Osnove elektrotehnike II - enačbe in formule

Diferenciali dolžin:
$\mathrm{d}x,\ \mathrm{d}y,\ \mathrm{d}z;$
$\mathrm{d}\rho,\ \rho\,\mathrm{d}\varphi,\ \mathrm{d}z;$
$\mathrm{d}r,\ r\,\mathrm{d}\vartheta,\ r\sin\vartheta\,\mathrm{d}\varphi$

Konstante: $e \cong 1{,}602\cdot10^{-19}$ C, $c_0 = 299792458$ m/s;
$\mu_0 = 4\pi\cdot10^{-7}$ Wb/(A m) $\cong 12{,}566\cdot10^{-7}$ Wb/(A m);
$\mu_0\varepsilon_0 c_0^2 = 1;\ \ \varepsilon_0 \cong 8{,}854\cdot10^{-12}$ C/(V m)

Lorentzova sila:
$\vec{F}_{\text{Lor.}} = Q(\vec{E} + \vec{w}\times\vec{B});$
$\vec{E} = \left(\vec{F}_{\text{Lor.}}/Q\right)\Big|_{w=0}$

Magnetna sila na tokovni element:
$\mathrm{d}\vec{F} = I\,\mathrm{d}\vec{l}\times\vec{B}(T)$

Biot-Savartov zakon:
$$\mathrm{d}\vec{B}(T) = \frac{\mu_0}{4\pi}\frac{I\,\mathrm{d}\vec{l}\,'\times\vec{R}}{R^3}$$

Magnetni pretok:
$$\phi = \int_{\mathcal{A}} \vec{B}\cdot\mathrm{d}\vec{a}$$

Lastnosti gostote magnetnega pretoka:
$$\oint_{\mathcal{A}} \vec{B}\cdot\mathrm{d}\vec{a} = 0;\quad \oint_{\mathcal{L}} \vec{B}\cdot\mathrm{d}\vec{l} = \mu_0 I_{\text{skozi }\mathcal{L}} = \mu_0\int_{\mathcal{A}} \vec{J}\cdot\mathrm{d}\vec{a}$$

Magnetni dipol: $\vec{m} = I\vec{S};$
$\vec{M}_{\text{m}} = \vec{m}\times\vec{B};\ \ W_{\text{mp}} = -\vec{m}\cdot\vec{B}$

Delo magnetne sile za premik zanke:
$A_{\text{m}} = I(\phi_{\text{končni}} - \phi_{\text{začetni}})$

Magnetik: $\vec{H} = \vec{B}/\mu_0 - \vec{M};$
$\vec{M} = \chi_{\text{m}}\vec{H};\ \ \vec{B} = \mu\vec{H};\ \ \chi_{\text{m}} + 1 = \mu_{\text{r}};$
$$\oint_{\mathcal{L}} \vec{H}\cdot\mathrm{d}\vec{l} = I_{\text{prosti skozi }\mathcal{L}} = \int_{\mathcal{A}} \vec{J}_{\text{prosti}}\cdot\mathrm{d}\vec{a}$$

Mejni pogoji: $B_n(T_+) - B_n(T_-) = 0;$
$H_{t1}(T_+) - H_{t1}(T_-) = K_{t2\ \text{prosti}}(T);$
$H_{t2}(T_+) - H_{t2}(T_-) = -K_{t1\ \text{prosti}}(T);$
$\vec{n}\times\left(\vec{H}(T_+) - \vec{H}(T_-)\right) = \vec{K}_{\text{prosti}}(T)$

Prelom gostotnic:
$$\frac{\tan\alpha_1}{\tan\alpha_2} = \frac{\mu_1}{\mu_2},$$
velja pri $K_{\text{prosti}} = 0$

Magnetna potencial in napetost:
$$\int_A^B \vec{H}\cdot\mathrm{d}\vec{l} = \Theta_{AB} = V_{\text{m}}(A) - V_{\text{m}}(B);$$
$\mathrm{d}V_{\text{m}} = -\vec{H}\cdot\mathrm{d}\vec{l};\ \ \vec{H} = -\vec{n}\,\partial V_{\text{m}}/\partial n$

Magnetni upor:
$\phi = G_{\text{m}}\Theta;\ \ G_{\text{m}}R_{\text{m}} = 1$

Zakona magnetnih vezij:
$$\sum_k (\pm)\phi_k = 0;\quad \sum_m (\pm)\Theta_m = 0$$

Sklep ψ je pretok, ki ga pentlja $\mathcal{L}$ objame v pozitivnem smislu.

