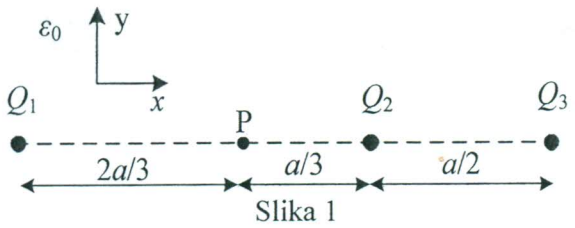
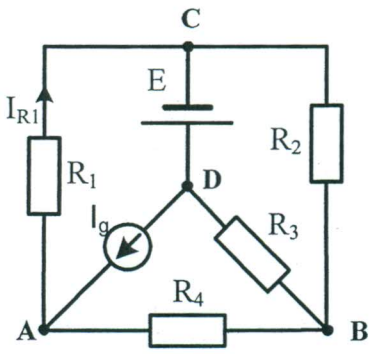
PRVI KOLOKVIJUM IZ ELEKTROTEHNIKE
26. novembar 2018.
GRUPA 1

1. Na Slici 1 prikazan je sistem sa tri tačkasta naelektrisanja: $Q_1 = 4Q$, $Q_2 = Q$ i $Q_3 = -5Q$, $Q > 0$, koja se nalaze u vazduhu, na istoj pravoj.

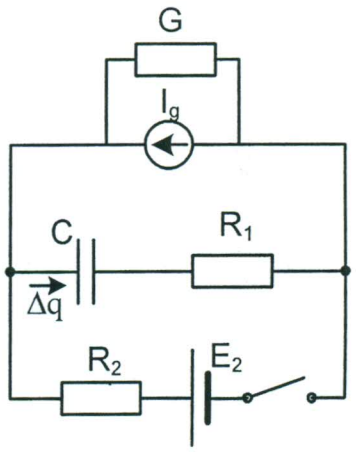
a) Odrediti i nacrtati vektor električnog polja u tački P. **(6 poena)**
b) Odrediti potencijal električnog polja u tački P. **(4 poena)**



Slika 1



Slika 2



Slika 3

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

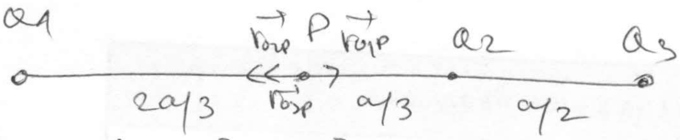
a) Primenom Tevenenove teoreme odrediti intenzitet struje I_{R1} kroz otpornik R_1. **(10 poena)**
b) Primenom metode superpozicije odrediti napon U_{AD} **(12 poena)**

3. U kolu na Slici 3 poznato je: $R_1 = 10\Omega$, $R_2 = 5\Omega$, $E_2 = 5\text{V}$, $I_g = 2\text{A}$, $G = 0.2\text{S}$, $C = 2\mu\text{F}$. 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.

G1

1)



a) $\vec{K_P} = \vec{K_{P1}} + \vec{K_{P2}} + \vec{K_{P3}}$

$$\vec{K_{P1}} = \frac{Q_1}{4\pi\varepsilon_0 (2a/3)^2}\vec{r_{01P}} = \frac{4Q}{4\pi\varepsilon_0 \cdot \frac{4a^2}{9}}\vec{i} = \frac{9Q}{4\pi\varepsilon_0 a^2}\vec{i}$$

$$\vec{K_{P2}} = \frac{Q_2}{4\pi\varepsilon_0 (a/3)^2}\vec{r_{02P}} = \frac{Q}{4\pi\varepsilon_0 \frac{a^2}{9}}(-\vec{i}) = -\frac{9Q}{4\pi\varepsilon_0 a^2}\vec{i}$$

$$\vec{K_{P3}} = \frac{Q_3}{4\pi\varepsilon_0 (5a/6)^2}\vec{r_{03P}} = \frac{-5Q}{4\pi\varepsilon_0 \frac{25a^2}{36}}(-\vec{i}) = +\frac{9Q}{5\pi\varepsilon_0 a^2}\vec{i}$$

$$\boxed{\vec{K_P} = \frac{9Q}{5\pi\varepsilon_0 a^2}\vec{i}}$$

b) $V_P = V_{P1} + V_{P2} + V_{P3}$

$$V_{P1} = \frac{Q_1}{4\pi\varepsilon_0 \, 2a/3} = \frac{3\cdot 4Q}{8\pi\varepsilon_0 a} = \frac{3Q}{2\pi\varepsilon_0 a} = \frac{6Q}{4\pi\varepsilon_0 a}$$

