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NAAC Re-Accredited 'A' Grade (CGPA 3.20)

DIELECTRIC CONSTANT

A project report submitted in partial fulfilment of the

Requirement for the degree

T.Y.B.Sc. (Physics)

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By

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CERTIFICATE

Seat No:

This is to certify that the project entitled ***Dielectric Constant.*** submitted by **Mandar Jitendra Nagarale** for award of T.Y.B.Sc. degree in Physics of Savitribai Phule Pune University, Pune. Authentic work carried out by his under by supervision and guidance. He has satisfactorily completed project work.

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Acknowledgement

In the accomplishment of this project successfully, many people have best owned upon me their blessing and the heart pledged support, this time I am utilizing to thank all the people who have been concerned with this project.

I would like to thank our head of department **Dr. P.G. LOKE** (Department of Physics, K.S.K.W. College Nashik) whose valuable guidance has been the ones that helped me patch this project and make it full proof success. Her suggestions and her instructions have served as the major contributor towards the completion of the project.

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Mandar Jitendra Nagarale

TY BSc (Physics)

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Abstract:

The dielectric constant of a material is one of the characteristic and unique feature in the field of electricity & magnetism. Determination of dielectric constant of a solid involves the measurement of capacitance of the capacitor with dielectric material, if one knows the physical dimensions

The simpler and easier to measure the dimensions of a capacitor is that of a parallel plate capacitor. Here, in this project we have tried to measure the permittivity of free space and the dielectric constants of various materials, using a parallel plate capacitor that was constructed by using commercially available aluminium / copper sheets which acts as conducting plates.

CHAPTER 1- INTRODUCTION

1.1 DIELECTRICS

In this chapter we shall study electric fields in matter. Matter, of course comes in many varieties-solids ,liquids ,gases ,metals ,woods ,glasses-and these substances do not all respond.

In the same way to electrostatic fields. Nevertheless most everyday objects belong (at least,in good approximation) to one two large classes: **conductors** and **insulators(**or **dielectrics).**We have already talked about conductor; these are substances that contain an "unlimited" supply of charges that are free to move about through the material. In practice what his ordinarily means is that many of the electrons (one or two per atom in a typical metal) are not associated.

A **dielectric** is the electrically insulating material between the metallic plates of a capacitor. An effective dielectric typically contains polar molecules that reorient in external electric field. This **dielectric polarization** increases the capacitor's capacitance. Generalizing this, any insulating substance can be called a **dielectric**. While the term "insulator" refers to a low degree of electrical conduction, the term "dielectric" is typically used to describe materials with a high polarization density.Generalizing further, **dielectrics**, the study of **dielectric properties**, is concerned with the storage and dissipation of electric and magnetic energy in materials.

1.1.1 Linear Dielectrics:

We know that the polarization of a dielectric ordinarily results from an electric field, which lines up the atomic or molecular dipoles. For many substances, in fact the polarization is *proportional* to the field, provided **E** is not too strong:

$$\mathbf{P}= e_0 X_e \mathbf{E}$$

The constant of proportionality , X_e, is called the **electric susceptibility** of the medium (a factor of e_0 has been extracted to make X_e dimensionless).

In linear media we have

$$\mathbf{D}= \mathbf{e_0 E}+\mathbf{P} = \mathbf{e_0 E}+e_0 X_e \mathbf{E}= e_0(1+Xe)\mathbf{E}$$

So **D** is also proportional to **E:**

$$\mathbf{D = eE,}$$

where

$$e = e_0(1+Xe)$$

This new constant e is called the **permittivity** of the material. In vaccum, there is no matter to polarize, the susceptibility is zero, and the permittivity is e_0. That's why e_0 is called the **permittivity of free space.** In which the permittivity happens to have the value **8.85** x $\mathbf{10^{-12}}$ $\mathbf{C^2/N.m^2}$ .If you remove a factor of e_0 , the remaining dimensionless quantity

$$e_r = 1+Xe=e/e_0$$

is called the **relative permittivity,** or **dielectric constant,** of the material.

1.2 DIELECTRIC CONSTANT

How effective a dielectric is at allowing a capacitor to store more charges depends on the material the dielectric is made from? Every material has a dielectric constant κ. This is the ratio of the field without the dielectric (E_o) to the net field (E) with the dielectric: $\mathbf{k = E_o/E}$

E is always less than or equal to E_o, so the dielectric constant is greater than or equal to 1. The larger the dielectric constant, the more charge can be stored.

