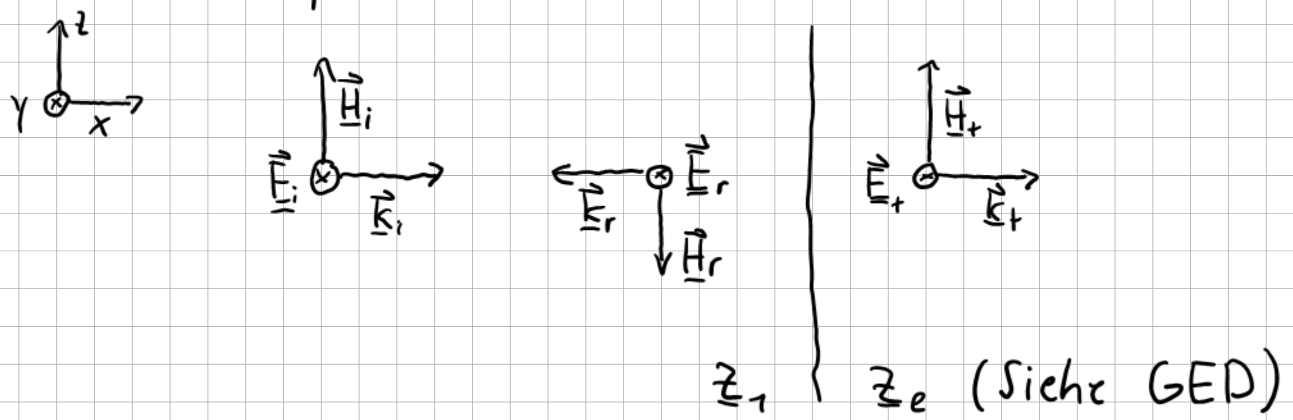
# • Analytische Lösung "thin film"

· Welle mit y-Polarisation




· $\underline{Z}_e$: Ersatzimpedanz für Übertragung der Welle durch den "thin film" in ebene 3

$$\rightarrow \underline{Z}_e = \underline{Z}_1 \cdot \frac{1 + \frac{\underline{Z}_2}{\underline{Z}_1} \cdot j\tan(k_2 d)}{1 + \frac{\underline{Z}_1}{\underline{Z}_2} \cdot j\tan(k_2 d)}$$

$k_2$: Wellenzahl im "thin film"

$\underline{Z}_2$: Wellenimpedanz " – "

· Reflexionsfaktor: $\underline{r} = \frac{\underline{Z}_e - \underline{Z}_1}{\underline{Z}_e + \underline{Z}_1}$

· Transmissionsfaktor: $\underline{t} = \frac{2 \cdot \underline{Z}_e}{\underline{Z}_e + \underline{Z}_1}$

· Welle in Medium 1:

$$\rightarrow \vec{\underline{E}}_1 = \left[ \underline{E}_0 \cdot e^{-j\underline{k}_1 x} + \underline{r} \cdot \underline{E}_0 \cdot e^{j\underline{k}_1 x} \right] \vec{e}_y$$

$$\rightarrow \vec{\underline{H}}_1 = \left[ \frac{\underline{E}_0}{\underline{Z}_1} \cdot e^{-j\underline{k}_1 x} - \underline{r} \cdot \frac{\underline{E}_0}{\underline{Z}_1} \cdot e^{j\underline{k}_1 x} \right] \vec{e}_z$$

· Welle in Medium (nach "thin film"):

$$\rightarrow \vec{\underline{E}}_3 = \left[ \underline{t} \cdot \underline{E}_0 \cdot e^{-j\underline{k}_3 x} \right] \vec{e}_y$$

$$\rightarrow \vec{\underline{H}}_3 = \left[ \underline{t} \cdot \frac{\underline{E}_0}{\underline{Z}_e} \cdot e^{-j\underline{k}_3 x} \right] \vec{e}_z$$

