

34. Electrical capacity :

- Electrical capacity of a conductor is its ability to store electric charge.
- The potential acquired by a conductor is directly proportional to the charge given to it i.e., $V \propto Q$.
i.e., $Q \propto V$ or $Q = CV$ where the constant of proportionality 'C' is called the electrical capacity of the conductor.
- Thus the capacity of a conductor is defined as the ratio of the charge to the potential.

iv) Its SI unit is farad. , C.G.S. = Stat Farad } $\Rightarrow 1 F = 9 \times 10^{12}$ Stat Farad

v) 1 milli farad (1 mF) = 10^{-3} farad

1 micro farad (1 μF) = 10^{-6} farad

1 pico farad (1 pF) = 10^{-12} farad

vi) The capacity of a spherical conductor in farad is given by $C = 4\pi\epsilon_0 r$, where r = radius of the conductor.

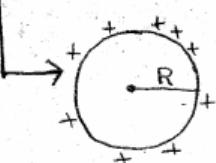
vii) If we imagine Earth to be a uniform solid sphere then the capacity of earth

$$C = 4\pi\epsilon_0 R = \frac{6400 \times 10^3}{9 \times 10^9} = 711 \mu F \approx 1 mF$$

} theoretical value

Practical 3.12 Infinite Earth
∴ ते charges की अन्तर्मित मात्रा

$$\text{Dimension} \rightarrow C = \frac{Q}{V} = \frac{[A \cdot T]}{[m^2 L^2 T^4 A^2]} = [m^{-2} L^2 T^4 A^2]$$



$$C = \frac{Q}{V} = \frac{Q}{\frac{4\pi kq}{R}} = \frac{R}{k} = \boxed{4\pi\epsilon_0 R} = \boxed{\frac{R}{9 \times 10^9}}$$

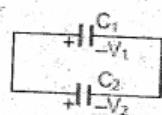
C.G.S. में K के अस्तित्व नहीं तो CGS में $C = R$

Uses of condenser (Capacitor):

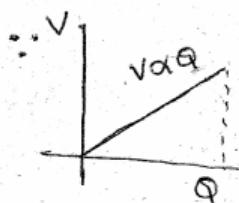
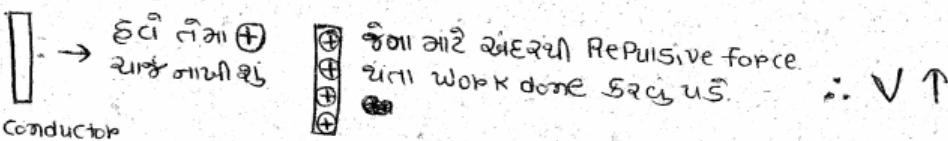
- Capacitors are used to establish desired uniform and strong electric fields in small space.
- Capacitors can confine strong electric field for small volumes. They serve as useful devices for storing electrical energy. BE SURE
- A capacitor blocks direct current and allows alternating currents. Capacitors are used in filter circuits.
- Capacitors are used in generation and detection of oscillating electric fields.
- Capacitors are widely used in tuning circuits of radio and T.V. receivers.
- To reduce voltage fluctuations in electric power supplies, to transmit pulsed signals and to provide time delays capacitors are essential. સુધીની વિધાન

Energy of capacitor :

- The electrostatic energy stored in a charged capacitor is equal to $U = \frac{Q^2}{2C}$ or $\frac{CV^2}{2}$ or $\frac{QV}{2}$.
- This energy is stored in the uniform electric field that is present between the plates of the capacitor.



નિયમિત પરિદ્ધિ



$$\text{Work Done} = \text{Energy} = \frac{1}{2} \text{ નિયમિત પરિદ્ધિ} = \frac{1}{2} \text{ માટી} \times \text{વૈદ્ય} = \frac{1}{2} QV$$

$$U = \frac{1}{2} QV = \frac{1}{2} CV^2 = \frac{Q^2}{2C} \quad] \text{using } C = \frac{Q}{V}$$

Energy stored

જ્ઞાન લેખો થી Capacitor charge કરાય.

લેખો પાસે $Q \times V = U$ હશે. પણ Capacitor પાસે $\frac{1}{2} QV$ કિએ?

∴ જ્ઞાન અને $\frac{1}{2} QV$ Capacitor ની સંબંધ $\frac{1}{2} QV$ heat રાખું 1055

45. Combination of charged spherical drops :

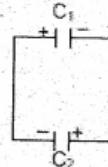
When 'n' identical charged small spherical drops are combined to form a Big drop.