Completely filling the space between capacitor plates with a dielectric increases the capacitance by a factor of the dielectric constant:

$$\mathbf{C = k\, C_o,}$$

Where C_o is the capacitance with no dielectric between the plates

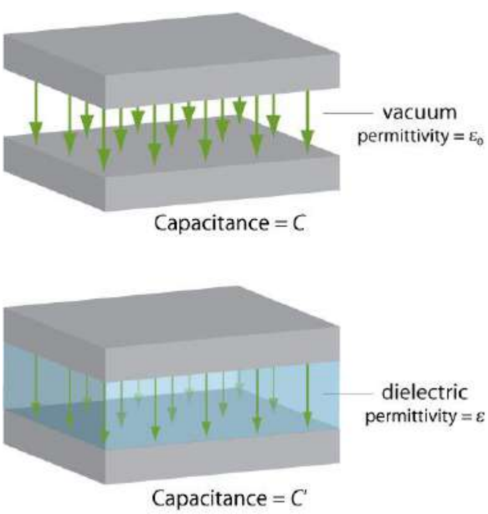
For a parallel-plate capacitor containing a dielectric that completely fills the space between the plates, the capacitance is given by:

$$\mathbf{C = k\, e_o\, A / d}$$

The capacitance is maximized if the dielectric constant is maximized, and the capacitor plates have large area and are placed as close together as possible.

Material	Dielectric constant	Dielectric Strength (KV/mm)
Vacuum	1.00000	-
Air (dry)	1.00059	3
Polystyrene	2.6	24
Paper	3.6	16
Water	80	-

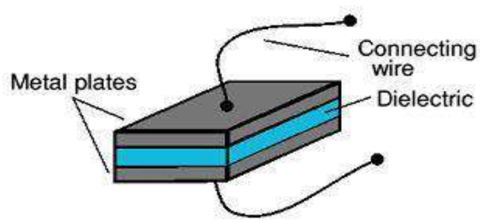
Dielectrics have the strange property of making space seem bigger or smaller than it looks. The dielectric constant value tells you how much smaller or bigger the space gets. It shows itself in two ways.



$$\kappa = C'/C \qquad \kappa = \varepsilon/\varepsilon_0$$

1.2.1 Dielectric Capacitor

A dielectric capacitor consists of two metal sheets placed on either side of a layer of dielectric material. Dielectrics are materials like glass or plastics (polymers) which are insulators. The behavior of a dielectric is determined by its dielectric constant value.



Dielectric capacitor

Most text books quote the formula shown here to link the value of a capacitor to its plate area (the size of the plate surfaces facing each other), the distance between the plates, and the dielectric constant of the material used. Alas, this simple formula is only approximately correct! Capacitors are designed in a number of different ways.

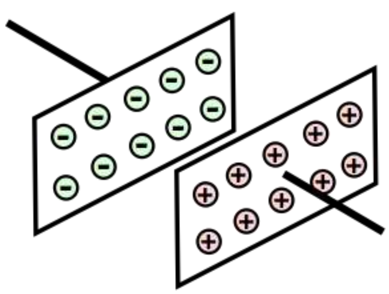
C = Capacitance

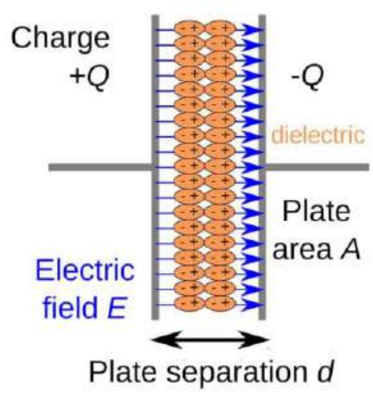
$$C = \frac{\varepsilon A}{d}$$

A = Area of plates

d = Plate spacing (thickness of dielectric)

ε = Dielectric constant





1.3.DIELECTRIC MATERIALS

Materials which are electrical insulators or in which an electric field can be sustained with a minimal dissipation of power. Dielectrics are employed as insulation for wires, cables, and electrical equipment, as polarizable media for capacitors, in apparatus used for the propagation or reflection of electromagnetic waves, and for a variety of artifacts, such as rectifiers and semiconductor devices, piezoelectric transducers, dielectric amplifiers, and memory elements.

