Grundlagen

E-Feld:

$$U_{12} = \int_{P1}^{P2} \vec{E} d\vec{r} \tag{1.2}$$

$$Q = \varepsilon_0 \oiint_A \vec{E} d\vec{A} \tag{1.5}$$

$$\vec{F} = q \cdot \vec{E} \; nqv = \tfrac{i}{e} \tag{1.1}$$

B-Feld:

$$B = \tfrac{\mu_0 i}{2\pi r}\vec{t} \; ; \|t\| = 1; t \perp \vec{i} \tag{1.41}$$

$$\Phi = AB \tag{1.42}$$

$$F = q\left(\vec{v} \times \vec{B}\right) \tag{1.45}$$

$$\kappa = enb \tag{1.18}$$

$$\oiint \vec{B} \, d\vec{A} = 0 \tag{1.44}$$

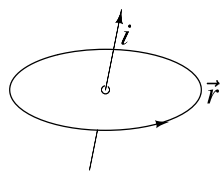
Induktion:

$$U_{12} = n\tfrac{d\Phi}{dt} \tag{1.49}$$

Das Durchflutungsgesetz: (1.53,1.52

$$\Theta = \oint_C \tfrac{\vec{B}}{\mu} d\vec{r}$$

$$\Theta = \textstyle\sum_n \pm i_n$$



Allgemein:

$$J = \tfrac{i}{A} \tag{1.19}$$

$$\vec{J} = \kappa \vec{E} \tag{1.17}$$

$$C = \tfrac{Q}{U} \quad \text{(S. 50)}$$

Leistung:

$$\underline{P} = I^2 \underline{Z} = U^2 \underline{Y}^* = \underline{U}\,\underline{I}^* \quad \text{(2.42, 2.38)}$$

Maximale Leistungsübertragung:

$$\underline{Z} = \underline{Z}_0^* \tag{4.51}$$

Leiter, allgemein:

$$\vec{v} = -b\vec{E} \tag{1.14}$$

$$R = \frac{l}{\kappa A} \tag{1.23}$$

$$W_F = \left(3\pi^2 n\right)^{\frac{2}{3}} \frac{\hbar^2}{2m} \tag{1.12}$$

Breite eines Bandes:

$$W_{max} = \frac{2\hbar^2}{ma^2} \qquad ; a = \text{Atomabstand} \tag{1.13}$$

Nichtleiter:

Diamant: Bandlücke 5eV

Halbleiter, undotiert:

$$p = n = n_i \tag{S. 21}$$

Halbleiter, allgemein:

$$n_i = 2\left(\frac{m_e k_b T}{2\pi\hbar^2}\right)^{\frac{3}{2}} e^{-\frac{\overbrace{W_c - W_v}^{\text{Bandlücke}}}{2k_b T}} \text{[1em]} ; \frac{mk_b}{2\pi\hbar^2} = 1{,}799\,853\,6 \cdot 10^{14} \frac{1}{Km^2} \tag{1.25}$$

$$n_i^2 = pn \tag{1.27}$$

$$\kappa = e\left(nb_n + pb_p\right) \tag{1.26}$$

$$p = n_i e^{\frac{W_i - W_F}{K_B T}} \qquad n = n_i e^{\frac{W_F - W_i}{K_B T}} \tag{1.28a,b}$$

$$n_a = n_p \qquad p_D = p_n \tag{S. 22}$$

Raumladungsdichte:

$$\rho = -en_a = en_d$$

Diode:

$$i = I_s\left(e^{\frac{U}{U_t}} - 1\right) \tag{1.39}$$

$$U_D = \frac{e}{2\varepsilon_0}\left(n_P x_p^2 + n_n x_n^2\right) \tag{1.31}$$

$$\frac{x_p}{x_n} = \frac{n_n}{n_p} \tag{1.38}$$

$$x_n = \sqrt{\frac{2\varepsilon U_D n_A}{en_D(n_A + n_D)}} \tag{1.16}$$

$$C = A\sqrt{\frac{\varepsilon e}{2(U_D - u)} \frac{n_a n_D}{n_A + n_D}} \tag{1.18}$$

$$i_{Sperr} \propto n_i^2 \tag{M1}$$

Konstanten

(Anhang A)

$$
\begin{aligned}
c_0 &= 299\,792\,458 \, \mathrm{m/s} \approx 0{,}3 \, \mathrm{m/ns} \\
\varepsilon_0 &= 8{,}854\,187\,818 \cdot 10^{-12} \, \mathrm{F/m} \\
\mu_0 &= 4\pi \cdot 10^{-7} \, \mathrm{H/m} \\
h &= 6{,}626\,176 \cdot 10^{-34} \, \mathrm{Ws^2} \\
\hbar &= h/2\pi = 1{,}054\,589 \cdot 10^{-34} \, \mathrm{Ws^2} \\
e &= 1{,}602\,189 \cdot 10^{-19} \, \mathrm{C} \\
m_e &= 9{,}109\,534 \cdot 10^{-31} \, \mathrm{kg} \\
k_b &= 1{,}380\,662 \cdot 10^{-23} \, \mathrm{Ws/K} \\
g &= 9{,}806\,65 \, \mathrm{m/s^2} \\
\pi &= 3{,}141\,592\,654 \\
e &= 2{,}718\,281\,828
\end{aligned}
$$