Sno.	Quantity	For each charged small drop	For the big drop	
a.	Radius	r	$R = n^{1/3} r$	$\frac{4}{3} \pi R^3 = \frac{4}{3} n \pi r^3 \Rightarrow R = n^{2/3} r$
b.	Charge	q	$Q = n \times q$	Charge conserved
c.	Capacity	C	$C' = n^{1/3} \times C$	$C = \frac{q}{V} = \frac{nq}{n^{2/3} V} = n^{1-2/3} = n^{1/3} C$
d.	Potential	V	$V' = n^{2/3} \times V$	$V = \epsilon_0 q = n^{2/3} \cdot n^1 C q = n^{2/3} U$
e.	Energy	U	$U' = n^{5/3} U$	$U = \frac{1}{2} Q V = \frac{1}{2} nq \times n^{2/3} V = n^{5/3} U$
f.	Surface density of charge	σ	$\sigma' = n^{1/3} \cdot \sigma$	$\frac{\sigma'}{\sigma} = \frac{n \sigma}{4\pi \epsilon_0 R^2 \cdot \epsilon_0}$ $= \frac{n^2}{2}$

Combination of charged capacitors : Q Shaking of capacitor

- i) If two condensers of capacities C_1 and C_2 are charged to potentials V_1 and V_2 respectively and are joined in parallel (+ve plate connected to +ve plate) then the common potential
- $$V = \frac{Q_1+Q_2}{C_1+C_2} = \frac{C_1V_1+C_2V_2}{C_1+C_2} = \frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 = -\left[\frac{1}{2}C_1V^2 + \frac{1}{2}C_2V^2\right]$$
- ii) The loss of energy in this process (manifested as heat) is given by $U = \frac{C_1C_2}{2(C_1+C_2)}(V_1-V_2)^2$.

- iii) When two condensers of capacities C_1 and C_2 charged to potentials V_1 and V_2 are connected antiparallel (+ve plate connected to -ve plate) as shown in the figure.



a) Common potential $V = \frac{Q_1+Q_2}{C_1+C_2} = \frac{C_1V_1-C_2V_2}{C_1+C_2}$

b) Loss of energy

$$\frac{\frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 - \frac{1}{2}(C_1+C_2)V^2}{V_i} = \frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1+V_2)^2$$

where $V = \frac{C_1V_1+C_2V_2}{C_1+C_2}$

charge



$Q = Q_1 + Q_2$ (conserved)

$$\frac{Q_1}{Q_2} = \frac{C_1V}{C_2V} = \frac{4\pi\epsilon_0 r_1}{4\pi\epsilon_0 r_2} = \frac{r_1}{r_2}$$

गिरिजा इसीलाई

$$1 + \frac{Q_1}{Q_2} = 1 + \frac{r_1}{r_2}$$

$$\frac{Q_1+Q_2}{Q_2} = \frac{r_1+r_2}{r_2}$$

$$Q_2 = Q \left[\frac{r_2}{r_1+r_2} \right]$$

$$Q_1 = Q \left[\frac{r_1}{r_1+r_2} \right]$$

Capacitance of spherical condenser:

a) Capacitance of single isolated sphere $= 4\pi\epsilon_0 R$, where R is its radius.

b) In two concentric spheres (outer radius a and inner radius b).

i) When the inner is charged and the outer is earthed, then

$$C = \frac{4\pi\epsilon_0 \epsilon_r ab}{a-b} = 4\pi\epsilon_0 \cdot \frac{Kab}{(a-b)}$$

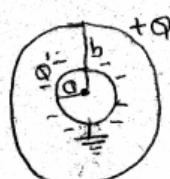
dielectric area

S.I. एवं C.G.S में $4\pi\epsilon_0$ का अर्थ है।

$\therefore C = \frac{ab}{b-a}$

ii) When the inner sphere is earthed, then

$$C = \frac{4\pi\epsilon_0 \epsilon_r a^2}{a-b} = \frac{4\pi\epsilon_0 Ka^2}{a-b}$$



जो उनकी दबावाली outer की $+Q$ ताक्ष बनायी जाए।
तो (\rightarrow) उद्या inner की दबावाली भी बढ़ती रहती है।
inner की earthing करता हो तो याक्ष बढ़ता है।

