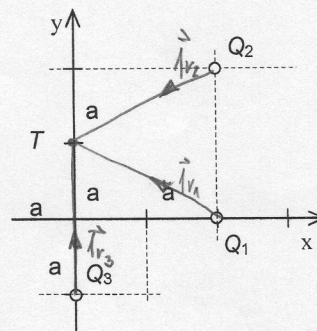
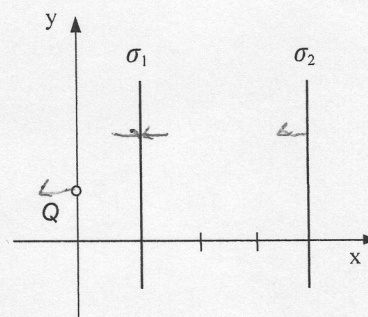


1. KOLOKVIJ — Osnove elektrotehnike I (27. 10. 2011) skupina A

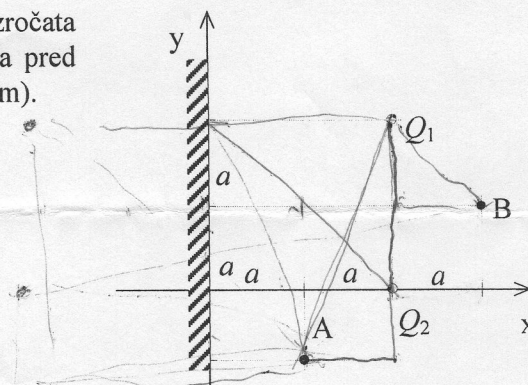
1. Določite Q_3 tako, da bo električna poljska jakost v točki T enaka nič. $Q_1 = 2 \cdot 10^{-9}$ As, $Q_2 = -2 \cdot 10^{-9}$ As in As, ($a=5$ cm); elektrine so nameščene v zraku tako kot je prikazano na sliki).



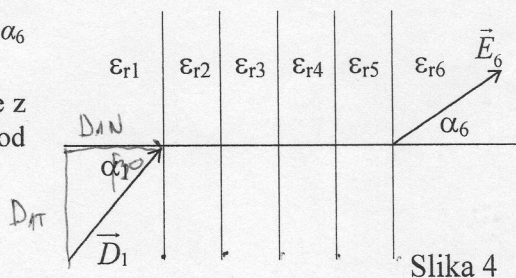
2. Izračunajte silo na točkasto elektrino $Q = 5 \cdot 10^{-6}$ As/ v polju dveh ravninskih elektrin: $\sigma_1 = -8 \cdot 10^{-6}$ As/m² in $\sigma_2 = 4 \cdot 10^{-6}$ As/m²



3. Izračunajte napetost U_{AB} med točkama A in B. Napetost povzročata krogelni elektrini $Q_1 = 5 \cdot 10^{-9}$ As in $Q_2 = -6 \cdot 10^{-9}$ As, ki ležita pred ozemljeno prevodno površino kot je prikazano na sliki ($a = 10$ cm).

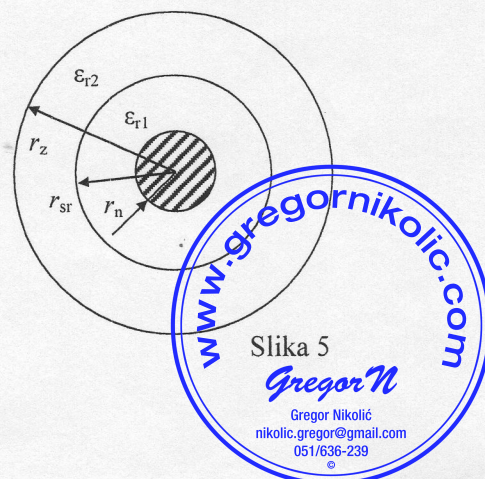


4. Izračunajte električno poljsko jakost E_6 in pod kakšnim kotom α_6 prehaja dielektrik z $\epsilon_6 = 9$ po prehodu polja skozi dielektrike z $\epsilon_{r2} = 7$, $\epsilon_{r3} = 4$, $\epsilon_{r4} = 5$ in $\epsilon_{r5} = 9$, če je v dielektriku z $\epsilon_{r1} = 3$ polje z gostoto el. pretoka $D_1 = 4 \cdot 10^{-9}$ As/m² in prehaja dielektrik pod kotom $\alpha_1 = 30^\circ$ (slika 4)?