$$
\begin{aligned}
1Nm &= 1Ws \\
1kg &= 1 \, \mathrm{Vas^2/m^2}
\end{aligned}
$$

$$1\mathrm{H} = 1\Omega\mathrm{s} = 1\,\mathrm{Vs/A} = 1\,\mathrm{N/A^2m}$$

$$1\mathrm{F} = 1\,\mathrm{s/\Omega} = 1\,\mathrm{As/V} = 1\,\mathrm{A^2s^2/Nm}$$

Fermi- Energien: (S. 11)

$$
\begin{array}{ll}
\mathrm{Al} = 11{,}6\mathrm{eV} & \mathrm{Ag} = 5{,}5\mathrm{eV} \\
\mathrm{Cu} = 7{,}0\mathrm{eV} & \mathrm{Li} = 4{,}7\mathrm{eV}
\end{array}
$$

Bandlücken: (S. 20)

$$\mathrm{Si} = 1{,}1\mathrm{eV} \quad \mathrm{Ge} = 0{,}7\mathrm{eV}$$

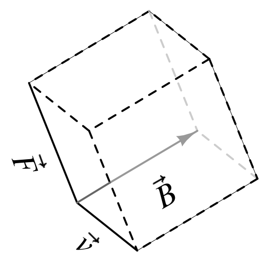
Weiteres bei Silizium: (S. 20)

$$\text{Durchbruchfeldstärke} \approx 3 \cdot 10^7 \, \mathrm{V/m} \tag{B3 d}$$

$$\varepsilon_{Si} = 11{,}8\varepsilon_0 \tag{B3 b}$$

$$n_i = 1{,}5 \cdot 10^{16} \, \mathrm{1/m^3} \tag{B4}$$

Linke- Hand- Regel:



$q > 0$

Zweitormatrixtransformationen

	$\underline{Z}$	$\underline{Y}$	$\underline{H}$	$\underline{G}$	$\underline{A}$	$\underline{B}$
$\underline{Z}$	$\underline{Z}=\underline{Z}$	$\underline{Z}=\frac{1}{\Delta\underline{Y}}\begin{pmatrix}\underline{y}_{22} & -\underline{y}_{12}\\ -\underline{y}_{21} & \underline{y}_{11}\end{pmatrix}$	$\underline{Z}=\frac{1}{\underline{h}_{22}}\begin{pmatrix}\Delta\underline{H} & \underline{h}_{12}\\ -\underline{h}_{21} & 1\end{pmatrix}$	$\underline{Z}=\frac{1}{\underline{g}_{11}}\begin{pmatrix}1 & -\underline{g}_{12}\\ \underline{g}_{21} & \Delta\underline{G}\end{pmatrix}$	$\underline{Z}=\frac{1}{\underline{a}_{21}}\begin{pmatrix}\underline{a}_{11} & \Delta\underline{A}\\ 1 & \underline{a}_{22}\end{pmatrix}$	$\underline{Z}=\frac{1}{\underline{b}_{21}}\begin{pmatrix}-\underline{b}_{22} & -1\\ -\Delta\underline{B} & -\underline{b}_{11}\end{pmatrix}$
$\underline{Y}$	$\underline{Y}=\frac{1}{\Delta\underline{Z}}\begin{pmatrix}\underline{z}_{22} & -\underline{z}_{12}\\ -\underline{z}_{21} & \underline{z}_{11}\end{pmatrix}$	$\underline{Y}=\underline{Y}$	$\underline{Y}=\frac{1}{\underline{h}_{11}}\begin{pmatrix}1 & -\underline{h}_{12}\\ \underline{h}_{21} & \Delta\underline{H}\end{pmatrix}$	$\underline{Y}=\frac{1}{\underline{g}_{22}}\begin{pmatrix}\Delta\underline{G} & \underline{g}_{12}\\ -\underline{g}_{21} & 1\end{pmatrix}$	$\underline{Y}=\frac{1}{\underline{a}_{12}}\begin{pmatrix}\underline{a}_{22} & -\Delta\underline{A}\\ -1 & \underline{a}_{11}\end{pmatrix}$	$\underline{Y}=\frac{1}{\underline{b}_{12}}\begin{pmatrix}-\underline{b}_{11} & 1\\ \Delta\underline{B} & -\underline{b}_{21}\end{pmatrix}$
$\underline{H}$	$\underline{H}=\frac{1}{\underline{z}_{22}}\begin{pmatrix}\Delta\underline{Z} & \underline{z}_{12}\\ -\underline{z}_{21} & 1\end{pmatrix}$	$\underline{H}=\frac{1}{\underline{y}_{11}}\begin{pmatrix}1 & -\underline{y}_{12}\\ \underline{y}_{21} & \Delta\underline{Y}\end{pmatrix}$	$\underline{H}=\underline{H}$	$\underline{H}=\frac{1}{\Delta\underline{G}}\begin{pmatrix}\underline{g}_{22} & -\underline{g}_{12}\\ -\underline{g}_{21} & \underline{g}_{11}\end{pmatrix}$	$\underline{H}=\frac{1}{\underline{a}_{22}}\begin{pmatrix}\underline{a}_{12} & \Delta\underline{A}\\ -1 & \underline{a}_{21}\end{pmatrix}$	$\underline{H}=\frac{1}{\underline{b}_{11}}\begin{pmatrix}-\underline{b}_{12} & 1\\ -\Delta\underline{B} & -\underline{b}_{12}\end{pmatrix}$
$\underline{G}$	$\underline{G}=\frac{1}{\underline{z}_{11}}\begin{pmatrix}1 & -\underline{z}_{12}\\ \underline{z}_{21} & \Delta\underline{Z}\end{pmatrix}$	$\underline{G}=\frac{1}{\underline{y}_{22}}\begin{pmatrix}\Delta\underline{Y} & \underline{y}_{12}\\ -\underline{y}_{21} & 1\end{pmatrix}$	$\underline{G}=\frac{1}{\Delta\underline{H}}\begin{pmatrix}\underline{h}_{22} & -\underline{h}_{12}\\ -\underline{h}_{21} & \underline{h}_{11}\end{pmatrix}$	$\underline{G}=\underline{G}$	$\underline{G}=\frac{1}{\underline{a}_{11}}\begin{pmatrix}\underline{a}_{21} & -\Delta\underline{A}\\ 1 & \underline{a}_{12}\end{pmatrix}$	$\underline{G}=\frac{1}{\underline{b}_{22}}\begin{pmatrix}-\underline{b}_{21} & -1\\ \Delta\underline{B} & \underline{b}_{12}\end{pmatrix}$
$\underline{A}$	$\underline{A}=\frac{1}{\underline{z}_{21}}\begin{pmatrix}\underline{z}_{11} & \Delta\underline{Z}\\ 1 & \underline{z}_{22}\end{pmatrix}$	$\underline{A}=\frac{1}{\underline{y}_{21}}\begin{pmatrix}-\underline{y}_{22} & -1\\ -\Delta\underline{Y} & -\underline{y}_{11}\end{pmatrix}$	$\underline{A}=\frac{1}{\underline{h}_{21}}\begin{pmatrix}-\Delta\underline{H} & -\underline{h}_{11}\\ -\underline{h}_{22} & -1\end{pmatrix}$	$\underline{A}=\frac{1}{\underline{g}_{21}}\begin{pmatrix}1 & \underline{g}_{22}\\ \underline{g}_{11} & \Delta\underline{G}\end{pmatrix}$	$\underline{A}=\underline{A}$	$\underline{A}=\frac{1}{\Delta\underline{B}}\begin{pmatrix}\underline{b}_{22} & -\underline{b}_{12}\\ -\underline{b}_{21} & \underline{b}_{11}\end{pmatrix}$
$\underline{B}$	$\underline{B}=\frac{1}{\underline{z}_{21}}\begin{pmatrix}\underline{z}_{22} & -\Delta\underline{Z}\\ -1 & \underline{z}_{11}\end{pmatrix}$	$\underline{B}=\frac{1}{\underline{z}_{12}}\begin{pmatrix}-\underline{y}_{11} & 1\\ \Delta\underline{Y} & -\underline{y}_{22}\end{pmatrix}$	$\underline{B}=\frac{1}{\underline{h}_{12}}\begin{pmatrix}1 & -\underline{h}_{11}\\ -\underline{h}_{22} & \Delta\underline{H}\end{pmatrix}$	$\underline{B}=\frac{1}{\underline{g}_{12}}\begin{pmatrix}-\Delta\underline{G} & \underline{g}_{22}\\ \underline{g}_{11} & -1\end{pmatrix}$	$\underline{B}=\frac{1}{\Delta\underline{A}}\begin{pmatrix}\underline{a}_{22} & -\underline{a}_{12}\\ -\underline{a}_{21} & \underline{a}_{11}\end{pmatrix}$	$\underline{B}=\underline{B}$

