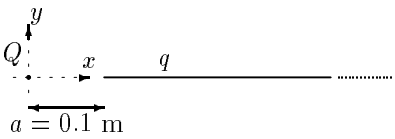
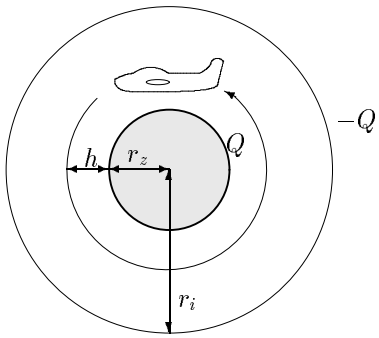
1. kolokvij OE I

01.12.1999

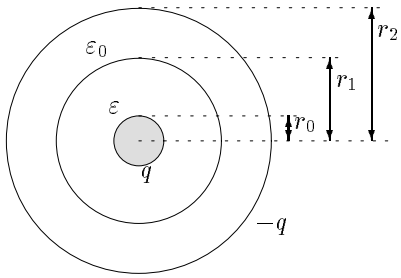
1. Določite silo poltraka z gostoto linijske elektrine $q = 10^{-6}$ As/m na točkasto elektrino Q =-10^{-9} As.



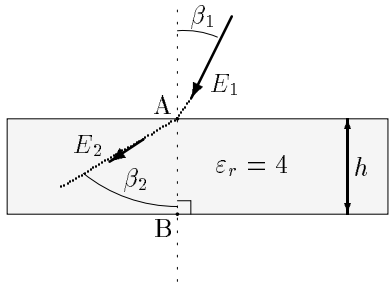
2. Letalo na sliki izmeri električno poljsko jakost 162 V/m. Ocenite višino h na kateri leti, če je napetost med površino zemlje r_z in ionosfero r_i enaka U_{zi} = 20 MV.
Podatka: r_z = 6375 km, r_i = 6500 km.



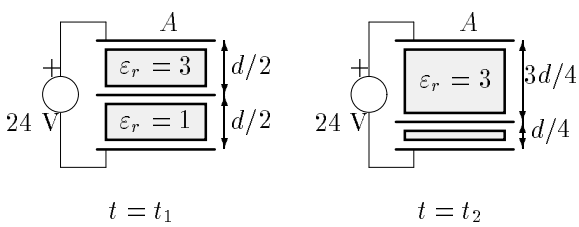
3. Določite napetost za dvoplastni kabel na sliki, če naj bosta maksimalni električni poljski jakosti v obeh medijih enaki prebojni trdnosti E_p = 3 MV/m.
Podatki: r_0 = 0.5 mm, r_1 = 1 mm, r_2 = 2 mm.



4. Pod kotom $\beta_1 = 30^o$ na normalo plasti dielektrika $\varepsilon_r = 4$ vzpostavimo homogeno električno polje jakosti E_1 = 100 V/m. Določite napetost med točkama A in B na razdalji h = 1 cm.



5. Za koliko se spremeni energija sistema, ko položaj srednje plošče spremenimo, kot kaže slika?
Podatki: d = 1 cm, A = 100 cm^2.



Na izdelek napišite ime, priimek in vpisno številko!

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

$\varepsilon_0 \approx 10^{-9}/(4\pi \cdot 9)$ As/Vm

Rešitve

za kolokvij iz predmeta Osnove elektrotehnike I, dne 01.12.1999

1.

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

$$d\mathbf{E} = -\mathbf{1}_x \frac{q \cdot dx}{4\pi\varepsilon x^2}$$

$$\mathbf{E} = \int_a^\infty d\mathbf{E} = -\mathbf{1}_x \frac{q}{4\pi\varepsilon a}$$

$$\mathbf{F} = -\mathbf{1}_x(-10^{-9})\frac{10^{-6}10^9 9}{4\pi(1/(4\pi))\cdot 0.1} = \mathbf{1}_x 9 \cdot 10^{-5} \text{ N}.$$

2.

$$|\mathbf{E}| = \frac{Q}{4\pi\varepsilon(r_z+h)^2} \Rightarrow h = \sqrt{\frac{Q}{4\pi\varepsilon E}} - r_z$$

$$U = \frac{Q}{4\pi\varepsilon}\Big(\frac{1}{r_z} - \frac{1}{r_i}\Big) \Rightarrow \frac{Q}{4\pi\varepsilon} = U \cdot \frac{r_i r_z}{r_i - r_z}$$

$$h = \sqrt{\frac{r_i r_z}{r_i - r_z} \cdot \frac{U}{E}} - r_z \approx 22.337 \text{ km}.$$

3.

$$E_{1,max} = E_{2,max} = E_p \Rightarrow \frac{q}{2\pi\varepsilon_1 r_0} = \frac{q}{2\pi\varepsilon_2 r_1} \Rightarrow \varepsilon_1 r_0 = \varepsilon_2 r_1 \Rightarrow\Rightarrow \varepsilon_1 = 2\varepsilon_0$$

$$\frac{q}{2\pi} = \varepsilon_1 r_0 E_p = \varepsilon_2 r_1 E_p$$

$$U = \frac{q}{2\pi}\Big[\frac{1}{\varepsilon_1} ln\frac{r_1}{r_0} + \frac{1}{\varepsilon_2} ln\frac{r_2}{r_1}\Big] = \varepsilon_1 r_0 E_p \Big[\frac{1}{\varepsilon_1} ln\frac{r_1}{r_0} + \frac{1}{\varepsilon_2} ln\frac{r_2}{r_1}\Big] =$$

$$= 0.5 \cdot 10^{-3} 3 \cdot 10^6 \big[ln2 + 2 \cdot ln2\big] = 3.15 \text{ kV}.$$

4.

$$U = \int_A^B \mathbf{E} \cdot d\mathbf{l} = E_2 cos\beta_2 \cdot h$$

$$E_1 sin\beta_1 = E_2 sin\beta_2$$

$$\varepsilon_1 E_1 cos\beta_1 = \varepsilon_2 E_2 cos\beta_2 \Rightarrow E_2 cos\beta_2 = \frac{\varepsilon_1}{\varepsilon_2} E_1 cos\beta_1$$

$$U = \frac{\varepsilon_1}{\varepsilon_2} E_1 cos\beta_1 \cdot h = \frac{1}{4} \cdot 100 \cdot \frac{\sqrt{3}}{2} \cdot 0.01 = \frac{\sqrt{3}}{8} \approx 0.22 \text{ V}.$$

5.

$$\Delta W = \frac{1}{2}(C_2 - C_1) \cdot U^2$$

$$\frac{1}{C_1} = \frac{1}{\varepsilon_1 \frac{A}{d/2}} + \frac{1}{\varepsilon_2 \frac{A}{d/2}} \Rightarrow C_1 = \frac{3}{2}\varepsilon_2 \frac{A}{d}$$

$$\frac{1}{C_2} = \frac{1}{\varepsilon_1 \frac{A}{3d/4}} + \frac{1}{\varepsilon_2 \frac{A}{d/4}} \Rightarrow C_2 = 2\varepsilon_2 \frac{A}{d}$$

$$\Delta W = \frac{1}{2}\big(2\varepsilon_2 \frac{A}{d} - \frac{3}{2}\varepsilon_2 \frac{A}{d}\big)U^2 = \frac{A}{4d}\varepsilon_2 U^2 = \frac{1}{4} 8.85 \cdot 10^{-12} \frac{10^{-2}}{10^{-2}} \cdot 24^2 = 1.27 \text{ nJ}.$$

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