Osnove elektrotehnike I - enačbe in formule

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

Naboj: osnovni naboj je $e \cong 1{,}602\cdot10^{-19}$ C;
v izoliranem sistemu je $\sum_k Q_k = konst.$

Tok: $\mathrm{d}Q_{\text{skozi }\mathcal{A}} = i_{\text{skozi }\mathcal{A}}\,\mathrm{d}t;\quad \vec{J} = \rho\vec{w};$
$i_{\text{skozi }\mathcal{A}} = \int_{\mathcal{A}} \vec{J}\cdot\mathrm{d}\vec{a};\quad \oint_{\mathcal{A}} \vec{J}\cdot\mathrm{d}\vec{a} = -\frac{\mathrm{d}Q_{\text{not.}}}{\mathrm{d}t}$

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

Influenčna konstanta:
$\varepsilon_0 \cong 8{,}854\cdot10^{-12}\ \frac{\text{C}}{\text{V}\cdot\text{m}} \cong \frac{10^{-9}}{36\pi}\ \frac{\text{C}}{\text{V}\cdot\text{m}}$

Lastnosti električne poljske jakosti:
$\oint_{\mathcal{A}} \vec{E}\cdot\mathrm{d}\vec{a} = \frac{Q_{\text{not.}}}{\varepsilon_0};\quad \oint_{\mathcal{L}} \vec{E}\cdot\mathrm{d}\vec{l} = 0$

Električni dipol:
$\vec{p} = Q\vec{d};\quad \vec{M}_{\text{e}} = \vec{p}\times\vec{E}$
$W_{\text{ep}} = -\vec{p}\cdot\vec{E}$

Potencialna energija, potencial in napetost:
$W_{\text{ep}} = QV;\quad \int_A^B \vec{E}\cdot\mathrm{d}\vec{l} = U_{AB} = V(A) - V(B)$
$\mathrm{d}V = -\vec{E}\cdot\mathrm{d}\vec{l};\quad \vec{E} = -\vec{n}\frac{\partial V}{\partial n}$

Prevodnik:
$\sigma_{\text{prosti}}(T) = \varepsilon E_n(T_+)$
$\vec{J} = \gamma\vec{E};\quad \gamma\rho = 1$
$p = \vec{J}\cdot\vec{E}$

Dielektrik:
$\vec{D} = \varepsilon_0\vec{E} + \vec{P};\quad \vec{P} = \chi_{\text{e}}\varepsilon_0\vec{E}$
$\vec{D} = \varepsilon\vec{E};\quad \chi_{\text{e}} + 1 = \varepsilon_{\text{r}}$
$\oint_{\mathcal{A}} \vec{D}\cdot\mathrm{d}\vec{a} = Q_{\text{not. prosti}}$

Energija:
$W_{\text{e}} = \frac{1}{2}\int V\mathrm{d}Q$
$w_{\text{e}} = \frac{1}{2}\varepsilon E^2$

Prelom gostotnic:
$\frac{\tan\alpha_1}{\tan\alpha_2} = \frac{\gamma_1}{\gamma_2}\left(\text{ali } \frac{\varepsilon_1}{\varepsilon_2} \text{ pri } \sigma_{\text{prosti}} = 0\right)$

Gibalni procesi:
$\mathrm{d}W_{\text{e}} = \pm\vec{F}_{\text{e}}\cdot\mathrm{d}\vec{l}$

Mejni pogoji: $E_t(T_+) - E_t(T_-) = 0;$
$D_n(T_+) - D_n(T_-) = \sigma_{\text{prosti}}(T);\quad J_n(T_+) - J_n(T_-) = 0$

Kirchhoffova zakona:
$\sum_k (\pm) I_k = 0;\quad \sum_m (\pm) U_m = 0$

Vir:
$U = U_{\text{g}} - R_{\text{g}} I$
$I = I_{\text{g}} - G_{\text{g}} U$

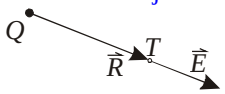
Kondenzator:
$Q = CU;\quad W_{\text{e}} = \frac{1}{2}CU^2$

Polnilni tok: $i = C\frac{\mathrm{d}u}{\mathrm{d}t}$

Upor: $I = GU;\quad GR = 1;\quad P = IU;$
$R(T) = R(T_0)\left(1 + \alpha(T - T_0)\right);\quad T_0 = 20\ ^\circ\text{C}$

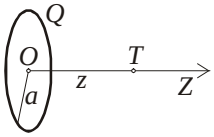
Thevenin, Norton, prilagoditev: $U_{\text{The.}} = U_{\text{od. sp.}};\quad I_{\text{Nor.}} = I_{\text{kr. st.}};$
$R_{\text{not.}} = U_{\text{The.}}/I_{\text{Nor.}};\quad R_{\text{b}} = R_{\text{not.}};\quad P_{\text{max.}} = U_{\text{The.}}^2/4R_{\text{not.}}$

Točkasti naboj:



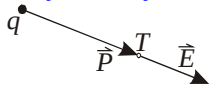
$\vec{E}(T) = \frac{Q\vec{e}_R}{4\pi\varepsilon_0 R^2}\left(= \frac{Q\vec{R}}{4\pi\varepsilon_0 R^3}\right)$
$V(T) = \frac{Q}{4\pi\varepsilon_0 R}$

Naelektren obroč:



$E_z(z) = \frac{Q}{4\pi\varepsilon_0}\frac{z}{(a^2+z^2)^{3/2}}$
$V(z) = \frac{Q}{4\pi\varepsilon_0\sqrt{a^2+z^2}}$

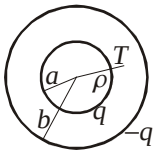
Linijski naboj:



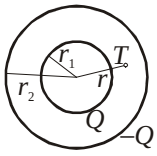
$\vec{E}(T) = \frac{q\vec{e}_P}{2\pi\varepsilon_0 P}\left(= \frac{q\vec{P}}{2\pi\varepsilon_0 P^2}\right)$
$V(T) = -\frac{q}{2\pi\varepsilon_0}\ln P + konst.$

Ploščni kondenzator:
$E = \frac{|\sigma|}{\varepsilon} = \frac{|U|}{d}$
$C = \varepsilon S/d$

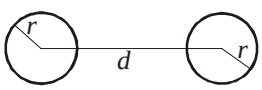
Koaksialni kabel: $C = \frac{2\pi\varepsilon l}{\ln(b/a)};$
$V(T) = \frac{q}{2\pi\varepsilon}\ln\frac{b}{\rho};\quad E_\rho(T) = \frac{q}{2\pi\varepsilon\rho}$



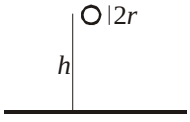
Krogelni kondenzator: $C = 4\pi\varepsilon\frac{r_1 r_2}{r_2 - r_1};$
$V(T) = \frac{Q}{4\pi\varepsilon}\frac{r_2 - r}{r_2 r};\quad E_r(T) = \frac{Q}{4\pi\varepsilon r^2}$



Simetrični dvovod: $e = \frac{d - \sqrt{d^2 - 4r^2}}{2};$
$C = \pi\varepsilon l\left(\ln\frac{d + \sqrt{d^2 - 4r^2}}{2r}\right)^{-1}$



Nadzemni vodnik:
$C \cong \frac{2\pi\varepsilon_0 l}{\ln(2h/r)}$



Raznoimenska točkasta naboja:
$de = r^2;\quad Q_1 r = -Q_2 d$