Capacitors & Dielectric

Question 01:-

Data

$C_1 = 6\ \mu F$

$C_2 = 4\ \mu F$

$V = 200V$

a) $C = ?$

b) $Q_1 = ?$; $Q_2 = ?$

c) $V_1 = ?$; $V_2 = ?$

Solution:

a) $C = ?$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{6} + \frac{1}{4} = \frac{5}{12}$$

$$C = \frac{12}{5}$$

$$C = 2.40\ \mu F$$

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b) $Q_1 = ?$; $Q_2 = ?$

For Q_1:-

$Q_T = C_T V_T$

$= 2.4 \times 10^{-6} \times 200$

$Q_T = 4.8 \times 10^{-4}\ C$

Since the capacitors are in series

$Q_1 = Q_2 = 4.8 \times 10^{-4}\ C$

c) $V_1 = ?$, $V_2 = ?$

$V_1 = \frac{Q_1}{C_1} = \frac{4.8 \times 10^{-4}}{6 \times 10^{-6}}$

$V_1 = 80V$

$V_2 = \frac{Q_2}{C_2}, 120V$

Question 02

$r = 8.22cm = 0.0822\ m$

$d = 1.31mm = 1.31 \times 10^{-3}\ m$

i) $C = ?$

2) $Q = ?$ when $V = 116V$

Solution

1) $C = \frac{A\epsilon_0}{d} = \frac{\pi (0.0822)_{\times} 8.85 \times 10^{-12}}{1.31 \times 10^{-3}}$

$C = 1.745 \times 10^{-9}\ F$

2) Q when $V = 116V$

$Q = 116 \times 1.745 \times 10^{-9}$

$Q = 2.024 \times 10^{-7}\ C$

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Question 03

$C = 32\mu F$

$V(t) = 6 + 4t - 2t^2$

$t = 0.5s$

a) $Q = ?$

b) $I = ?$

c) $P = ?$

For V:-

$V = 6 + 4(0.5) - 2(0.5)^2$

$V = 7.5V$

FOR Q:-

$Q = C \times V = 32 \times 10^{-6} \times 7.5$

$Q = 2.4 \times 10^{-4} C$

FOR I:-

$I = dQ/dt$

$I = C\frac{dV}{dt}$

$I = 32 \times 10^{-6} (4 - 4t)$

$= 32 \times 10^{-6} \times (4 - 4(0.5))$

$I = 6.4 \times 10^{-5} A$

FOR P:-

$P = VI = (6 + 4(0.5) - 2(0.5)^2) \times 6.4 \times 10^{-5}$

$P = 4.8 \times 10^{-4} \omega$

$P = 480 \mu\omega$

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Question 04

$A = 12\,cm^2 = 1.2\times10^{-3}\,m^2$

$d = 2\,mm = 2\times10^{-3}\,m$

$V = 60V$

$C = ?$

$Q = ?$

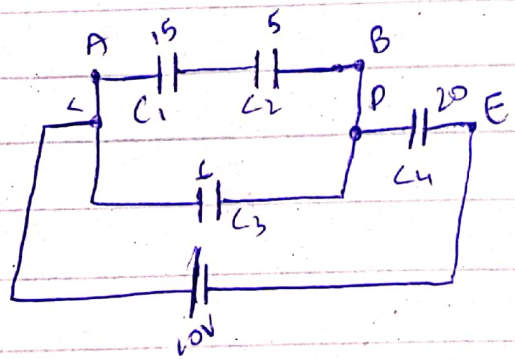
$$C = \frac{\epsilon_0 \times 1.2\times10^{-3}}{2\times10^{-3}}$$

$C = 5.31\,pF$

$Q = 5.31\times10^{-12}\times60$

$Q = 318\,pC$

Question 05:

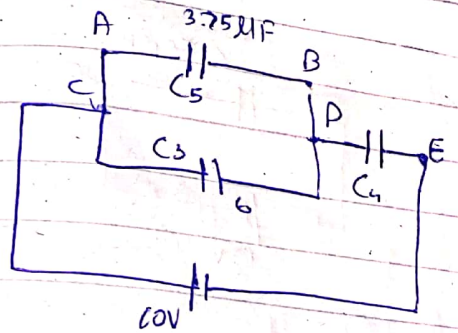


~~FOR C_1~~

1) For eq capacitance of C_1 & C_2

$$\frac{1}{C_5} = \frac{1}{C_1} + \frac{1}{C_2}$$

$C_5 = 3.75\,\mu F$



2) For eq capacitance of C_3 & C_5

$C_6 = C_5 + C_3$

$C_6 = 9.75\,\mu F$

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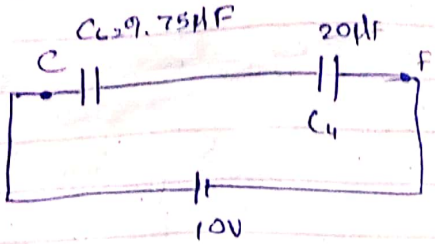
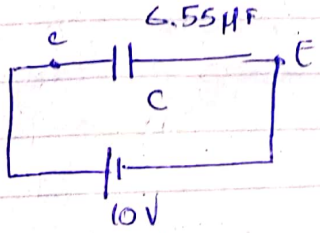


$$\frac{1}{C} = \frac{1}{C_6} + \frac{1}{C_4}$$

$C = 6.55\mu F$



FOR Q_1:-

$Q_2 = CV_2 = 6.55 \times 10^{-6} \times 10$

$Q_2 = 6.55 \times 10^{-5} C$

→ FOR Q_6, Q_4 & V_6 & V_4

Since both are connected in parallel

$Q_6 = Q_4 = 6.55 \times 10^{-5} C$

FOR V_4:-

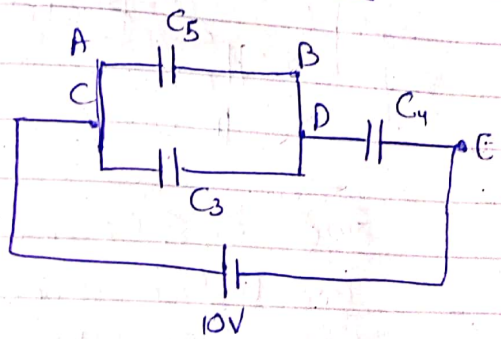
$V_4 = \frac{Q_4}{C_4} = \frac{6.55 \times 10^{-5}}{20 \times 10^{-6}}$

$V_4 = 3.275 V$

FOR V_6:-

$V_6 = \frac{6.55 \times 10^{-5}}{9.75 \times 10^{-6}}$

$V_6 = 6.718 V$



→ FOR Q_5, Q_3 & C_5, C_3

Since C_3 & C_5 are connected in parallel

$V_3 = V_5 = 6.718 V$

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FOR Q_3 & Q_5:-

$Q_3 = C_3 V_3$

$= 6 \times 10^{-6} \times 6.718$

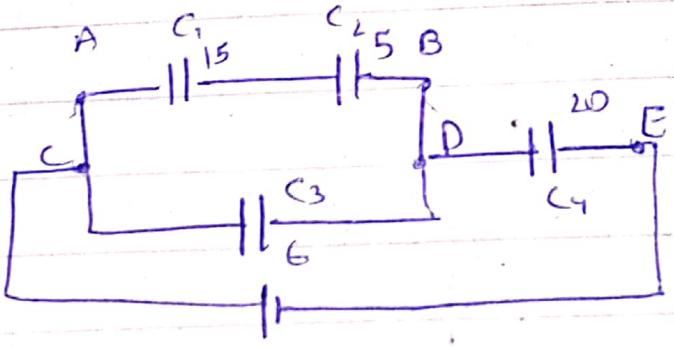
$Q_3 = 4.03 \times 10^{-5}\ C$

$Q_5 = C_5 \times V_5$

$= 3.75 \times 6.718 \times 10^{-6}$

$Q_5 = 2.519 \times 10^{-5}\ C$

→ FOR Q_1, Q_2 & V_1, V_2



Since C_1 & C_2 are connected in series

$Q_1 = Q_2 = Q_5 = 2.519 \times 10^{-5}\ C$

FOR V_1:-

$V_1 = Q_1 / C_1 = 2.519 \times 10^{-5} / 15 \times 10^{-6}$

$V_1 = 1.679\ V$

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FOR V_2 :-

$$V_2 = Q_2/C_2 = 2.519 \times 10^{-5} / 5 \times 10^{-6}$$

$$V_2 = 5.038\,V$$

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