Indukcijski zakon: $u_{\text{ind.}} = -\mathrm{d}\psi/\mathrm{d}t;$
$$\oint_{\mathcal{L}} \vec{E}\cdot\mathrm{d}\vec{l} = -\frac{\mathrm{d}}{\mathrm{d}t}\int_{\mathcal{A}} \vec{B}\cdot\mathrm{d}\vec{a};$$
$$u_{\text{ind.}} = -\int_{\mathcal{A}} \frac{\partial\vec{B}}{\partial t}\cdot\mathrm{d}\vec{a} + \oint_{\mathcal{L}} (\vec{w}\times\vec{B})\cdot\mathrm{d}\vec{l}$$

Energija:
$$W_{\text{m}} = \tfrac{1}{2}\sum_{k=1}^{n}\sum_{j=1}^{n} L_{jk}i_j i_k = \tfrac{1}{2}\sum_{k=1}^{n}\psi_k i_k;$$
$w_{\text{m}} = \tfrac{1}{2}\mu H^2$

Tlak na reži:
$f_{mn} = B^2/2\mu_0$

Energija magnetenja:
$$W_{\text{mag.}}(t_1,t_2) = \int_{t_1}^{t_2} i\,\mathrm{d}\psi;\quad w_{\text{mag.}}(t_1,t_2) = \int_{t_1}^{t_2} H\,\mathrm{d}B$$

Upor: $u = Ri;$
$p_{\text{t}} = Ri^2 = W_{\text{t}}'$

Kondenzator: $i = Cu';$
$W_{\text{e}} = \tfrac{1}{2}Cu^2;\ \ p_{\text{e}} = W_{\text{e}}'$

Tuljava: $u = Li';\ \ W_{\text{m}} = \tfrac{1}{2}Li^2;\ \ p_{\text{m}} = W_{\text{m}}'$

Sklop dveh tuljav:
$u_1 = L_1 i_1' \pm Mi_2';\ u_2 = \pm Mi_1' + L_2 i_2';$
$W_{\text{m}} = \tfrac{1}{2}L_1 i_1^2 \pm Mi_1 i_2 + \tfrac{1}{2}L_2 i_2^2;\ p_{\text{m}} = W_{\text{m}}'$

Periodična količina, perioda in frekvenca:
$g(t+T) = g(t);\ \ Tf = 1$

Srednja in efektivna vrednost:
$G_{\text{sr.}} = T^{-1}\int_{\tau}^{\tau+T} g(t)\mathrm{d}t;\ G_{\text{ef.}}^2 = T^{-1}\int_{\tau}^{\tau+T} g^2(t)\mathrm{d}t$

Zakona električnih vezij: $\sum_k (\pm)i_k = 0;\quad \sum_m (\pm)u_m = 0$

Kompleksno število:
$\mathrm{e}^{\pm\mathrm{j}\varphi} = \cos\varphi \pm \mathrm{j}\sin\varphi;\ \ \underline{z} = x + \mathrm{j}y;$
$x = \mathrm{Re}(\underline{z});\ \ y = \mathrm{Im}(\underline{z});$
$|\underline{z}| = \mathrm{abs}(\underline{z}) = \sqrt{x^2+y^2};$
$$\alpha = \arg(\underline{z}) = \begin{cases}\arctan y/x, & x \ge 0\\ \pm\pi + \arctan y/x, & x < 0\end{cases};$$
$\underline{z} = |\underline{z}|(\cos\alpha + \mathrm{j}\sin\alpha)$

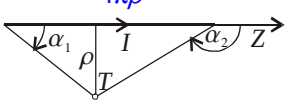
Harmonična količina in njen kazalec:
$g(t) = G_{\text{m}}\cos(\omega t + \alpha) \Leftrightarrow \underline{G} = G_{\text{m}}\mathrm{e}^{\mathrm{j}\alpha};$
$g(t) = \mathrm{Re}(\underline{G}\,\mathrm{e}^{\mathrm{j}\omega t})$

