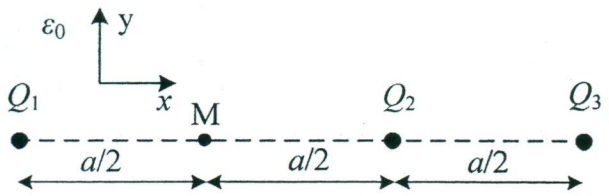
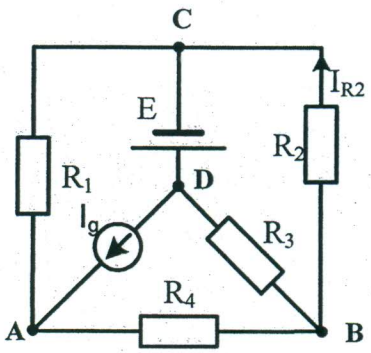
PRVI KOLOKVIJUM IZ ELEKTROTEHNIKE
26. novembar 2018.
GRUPA 3

1. Na Slici 1 prikazan je sistem sa tri tačkasta naelektrisanja: $Q_1 = 3Q$, $Q_2 = -Q$ i $Q_3 = 4Q$, $Q > 0$, koja se nalaze u vazduhu, na istoj pravoj.

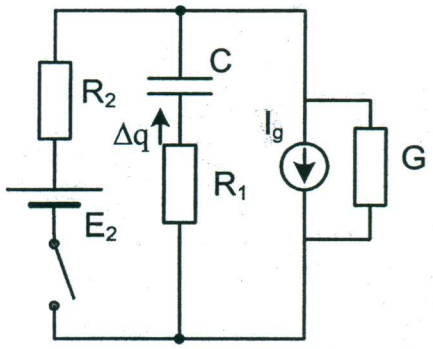
a) Odrediti i nacrtati vektor električnog polja u tački M. **(6 poena)**
b) Odrediti potencijal električnog polja u tački M. **(4 poena)**



Slika 1



Slika 2



Slika 3

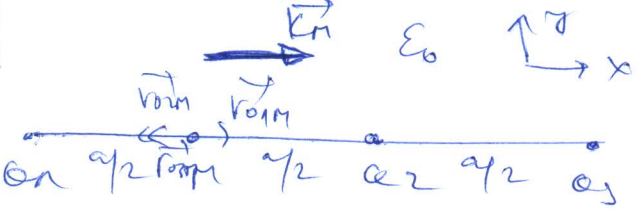
2. U kolu na Slici 2 poznato je: $R_1 = R_2 = R_3 = R_4 = R = 6\ \Omega$, $E = 12\text{V}$, $I_g = 6\text{ A}$.

a) Primenom Tevenenove teoreme odrediti intenzitet struje I_{R2} kroz otpornik R_2. **(10 poena)**
b) Primenom metode superpozicije odrediti napon U_{DB} **(12 poena)**

3. U kolu na Slici 3 poznato je: $R_1 = 10\Omega$, $R_2 = 5\Omega$, $E_2 = 5\text{V}$, $I_g = 1\text{A}$, $G = 0.1\text{S}$, $C = 2\text{nF}$. Prekidač je otvoren. Odrediti količinu naelektrisanja Δq koja će proteći kroz granu sa kondenzatorom nakon zatvaranja prekidača.
(8 poena)

Izrada kolokvijuma traje 90 minuta. Nije dozvoljena upotreba digitrona. Na vežbanci napisati broj grupe zadataka. Papir sa tekstom zadataka predaje se u vežbanci tj. ne sme se izneti.

G3

① 

a) $\vec{E_M} = \vec{E_{M1}} + \vec{E_{M2}} + \vec{E_{M3}}$

$$\vec{E_{M1}} = \frac{Q_1}{4\pi\varepsilon_0 (q/2)^2}\vec{r}_{01M} = \frac{Q_1}{4\pi\varepsilon_0 \frac{q^2}{4}}\vec{i} = \frac{3Q}{\pi\varepsilon_0 q^2}\vec{i}$$