Zweitormatritzen

$$\begin{pmatrix} \underline{U}_1 \\ \underline{U}_2 \end{pmatrix} = \begin{pmatrix} \underline{z}_{11} & \underline{z}_{12} \\ \underline{z}_{21} & \underline{z}_{22} \end{pmatrix} \cdot \begin{pmatrix} \underline{I}_1 \\ \underline{I}_2 \end{pmatrix} \qquad \begin{pmatrix} \underline{I}_1 \\ \underline{I}_2 \end{pmatrix} = \begin{pmatrix} \underline{y}_{11} & \underline{y}_{12} \\ \underline{y}_{21} & \underline{y}_{22} \end{pmatrix} \cdot \begin{pmatrix} \underline{U}_1 \\ \underline{U}_2 \end{pmatrix}$$

$$\begin{pmatrix} \underline{U}_1 \\ \underline{I}_1 \end{pmatrix} = \begin{pmatrix} \underline{a}_{11} & \underline{a}_{12} \\ \underline{a}_{21} & \underline{a}_{22} \end{pmatrix} \cdot \begin{pmatrix} \underline{U}_2 \\ -\underline{I}_2 \end{pmatrix} \qquad \begin{pmatrix} \underline{U}_2 \\ -\underline{I}_2 \end{pmatrix} = \begin{pmatrix} \underline{b}_{11} & \underline{b}_{12} \\ \underline{b}_{21} & \underline{b}_{22} \end{pmatrix} \cdot \begin{pmatrix} \underline{U}_1 \\ \underline{I}_1 \end{pmatrix}$$

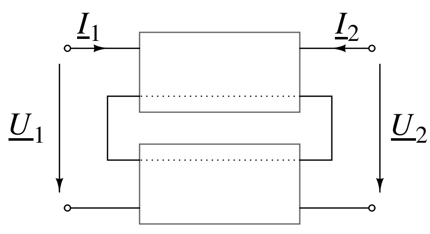
$$\begin{pmatrix} \underline{U}_1 \\ \underline{I}_2 \end{pmatrix} = \begin{pmatrix} \underline{h}_{11} & \underline{h}_{12} \\ \underline{h}_{21} & \underline{h}_{22} \end{pmatrix} \cdot \begin{pmatrix} \underline{I}_1 \\ \underline{U}_2 \end{pmatrix} \qquad \begin{pmatrix} \underline{I}_1 \\ \underline{U}_2 \end{pmatrix} = \begin{pmatrix} \underline{g}_{11} & \underline{g}_{12} \\ \underline{g}_{21} & \underline{g}_{22} \end{pmatrix} \cdot \begin{pmatrix} \underline{U}_1 \\ \underline{I}_2 \end{pmatrix}$$

$$\begin{aligned} \underline{U}_1 &= \underline{z}_{11} \cdot \underline{I}_1 + \underline{z}_{12} \cdot \underline{I}_2 & \qquad \underline{I}_1 &= \underline{y}_{11} \cdot \underline{U}_1 + \underline{y}_{12} \cdot \underline{U}_2 \\ \underline{U}_2 &= \underline{z}_{21} \cdot \underline{I}_1 + \underline{z}_{22} \cdot \underline{I}_2 & \qquad \underline{I}_2 &= \underline{y}_{21} \cdot \underline{U}_1 + \underline{y}_{22} \cdot \underline{U}_2 \end{aligned}$$

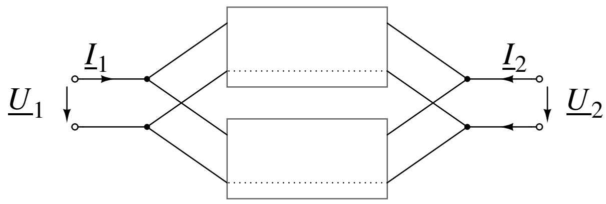
$$\begin{aligned} \underline{U}_1 &= \underline{a}_{11} \cdot \underline{U}_2 + \underline{a}_{12} \cdot (-\underline{I}_2) & \qquad \underline{U}_2 &= \underline{b}_{11} \cdot \underline{U}_1 + \underline{b}_{12} \cdot \underline{I}_1 \\ \underline{I}_1 &= \underline{a}_{21} \cdot \underline{U}_2 + \underline{a}_{22} \cdot (-\underline{I}_2) & \qquad -\underline{I}_2 &= \underline{b}_{21} \cdot \underline{U}_1 + \underline{b}_{22} \cdot \underline{I}_1 \end{aligned}$$

$$\begin{aligned} \underline{U}_1 &= \underline{h}_{11} \cdot \underline{I}_1 + \underline{h}_{12} \cdot \underline{U}_2 & \qquad \underline{I}_1 &= \underline{g}_{11} \cdot \underline{U}_1 + \underline{g}_{12} \cdot \underline{I}_2 \\ \underline{I}_2 &= \underline{h}_{21} \cdot \underline{I}_1 + \underline{h}_{22} \cdot \underline{U}_2 & \qquad \underline{U}_2 &= \underline{g}_{21} \cdot \underline{U}_1 + \underline{g}_{22} \cdot \underline{I}_2 \end{aligned}$$