जो Q' की inner charged की magnitude

$$\text{तो } Q' = -\frac{a}{b}Q, C' = 4\pi\epsilon_0 \frac{b^2}{b-a}$$

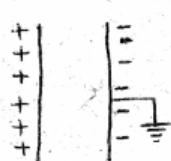
अहीं Q' कीले गैराचाही नहीं कि कि inner ताक्ष बढ़ायी तो outer की GE की charge की

\therefore Radius बढ़ायी

$$b \quad Q \quad \frac{a}{b} \quad Q = \text{conserved}$$

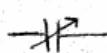
जोकी capacitance outer $\rightarrow +Q$ inner $\rightarrow Q'$ ताक्ष बढ़ाया जाए (इ)

Capacitor



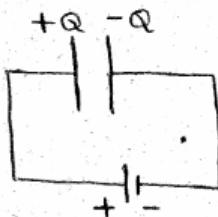
→ લેટોન્ડ [કોઈપણ શૈખ કે size] ની પાછો
→ સૈંકદારીની નિયમ રખાય જાને અને એવા અને
opposite charge રહાયે.

Symbol



આ Variable Capacitor નીંમાં જુદીયાત કુઝાં
Capacity આ. ક્રીકાર હાં.

Charging

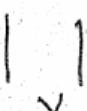


કુંપેસીટર સાચે બેઠો બીજો તૈની charge
કરી રહાય.

બેઠોના + સાઈડ સાચે હેચેર બૈટરીન તે +
બેઠોના - સાઈડ સાચે હેચેર બૈટરીન તે -

⇒ Capacitor ખેંકવાનું charge હયા પછી બેઠો
પછાં ખરજી અથ. વ્યારી

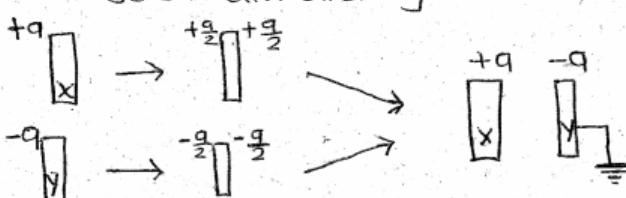
ચેરેચેરીની Potential Difference = બેઠોના બિની છોડિ
વર્ગી Potential Difference



Charge on Capacitor

→ સામાન્ય રીતે $\frac{1}{2} \times \frac{1}{2}$ Capacitor ની Net charge = 0

પછાં એવા chapter ની આ } \rightarrow તો magnitude of charge in
charge of each plate } each plate.

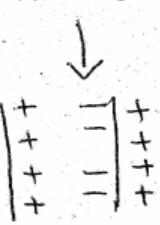
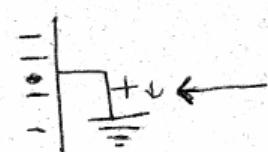


⇒ કઈ રીતે capacitor અને

A વાલી + વાંડ રહેયે
 ધારી વ્યુકર રહેયાયા,

B + + + +

earthing
દળા \oplus charge
જીવનમાં ઉત્તરીધાન



35. Dielectric materials, Polar and non polar molecules :

a) *Dielectric material* : Any material that do not allow the electrical charges to easily pass through them is called insulator or dielectric material or simply a dielectric.

Dielectric is a technical term for an insulator.

b) Non-polar molecule :

i) In certain kind of materials, ordinarily the molecules will have symmetric charge distributions.

ii) Such kind of molecules are called non-polar molecules.

iii) In the absence of any external electric field, a non-polar molecule will have its centre of positive charge coinciding with centre of negative charge. (*It has no net dipole moment*)

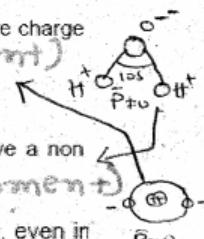
c) Polar molecule :

i) Certain dielectrics like water, hydrochloride and alcohol are made of molecules that have a non uniform distribution of electric charge. (*It has some net dipole moment*)

ii) In such molecules, the positive charge centre will not coincide with the negative charge centre, even in the absence of any external field.

iii) The molecules are polarized even in the absence of any external electric field.

iv) Such kind of molecules are called Polar molecules.



This concept

~~We think → generally non conducting material = Dielectric~~

X

~~Incorrect
Wrong~~

True → non conducting material } = Dielectric ✓
having non polar molecules }

Parallel plate Capacitor :

અને કોઈ લિંગની નાચક રીતાં કરીની
equal અને opposite charge એવાં.