$$\vec{E_{M2}} = \frac{Q_2}{4\pi\varepsilon_0 (q/2)}\vec{r}_{02M} = \frac{Q_2}{4\pi\varepsilon_0 \frac{q^2}{4}}(-\vec{i}) = \frac{-Q}{\pi\varepsilon_0 q^2}(-\vec{i}) = \frac{Q}{\pi\varepsilon_0 q^2}\vec{i}$$

$$\vec{E_{M3}} = \frac{Q_3}{4\pi\varepsilon_0 (q/2+q/2)^2}\vec{r}_{03M} = \frac{Q_3}{4\pi\varepsilon_0 q^2}(-\vec{i}) = \frac{-4Q}{4\pi\varepsilon_0 q^2}\vec{i} = \frac{-Q}{\pi\varepsilon_0 q^2}\vec{i}$$

$$\boxed{\vec{E_M} = \frac{3Q}{\pi\varepsilon_0 q^2}\vec{i}}$$

b) $V_M = V_{M1} + V_{M2} + V_{M3}$

$$V_{M1} = \frac{Q_1}{4\pi\varepsilon_0 q/2} = \frac{3Q_1}{2\pi\varepsilon_0 a}$$

$$V_{M2} = \frac{Q_2}{4\pi\varepsilon_0 q/2} = \frac{-Q}{2\pi\varepsilon_0 a}$$

$$V_{M3} = \frac{Q_3}{4\pi\varepsilon_0 a} = \frac{4Q}{4\pi\varepsilon_0 a} = \frac{2Q}{2\pi\varepsilon_0 a}$$

$$\boxed{V_M = \frac{4Q}{2\pi\varepsilon_0 a} = \frac{2Q}{\pi\varepsilon_0 a}}$$

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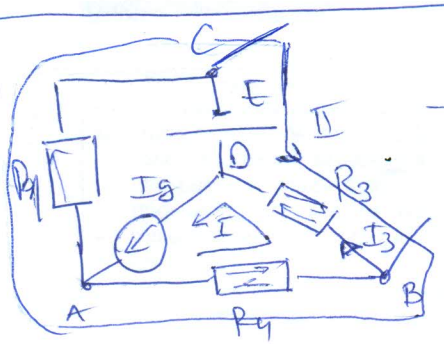
② 

a)

$$I_I = I_g$$

$$-(R_3+R_4)I_I + (R_1+R_3+R_4)I_{II} = E$$

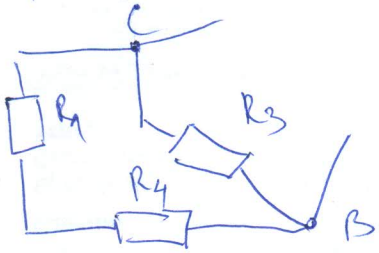
$$-2RI_g + 3RI_{II} = E$$

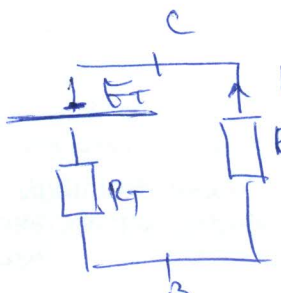
$$I_{II} = \frac{E+2RI_g}{3R} = \frac{E}{3R} + \frac{2}{3}I_g$$

$$I_3 = I_I - I_{II} = I_g - \frac{E}{3R} - \frac{2}{3}I_g = \frac{I_g}{3} - \frac{E}{3R}$$

$$E_T = U_{BC}^{or} = E + R_3 I_3 = E + R\frac{I_g}{3} - \frac{E}{3} = \boxed{\frac{RI_g+2E}{3} = E_T}$$

$$R_T = R_3 \| (R_1+R_4) = R \| (R+R) = R \| 2R = \boxed{\frac{2R}{3} = R_T}$$



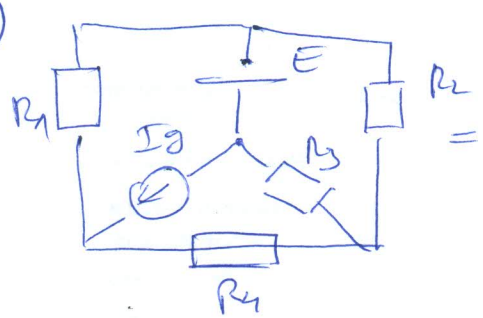


$$I_{R_2} = \frac{E_T}{R_T + R_2} = \frac{\frac{RI_g+2E}{3}}{\frac{2R}{3}+R}$$

$$I_{R_2} = \frac{RI_g+2E}{2R+3R} = \frac{RI_g+2E}{5R}$$

$$\boxed{I_{R_2} = 2A}$$

b)



