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ELEKTROTECHNIK
FORMELSAMMLUNG

01. WIDERSTAND

Widerstand: $R = \frac{U}{I}$

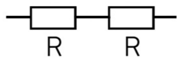
Leiterwiderstand: $R = \rho \cdot \frac{l}{A}$

Wärmewiderstand: $R = R_0(1 + \alpha \cdot \Delta T)$

Spezifische Leitfähigkeit: $\gamma = \frac{1}{\rho}$

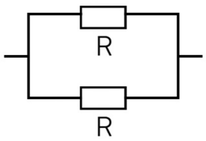
Leitwert: $G = \frac{1}{R}$

Reihe



$$R_g = R_1 + R_2$$
$$I = I_1 = I_2$$
$$U = U_1 + U_2$$

Parallel



$$\frac{1}{R_g} = \frac{1}{R_1} + \frac{1}{R_2} \qquad R_g = \frac{R_1 R_2}{R_1 + R_2}$$
$$I = I_1 + I_2$$
$$U = U_1 = U_2$$

Leistung: $P = UI = \frac{U^2}{R} = I^2 R$

Wirkungsgrad: $\eta = \frac{P_2}{P_1}$

02. SCHALTUNGSGESETZE

Knotenregel: $\sum I = 0$

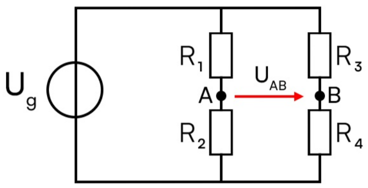
Maschenregel: $\sum U = 0$

Spannungsteiler Regel: $\frac{U_1}{U_2} = \frac{R_1}{R_2}$

Stromteiler Regel: $\frac{I_1}{I_2} = \frac{R_2}{R_1}$

Wheatstonesche Brückenschaltung

$$U_{AB} = 0V \qquad \frac{R_1}{R_2} = \frac{R_3}{R_4}$$



$$U_{AB} \neq 0V$$
$$U_{AB} = U_g\left(\frac{R_2}{R_1 + R_2} - \frac{R_4}{R_3 + R_4}\right)$$

03. KNOTEN-MASCHEN-VERFAHREN

Maschenstrom -Verfahren

$$\begin{bmatrix} \sum R_{M1} & \pm R_{12} & \pm R_{13} \\ \pm R_{12} & \sum R_{M2} & \pm R_{23} \\ \pm R_{13} & \pm R_{23} & \sum R_{M3} \end{bmatrix} \cdot \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} \pm \sum U_{quelle} \\ \pm \sum U_{quelle} \\ \pm \sum U_{quelle} \end{bmatrix}$$

$$U_q \ \ mit \ \ Umlaufsinn = -$$
$$U_q \ \ gegen \ \ Umlaufsinn = +$$

Knotenpotential -Verfahren

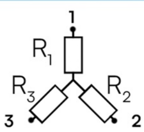
$$\begin{bmatrix} \sum G_A & -G_{AB} & -G_{AC} \\ -G_{AB} & \sum G_B & -G_{BC} \\ -G_{AC} & -G_{BC} & \sum G_C \end{bmatrix} \cdot \begin{bmatrix} U_{AD} \\ U_{BD} \\ U_{CD} \end{bmatrix} = \begin{bmatrix} \pm \sum I_{quelle} \\ \pm \sum I_{quelle} \\ \pm \sum I_{quelle} \end{bmatrix}$$

$$I_q \quad in = +$$
$$I_q \quad aus = -$$

04. DREIECK - STERN UMWANDLUNG

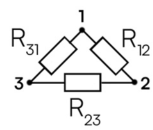
Dreieck -> Stern

$$R_1 = \frac{R_{12}R_{31}}{R_{12} + R_{23} + R_{31}} \qquad R_2 = \frac{R_{23}R_{12}}{R_{12} + R_{23} + R_{31}} \qquad R_3 = \frac{R_{31}R_{23}}{R_{12} + R_{23} + R_{31}}$$



Stern -> Dreieck

$$R_{12} = \frac{R_1 R_2}{R_3} + R_1 + R_2 \qquad R_{23} = \frac{R_2 R_3}{R_1} + R_2 + R_3 \qquad R_{31} = \frac{R_3 R_1}{R_2} + R_3 + R_1$$



05. ELEKTRISCHES FELD, KONDENSATOR

Coulombsch'es Kraft $\quad \mathrm{F} = \frac{\mathrm{Q}_1 \cdot \mathrm{Q}_2}{4 \cdot \pi \cdot \varepsilon_0 \cdot \varepsilon_r \cdot \mathrm{r}^2}$

