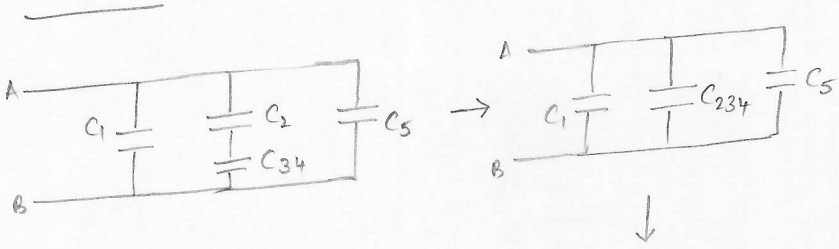
Solutions

PHYS-205B (Midterm Exam 02) Fall 2024

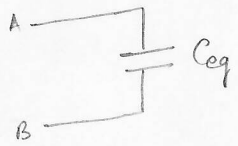
Problem 1



$$C_{34} = C_3 + C_4 = 3.0 + 4.0 = 7.0\,\mu F$$

$$\frac{1}{C_{234}} = \frac{1}{C_2} + \frac{1}{C_{34}} = \frac{1}{2.0} + \frac{1}{7.0} = \frac{9.0}{14}$$

$$C_{234} = \frac{14}{9.0}\,\mu F$$



$$C_{eq} = C_1 + C_{234} + C_5 = 1.0 + \frac{14}{9.0} + 5.0$$

$$\boxed{C_{eq} = 7.6\,\mu F} \rightarrow \text{Answer}$$

Problem 2

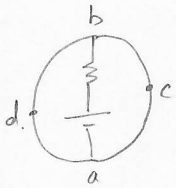
loop rule (rectangle): $+V - IR = 0$

$$\Rightarrow I = \frac{V}{R}$$

loop rule for abca:

$$+V - IR = 0$$

$$\Rightarrow I = \frac{V}{R}$$



Thus, current is same in both cases.

Problem 3

$$\left.\begin{aligned} V &= IR \\ V &= \frac{Q}{C} \end{aligned}\right\} \Rightarrow [RC] = \frac{[Q]}{[I]} = \text{Time} = T$$

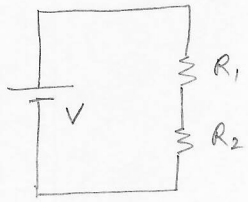
Problem 4

$$\omega = \frac{qB}{m} = \frac{(1.6\times10^{-19})(0.50\times10^{-4})}{(9.1\times10^{-31})} = 8.8\times10^{6}\ \text{Hz}$$

$$R = \frac{V}{\omega} = \frac{1.0\times10^{7}}{8.8\times10^{6}} = 1.1\ \text{meter}$$

$R < 1.1$ meter depending on direction of initial velocity.

Problem 5



(a) $R_{eq} = R_1 + R_2$
$= 100.0 + 200.0 = 300.0\ \Omega$

(b) $I_1 = I_2 = \dfrac{V}{R_{eq}} = \dfrac{10.0}{300.0} = 33.3\ mA$

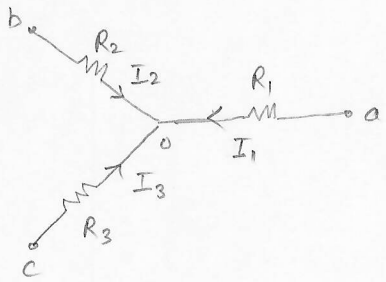
(c) $V_1 = I_1 R_1 = (33.3\times10^{-3})(100.0) = 3.33$ Volts

$V_2 = I_2 R_2 = (33.3\times10^{-3})(200.0) = 6.66$ Volts

(d) $P_1 = I_1^2 R_1 = (33.3\times10^{-3})^2(100.0) = 0.111$ Watts

$P_2 = I_2^2 R_2 = (33.3\times10^{-3})^2(200.0) = 0.222$ Watts

Problem 6



junction rule at o: $I_1 + I_2 + I_3 = 0$

$\Rightarrow I_3 = -I_1 - I_2$

Path coa: $+V_c - I_3 R_3 + I_1 R_1 = V_a$.

$30.0 - (-I_1 - I_2)\,30.0 + I_1(10.0) = +10.0$

$40.0\,I_1 + 30.0\,I_2 = -20.0$ — (1)

Path boa: $+V_b - I_2 R_2 + I_1 R_1 = V_a$.

$20.0 - I_2\,20.0 + I_1\,10.0 = 10.0$

$10.0\,I_1 - 20.0\,I_2 = -10.0$ — (2)

Using (1) & (2)

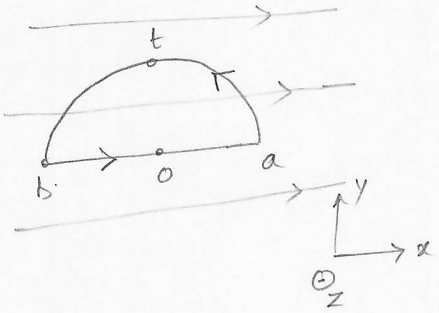
$$I_1 = \frac{\begin{vmatrix} -20.0 & 30.0 \\ -10.0 & -20.0 \end{vmatrix}}{\begin{vmatrix} 40.0 & 30.0 \\ 10.0 & -20.0 \end{vmatrix}} = \frac{+400. + 300.}{-800. - 300.} = -0.636\,A$$

$$I_2 = \frac{\begin{vmatrix} 40.0 & -20.0 \\ 10.0 & -10.0 \end{vmatrix}}{\begin{vmatrix} 40.0 & 30.0 \\ 10.0 & -20.0 \end{vmatrix}} = \frac{-400. + 200.}{-800. - 300.} = +0.182\,A$$

$I_3 = -I_1 - I_2$
$= +0.455\,A.$

Problem 7

Total force on the loop is zero (in uniform $\vec{B}$)



Thus,

$$\vec{F}_{atb} + \vec{F}_{boa} = 0$$

$$\vec{F}_{atb} = -\vec{F}_{boa}$$

$$= -I L_{boa} \underbrace{\hat{x} \times \hat{x}}_{=0} B$$

$$= 0$$

Segment atb experiences no force.