2-1)C^2 - A^2+1\right\}}{F}$$

$$\frac{E_2^+}{E_{io}} = - \frac{2(C+1)}{F}, \qquad \frac{E_2^-}{E_{io}} = - \frac{2A^2(C-1)}{F}$$

$$\frac{E_{to}}{E_{io}} = - \frac{4AC}{BF}$$

Rekjum upp í grunnstærðir

$$B = \exp(i\beta_0 d) = \exp\left(2\pi i \frac{d}{\lambda_0}\right)$$

góður leiðari

$$k_2 = \beta_2 + i\alpha_2 \,, \quad \text{með} \quad \alpha_2 = \beta_2 = \sqrt{\pi f \mu_0 \sigma}$$

Tíðnin f er alls staðar föst $\quad f = \frac{c}{\lambda_0}$

notum

$$\beta_2 = \frac{2\pi}{\lambda_2} = \sqrt{\frac{\pi c}{\lambda_0}\mu_0\sigma} \quad \rightarrow \quad \beta_2 d = d\sqrt{\frac{\pi c}{\lambda_0}\mu_0\sigma}$$

$$\beta_2 d = \frac{2\pi d}{\lambda_0}\sqrt{\frac{\pi c \mu_0 \sigma}{\lambda_0}\frac{\lambda_0^2}{4\pi^2}} = \frac{2\pi d}{\lambda_0}\sqrt{\frac{c\mu_0\sigma\lambda_0}{4\pi}}$$

$$= \frac{2\pi d}{\lambda_0}\sqrt{\frac{c\mu_0\sigma d}{4\pi}\left(\frac{\lambda_0}{d}\right)} = 2\pi\sqrt{\frac{d}{\lambda_0}}\sqrt{\frac{c\mu_0\sigma d}{4\pi}}$$

$\sqrt{\frac{c\mu_0 \sigma d}{4\pi}}$ er víddarlaus fasti

fyrir kopar með $\sigma = 5.8 \cdot 10^7$ S/m
og $\underline{d = 1 \cdot 10^{-6}\,m}$ (micron) fast $\sim \underline{41.7}$

og $d = 100\,n$ $\sim \underline{13.2}$

$d = 10\,n$ $\sim \underline{4.2}$

köllum

$$C_d = \sqrt{\frac{c\mu_0 \sigma d}{4\pi}}$$

$$A = \exp(ik_2 d) = \exp\left(2\pi i \sqrt{\frac{d}{\lambda_0}}\, C_d - 2\pi \sqrt{\frac{d}{\lambda_0}}\, C_d\right) = \exp\left\{2\pi \sqrt{\frac{d}{\lambda_0}}\, C_d (i-1)\right\}$$

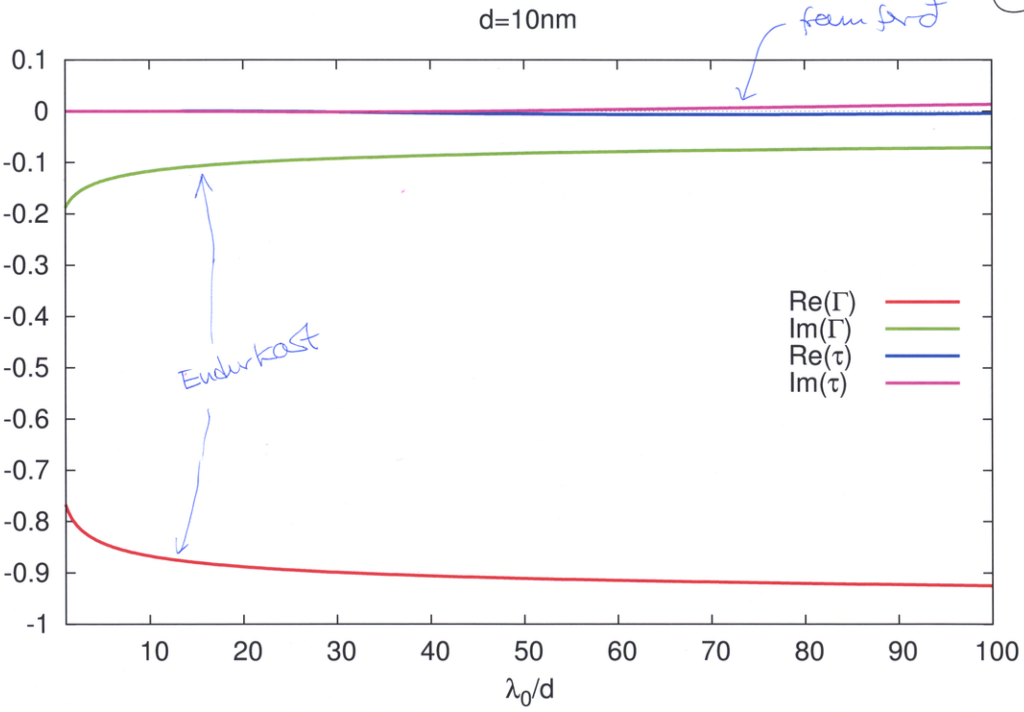
$$C = \frac{\eta_0}{\eta_2} = \frac{1}{1-i}\sqrt{\frac{\mu_0}{\epsilon_0}\frac{\sigma}{\pi f \mu_0}} = \frac{1}{1-i}\sqrt{\frac{\sigma d c \mu_0}{\pi}\left(\frac{\lambda_0}{d}\right)}$$