- i) Condenser (usually, a combination of two conductors) is a device by means of which larger amount of charge can be stored at a given potential by increasing its electric capacity.
- ii) Capacitance of a capacitor or condenser is the ratio of the charge on either of its plates to the potential difference between them.

iii) Capacity of a parallel plate condenser without medium between the plates $C_0 = \frac{\epsilon_0 A}{d}$

A = area of each plate ; d = distance between the plates

$$C = \frac{Q}{V} = \frac{\sigma \cdot A}{E \cdot d}$$

$$= \frac{\sigma \cdot A}{\left(\frac{\sigma}{\epsilon_0}\right) d}$$

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

iv) With a medium of dielectric constant K completely filling the space between the plates $C = K \frac{\epsilon_0 A}{d}$

v) The dielectric constant of a dielectric material is defined as the ratio of the capacity of the parallel plate condenser with the dielectric between the plates to its capacity with air or vacuum between the plates.

$$K = \frac{C}{C_0} = \frac{\text{Capacity of the condenser with dielectric medium between plates}}{\text{Capacity of the same condenser with air as medium between plates}}$$

$$C' = KC \quad C' = \frac{Q}{V} = \frac{Q}{V/K} = K \frac{Q}{V} = KC$$

vi) When a dielectric slab of thickness 't' is introduced between the plates $C = \frac{\epsilon_0 A}{d-t+\frac{t}{k}} = \frac{\epsilon_0 A}{d-t(1-\frac{1}{k})}$

vii) In this case the distance of separation decreases by $t(1-\frac{1}{k})$ and hence the capacity increases

viii) To restore the capacity to original value the distance of separation is to be increased by $t(1-\frac{1}{k})$

ix) a) If a metal slab of thickness t is introduced between the plates $C = \frac{\epsilon_0 A}{d-t}$ because for metals K is infinity.

b) If a number of dielectric slabs are inserted between the plates, each parallel to plate surface, then equivalent capacity. $C = \frac{\epsilon_0 A}{d-t_1\left(1-\frac{1}{K_1}\right)-t_2\left(1-\frac{1}{K_2}\right)-\dots-t_n\left(1-\frac{1}{K_n}\right)} = \frac{\epsilon_0 A}{d-(t_1+t_2+\dots)+\left(\frac{t_1}{K_1}+\frac{t_2}{K_2}+\dots\right)}$

If those slabs completely fill up the gap between the plates leaving without any air gap,

$$C = \frac{\frac{t_1}{K_1} + \frac{t_2}{K_2} + \dots + \frac{t_n}{K_n}}{d}$$

x) In a parallel plate capacitor, the electric field at the edges is not uniform and that field is called as the fringing field.

$$E_{1/2}$$

xi) Electric field between the plates is uniform electric intensity $E = \frac{\sigma}{\epsilon_0} = \frac{Q}{A\epsilon_0} = \frac{Q}{Cd}$ Here σ is the surface charge density on the plates = Q/A .

$$C = \frac{AE_0}{d} \text{ unit}$$

xii) Potential difference between the plates $V = E.d = \frac{\sigma}{\epsilon_0} \cdot d$

xiii) Force on each plate $F = \frac{1}{2} EQ = \frac{1}{2} \frac{Q^2}{2 Cd} = \frac{1}{2} \frac{CV^2}{d} = \frac{1}{2} \frac{Q^2}{2 \epsilon_0 A} = \frac{1}{2} \frac{A\epsilon_0 E^2}{2}$

$$C = \frac{Q}{V} = \frac{AE_0}{d}$$

$$\frac{Q}{E \cdot d} = \frac{AE_0}{d}$$

$$Q^2 = A^2 \epsilon_0 E^2 \cdot E^2$$

xiv) Energy stored per unit volume of the medium = $\frac{1}{2} \epsilon_0 E^2$
= Energy Density

$$\begin{aligned} \text{Energy Density} &= \frac{\text{Energy}}{\text{Volume}} = \frac{\frac{1}{2} CV^2}{A \cdot d} = \frac{\frac{1}{2} \left[\frac{AE_0}{d} \right] V^2}{A \cdot d} \\ &= \frac{1}{2} \epsilon_0 \left(\frac{V}{d} \right)^2 \\ &= \frac{1}{2} \epsilon_0 E^2 \end{aligned}$$

For Parallel Plate Capacitor

$$C = \frac{\epsilon_0 A}{d} \quad \text{S.I. એટી એજ}$$

C.G.S એ ક એ આવે અતિલાં તો $\frac{1}{4\pi\epsilon_0}$ એ વાપરા.