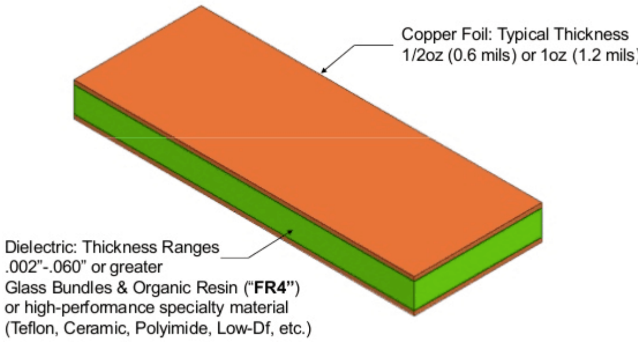
The term dielectric, though it may be used for all phases of matter, is usually applied to solids and liquids.

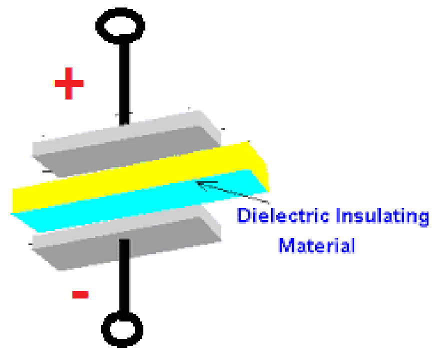
The ideal dielectric material does not exhibit electrical conductivity when an electric field is applied. In practice, all dielectrics do have some conductivity, which generally increases with increase in temperature and applied field. If the applied field is increased to some critical magnitude, the material abruptly becomes conducting, a large current flows (often accompanied by a visible spark), and local destruction occurs to an extent dependent upon the amount of energy which the source supplies to the low-conductivity path. However, synthetic polymers such as polyethylene, polypropylene, polystyrene, polytetrafluoroethylene, polyvinyl chloride, polymethyl methacrylate, polyamide, and polyimide have become important, as has polycarbonate because it can be fabricated into very thin films. Generally, polymers have crystalline and amorphous regions, increasing crystallinity causing increased density, hardness, and resistance to chemical attack, but often producing brittleness.

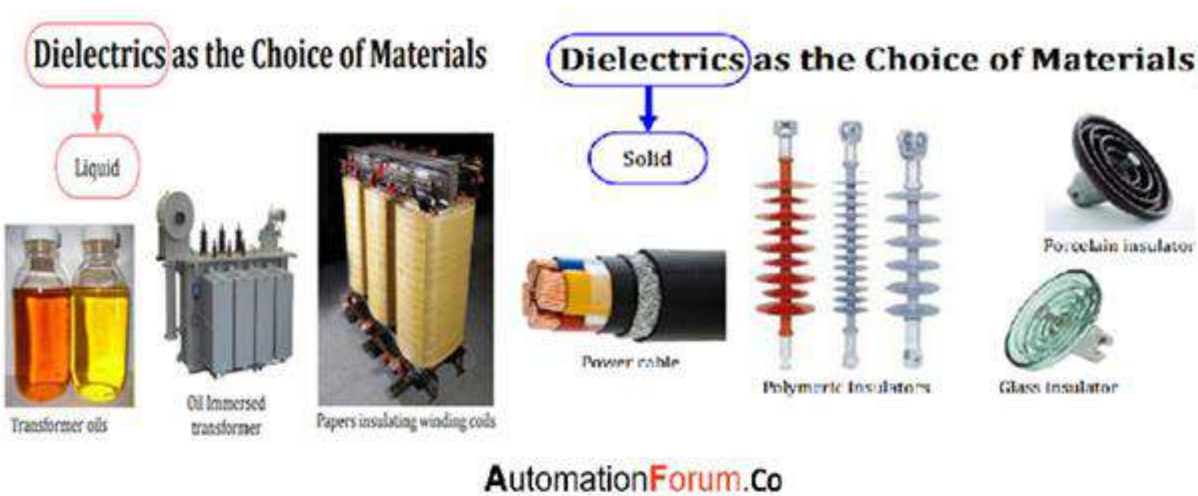
An important property of a dielectric is its ability to support an electrostatic field while dissipating minimal energy in the form of heat. The lower the *dielectric loss* (the proportion of energy lost as heat), the more effective is a dielectric material. Another consideration is the *dielectric constant*, the extent to which a substance concentrates the electrostatic lines of flux. Substances with a low dielectric constant include a perfect vacuum, dry air, and most pure, dry gases such as helium and nitrogen. Materials with moderate dielectric constants include ceramics, distilled water, paper, mica, polyethylene, and glass. Metal oxides, in general, have high dielectric constants.