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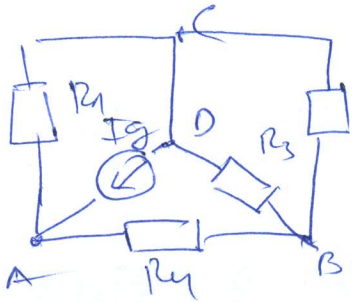

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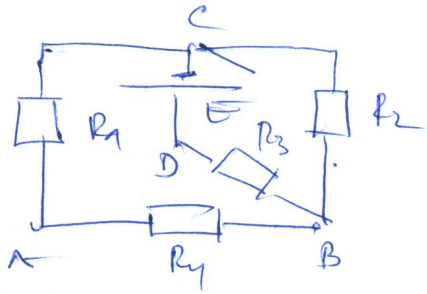
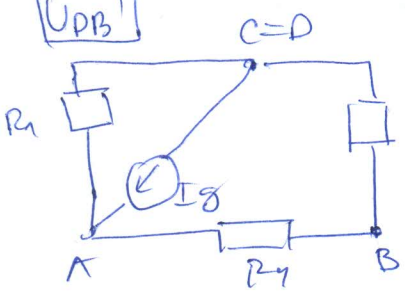


$$U_{DB} = U_{DB}' + U_{DB}''$$

U_{DB}'



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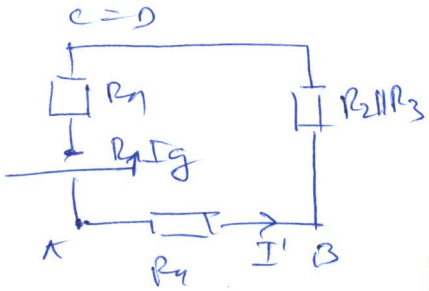


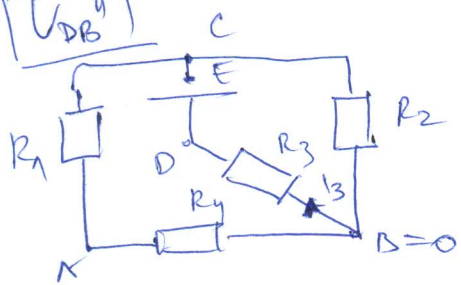
$$I' = \frac{R_1 I_g}{R_1 + R_4 + R_2 \| R_3}$$

$$I' = \frac{R I_g}{R + R + R/2}$$

$$\boxed{I' = \frac{2 I_g}{5}}$$

$$\boxed{U_{DB}' = -R_2 \| R_3 \, I' = -\frac{R}{2} \cdot \frac{2 I_g}{5} = -\frac{R I_g}{5}}$$

U_{DB}''



$$\left(\frac{1}{R_1+R_4} + \frac{1}{R_3} + \frac{1}{R_2}\right) U_{CO} = \frac{-E}{R_3}$$

$$\left(\frac{1}{2R} + \frac{1}{R} + \frac{1}{R}\right) U_{CO} = \frac{-E}{R}$$

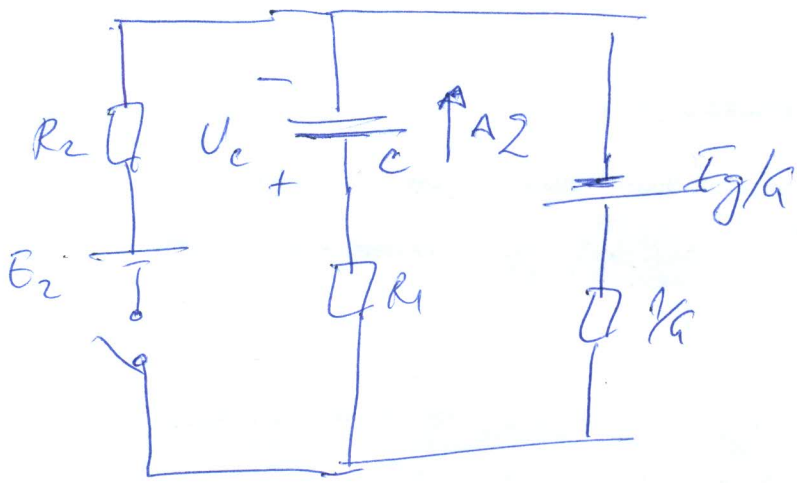
$$\frac{5}{2} U_{CO} = -E \Rightarrow \boxed{U_{CO} = -\frac{2}{5} E}$$