· Poyntinvector Medium 1:

$$\vec{\underline{S}}_1 = \frac{1}{2}\cdot \vec{\underline{E}}_1 \times \vec{\underline{H}}_1^* = \frac{1}{2}\cdot\left[\underline{E}_0\cdot e^{-j\underline{k}_1 x} + \underline{r}\cdot \underline{E}_0\cdot e^{j\underline{k}_1 x}\right]\vec{e}_y \times$$
$$\left[\frac{\underline{E}_0^*}{\underline{Z}_1^*}\cdot e^{j\underline{k}_1 x} - \underline{r}^*\cdot\frac{\underline{E}_0^*}{\underline{Z}_1^*}\cdot e^{-j\underline{k}_1 x}\right]\vec{e}_z$$

$$= \frac{1}{2}\left[\underline{E}_0\cdot e^{-j\underline{k}_1 x} + \underline{r}\cdot\underline{E}_0 e^{j\underline{k}_1 x}\right]\cdot\left[\frac{\underline{E}_0^*}{\underline{Z}_1^*}e^{j\underline{k}_1 x} - \underline{r}^*\cdot\frac{\underline{E}_0^*}{\underline{Z}_1^*}e^{-j\underline{k}_1 x}\right]\cdot\overbrace{(\vec{e}_y\times\vec{e}_z)}^{=\vec{e}_x}$$

$$\rightarrow \underline{S}_{1x} = \frac{1}{2}\cdot\frac{\underline{E}_0\underline{E}_0^*}{\underline{Z}_1^*} - \frac{1}{2}\cdot\underline{r}\underline{r}^*\cdot\frac{\underline{E}_0\underline{E}_0^*}{\underline{Z}_1^*} - \frac{1}{2}\cdot\underline{r}^*\frac{\underline{E}_0\underline{E}_0^*}{\underline{Z}_1^*}\cdot e^{-j2\underline{k}_1 x} + \frac{1}{2}\underline{r}\cdot\frac{\underline{E}_0\underline{E}_0^*}{\underline{Z}_1^*}\cdot e^{j2\underline{k}_1 x}$$

$$= \frac{1}{2}\frac{|\underline{E}_0|^2}{\underline{Z}_1^*} - \frac{1}{2}|\underline{r}|^2\cdot\frac{|\underline{E}_0|^2}{\underline{Z}_1^*} + Re\{\underline{r}\}\cdot\frac{1}{2}\cdot\frac{|\underline{E}_0|^2}{\underline{Z}_1^*}\cdot\left(e^{j2\underline{k}_1 x} - e^{-j\underline{k}_1 x}\right)$$
$$+ j\,Im\{\underline{r}\}\cdot\frac{1}{2}\cdot\frac{|\underline{E}_0|^2}{\underline{Z}_1^*}\cdot\left(e^{j2\underline{k}_1 x} + e^{-j2\underline{k}_1 x}\right)$$

$\underline{Z}_1$ u. $\underline{k}_1$ reell !

$$= \underbrace{\frac{1}{2}\frac{|\underline{E}_0|^2}{Z_1} - \frac{1}{2}|\underline{r}|^2\frac{|\underline{E}_0|^2}{Z_1}}_{1} \underbrace{+ jIm\{\underline{r}\}\cdot\frac{1}{2}\frac{|\underline{E}_0|^2}{Z_1}\cdot 2\cos(2k_1 x) + jRe\{r\}\cdot\frac{1}{2}\cdot\frac{|\underline{E}_0|^2}{Z_1}\cdot 2\sin(2k_1 x)}_{2}$$

1 Intensität – Mittlere übertragene Leistung über Zeit

2 "Blindleistung"

· Poyntinvector medium 3:

$$\rightarrow \vec{\underline{S}}_3 = \frac{1}{2}\cdot\vec{\underline{E}}_3\times\vec{\underline{H}}_3^* = \frac{1}{2}\cdot\left[\underline{t}\cdot\underline{E}_0\cdot e^{-j\underline{k}_3 x}\right]\cdot\left[\underline{t}^*\cdot\frac{\underline{E}_0^*}{\underline{Z}_e^*}\cdot e^{j\underline{k}_3 x}\right]\cdot(\vec{e}_y\times\vec{e}_z)$$
$$= \frac{1}{2}|\underline{t}|^2\cdot\frac{|\underline{E}_0|^2}{\underline{Z}_e^*}\cdot\vec{e}_x$$

→ Intensität: Real$\{\vec{\underline{S}}_3\}$