Slika 4

5. Dvoslojno izoliran vodnik na sliki 5 ima naslednje geometrijske in snovne podatke: prva plast izolatorja ima relativno dielektrično konstanto $\epsilon_{r1} = 6$, zunanja plast izolatorja ima $\epsilon_{r2} = 3$. Določite zunanji polmer vodnika tako, da bo napetost na notranji plasti dielektrika dvakrat toliko kot napetosti na zunanji plasti. ($r_n = 0,3$ cm, $r_{sr} = 1,2$ cm).



Slika 5

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Kolokvij - skrupina A 27.10.2011

[HAVING FUN?!?]⁻¹ · ∞

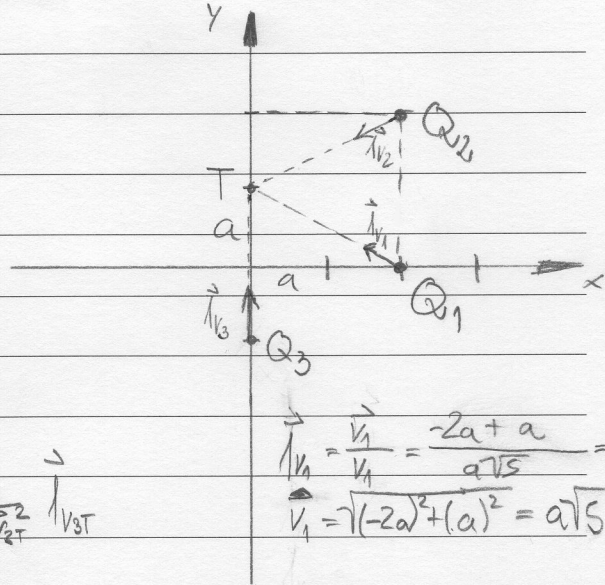
①

$$Q_1 = 2 \cdot 10^{-9} \text{ As} \quad a = 5 \text{ cm} = 5 \cdot 10^{-2} \text{ m}$$

$$Q_2 = -2 \cdot 10^{-9} \text{ As}$$

$$Q_3 = ?$$

$$E_T = 0 \quad F_T = F_1 + F_2 + F_3 = 0$$



$$\vec{F}_1 = \frac{Q_1 Q_2}{4\pi\epsilon_0 r^2} \vec{r}$$

$$\frac{Q_1}{4\pi\epsilon_0 r_1^2} \vec{r}_1 + \frac{Q_2}{4\pi\epsilon_0 r_2^2} \vec{r}_2 = - \frac{Q_3}{4\pi\epsilon_0 r_3^2} \vec{r}_3$$

$$\vec{r}_1 = \frac{\vec{r}_2}{r_1} = \frac{-2a + a}{a\sqrt{5}} = -\frac{2}{\sqrt{5}} \hat{x} + \frac{1}{\sqrt{5}} \hat{y}$$

$$r_1 = \sqrt{(-2a)^2 + (a)^2} = a\sqrt{5}$$

$$F_1 = \frac{2 \cdot 10^{-9}}{4\pi \cdot 8,85 \cdot 10^{-12} \cdot (5 \cdot 10^{-2} \cdot \sqrt{5})^2} \left(-\frac{2}{\sqrt{5}} \hat{x} + \frac{1}{\sqrt{5}} \hat{y} \right) = (-1286,2 \hat{x} + 643,1 \hat{y}) \text{ V/m}$$