If the voltage across a dielectric material becomes too great -- that is, if the electrostatic field becomes too intense -- the material will suddenly begin to conduct current. This phenomenon is called *dielectric breakdown*. In components that use gases or liquids as the dielectric medium, this condition reverses itself if the voltage decreases below the critical point. But in components containing solid dielectrics, dielectric breakdown usually results in permanent damage.

S. No.	**Materials**	**Minimum**	**Maximum**
1	**Bakelite**	**3**	**22**
2	**Teflon**	**2.0**	**2.8**
3	**Glass**	**3**	**10**
4	**Paper**	**1.5**	**3**
5	**Rubber**	**2.5**	**4.6**
6	**Polyethylene**	**2**	**4**


Copper Foil: Typical Thickness
1/2oz (0.6 mils) or 1oz (1.2 mils)
Dielectric: Thickness Ranges
.002"-.060" or greater
Glass Bundles & Organic Resin ("FR4")
or high-performance specialty material
(Teflon, Ceramic, Polyimide, Low-Df, etc.)


+
Dielectric Insulating
Material
-


Dielectrics as the Choice of Materials
Liquid
Transformer oils
Oil Immersed
transformer
Papers insulating winding coils
Dielectrics as the Choice of Materials
Solid
Power cable
Polymeric Insulators
Porcelain insulator
Glass insulator
AutomationForum.Co


Types of Dielectric Materials
• Dielectric materials can be divided into following groups:
– Solid Dielectrics - are of following types:
• Mica – is inorganic material and is crystalline in nature.
• Glass – is inorganic material made by fusion of different oxides.
• Rubber – is a organic polymer, which can be natural or artificial.
• Ceramic – is non-metallic organic compound such as silicates
Mica Dielectric
(A)
Glass Dielectric
Rubber Dielectric Sheet
Ceramic Dielectric
24 Nov '14
Mohdlimdi23 - Dielectrics
16


Properties of a Good Dielectric Material
• High resistivity to leakage current.
• High dielectric strength.
• High mechanical strength.
• High fire resistance.
• Low thermal expansion.
• Low dielectric loss.
• Low water absorption quality.
• High chemical inertness.

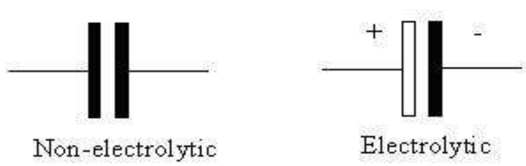
CHAPTER.2- CAPACITORS

2.1. CAPACITOR

A capacitor is a passive electronic component that stores energy in the form of an electrostatic field. In its simplest form, a capacitor consists of two conducting plates separated by an insulating material called the Dielectric. The capacitance is directly proportional to the surface areas of the plates, and is inversely proportional to the separation between the plates. Capacitance also depends on the dielectric constant of the substance separating the plates. The standard unit of capacitance is the Farad, abbreviated F. This is a large unit; more common units are the microfarad, abbreviated µF (1 µF =10-6F) and the Pico farad, abbreviated pF (1 pF = 10-12 F).

Large capacitors are used in the power supplies of electronic equipment of all types, including computers and their peripherals. In these systems, the capacitors smooth out the rectified utility AC, providing pure, battery-like DC. The capacitor is constructed with two electrode plates facing each other, but separated by an insulator. When DC voltage is applied to the capacitor, an electric charge is stored on each electrode. While the capacitor is charging up, current flows. The current will stop flowing when the capacitor has fully charged. The value of a capacitor (the capacitance), is designated in units called the Farad (F). The capacitance of a capacitor is generally very small, so units such as the microfarad (10^{-6}F), nanofarad (10^{-9}F), and picofarad (10^{-12}F) are used.

Recently, a new capacitor with very high capacitance has been developed. The Electric Double Layer capacitor has capacitance designated in Farad units. These are known as "Super Capacitors." **Capacitors** are short term charge-stores, a bit like an electrical spring. They are used widely in electronic circuits. It consists of two metal plates separated by a layer of insulating material called a **dielectric**. The symbol for a capacitor is shown below:

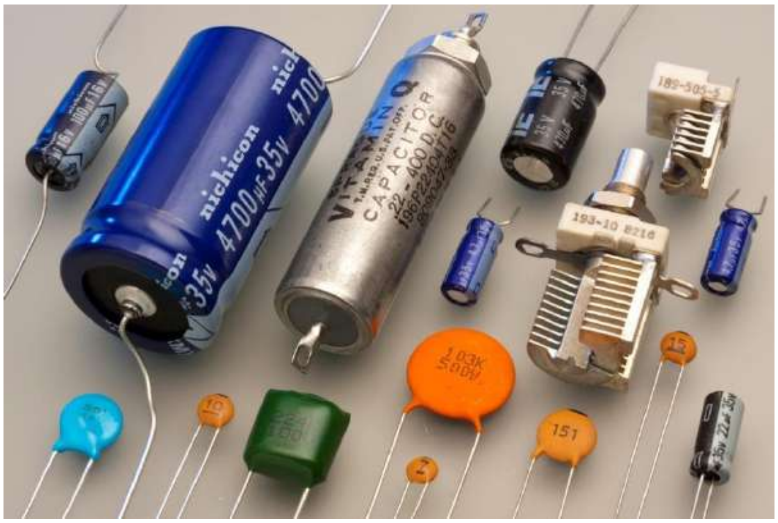


There are two types of capacitor, **electrolytic** and **non-electrolytic**. We won't worry at the moment what these terms mean, other than to say:

- Electrolytic capacitors hold much more charge;

- Electrolytic capacitors have to be connected with the correct polarity, otherwise they can explode.

If we pump electrons onto the negative plate, electrons are repelled from the negative plate. Since positives do not move, a positive charge is induced. The higher the potential difference, the more charge is crowded onto the negative plate and the more electrons repelled from the positive plate. Therefore charge is stored. The plates have a certain **capacitance**.



2.1.1. Capacitance

Capacitance (symbol C) is a measure of a capacitor's ability to store charge. A large capacitance means that more charge can be stored. However 1F is very large, so prefixes (multipliers) are used to show the smaller values:

- μ (micro) means 10^{-6} (millionth), so 1000000μF = 1F
- n (nano) means 10^{-9} (thousand-millionth), so 1000nF = 1μF
- p (pico) means 10^{-12} (million-millionth), so 1000pF = 1nF

Polarized capacitor symbol

Un polarized capacitor symbol

Capacitance is defined as the charge required to cause unit potential difference in a conductor.

Or

1 Farad is the capacitance of a conductor, which has potential difference of 1 volt when it carries a charge of 1 coulomb.

So we can write from this definition:

$$\text{Capacitance (F)} = \frac{\text{Charge (C)}}{\text{Voltage (V)}}$$

Capacitance is measured in units called **farads** (F).

Charge and Energy Stored

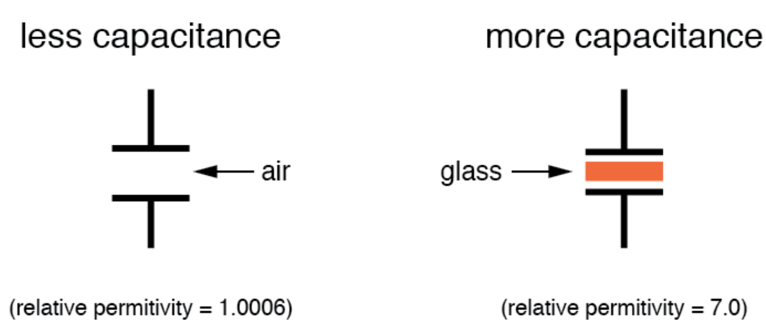
The amount of charge (symbol Q) stored by a capacitor is given by:

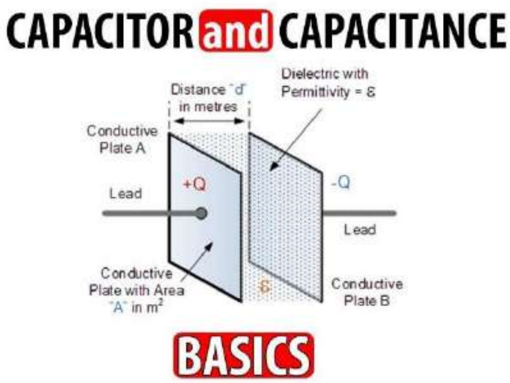
Charge, **Q = C × V**

Where: Q = charge in coulombs (C)
C = capacitance in farads (F)
V = voltage in volts (V)

When they store charge, capacitors are also storing energy:

Energy, **E = ½QV = ½CV²** where E = energy in joules (J).