અણી એક ϵ_0 એ. તો ઉપરનીં 4π બુઝાતા.

$$C = \frac{4\pi\epsilon_0 A}{4\pi d}$$

$$\boxed{C = \frac{A}{4\pi d}}$$

For Dielectric

If Dielectric is
filled between
Capacitor

Capacitance ↑ But Potential ↓
as ($C = \frac{Q}{V}$)

એની પહોંચાયી કે માત્રામાં સાચી
separation increase સાચી નાં ($t+d'$)

$$\therefore \frac{\epsilon_0 A}{(d+t+\frac{t}{K})} = C = \frac{\epsilon_0 A}{d}$$

which gives

$$\boxed{K = \frac{t}{t-d'}}$$

43. Introduction of dielectric in a charged capacitor

A dielectric slab (K) is introduced between the plates of the capacitor.

S no	Physical quantity	With battery permanently connected	With battery disconnected
1.	Capacity	K time increases.	K times increases
2.	Charge	K times increases	Remains constant
3.	P.D.	Remains constant	K times decreases
4.	Electric intensity	Remains constant	K times decreases
5.	Energy stored in condenser	K times increases	K times decreases

→ When not provide anything
assume that battery is
disconnected

Combination of Condensers Or Grouping of Capacitors

Series: When condensers are connected in series

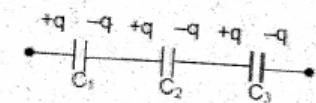
- Grouping**
- 1) All plates have the same charge in magnitude
 - 2) Potential differences between the plates are different
 - 3) $V_1 : V_2 : V_3 = \frac{1}{C_1} : \frac{1}{C_2} : \frac{1}{C_3}$
 - 4) Equivalent capacity is C then,

$$V_1 = V \left(\frac{C_1}{C_1 + C_2 + C_3} \right)$$

5) The equivalent capacity is less than the least individual capacity

$$6) \text{ Energies of the condensers } E_1 : E_2 : E_3 = \frac{1}{C_1} : \frac{1}{C_2} : \frac{1}{C_3}$$

$$7) \text{ Total energy of the combination} = E_1 + E_2 + E_3.$$



$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$V_1 = V \left(\frac{C_1}{C_1 + C_2 + C_3} \right)$$

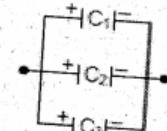
$$V_2 = V \left(\frac{C_2}{C_1 + C_2 + C_3} \right)$$

for two capacitor
C1 & C2 द्वारा योगीय कूल

Charge Same ॥

Parallel ii) When condensers are connected in parallel

- Grouping**
- 1) P.D. across each condenser is same
 - 2) Charge of each condenser is different $Q_1 : Q_2 : Q_3 = C_1 : C_2 : C_3$
 - 3) Equivalent capacity of the combination $C_{\text{eq}} = C_1 + C_2 + C_3$
 - 4) The equivalent capacity is greater than the greatest individual capacity
 - 5) Energies of the condensers $E_1 : E_2 : E_3 = C_1 : C_2 : C_3$
 - 6) Total energy of the combination $= E_1 + E_2 + E_3$



Potential
Same ॥

$$Q_1 = Q \left(\frac{C_1}{C_1 + C_2} \right)$$

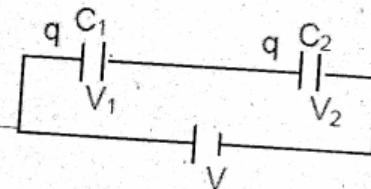
$$Q_2 = Q \left(\frac{C_2}{C_1 + C_2} \right)$$

for two capacitor
C1 & C2 द्वारा योगीय कूल

iii) When n identical condensers each of capacity C .

- 1) Combined in series, the effective capacity $\rightarrow V' = V/n$
 $= C_s = C/n$
- 2) Combined in parallel, the effective capacity $C_p = nc$. $\rightarrow Q' = Q/n$
- 3) Ratio of the effective capacities $C_s : C_p = 1 : n^2$
- iv) **Mixed group**: If there are N capacitors each rated at capacity C and voltage V , by combining those we can obtain effective capacity rated at C' and voltage V' . For this n capacitors are connected in a row and m such rows are connected in parallel.

$$\text{Then } n = \frac{V'}{V} \text{ and } m = \frac{nC'}{C} \text{ where } mn = N$$



