KGÜ 1

Montag, 11. April 2011
08:58

KGÜ 19.4. / 26.4. 15:00 - 16:00

Verschiebung um 8:30

Hinweise zu Hausaufgabe 1

1.3 zeitgemittelter reeller Poyntingvektor

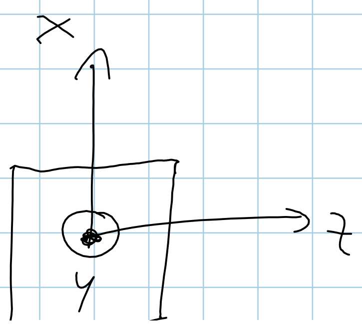
$$\overline{\vec{S}_r} = \frac{1}{T}\int_0^T \vec{S}_r \, dt = \frac{1}{2} Re\{\underline{\vec{S}}_r\}$$

2.1 $\vec{S} = \vec{E} \times \vec{H}$ zeigt in Ausbreitungsrichtung der Welle

2.3 $r = \frac{E_{r0}}{E_{p0}} = \frac{Z_2 - Z_1}{Z_1 + Z_2}$ $\quad t = \frac{2 Z_2}{Z_1 + Z_2}$

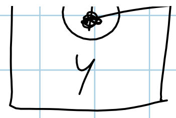
2.4 Leistungsbilanz:

$$-\mathrm{div}\,\overline{\vec{S}} = \overline{P}_{joule} + \overline{P}_{el} + \overline{P}_{magn} = 0$$



$$\iiint_V \mathrm{div}\,\vec{S}\, dV = \oint_F \vec{S}\, d\vec{F} = 0$$

Gaußscher Integralsatz



Gaußscher Integralsatz

1.1) $\vec{E}_p(z,t) = -Z\,(\vec{n} \times \vec{H})$

$\vec{E}_p(z,t) = \mathcal{E}_{p0}\, e^{-jk_1 z}\, e^{-j\omega t} \cdot \vec{e}_x$

$\vec{H}_p(z,t) = H_{p0}\, e^{-jk_1 z}\, e^{-j\omega t}\, \vec{e}_y$

$\vec{E}_p(z,t) = -Z\; \vec{e}_z \times \vec{e}_y \cdot H_{p0}\, e^{-jk_1 z}\, e^{-j\omega t}$

$\mathcal{E}_{p0}\, \cancel{e^{jk_1 z}}\, \cancel{e^{-j\omega t}}\, \vec{e}_x = +Z\, \vec{e}_x\, H_{p0}\, \cancel{e^{-jk_1 z}}\, \cancel{e^{-j\omega t}}$

$\mathcal{E}_{p0} = Z \cdot H_{p0}$

1.2) $\vec{E}_p(z,t) = \mathcal{E}_{p0}\, e^{-jk_1 z}\, e^{j\omega t}\, \vec{e}_x$

$\varphi(z,t) = -k_1 z + \omega t$

$-k_1 z + \omega t = c$

$\Rightarrow \quad +k_1 z = -c + \omega t$

$z = \underline{\omega t - c} \qquad \Big| \, \frac{d}{d\ldots}$

$$z = \frac{\omega t - c}{k_1} \quad \Big| \frac{d}{dt}$$

$$v_{ph} = \frac{\omega}{k_1}$$

1.1 Einfallende Welle:

$$\underline{\vec{E}}_p(z,t) = \mathcal{E}_{p0} \, e^{-jk_1 z} \, e^{j\omega t} \, \vec{e}_x$$

$$\underline{\vec{H}}_p(z,t) = H_{p0} \cdot e^{-jk_1 z} \, e^{j\omega t} \, \vec{e}_y$$

$$H_{p0} = \frac{\mathcal{E}_{p0}}{Z_1} \qquad Z_1 = \sqrt{\frac{\mu_0}{\varepsilon_1}}$$

$$k_1 = \omega \sqrt{\mu_0 \, \varepsilon_1}$$

1.2 Phase der einf. Welle:

$$\varphi(z,t) = \omega t - k_1 z$$

Phasengeschw. $\varphi(z,t) = \varphi_0 = \omega t - k_1 z$

$$\Rightarrow \quad z = \frac{\omega t}{k_1} - \frac{\varphi_0}{k_1}$$

beschreibt feste Phasenfläche

$$v_{ph} = \frac{dz}{dt} = \frac{\omega}{k_1}$$

1.3) $\underline{\vec{S}}_p = \underline{\vec{E}}_p \times \underline{\vec{H}}_p^*$

$$= E_{p0}\, e^{-jk_1 z}\, e^{j\omega t}\, \vec{e}_x \times \vec{e}_y\, H_{p0}\, e^{jk_1 z}\, e^{-j\omega t}$$

$$= E_{p0} \frac{E_{p0}}{Z_1} \vec{e}_z = \frac{E_{p0}^2}{Z_1} \vec{e}_z \checkmark$$

$$\overline{\vec{S}}_p = \frac{1}{2} \operatorname{Re}\{\underline{\vec{S}}_p\} = \frac{1}{2} \frac{E_{p0}^2}{Z_1} \vec{e}_z (\checkmark)$$