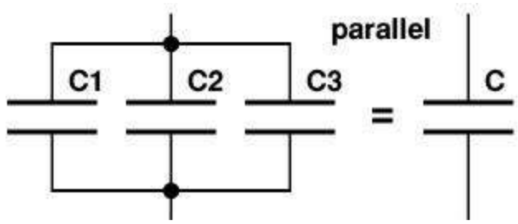


2.2 CAPACITORS IN PARALLEL

Capacitors in Parallel:

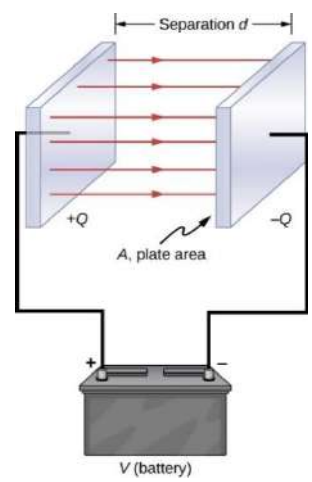
When capacitors are connected in parallel their value is added up. The reason is that the capacity is increased due to larger plate surface area. The formula for parallel capacitor is same as the resistance in series.

Combined capacitance (C) of capacitors when they are connected in parallel:



$C = C + C + C + ...1 \quad 2 \quad 3$

Two or more capacitors are rarely deliberately connected in series in real circuits, but it can be useful to connect capacitors in parallel to obtain a very large capacitance, for example to smooth a power supply.