Elektr. Feldstärke $\quad E = \frac{F}{Q} \qquad E = \frac{U}{d}$

Verschiebungsdichte $\quad D = \frac{Q}{A}$

Elektr. Ladung $\quad Q = I \cdot t \qquad Q = N \cdot e$

Kapazität $\quad C = \frac{Q}{U} \qquad C = \varepsilon_0 \cdot \varepsilon_r \frac{A}{d}$

Kondensator Energie $\quad W = \frac{1}{2} C U^2$

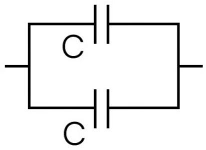
Reihe

$\frac{1}{C_g} = \frac{1}{C_1} + \frac{1}{C_2} \qquad C_g = \frac{C_1 C_2}{C_1 + C_2}$

$U = U_1 = U_2$

$Q = Q_1 + Q_2$

Parallel



$C_g = C_1 + C_2$

$U = U_1 + U_2$

$Q = Q_1 = Q_2$

Zylinder (Kondensator) $\quad C = \frac{2\pi\varepsilon_0\varepsilon_r \cdot l}{ln \frac{r_2}{r_1}}$

$\epsilon_r = Luft = 1$

$\varepsilon_0 = 8.85 \cdot 10^{-12} [As/Vm]$

06. MAGNETISCHES FELD

Magnetische Feldstärke $\quad \oint \vec{H} \cdot d\vec{s} = I$

Flußdichte (Leiter) $\quad B = \mu_0 \cdot \mu_r \cdot \frac{I}{2\pi r}$

Flußdichte (Spule) $\quad B = \mu_0 \cdot \mu_r \cdot \frac{NI}{l}$

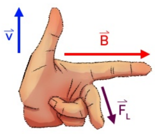
Fluß $\quad \Phi = \int B dA$

Durchflutung $\quad \Theta = I \cdot \mathbf{N}$

Mag. Widerstand $\quad R_M = \frac{l}{\mu_0 \cdot \mu_r A} = \frac{\Theta}{\Phi}$

Lorentzkraft $\quad F = Q \cdot \vec{v} \times \vec{B}$

$F = I \cdot \vec{l} \times \vec{B}$



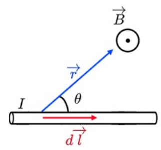
Induktionsgesetz $\quad U_i = -N \frac{d\Phi}{dt} \qquad U_i = -L \frac{dI}{dt}$

Leiter Induktion $\quad U_i = -l \cdot B \cdot v$

Induktivität $\quad L = \mu_0 \cdot \mu_r \cdot \frac{N^2 \cdot A}{l}$

Mag. Energie $\quad W = \frac{1}{2} L I^2$

Biot Savart Gesetz $\quad \vec{B} = \frac{\mu_0 I}{4\pi} \int \frac{\vec{dl} \times \hat{r}}{r^2}$



$\mu_r = Luft = 1 \qquad \mu_0 = 1.256 \cdot 10^{-6} [Vs/Am]$

07. WECHSELSTROM

Mittelwert $\quad \overline{U} = \frac{1}{T} \int_0^T U(t) dt$

Gleichrichtwert $\quad |\overline{U}| = \frac{1}{T} \int_0^T |U(t)| dt$

Effektivwert $\quad U_{eff} = \sqrt{\frac{1}{T} \int_0^T U(t)^2 dt}$

Sin/Cos Effektivwert $\quad U_{eff} = \sqrt{\overline{U}^2 + (\frac{\hat{U}}{\sqrt{2}})^2}$

Kreisfrequenz $\quad w = 2\pi f = \frac{2\pi}{T}$

Induktiver Widerstand $\quad X_L = w \cdot L \qquad \cdot (j)$

Kapazitiver Widerstand $\quad X_C = \frac{1}{w \cdot C} \qquad \cdot (-j)$

Scheinleistung $\quad \underline{S} = U \cdot I$

Wirkleistung $\quad P = U \cdot I \cos\varphi$

Blindleistung $\quad Q = U \cdot I \sin\varphi$

Komplex-Form $\quad \underline{Z} = a + bj \qquad \underline{Z} = r \cdot e^{\varphi j}$