$\overline{\vec{S}}_p$ beschreibt Leistungstransport der Welle

$$[\underline{\vec{S}}_p] = \frac{W}{m^2} \checkmark$$

2.1 $\underline{\vec{E}}_r(z,t) = E_{r0}\, e^{jk_1 z}\, e^{j\omega t}\, \vec{e}_x \checkmark$

$$\underline{\vec{H}}_r(z,t) = H_{r0}\, e^{jk_1 z}\, e^{j\omega t} (-\vec{e}_y) \checkmark$$

$$\underline{\vec{E}}_t(z,t) = E_{t0}\, e^{-jk_2 z}\, e^{j\omega t}\, \vec{e}_x \checkmark$$

$$\underline{\vec{H}}_t(z,t) = H_{t0}\, e^{-jk_2 z}\, e^{j\omega t}\, \vec{e}_y \checkmark$$

mit $H_{r0} = \frac{E_{r0}}{Z_1}$ $\quad H_{t0} = \frac{E_{t0}}{Z_2}$

2.2)

$H_{tan} =$ stetig
$E_{tan} =$ stetig

bei $z = 0$

$$\vec{H}_p - \vec{H}_r = \vec{H}_t$$

$$H_{p0} - H_{r0} = H_{t0}$$

$$\vec{E}_p + \vec{E}_r = \vec{E}_t$$

$$\underline{E_{p0} + E_{r0} = E_{t0}}$$

$$H_{p0} - H_{r0} = H_{t0}$$

$$\Rightarrow \underline{\frac{E_{p0}}{Z_1} - \frac{E_{r0}}{Z_1} = \frac{E_{t0}}{Z_2}}$$

$$E_{t0} = \frac{Z_2}{Z_1}(E_{p0} - E_{r0})$$

$$\varepsilon_{p0} + \varepsilon_{r0} = \frac{Z_2}{Z_1}\left(\varepsilon_{p0} - \varepsilon_{r0}\right) \qquad \big| : \varepsilon_{p0}$$

$$1 + \frac{\varepsilon_{r0}}{\varepsilon_{p0}} = \frac{Z_2}{Z_1} - \frac{\varepsilon_{r0}}{\varepsilon_{p0}} \frac{Z_2}{Z_1}$$

$$\frac{\varepsilon_{r0}}{\varepsilon_{p0}}\left(1 + \frac{Z_2}{Z_1}\right) = \frac{Z_2}{Z_1} - 1$$

$$r = \frac{\varepsilon_{r0}}{\varepsilon_{p0}} = \frac{\frac{Z_2}{Z_1} - 1}{1 + \frac{Z_2}{Z_1}} = \frac{Z_2 - Z_1}{Z_1 + Z_2} \checkmark$$

$$t = \frac{\varepsilon_{t0}}{\varepsilon_{p0}} \qquad \varepsilon_{r0} = \varepsilon_{t0} - \varepsilon_{p0}$$

$$\Rightarrow \frac{\varepsilon_{p0}}{Z_1} - \frac{\varepsilon_{t0} - \varepsilon_{p0}}{Z_1} = \frac{\varepsilon_{t0}}{Z_2} \qquad : \varepsilon_{p0}$$

$$\frac{1}{Z_1} - \frac{\varepsilon_{t0}}{\varepsilon_{p0}} \frac{1}{Z_1} - \frac{1}{Z_1} = \frac{\varepsilon_{t0}}{\varepsilon_{p0}} \frac{1}{Z_2}$$

$$\frac{\varepsilon_{t0}}{\varepsilon_{p0}}\left(\frac{1}{Z_2} + \frac{1}{Z_1}\right) =$$

$$\mathcal{E}_{p0} + \mathcal{E}_{r0} = \mathcal{E}_{t0}$$

$$1 + \frac{\mathcal{E}_{r0}}{\mathcal{E}_{p0}} = \frac{\mathcal{E}_{t0}}{\mathcal{E}_{p0}}$$

$$1 + r = t \quad \Rightarrow \quad t - r = 1 \quad ✓$$

$$t = 1 + r = 1 + \frac{Z_2 - Z_1}{Z_2 + Z_1}$$

$$= \frac{2 Z_2}{Z_2 + Z_1} \quad ✓$$

2.3)

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