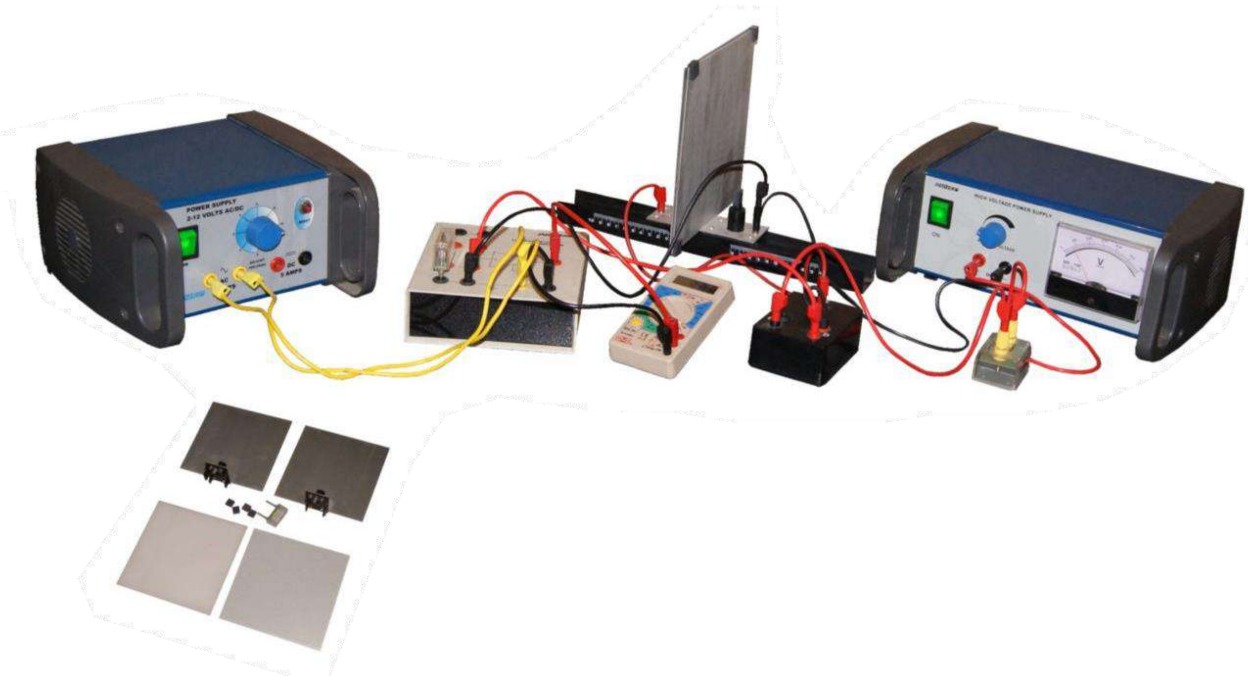
CHAPTER 3-EXPERIMENTAL SET UP

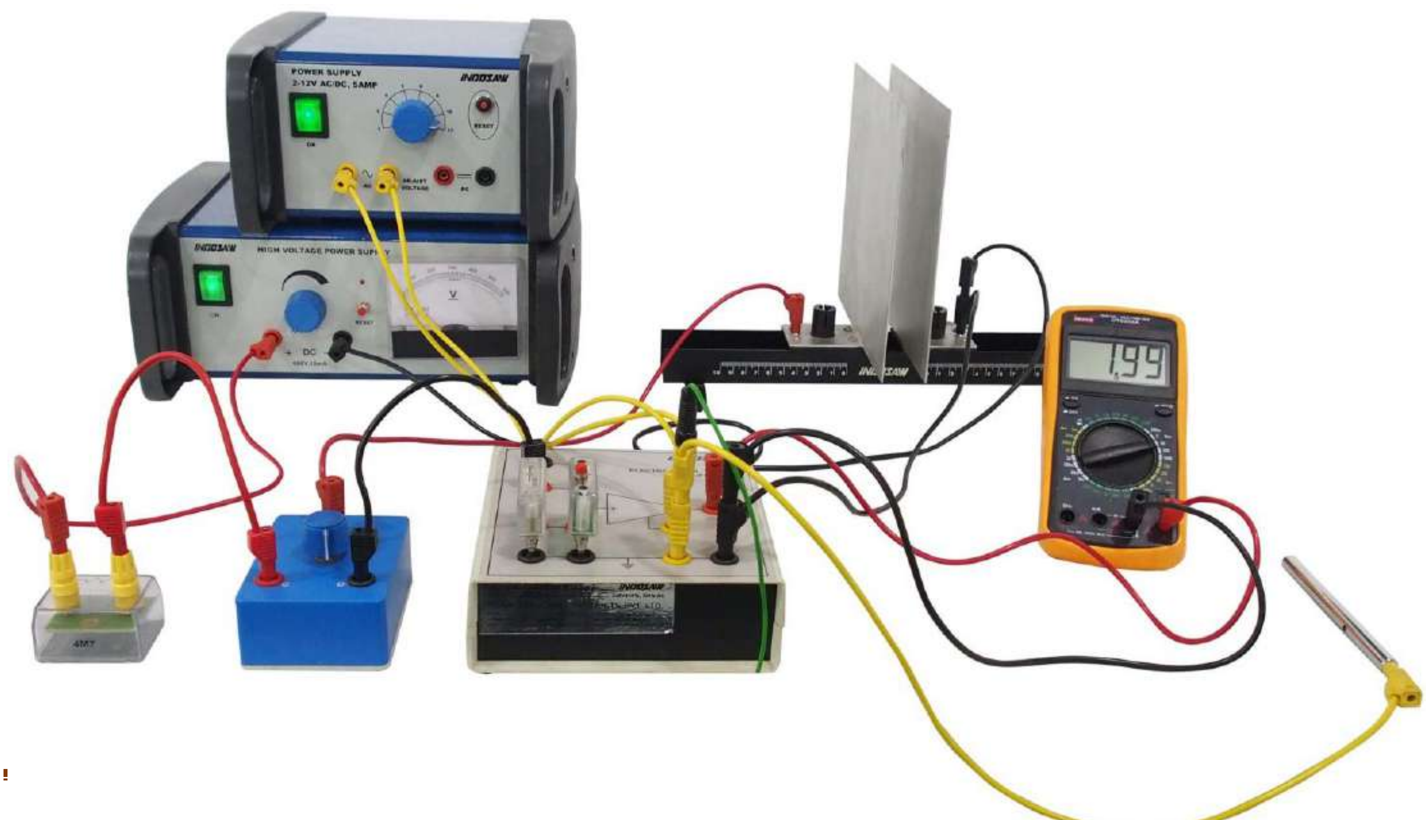
Project Name

DIELECTRIC CONSTANT

Determining the Capacitance of Plate Capacitor

(Measuring the charge with the Electrometer Amplifier)




POWER SUPPLY
2-12V AC/DC, 5AMP
1.99

!

Experiment Objectives/Aims:-

1. Measuring the charge Q on a plate capacitor as a function of the applied voltageE.
2. Determining the capacitance C as a function of areas A of plates.
3. Determining the capacitance C with different dielectrics between the plates.
4. Determining the capacitance C as a function of the distance d between the plates.