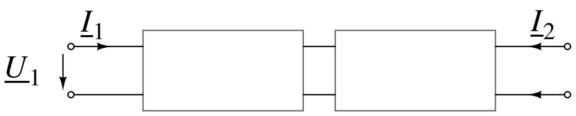
Zweitorverbindungen



$$\underline{Z} = \underline{Z}_1 + \underline{Z}_2 \tag{292}$$

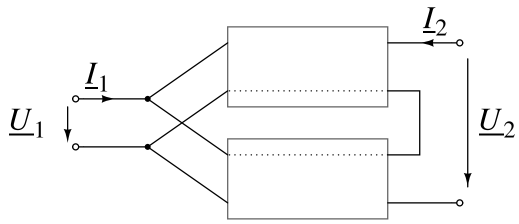


$$\underline{Y} = \underline{Y}_1 + \underline{Y}_2 \tag{293}$$

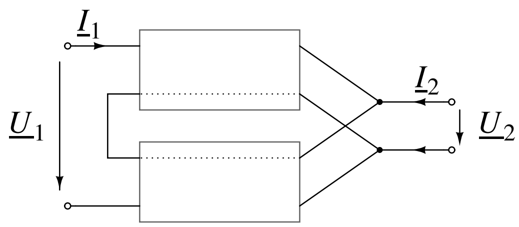


$$\underline{A} = \underline{A}_1 \cdot \underline{A}_2 \tag{295}$$

$$\underline{B} = \underline{A}^{-1} = \underline{A}_2^{-1} \cdot \underline{A}_1^{-1}$$

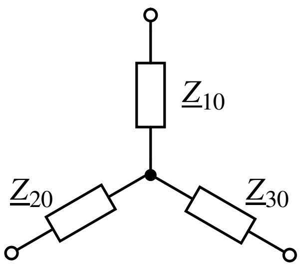


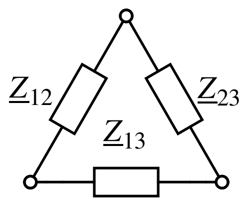
$$\underline{G} = \underline{G}_1 + \underline{G}_2 \qquad \text{(Tip s. 300)}$$



$$\underline{H} = \underline{H}_1 + \underline{H}_2 \qquad \text{(Tip s. 300)}$$

Drehstrom



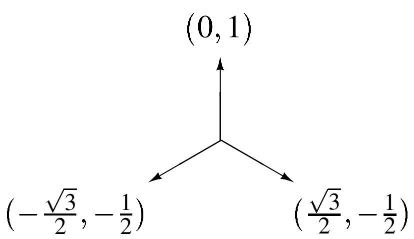


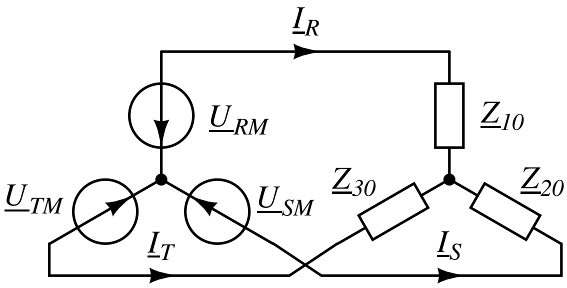
(310)

$$\underline{Z}_{10} = \frac{\underline{Z}_{12}\underline{Z}_{13}}{\underline{Z}_{12}+\underline{Z}_{13}+\underline{Z}_{23}} \qquad \underline{Z}_{12} = \frac{\underline{Z}_{10}\underline{Z}_{20}+\underline{Z}_{20}\underline{Z}_{30}+\underline{Z}_{30}\underline{Z}_{10}}{\underline{Z}_{30}}$$

$$\underline{Z}_{20} = \frac{\underline{Z}_{12}\underline{Z}_{23}}{\underline{Z}_{12}+\underline{Z}_{13}+\underline{Z}_{23}} \qquad \underline{Z}_{23} = \frac{\underline{Z}_{10}\underline{Z}_{20}+\underline{Z}_{20}\underline{Z}_{30}+\underline{Z}_{30}\underline{Z}_{10}}{\underline{Z}_{10}}$$

$$\underline{Z}_{30} = \frac{\underline{Z}_{13}\underline{Z}_{23}}{\underline{Z}_{12}+\underline{Z}_{13}+\underline{Z}_{23}} \qquad \underline{Z}_{13} = \frac{\underline{Z}_{10}\underline{Z}_{20}+\underline{Z}_{20}\underline{Z}_{30}+\underline{Z}_{30}\underline{Z}_{10}}{\underline{Z}_{20}}$$





$$\underline{I}_R = \frac{\underline{Y}_{10}\underline{Y}_{30}\underline{U}_{RT}+\underline{Y}_{10}\underline{Y}_{20}\underline{U}_{RS}}{\underline{Y}_{10}+\underline{Y}_{20}+\underline{Y}_{30}}$$
$$\underline{I}_S = \frac{\underline{Y}_{20}\underline{Y}_{10}\underline{U}_{SR}+\underline{Y}_{20}\underline{Y}_{30}\underline{U}_{ST}}{\underline{Y}_{10}+\underline{Y}_{20}+\underline{Y}_{30}}$$
$$\underline{I}_T = \frac{\underline{Y}_{30}\underline{Y}_{20}\underline{U}_{TS}+\underline{Y}_{30}\underline{Y}_{10}\underline{U}_{TR}}{\underline{Y}_{10}+\underline{Y}_{20}+\underline{Y}_{30}} \quad (5.72 \text{ a-c})$$

