NORTH SOUTH UNIVERSITY

Department of Mathematics & Physics

Assignment – 5

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Ans. to the ques. no. 32

Given,

Plate Area, $A = 40\ cm^2 = 0.0040\ m^2$

Plate distance $d = 1.00\ mm = 0.0010\ m$

Potential difference, $V = 600\ V$

a)

We know,

Capacitance of a parallel-plate capacitor is,

$$C = \frac{\epsilon_0 A}{d}$$

$$= \frac{8.85 \times 10^{-12} \times 0.0040}{0.0010}\ F$$

$$= 3.54 \times 10^{-11}\ F$$

Therefore, the capacitance is $3.54 \times 10^{-11}\ F$

b)

Magnitute of charge on each plate.

$$Q = CV$$

$$= (3.54 \times 10^{-11} \times 600)\ C$$

$$= 2.124 \times 10^{-8}\ C$$

c)

Stored energy,

$$U = \frac{1}{2} C V^2$$

$$= \frac{1}{2} \times (3.54 \times 10^{-11}) \times (600)^2\ J$$

$$= 6.372 \times 10^{-6}\ J.$$

d)

Electric Field between the plate,

$$E = \frac{V}{d} = \frac{600}{0.0010} = 600000\ V/m$$

e)

Energy density,

$$u = \frac{1}{2} \epsilon_0 E^2$$

$$= \frac{1}{2} \times 8.85 \times 10^{-12} \times (600000)^2 \ J/m^3$$

$$= 1.593 \ J/m^3$$

Ans. to the ques. no. 37

Given that,

Plate Area, $A = 8.50 \ cm^2 = 0.00085 \ m^2$

Initial separation, $d = 3mm = 0.003 \ m$

Final separation, $d' = 8 \ mm = 0.0008 m$

Initial Voltage, $V = 6V$

a)

In initial position,

$$E = \frac{V}{d} = \frac{6}{0.003} = 2000 \ V/m$$

Aftere separation electric field will be the same,

$$\therefore E = \frac{V'}{d'} \quad ; \quad V' = \text{final voltage}$$

$$\therefore V' = Ed' = 2000 \times 0.008 = 16 \ V$$

Therefore, the final potential difference is 16V.

b)

Initial stored energy,

$$U = \frac{1}{2} C V^2$$

$$= \frac{1}{2} \cdot \epsilon . \frac{A}{d} \cdot V^2$$

$$= \frac{0.5 \times 8.85 \times 10^{-12} \times 0.00085 \times 6^2}{0.003}$$

$$= 4.5135 \times 10^{-11} \text{ J}$$

c)

Final stored energy,

$$U' = \frac{1}{2} \epsilon . \frac{A}{d'} \cdot (V')^2$$

$$= \frac{0.5 \times 8.85 \times 10^{-12} \times 0.00085 \times (16)^2}{0.008}$$

$$= 1.2036 \times 10^{-10} \text{ J}$$

d)

The work required to separate the plates,

$$W = U' - U$$

$$= (1.2036 \times 10^{-10}) - (4.5135 \times 10^{-11}) \; J$$

$$= 7.5225 \times 10^{-11} \; J$$

Ans

Ans. to the ques. no. 48

When a dielectric material is inserted between the plates,

the capacitance is given by,

$$\cancel{C = k.\epsilon.\frac{A}{}} \quad C = k \cdot C_{Air}$$

$$= k.\epsilon.\frac{A}{d}$$

$$\therefore C_1 = k_1 \epsilon . \frac{A/2}{d} = \frac{7.00 \times 8.85 \times 10^{-12} \times 0.000556}{0.00556 \times 2}$$

$$= 3.0975 \times 10^{-12} \; F$$

$A = 5.56 \; cm^2$
$= 0.000556 \; m^2$
$d = 5.56 \; mm$
$= 0.00556 \; m$

$\therefore C_R = k_2 \cdot \epsilon \cdot \frac{A/2}{d} = \frac{12 \times 8.85 \times 10^{-12} \times 0.000556}{0.00556 \times 2}$

$= 5.31 \times 10^{-12}$ F

$\therefore$ Total Capacitance,

$C = C_L + C_R$

$= 3.0975 \times 10^{-12} + 5.31 \times 10^{-12}$

$= 8.4075 \times 10^{-12}$ F

Ans. to the ques no. 49

Given that,

Plate Area, $A = 7.89\ cm^2$

$= 0.000789\ m^2$

Separation, $d = 4.62$ mm

$= 0.00462$ m

$k_1 = 11$

$k_2 = 12$

Capacitance of a capaciton when two dielectric stacked,

$$C = \epsilon_0 \cdot \frac{A}{d} \cdot \frac{2k_1 k_2}{k_1 + k_2}$$

$$= \frac{8.85 \times 10^{-12} \times 0.000789 \times 2 \times 11 \times 12}{0.00462 \times (11+12)} \text{ F}$$

$$= 1.7348 \times 10^{-11} \text{ F}$$

Ans

Ans. to the ques. no. 50

Given,

Plates Anea $= 10.5 \text{ cm}^2$

$= 0.00105 \text{ m}^2$

Plate sepenation, $D = 2d = 7.12 \text{mm}$

$= 0.00712 \text{ m}$

$k_1 = 21$

$k_2 = 42$

$k_3 = 58$

Left side,

$$C_L = k \cdot \epsilon_0 \cdot \frac{A/2}{D}$$

$$= \frac{21 \times 8.85 \times 10^{-12} \times 0.00105}{0.00712 \times 2} \text{ F}$$

$$= 1.37 \times 10^{-11} \text{ F}$$

Right side, two dielectric are stacked,

$$C_R = \epsilon_0 \cdot \frac{A/2}{D} \cdot \frac{2 k_2 k_3}{k_2 + k_3}$$

$$= \frac{8.85 \times 10^{-12} \times 0.00105 \times 2 \times 42 \times 58}{0.00712 \times 2 \times (42+58)}$$

$$= 3.18 \times 10^{-11} \text{ F}$$

$\therefore$ Total Capacitance

$$C = C_L + C_R$$

$$= 1.37 \times 10^{-11} + 3.18 \times 10^{-11}$$

$$= 4.55 \times 10^{-11} \text{ F}$$