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$$F_2 = \frac{-2 \cdot 10^{-9}}{4\pi \cdot 8,85 \cdot 10^{-12} \cdot (5 \cdot 10^{-2} \cdot \sqrt{5})^2} \left(\frac{2}{\sqrt{5}} \hat{x} + \frac{1}{\sqrt{5}} \hat{y} \right) = (1286,2 \hat{x} + 643,1 \hat{y}) \text{ V/m}$$

$$F_1 + F_2 = -F_3$$

$$+F_3 = -1286,2 \hat{y} \text{ V/m}$$

$$r_3 = \sqrt{0^2 + 2a^2} = 2a$$

$$\frac{Q_3}{4\pi\epsilon_0 \cdot r_3^2} = -1286,2 \frac{\text{V}}{\text{m}}$$

$$Q_3 = -1286,2 \frac{\text{V}}{\text{m}} \cdot 4\pi \cdot 8,85 \cdot 10^{-12} \cdot (2 \cdot 5 \cdot 10^{-2})^2$$

$$Q_3 = -1,43 \cdot 10^{-9} \text{ As}$$

$$\frac{\frac{\text{V}}{\text{m}} \cdot \text{As}}{\frac{\text{V}}{\text{m}} \cdot \frac{\text{m}^2}{\text{As}}} = \text{As}$$

Postavni nasvet pred vašimi vrati

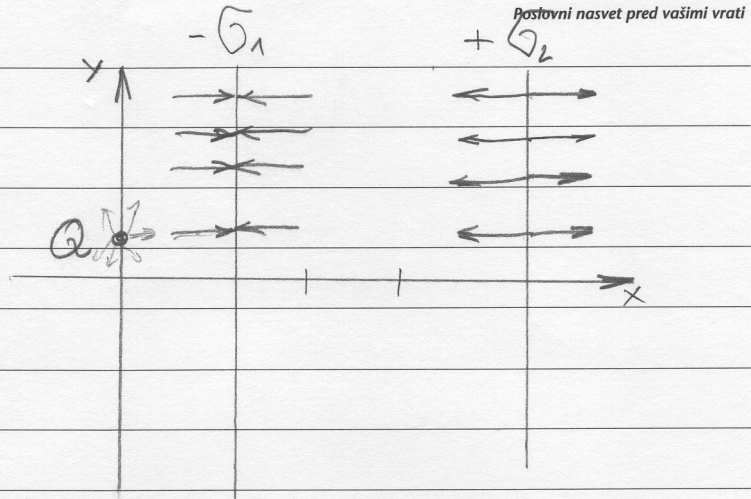
2.

$$Q = 5 \cdot 10^{-6} \text{ As}$$

$$\sigma_1 = -8 \cdot 10^{-6} \frac{\text{As}}{\text{m}^2}$$

$$\sigma_2 = 4 \cdot 10^{-6} \frac{\text{As}}{\text{m}^2}$$

$$\vec{F}_Q = ?$$



$$\vec{F} = Q \cdot \vec{E}$$

$$E = \frac{\sigma}{2\epsilon_0}$$

$$\vec{E}_1 = \frac{8 \cdot 10^{-6} \frac{\text{As}}{\text{m}^2}}{2 \epsilon_0 \frac{\text{As}}{\text{Vm}}} \cdot \vec{i}_x = +451,764 \cdot 10^3 \vec{i}_x \frac{\text{V}}{\text{m}}$$

$$\vec{E}_2 = \frac{4 \cdot 10^{-6} \frac{\text{As}}{\text{m}^2}}{2 \epsilon_0 \frac{\text{As}}{\text{Vm}}} \cdot (-\vec{i}_x) = -225,882 \cdot 10^3 \vec{i}_x \frac{\text{V}}{\text{m}}$$

$$\vec{E}_Q = 5 \cdot 10^{-6} \text{ As} \cdot 225,882 \cdot 10^3 \frac{\text{V}}{\text{m}}$$

$$\vec{F}_Q = (1,13 \vec{i}_x) \text{ N}$$

$$\left[\begin{array}{l}
 V = \frac{\text{kg} \cdot \text{m}^2}{\text{As}^2} \\
 \frac{\text{As} \cdot V}{\text{m}} = \frac{\text{kg} \cdot \text{m} \cdot \cancel{\text{As}} \cdot \cancel{\text{As}}}{\cancel{\text{As}} \cdot \text{m}} = \frac{\text{kg} \cdot \text{m}}{\text{s}^2} = \text{N}
 \end{array} \right]$$