$$= \frac{2}{1-i}\left(\frac{\lambda_0}{d}\right)^{1/4} C_d$$

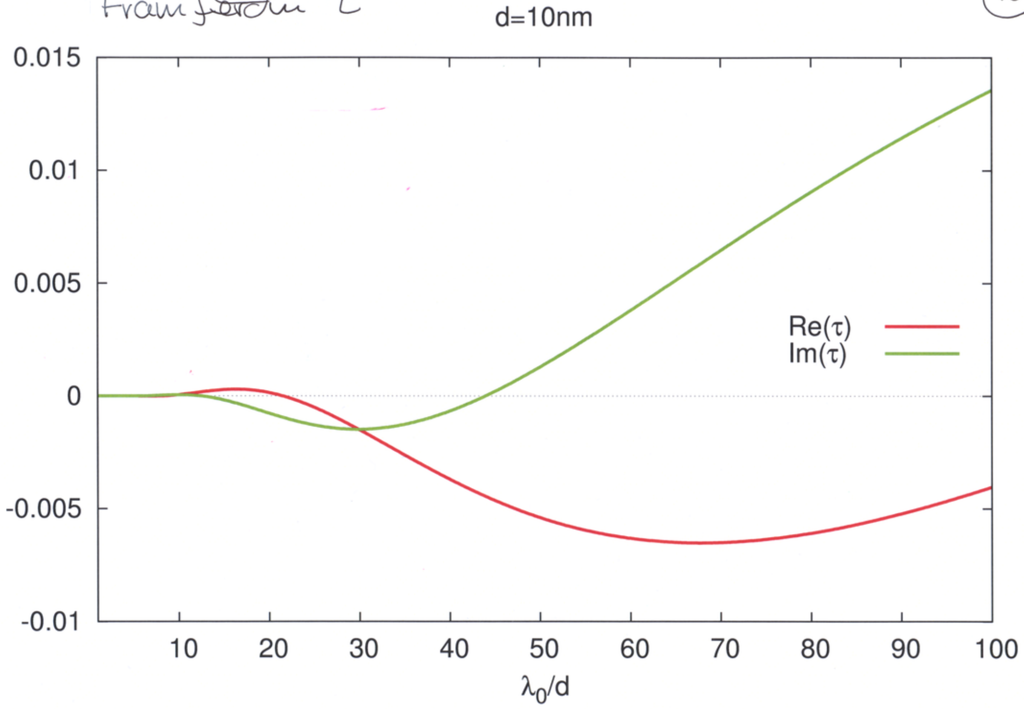
$$\Gamma = \frac{E_{ro}}{E_{io}} \quad \text{og} \quad \tau = \frac{E_{to}}{E_{io}}$$

Veljum $d = 10\,nm \longrightarrow C_d = 4.2$

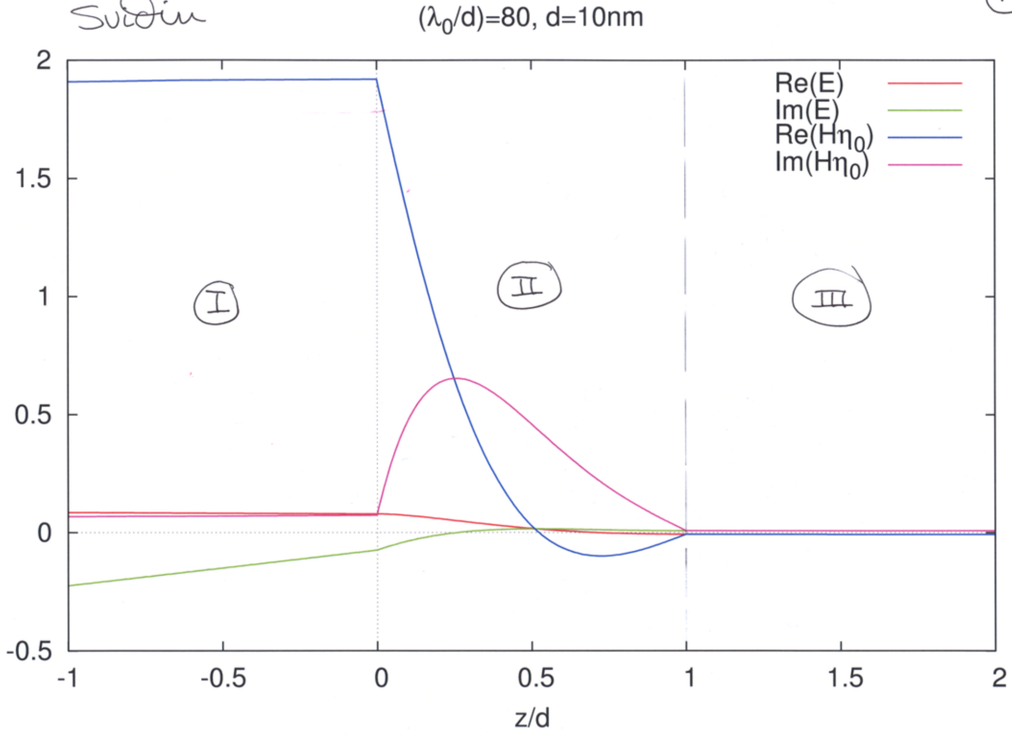
og reynum á myndum


d=10nm
fram ferð
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
Endurkast
Re(Γ)
Im(Γ)
Re(τ)
Im(τ)
10
20
30
40
50
60
70
80
90
100
λ0/d

Framfördin τ



Suidin



(λ0/d)=80, d=10nm
Re(E)
Im(E)
Re(Hη0)
Im(Hη0)
I
II
III
2
1.5
1
0.5
0
-0.5
-1
-0.5
0
0.5
1
1.5
2
z/d