$$U_{CO} = R_3 I_3 - E \Rightarrow I_3 = \frac{U_{CO} + E}{R_3} = \frac{E - \frac{2}{5}E}{R} = \frac{3E}{5R}$$

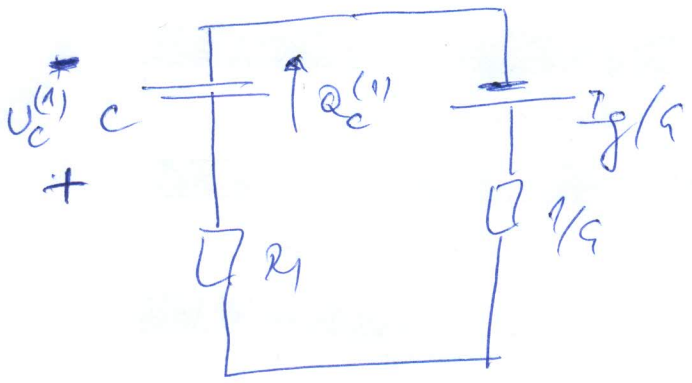
$$\boxed{U_{DB}'' = R_3 I_3 = R \cdot \frac{3E}{5R} = \frac{3}{5} E}$$

$$U_{DB} = U_{DB}' + U_{DB}'' = -\frac{R I_g}{5} + \frac{3E}{5} = \frac{3E - R I_g}{5} = 0\,V$$

(3)



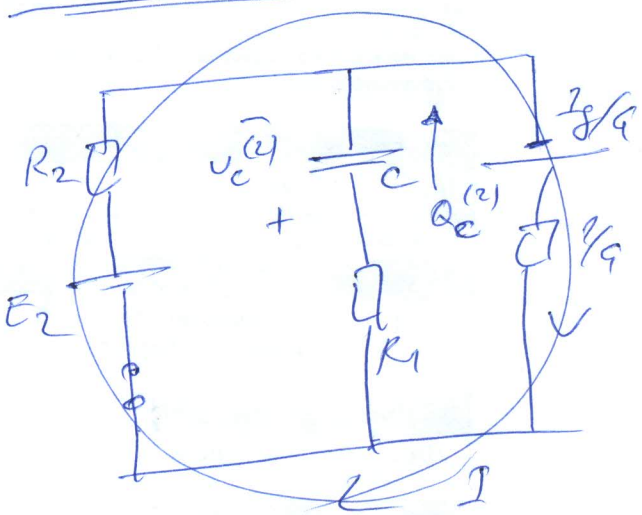
(1) — n , n=OFF



$U_c^{(1)} = I_g/G = \frac{1}{0{,}1} = 10\,V$

$Q_c^{(1)} = C U_c^{(1)} = 20\,mC$

(2) — n n=ON



$I = \frac{E_2 + I_g/G}{R_2 + \frac{1}{G}}$

$I = \frac{5 + \frac{1}{0{,}1}}{5 + \frac{1}{0{,}1}} = \frac{5+10}{5+10} = 1A$

$U_c^{(2)} = \frac{I_g}{G} - I \cdot \frac{1}{G}$

$U_c^{(2)} = \frac{1}{0{,}1} - 1 \cdot \frac{1}{0{,}1} = 0\,V$

$Q_c^{(2)} = C \cdot U_c^{(2)} = 0\,C$

$\Delta Q = Q_c^{(2)} - Q_c^{(1)}$

$\Delta Q = 0 - 20\,mC = -20\,mC$