Besondere Zweitore

Symmetrisch:

$$\underline{z}_{11} = \underline{z}_{22}; \quad \underline{y}_{11} = \underline{y}_{22};$$
$$\underline{z}_{12} = \underline{z}_{21} \quad \underline{y}_{12} = \underline{y}_{21}$$

Reziprok:

$$\underline{z}_{12} = \underline{z}_{21} \qquad \underline{y}_{12} = \underline{y}_{21}$$

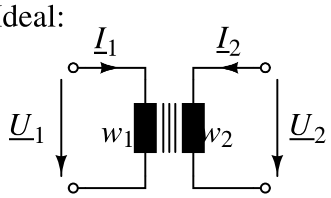
Spezielle Zweitormatritzen

Gyrator:

$$\underline{Y}=\begin{pmatrix} 0 & g \\ -g & 0 \end{pmatrix} \qquad \underline{Z}=\begin{pmatrix} 0 & -\frac{1}{g} \\ \frac{1}{g} & 0 \end{pmatrix}$$

$$\underline{A}=\begin{pmatrix} 0 & \frac{1}{g} \\ g & 0 \end{pmatrix} \qquad \underline{B}=\begin{pmatrix} 0 & \frac{1}{g} \\ -g & 0 \end{pmatrix}$$

Übertrager, Ideal:



$$\underline{U}_2 = \frac{w_2}{w_1}\underline{U}_1$$
$$\underline{I}_2 = \frac{w_1}{w_2}\underline{I}_2 \quad (64)$$

$$\underline{A}=\begin{pmatrix} ü & 0 \\ 0 & \frac{1}{ü} \end{pmatrix} \qquad \underline{B}=\begin{pmatrix} \frac{1}{ü} & 0 \\ 0 & ü \end{pmatrix}$$

$$\underline{H}=\begin{pmatrix} 0 & ü \\ -ü & 0 \end{pmatrix} \qquad \underline{G}=\begin{pmatrix} 0 & -\frac{1}{ü} \\ \frac{1}{ü} & 0 \end{pmatrix}$$

$$ü=\frac{w_1}{w_2} \qquad \frac{1}{ü}=\frac{w_2}{w_1} \tag{275}$$

Übertrager, allgemein:

$$\underline{Z}=\begin{pmatrix} j\omega L_1 & j\omega M \\ j\omega M & j\omega L_2 \end{pmatrix} \qquad \underline{Y}=\frac{1}{j\omega L_1 L_2 - j\omega M^2}\begin{pmatrix} L_2 & -M \\ -M & L_1 \end{pmatrix}$$

$$\underline{A}=\begin{pmatrix} \frac{L_1}{M} & -j\omega M + j\omega\frac{L_1 L_2}{M} \\ \frac{1}{j\omega M} & \frac{L_2}{M} \end{pmatrix} \qquad \underline{B}=\begin{pmatrix} \frac{L_2}{M} & j\omega M - j\omega\frac{L_1 L_2}{M} \\ -\frac{1}{j\omega M} & \frac{L_1}{M} \end{pmatrix}$$

$$\underline{H}=\begin{pmatrix} j\omega L_1 - j\omega\frac{M^2}{L_2} & \frac{M}{L_2} \\ -\frac{M}{L_2} & \frac{1}{j\omega L_2} \end{pmatrix} \qquad \underline{G}=\begin{pmatrix} \frac{1}{j\omega L_1} & -\frac{M}{L_1} \\ \frac{M}{L_1} & j\omega L_2 - j\omega\frac{M^2}{L_1} \end{pmatrix}$$

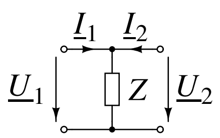
Zusätzlich, wenn Festgekoppelt:

$$M=\pm\sqrt{L_1 L_2}$$

$$\underline{A}=\begin{pmatrix} \frac{L_1}{M} & 0 \\ \frac{1}{j\omega M} & \frac{L_2}{M} \end{pmatrix} \qquad \underline{B}=\begin{pmatrix} \frac{L_2}{M} & 0 \\ -\frac{1}{j\omega M} & \frac{L_1}{M} \end{pmatrix}$$

$$\underline{H}=\begin{pmatrix} 0 & \frac{M}{L_2} \\ -\frac{M}{L_2} & \frac{1}{j\omega L_2} \end{pmatrix} \qquad \underline{G}=\begin{pmatrix} \frac{1}{j\omega L_1} & -\frac{M}{L_1} \\ \frac{M}{L_1} & 0 \end{pmatrix}$$