$$V_{P2} = \frac{Q_2}{4\pi\varepsilon_0 \, a/3} = \frac{3Q}{4\pi\varepsilon_0 a}$$

$$V_{P3} = \frac{Q_3}{4\pi\varepsilon_0 \, 5a/6} = \frac{-5Q\cdot 6}{4\pi\varepsilon_0 \cdot 5a} = \frac{-6Q}{4\pi\varepsilon_0 a}$$

$$\boxed{V_P = \frac{3Q}{4\pi\varepsilon_0 a}}$$

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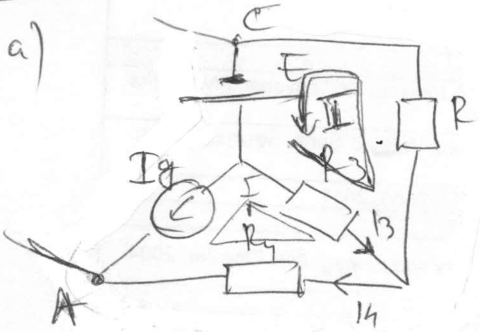
2) a)



$E_T = U_{AC}^{ov}$

$I_I = I_g$

$-R_3 I_I + (R_2 + R_3) I_{II} = E$

$2R I_{II} = E + R I_g$

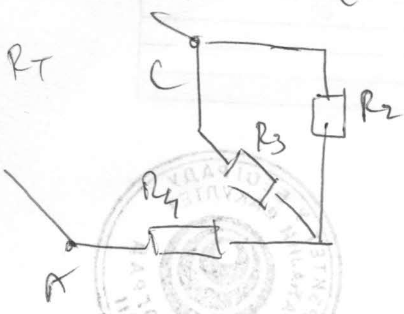
$$I_{II} = \frac{E + R I_g}{2R} = \frac{E}{2R} + \frac{I_g}{2}$$

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

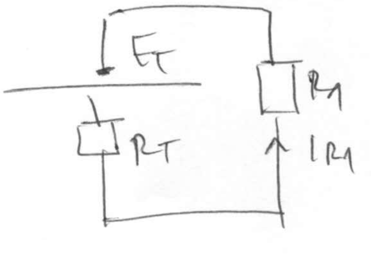
$I_4 = -I_g = -I_I$

$$E_T = U_{AC}^{ov} = E - R_3 I_3 - R_4 I_4 = E - \frac{E}{2} + \frac{R I_g}{2} + R I_g = \frac{E}{2} + \frac{3 R I_g}{2}$$

R_T



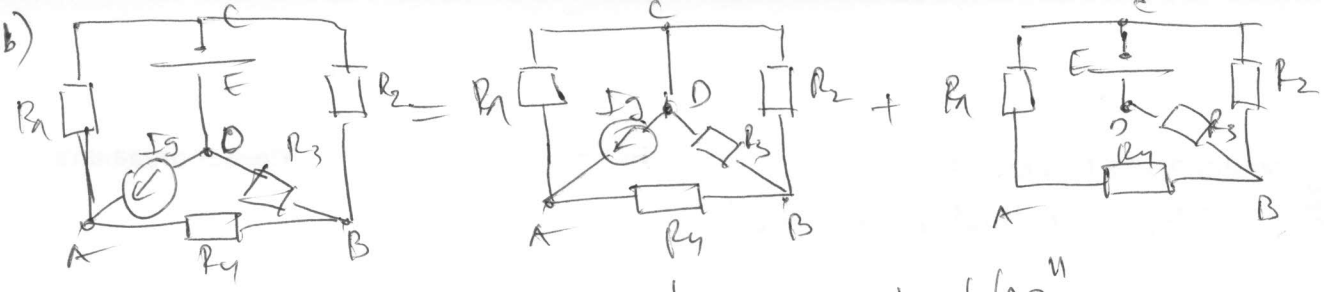
$R_T = R_4 + R_2 \| R_3 = R + R\|R = 3R/2$



$$I_{R1} = \frac{E_T}{R_T + R_1} = \frac{\frac{E}{2} + \frac{3RI_g}{2}}{\frac{3R}{2} + R}$$