08. TRANSIENTVORGÄNGE

Kondensator	$I_c = C \cdot \frac{dU_c}{dt}$	$\tau = R_i \cdot C$	Spule	$U_L = -L\frac{dI_L}{dt}$	$\tau = \frac{L}{R_i}$
Aufladung	$U_C = U_q\left(1 - e^{-\frac{t}{\tau}}\right)$	$I_C = I_q \cdot e^{-\frac{t}{\tau}}$	Aufladung	$U_L = U_q \cdot e^{-\frac{t}{\tau}}$	$I_L = I_q\left(1 - e^{-\frac{t}{\tau}}\right)$
Entladung	$U_C = U_q \cdot e^{-\frac{t}{\tau}}$	$I_C = -I_q \cdot e^{-\frac{t}{\tau}}$	Entladung	$U_L = -U_q \cdot e^{-\frac{t}{\tau}}$	$I_L = I_q \cdot e^{-\frac{t}{\tau}}$

Gedämpfte Schwingungsgleichung $x'' + 2\alpha \cdot x' + w_0^2 \cdot x = b$

Abklingkoeffezient $\delta = \sqrt{w_0^2 - w_d^2}$

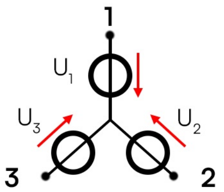
Güte $Q = \frac{w_0}{2\alpha}$

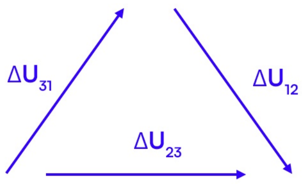
$w_0 = \alpha$ Kritisch
$w_0 > \alpha$ Unterkritisch
$w_0 < \alpha$ Überkritisch

09. DREHSTROM

Außenspannung
$$\Delta U = \sqrt{3} \cdot U_{str}$$
$$\Delta U_{12} = \sqrt{3} \cdot U_{str} \cdot e^{30^\circ j}$$
$$\Delta U_{23} = \sqrt{3} \cdot U_{str} \cdot e^{-90^\circ j}$$
$$\Delta U_{31} = \sqrt{3} \cdot U_{str} \cdot e^{150^\circ j}$$

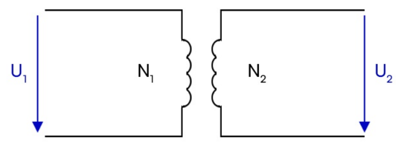
Scheinleistung $S = 3 \cdot U_{str} \cdot I_{str}$



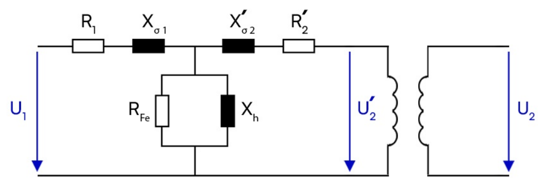


10. TRANSFORMATOR

Idealer Transformator $\frac{N_1}{N_2} = \frac{U_1}{U_2} = \frac{I_2}{I_1}$



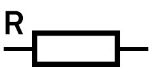
Realer Transformator



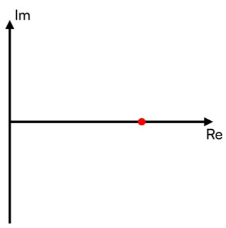
11. ORTSKURVE — IMPEDANZ { $\underline{Z}$ } — ADMITTANZ { $\underline{Y}$ }

$\underline{Y} = \frac{1}{\underline{Z}}$

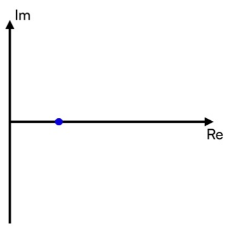
Widerstand



$\underline{Z} = R$

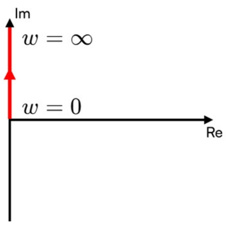


$\underline{Y} = \frac{1}{R}$

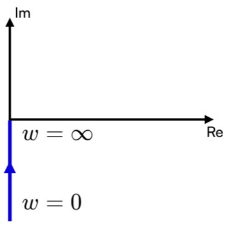


Spule

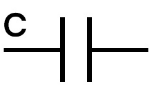
$\underline{Z} = wL \cdot j$



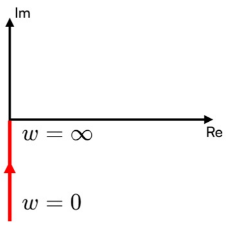
$\underline{Y} = \frac{1}{wL \cdot j}$



Kondensator



$\underline{Z} = \frac{1}{wC \cdot j}$



$\underline{Y} = wC \cdot j$