Assinment-3
ANSWER KEY

1. (c) Here the system can be considered as two capacitors C_1 and C_2 connected in series.

CASE BASED STUDY QUESTION

2. 1.(c) 2. (b) 3. (b) 4.(c)

2 MARKS ANSWERS

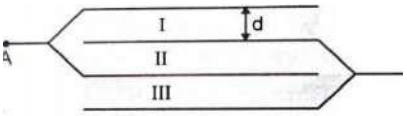
3. The capacitance of the parallel plate capacitor, filled with dielectric medium of dielectric constant K is given by $C=K\epsilon_0 A/d$

The capacitance of the parallel plate capacitor decreases with the removal of dielectric medium as for air or vacuum K = 1 and for dielectric K > 1.

If we disconnect the battery from capacitor, then the charge stored will remain the same due to conservation of charge.

The potential difference across the plates of the capacitor is given by V =q/C Since q is constant and C decreases which in turn increases V and therefore E increases as E = V/d.

4.



$C_p=3C=3\ A\varepsilon_O/d$

5. The capacitance of this capacitor is 221.2×10^{-13} F. The charge stored in any one of the plates 221.2 pC.

3 MARKS ANSWERS

6. Dielectric slab of thickness 5mm is equivalent to an air capacitor of thickness = $\frac{5}{10}$mm

Effective separation between the plates with air in between is = 5.5 mm

Effective new capacitance = 200 µF X $\frac{5}{5.5}$ = 182 µF

(i) Effective new electric field = $\frac{100}{5.5\times10^{-3}}$ =18182 V/m

New energy stored / original energy stored = 10/11

7.Given : $C_A= C_B = C$, Dielectric costant = K

Energy stored = $\frac{1}{2}Cv^2$ (i)

Net capacitance with switch S closed = C+C= 2C

E_1= Energy stored = CV^2 (ii)

After switch S is opened, capacitance of each capacitor = KC

Energy stored in capacitor A = $\frac{1}{2} kcv^2$ (iii)

For capacitor B,

Energy stored = $\frac{Cv^2}{2k}$ (iv)

From equations (iii) & (iv)

E = Total energy stored = $\frac{1}{2} cv^2 \left(\frac{k^2+1}{k}\right)$

Required Ratio = $\frac{E1}{E_2} = \frac{2k}{k^2+1}$

5-MARKS ANSWERS

8. Answer:

Given : $q_1 = 360\ \mu C = 360 \times 10^{-6}\ \mu C$, $q_2 = 120\ \mu C$
$= 120 \times 10^{-6}\ C$

$C = \frac{q_1}{V_1}$. Also $C = \frac{q_2}{V_2}$ and $C = \frac{q_3}{V_3}$

[∵ Capacitor is the same

$\because \quad \frac{q_1}{V_1} = \frac{q_2}{V_2}$

$\Rightarrow \quad \frac{(360 \times 10^{-6})}{V} = \frac{(120 \times 10^{-6})}{(V - 120)}$

On solving, **V = 180 V**

$$C = \frac{360 \times 10^{-6}}{180}$$

= **2μF** is the unknown capacitance.

Now the voltage has been increased by 120 V,
then V = 180 + 120 = 300 V

$$C = \frac{q_3}{300} = 2\mu F$$

$q_3 = 300 \times \mu C$ >

q_3 = 600 μC would be charge on the capacitor if voltage were incresed by 120 V.
[Ans : V = 60 V, c = 2 pF, Q3 = 200 μC].

9.

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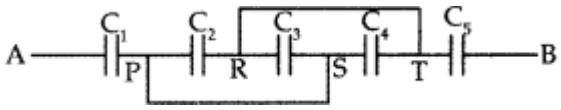
[Answer : V = 120 V, c = 2 μF, Q = 400 μC]

10.



Given : $C_1 = C_2 = C_3 = C_4 = C_5 = 2\mu F$
$= 2 \times 10^{-6}\ F$

(*i*) Capacitors C_2, C_3 and C_4 are in parallel

$\therefore \quad C_{234} = C_2 + C_3 + C_4 = 2 + 2 + 2$

$\therefore \quad C_{234} = 6\mu F$

Capacitors C_1, C_{234} and C_5 are in series

$$\therefore \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_{234}} + \frac{1}{C_5} = \frac{1}{2} + \frac{1}{6} + \frac{1}{2} = \frac{7}{6}\mu F$$

$$C_{equivalent} = \frac{6}{7}\mu F = \frac{6}{7} 10^{-6}\ F$$

(*ii*) Charge drawn from the source

$$Q = C_{eq}\ V = \frac{6}{7} \times 7\ \mu C = 6\ \mu C$$