Moči v kompleksnem: $\underline{S} = P + \mathrm{j}Q = \tfrac{1}{2}\underline{U}\,\underline{I}^*;$
$S = \tfrac{1}{2}U_{\text{m}}I_{\text{m}};\ \ P = \tfrac{1}{2}U_{\text{m}}I_{\text{m}}\cos\varphi;\ \ Q = \tfrac{1}{2}U_{\text{m}}I_{\text{m}}\sin\varphi$

Imitance elementov:
$\underline{Z} = \underline{U}/\underline{I};\ \ \underline{Y} = 1/\underline{Z};$
$\underline{Z}_R = R = 1/G = 1/\underline{Y}_R;$
$\underline{Z}_L = \mathrm{j}\omega L;\ \underline{Y}_C = \mathrm{j}\omega C$

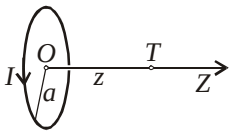
Prilagoditev: $\underline{Z}_{\text{b}} = \underline{Z}_{\text{Th}}^* \ \rightarrow\ P_{\text{b maks.}} = |\underline{U}_{\text{Th.}}|^2/(8R_{\text{Th.}});$
$R_{\text{b}} = |\underline{Z}_{\text{Th.}}| \ \rightarrow\ P_{\text{b maks.}} = |\underline{U}_{\text{Th.}}|^2/(4(R_{\text{Th.}} + |\underline{Z}_{\text{Th.}}|))$

Tokovna daljica:
$$B_\varphi(T) = \frac{\mu_0 I}{4\pi\rho}(\cos\alpha_1 - \cos\alpha_2)$$

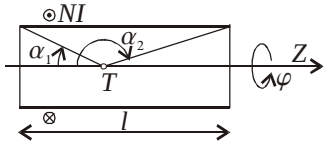


Tokovna premica:
$\alpha_1 \to 0,\ \alpha_2 \to \pi\ \Rightarrow$
$$B_\varphi(T) = \frac{\mu_0 I}{2\pi\rho}$$

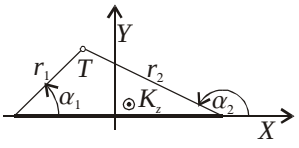
Krožna tokovna zanka:
$$B_z(T) = \frac{\mu_0 I}{2}\frac{a^2}{(a^2+z^2)^{3/2}}$$



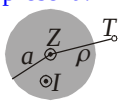
Dolga tuljava:
$$B_z(T) = \frac{\mu_0 NI}{2l}(\cos\alpha_1 - \cos\alpha_2)$$



Tračni vodnik:
$$B_x(T) = \frac{\mu_0 K_z}{2\pi}(\alpha_1 - \alpha_2);$$
$$B_y(T) = \frac{\mu_0 K_z}{2\pi}\ln\frac{r_1}{r_2}$$

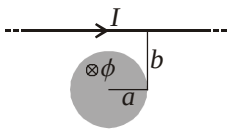


Vodnik okroglega preseka:

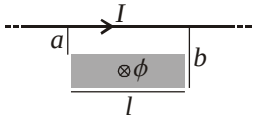


$$B_\varphi(T) = \begin{cases}\dfrac{\mu_0 I\rho}{2\pi a^2}, & \rho \le a\\[2ex] \dfrac{\mu_0 I}{2\pi\rho}, & \rho > a\end{cases}$$

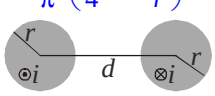
Pretok skozi krog:
$$\phi = \mu_0 I\left(b - \sqrt{b^2 - a^2}\right)$$



Pretok skozi pravokotnik:
$$\phi = \frac{\mu_0 Il}{2\pi}\ln\frac{b}{a}$$



Induktivnost dvovoda:
$$L = \frac{\mu_0 l}{\pi}\left(\frac{1}{4} + \ln\frac{d}{r}\right)$$



Medsebojna induktivnost dvovodov:
$$L_{12} = \frac{\mu_0 l}{2\pi}\ln\frac{D_{12}D_{21}}{d_{12}d_{21}}$$