→ In Series combination

Equivalent capacitor is always lesser than any individual capacitor

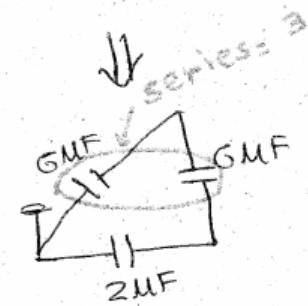
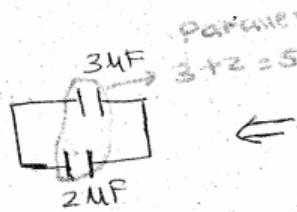
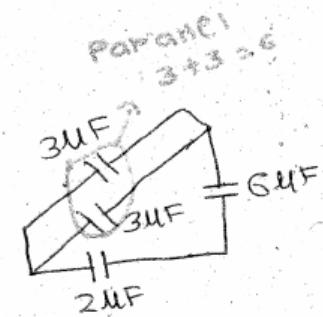
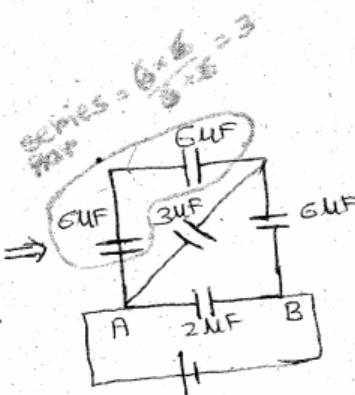
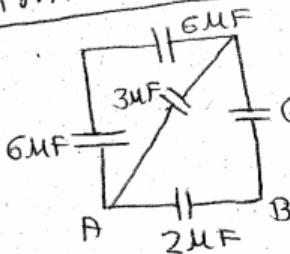
→ In Parallel combination

Equivalent capacitor is always greater than any individual capacitor

Network Solving

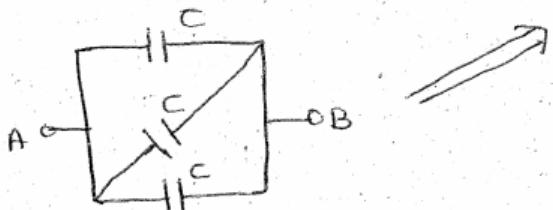
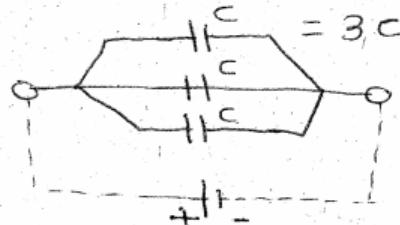
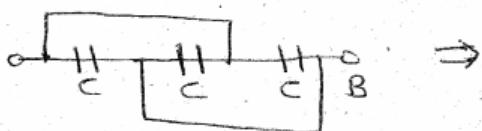
- ① Identify two points across which equivalent capacitance is to be calculated.
- ② Connect [Imagine] battery between this point.
- ③ Solve the network w.r.t Point A & Point B

Simple circuit



Circuit with extra wire

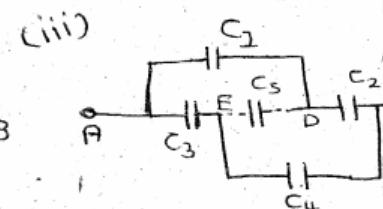
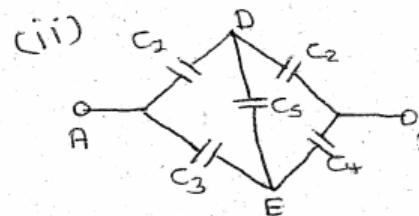
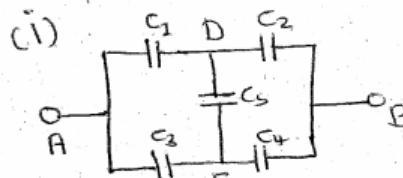
→ यदि नहीं दिया गया कोई विभिन्न कapacitor X
∴ उसकी दो Points की Same Potential



③ Wheatstone bridge based circuit.

→ નીચેની ગેલી circuit એવી Wheatstone bridge ની છે. એવી તૈયાર કરવાની

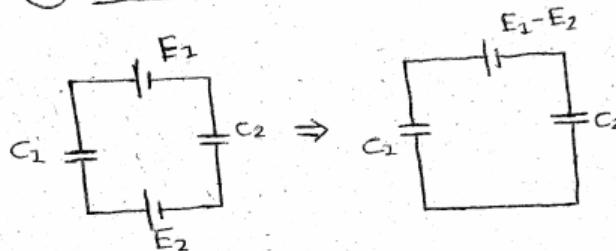
C_5 Remove કરું અને આટી $\frac{C_1}{C_2} = \frac{C_3}{C_4}$ રહું.