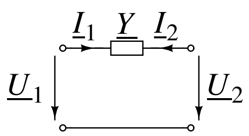
Zweipol als Zweitor:



$$\underline{Z}=\begin{pmatrix} \underline{Z} & \underline{Z} \\ \underline{Z} & \underline{Z} \end{pmatrix}$$

$$\underline{A}=\begin{pmatrix} 1 & 0 \\ \frac{1}{\underline{Z}} & 1 \end{pmatrix} \qquad \underline{B}=\begin{pmatrix} 1 & 0 \\ -\frac{1}{\underline{Z}} & 1 \end{pmatrix}$$

$$\underline{H}=\begin{pmatrix} 0 & 1 \\ -1 & \frac{1}{\underline{Z}} \end{pmatrix} \qquad \underline{G}=\begin{pmatrix} \frac{1}{\underline{Z}} & -1 \\ 1 & 0 \end{pmatrix}$$



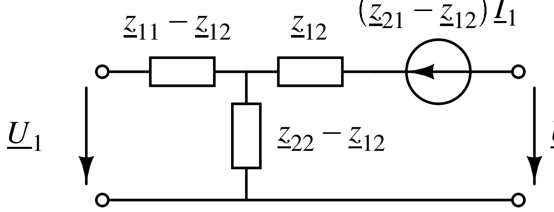
$$\underline{Y} = \begin{pmatrix} \underline{Y} & \underline{Y} \\ \underline{Y} & \underline{Y} \end{pmatrix}$$

$$\underline{A} = \begin{pmatrix} 1 & \underline{Z} \\ 0 & 1 \end{pmatrix} \qquad \underline{B} = \begin{pmatrix} 1 & -\underline{Z} \\ 0 & 1 \end{pmatrix}$$

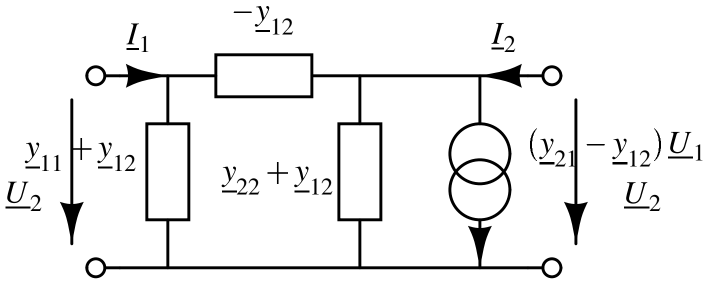
$$\underline{H} = \begin{pmatrix} \underline{Z} & 1 \\ -1 & 0 \end{pmatrix} \qquad \underline{G} = \begin{pmatrix} 0 & -1 \\ 1 & \underline{Z} \end{pmatrix}$$

Ersatznetzwerke (289)

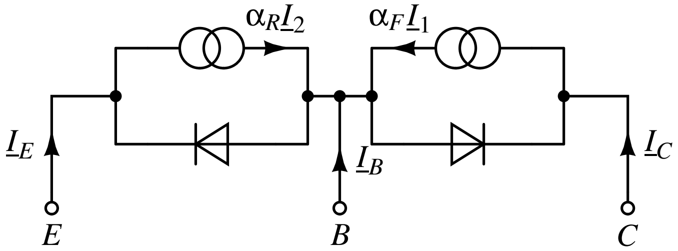
T- Ersatz- Netzwerk:



π- Ersatz- Netzwerk:



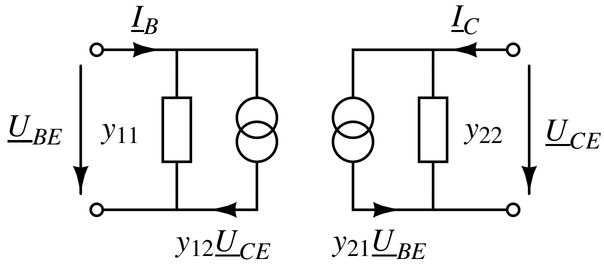
Transistoren



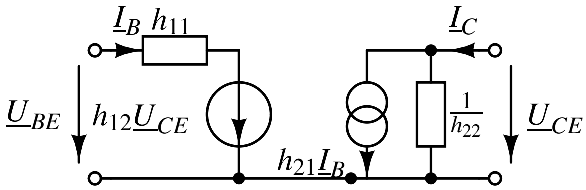
(97)

Das Ebers- Mollsche Modell.
Typische Parameter:

$$0,5 \leq \alpha_R \leq 0.8 \quad 0.99 \approx \alpha_F \leq 1$$

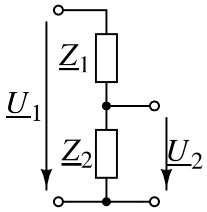


(104)



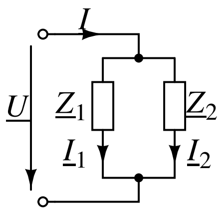
(105)

Zweipole etc.



$$\underline{U}_2 = \underline{U}_1 \cdot \frac{\underline{Z}_2}{\underline{Z}_1+\underline{Z}_2} \quad \underline{U}_2 = \underline{U}_1 \cdot \frac{\underline{Y}_1}{\underline{Y}_1+\underline{Y}_2}$$