$$Q_1 = 5 \cdot 10^{-9} \text{ As}$$

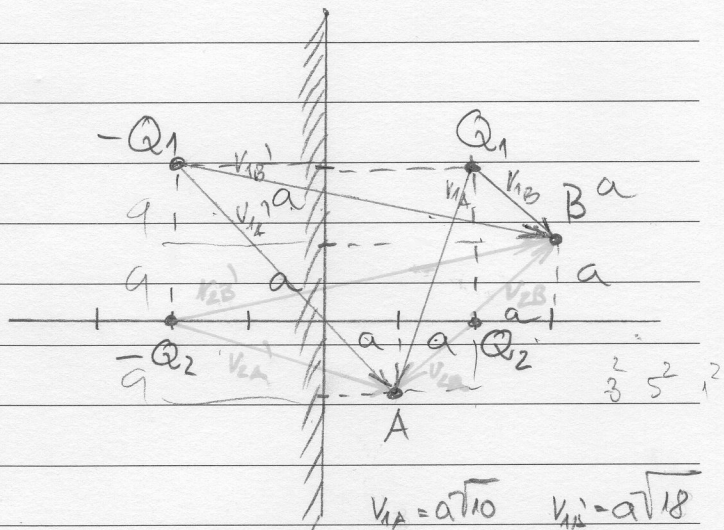
$$Q_2 = -6 \cdot 10^{-9} \text{ As}$$

$$a = 10 \text{ cm} = 10 \cdot 10^{-2} \text{ m}$$

$$U_{AB} = ?$$

$$U_{AB} = \frac{Q}{4\pi\epsilon_0} \left(\frac{1}{r} - \frac{1}{r_0} \right)$$

$$U_{AB} = U_{AB1} + U_{AB2} + U_{AB1'} + U_{AB2'}$$

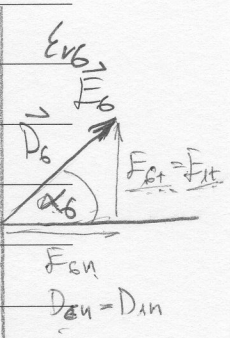
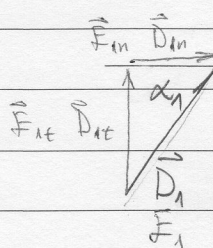


$$\begin{aligned}
 r_{1A} &= a\sqrt{10} & r_{1A}' &= a\sqrt{18} & 3\sqrt{2} \\
 r_{1B} &= a\sqrt{2} & r_{1B}' &= a\sqrt{26} \\
 r_{2A} &= a\sqrt{2} & r_{2A}' &= a\sqrt{10} \\
 r_{2B} &= a\sqrt{2} & r_{2B}' &= a\sqrt{26}
 \end{aligned}$$

$$U_{AB} = \frac{Q_1}{4\pi\epsilon_0} \left(\frac{1}{r_{1A}} - \frac{1}{r_{1B}} \right) + \frac{Q_2}{4\pi\epsilon_0} \left(\frac{1}{r_{2A}} - \frac{1}{r_{2B}} \right) + \frac{-Q_1}{4\pi\epsilon_0} \left(\frac{1}{r_{1A}'} - \frac{1}{r_{1B}'} \right) + \frac{-Q_2}{4\pi\epsilon_0} \left(\frac{1}{r_{2A}'} - \frac{1}{r_{2B}'} \right)$$

$$U_{AB} = \boxed{146,45 \text{ V}}$$

$\epsilon_{v1} = 3$	ϵ_{v1}	ϵ_{v2}	ϵ_{v3}	ϵ_{v4}	ϵ_{v5}	ϵ_{v6}
$\epsilon_{v2} = 7$						
$\epsilon_{v3} = 4$						
$\epsilon_{v4} = 5$						
$\epsilon_{v5} = 9$						
$\epsilon_{v6} = 9$						
$D_1 = 4 \cdot 10^{-9} \frac{As}{m^2}$						
$F_6 = ?$						
$\alpha_6 = ?$						
$\alpha_1 = 30^\circ$						