ગેલીની સોલે કરતી F1 F2 || |

$$C_{AB} = \frac{C_1 C_2}{C_1 + C_2} + \frac{C_3 C_4}{C_3 + C_4}$$

④ Network with more than one cell

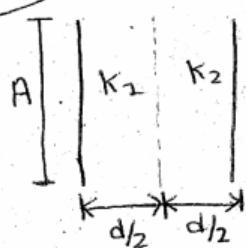


$$C_1 = (E_1 - E_2) \left(\frac{C_2}{C_1 + C_2} \right)$$

$$C_2 = (E_2 - E_1) \left(\frac{C_1}{C_1 + C_2} \right)$$

→ સુધીના અંતના dielectric અંતના રૂલના રીતે

Parallel Plate Capacitor દરેકી મુક્કામા આવે.

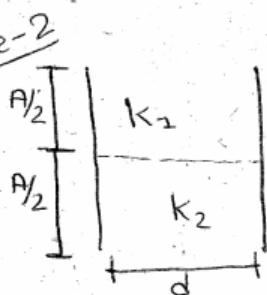


$$C_1 = \frac{K_1 \epsilon_0 A}{d/2}, \quad C_2 = \frac{K_2 \epsilon_0 A}{d/2}$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\Rightarrow C_{eq} = \left(\frac{2 K_1 K_2}{K_1 + K_2} \right) \frac{\epsilon_0 A}{d}$$

↓
Keq.

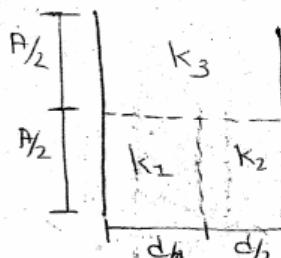


$$C_1 = \frac{K_1 \epsilon_0 A}{2d}, \quad C_2 = \frac{K_2 \epsilon_0 A}{2d}$$

$$C_{eq} = C_1 + C_2$$

$$\Rightarrow C_{eq} = \left(\frac{K_1 + K_2}{2} \right) \frac{\epsilon_0 A}{d}$$

↓
Keq.



$$C_1 = \frac{K_1 \epsilon_0 \frac{A}{2}}{d/2} = \frac{K_1 \epsilon_0 A}{d}$$

$$C_2 = \frac{K_2 \epsilon_0 \frac{A}{2}}{d/2} = \frac{K_2 \epsilon_0 A}{d}$$

$$C_3 = \frac{K_3 \epsilon_0 \frac{A}{2}}{d} = \frac{K_3 \epsilon_0 A}{2d}$$

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} + C_3 = \left(\frac{K_3}{2} + \frac{K_1 K_2}{K_1 + K_2} \right) \frac{\epsilon_0 A}{d}$$

↓
Keq.

v) If C_p and C_s are the equivalent capacities of two capacitors of capacity C_1 and C_2 in parallel and series respectively then

$$C_p = \frac{1}{2} [C_1 + C_2 + \sqrt{C_1^2 + 4C_1C_2}] \text{ and}$$

$$C_s = \frac{1}{2} [C_1 - \sqrt{C_1^2 - 4C_1C_2}] .$$

vi) Two capacitors are connected in parallel to a battery as shown in the figure.

$$\text{i)} V_1 = \frac{VC_1}{C_1 + C_2} \quad \text{ii)} V_2 = \frac{VC_2}{C_1 + C_2}$$

vii) Two capacitors are connected in parallel to a battery as shown in the figure.

$$\text{i)} q_1 = \frac{qC_1}{C_1 + C_2} \quad \text{ii)} q_2 = \frac{qC_2}{C_1 + C_2}$$

viii) If n identical capacitors each of capacity C are connected in a square then

a) The resultant capacity between any two adjacent corners A and B = $\frac{4C}{3}$

b) The resultant capacity between any two opposite corners A and C = C

ix) If n identical capacitors each of capacity C are connected in a polygon then

a) The resultant capacity between any two adjacent corners = $\frac{nC}{n-1}$

b) The resultant capacity between any two opposite corners = $\frac{4C}{n}$

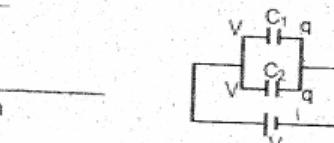
x) a) If n identical capacitors are given then they can be connected in 2^{n-1} different ways by taking all the condensers at a time ($n > 2$).

b) In n different capacitors are given then they can be connected in 2^n different ways by taking all the condensers at a time.