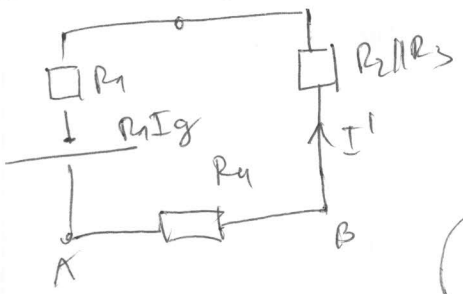
$$= \frac{E + 3RI_g}{5R} = \boxed{4\,A = I_{R1}}$$

b)



$U_{AD} = U_{AD}' + U_{AD}''$

U_{AD}'

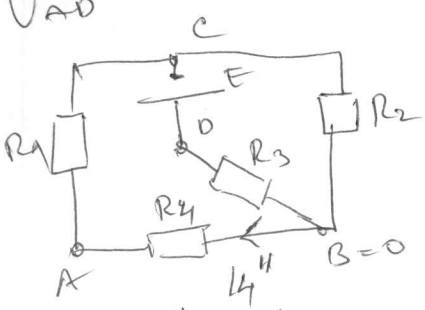


$$I' = \frac{R_1 I_g}{R_1 + R_4 + R_2 \| R_3} = \frac{R I_g}{R + R + R/2} = \frac{2 I_g}{5}$$

$$U_{AD}' = (R_4 + R_2 \| R_3)\, I' = \left(R + \frac{R}{2}\right) \cdot \frac{2 I_g}{5}$$

$$\boxed{U_{AD}' = \frac{3R}{2} \cdot \frac{2 I_g}{5} = \frac{3 R I_g}{5}}$$

U_{AD}''



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

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

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

$$U_{CO}'' = (R_1 + R_4)\, I_4'' \Rightarrow I_4'' = \frac{-U_{CO}''}{R_1 + R_4} = \frac{\frac{2}{5}E}{2R} = \frac{E}{5R}$$

$$\boxed{U_{AD}'' = -E + R_1 I_4'' = -E + \frac{E}{5} = -\frac{4}{5} E}$$

$$U_{AD} = U_{AD}' + U_{AD}'' = \frac{3RI_g - 4E}{5} = 12\,V$$

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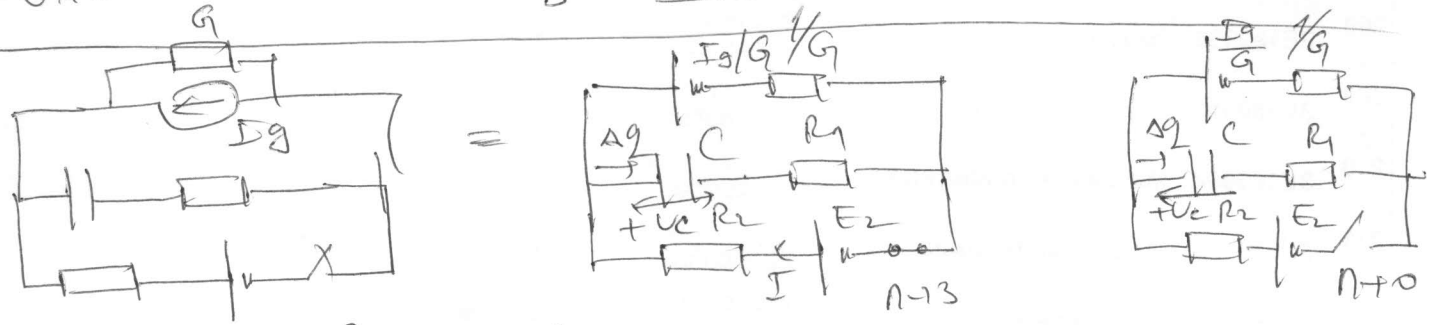
3)



$n=0$ $\quad U_c = \frac{I_g}{G} = \frac{2}{0{,}2} = 10\,V$

$n=3$ $\quad I = \frac{E_2 - \frac{I_g}{G}}{R_2 + \frac{1}{G}} = \frac{5 - \frac{2}{0{,}2}}{5 + \frac{1}{0{,}2}} = \frac{-5}{10} = -\frac{1}{2}\,A$

$$U_c = E_2 - R_2 I = 5 + 5 \cdot \frac{1}{2} = 5 + \frac{5}{2} = \frac{15}{2}\,V = 7{,}5\,V$$

$$\Delta q = C \cdot \Delta U_c = 2\mu F \left(\frac{15}{2} - 10\right) = -5\,\mu C$$