$$F = \frac{D}{\epsilon_0 \epsilon_r}$$

$$D_{1n} = D_{2n} = \dots = D_{6n}$$

$$F_{1t} = F_{2t} = \dots = F_{6t}$$

$$F_{6n} = \frac{D_{6n}}{\epsilon_0 \epsilon_{v6}} = D_{1n}$$

$$F_1 = \frac{D_1}{\epsilon_0 \epsilon_{v1}} = \frac{4 \cdot 10^{-9} \frac{As}{m^2}}{\epsilon_0 \cdot 3 \frac{As}{m^2}} = 150,59 \frac{V}{m}$$

$$F_{6n} = \frac{3,46 \cdot 10^{-9} \frac{As}{m^2}}{\epsilon_0 \cdot 9} \left[\frac{As}{m^2} \cdot \frac{1}{\frac{As}{m^2}} = \frac{V}{m} \right]$$

$$F_{6n} = 43,42$$

$$\sin \alpha_1 = \frac{F_{1t}}{F_1}$$

$$F_{1t} = \sin \alpha_1 \cdot F_1 = \sin 30^\circ \cdot 150,59 \frac{V}{m} = 75,295 \frac{V}{m}$$

$$\cos \alpha_1 = \frac{D_{1n}}{D_1}$$

$$D_{1n} = \cos \alpha_1 \cdot D_1 = \cos 30^\circ \cdot 4 \cdot 10^{-9} \frac{As}{m^2} = 3,46 \cdot 10^{-9} \frac{As}{m^2}$$

$$\tan \alpha_6 = \frac{F_{1t}}{F_{6n}} = \frac{75,295}{43,42}$$

$$F_6 = \sqrt{F_{1t}^2 + D_{1n}^2}$$

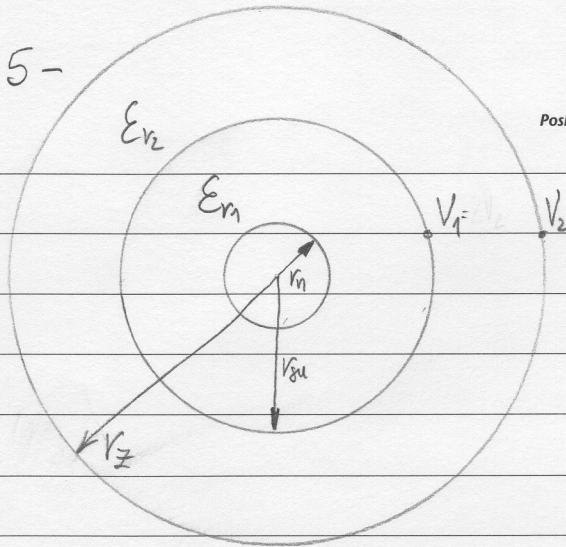
$$\alpha_6 = 60^\circ$$

$$F_6 = \sqrt{75,295^2 + 43,42^2}$$

$$F_6 = 86,42 \frac{V}{m}$$



- 5 -



$$\epsilon_{n1} = 6$$

$$\epsilon_{v2} = 3$$

$$U_1 = 2U_2$$

$$r_n = 0,3 \text{ cm} = 3 \cdot 10^{-3} \text{ m}$$

$$r_{su} = 1,2 \text{ cm} = 1,2 \cdot 10^{-2} \text{ m}$$

$$r_z = ?$$

$$U = \frac{Q}{2\pi\epsilon_0} \ln \frac{r_0}{r}$$

$$U_1 = 2U_2$$

$$\frac{Q}{2\pi\epsilon_0} \ln \frac{r_z}{r_n} = 2 \frac{Q}{2\pi\epsilon_0} \ln \frac{r_z}{r_{su}}$$

$$\ln \frac{r_z}{r_n} = 2 \ln \frac{r_z}{r_{su}}$$

$$\frac{r_z}{r_n} = \frac{r_z^2}{r_{su}^2}$$

$$r_{su}^2 = r_n \cdot r_z$$

$$r_z = \frac{r_{su}^2}{r_n} = \frac{1,2^2}{0,3} = \underline{\underline{4,8 \text{ cm}}}$$