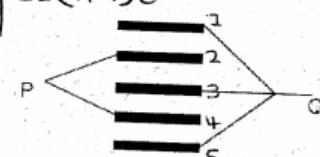
xi) In a parallel plate capacitor, if n similar plates at equal distance d are arranged such that alternate plates are connected together, the capacitance (C) of the arrangement is $\frac{(n-1)\epsilon_0 A}{d} | C' = (n-1)C$

for air or vacuum and it becomes $\frac{(n-1)\epsilon_0 A K}{d}$ in a dielectric medium of dielectric constant K .

For Dielectric medium



奇数 $\rightarrow 1, 3, 5, 7, \dots$
偶数 $\rightarrow 2, 4, 6, 8, \dots$



44. The distance between the plates of condenser is increased by n times.

S n o.	Physical quantity	With battery permanently connected	With battery disconnected
1.	Capacity	n time decreases	n times decreases
2.	Charge	n times decreases	Remains constant
3.	P.D.	Remains constant	n times increases
4.	Electric Intensity	n time decreases	Remain constant
5.	Energy stored in condenser	n times decreases	n times increases

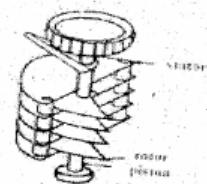
Types of condensers :

Capacitance of a variable capacitor can be varied gradually by varying the effective area included between the plates.

- a) Variable condenser, multiple condenser, paper condenser, electrolytic condenser etc. are the different types of condensers.

b) Variable capacitor :

- i) In variable capacitor, there are two sets of plates generally made of brass or aluminium.
- ii) One set of plates is static or fixed and is known as stator.
- iii) The other set of plates which rotates over the stator by rotating the pistons called rotor.
- iv) This capacitor is generally used in tuning circuits in radio and T.V. receivers.



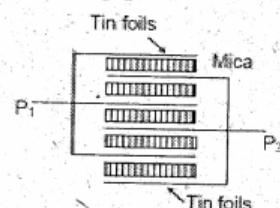
- v) Symbol of variable Capacitor is

સર્કારી કાર્પોરેશન દ્વારા પ્રદાન
કરીથાયાં
Capacity all



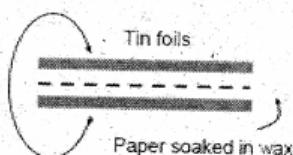
c) Multiple capacitor :

- i) In a multiple capacitor there are a number of parallel plates with mica sheets as dielectric between them.
- ii) The capacitance is n times the capacitance between any two plates where $n =$ number of mica sheets.
- iii) These are used in high frequency oscillating circuits as dielectric constant of mica does not change with temperature.
- vi) These are used as standard Capacitors in laboratory.



d) Paper capacitor :

- i) In a paper capacitor, paper soaked in wax or oil acts as a dielectric.
- ii) Plates are usually tin foils. It can be rolled and sealed in a cylinder.
- iii) These days to increase stability, paper is replaced by polystyrene.
- vi) These occupy small space and cheaper in cost.
- v) These are used in radio circuits and laboratories



e) Electrolytic capacitor :

- i) An electrolytic capacitor has two aluminium plates which are placed in a solution of ammonium borate.
- ii) When D.C. is passed through the capacitor, very thin film of aluminium oxide is formed on the anode plate.
- iii) The thickness of the oxide layer is of the order of 10^{-6} cm.

- iv) Oxide layer acts as the dielectric between the plates.

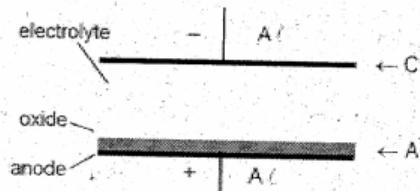
- v) This should be connected to proper polarity in a circuit

- vi) In this capacitor polarity of terminals will be indicated

- vii) Widely used when high capacitances are required.

- viii) Capacitor of the order of $10^3 \mu\text{F}$

- ix) Can be obtained with small volumes



1 ab-farad = 10^9 farad,

1 farad = 9×10^{11} stat-farad,

1 coulomb = 3×10^9 stat-coulomb,

1 ab-coulomb = 10 coulomb,

1 stat-volt = 300 volt,

1 volt = 10^8 ab-volt.