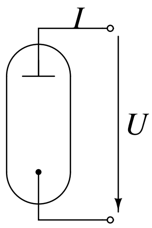
$$\underline{Z} = \underline{Z}_1 + \underline{Z}_2 \qquad \underline{Y} = \frac{\underline{Y}_1\underline{Y}_2}{\underline{Y}_1+\underline{Y}_2}$$



$$\underline{I}_1 = \underline{I} \cdot \frac{\underline{Z}_2}{\underline{Z}_1+\underline{Z}_2} \quad \underline{I}_1 = \underline{I} \cdot \frac{\underline{Y}_1}{\underline{Y}_1+\underline{Y}_2}$$

$$\underline{Z} = \frac{\underline{Z}_1\underline{Z}_2}{\underline{Z}_1+\underline{Z}_2} \qquad \underline{Y} = \underline{Y}_1 + \underline{Y}_2$$

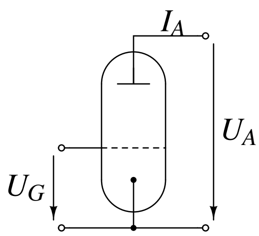
Diode:



$$I = K_D U^{\frac{3}{2}}$$ (1.171)

$$K_D = \frac{4\varepsilon_0 A_q}{9d^2}\sqrt{\frac{2e}{m}}$$

Triode:

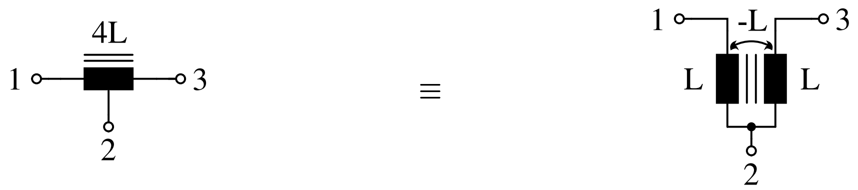


$$I_A = K_T \left(U_G + D U_A\right)^{\frac{3}{2}} \qquad (1.174)$$

$$D = \frac{C_{KA}}{C_{KG}} \qquad (1.173)$$

$$\frac{\delta U_A}{\delta U_G} = -\frac{1}{D} \qquad \text{im Arbeitspunkt} \qquad (141)$$

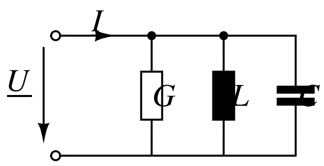
Angezapfte Spule:

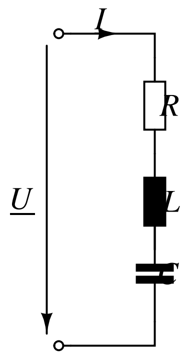


(V2)

$$L \propto w^2 \left(L = w^2 A \frac{\mu}{l}\right) \qquad (48)$$

Schwingkreise





(165; Parallel Vorschlag S. 169)

$$Q = \omega_0 RC = \frac{R}{\omega_0 L} = R\sqrt{\frac{C}{L}} \qquad Q = \omega_0 GL = \frac{G}{\omega_0 C} = G\sqrt{\frac{L}{C}}$$

$$\underline{Z} = R \cdot \frac{1}{1 + jQ\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)} \qquad \underline{Y} = G \cdot \frac{1}{1 + jQ\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)}$$

(cos & sin)

$$\cos x = \frac{e^{jx} + e^{-jx}}{2} \qquad \sin x = \frac{e^{jx} - e^{-jx}}{2j}$$

$$\cos x \pm y = \cos x \cos y \mp \sin x \sin y \qquad \sin x \pm y = \sin x \cos y \pm \cos x \sin y$$

$$\cos^2 x = \frac{1}{2}(1 + \cos 2x) \qquad \sin^2 x = \frac{1}{2}(1 - \cos 2x)$$

(Bronstein S. 60)

$$\cos x \cos y = \frac{1}{2}\Big(\cos(x-y) + \cos(x+y)\Big)$$

$$\cos x \sin y = \frac{1}{2}\Big(\sin(x-y) + \sin(x+y)\Big)$$

$$\sin x \sin y = \frac{1}{2}\Big(\cos(x-y) - \cos(x+y)\Big)$$

$$\cos(\omega t) + \cos(\omega t + a) + \cos\left(\omega t + a^2\right) = 0 \qquad \sin(\omega t) + \sin(\omega t + a) + \sin\left(\omega t + a^2\right) = 0$$

Komplexe Wechselstromrechung

$$\underline{U} = \frac{\sqrt{2}}{2}U_0 \Rightarrow u(t) = U_0 \cos\omega t$$
$$\underline{U} = j\frac{\sqrt{2}}{2}U_0 \Rightarrow u(t) = -U_0 \sin\omega t$$

WARNUNG

Diese Formelsammlung ist — wie unschwer zu erkennen — zum Großem Teil aus

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abgetippt worden. Daher auch die Quellenangaben. Der Rest mußte in der Regel für die Übungsaufgaben ermittelt werden.

Obwohl ich Alles mehrfach nachgeprüft habe, will ich keinerlei Garantie auf meine Arbeit geben.