Apparatus:-

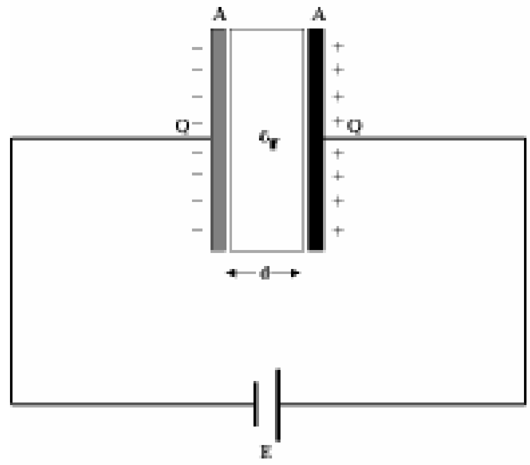
Item Name	**Qty**
Dielectric constant kit	1
Electrometer amplifier	1
Digital multimeter	1
Power supply (2-12 V AC/DC)	1
High voltage power supply (0-600V DC)	1
Flexible plug leads (50 cm), black	2
Flexible plug leads (50 cm), red	2
Earthing lead (100 cm), green	1
2 way switch	1
Capacitor module 0.01μF	1
Capacitor module 100nF	1
4.7 MΩ Resistance box	1
Flexible plug leads (25 cm), black	2
Flexible plug leads (25 cm), red	2
Flexible plug leads (50 cm), yellow	3
Flexible plug leads (100 cm), red & black	1

Working Principles:-

The relation between capacitance, charge and charging voltage is given as

$$C = Q / E \text{ ....(1)}$$

Where Q is charge on the capacitor & E ischarging voltage.
It is very clear from this expression that the capacitance of a plate capacitor depends on thearea A of the plates, the distance d between theplates and the non-conductive material betweenthe plates.
The capacitance of a parallel plate capacitor isgiven by the following formula:



$$C = \varepsilon_r \varepsilon_o \frac{A}{d} \quad \text{.....................} \quad (2)$$

Where, e = 8.85 x 10^{-12} As/Vm; permittivity of free space,
This formula is valid as long as the distance between the plates is much smaller than thedimensions of the plates and the field E between the plates is homogeneous. The permittivity e_r describes the change of the capacitance relatively to the vacuum value caused by the introduction of the material. The relation (2) is studied in the experiment by means of a demountable capacitor with variable geometrical dimensions. Capacitor plates with areas A = 400 cm^2 and A = 800 cm^2 are available. The distance d between theplates can be increased with spacers in steps on 1 mm. First the charge Q on the capacitor is measured as a function of the voltage E. The capacitance C is then determined as the slope of the straight line. In order to confirm the proportionality

$$C \propto A \quad \text{...................} \quad (3)$$

Which is derived from equation (2), the measurement is carried out at a fixed distance dwith different areas A of the plates. In addition, the permittivities () of two different dielectrics (polystyrene and glass) are determined by placing the dielectrics between thecapacitor plates. Variation of the distance d between the plates at a constant area A helps us confirm the proportionality

$$C \propto d \quad \ldots\ldots\ldots\ldots \quad (4)$$

The output charge is being measured by means of an electrometer amplifier, which isoperated as a coulomb meter. Any voltmeter may be used to display the output voltageV0. From the reference capacitance Cref

$$Q = Vo.Cref \quad \ldots\ldots\ldots\ldots \quad (5)$$

is obtained. For example, with Cref = 10nF and Vo = 1 volt we get the charge Q =10nAs.
The unit nAs is same as nC(nano-coulomb).

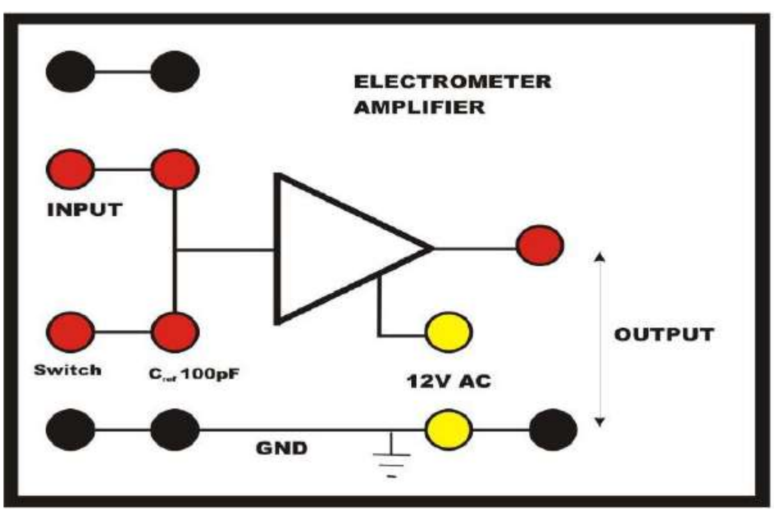
Electrical Circuit:-

The photoelectrons incident on the metal ring of the photocell charge a capacitor,generating the limit voltage U0 required for determining the kinetic energy. The electrometer amplifier is used to measure the voltage at the capacitor.

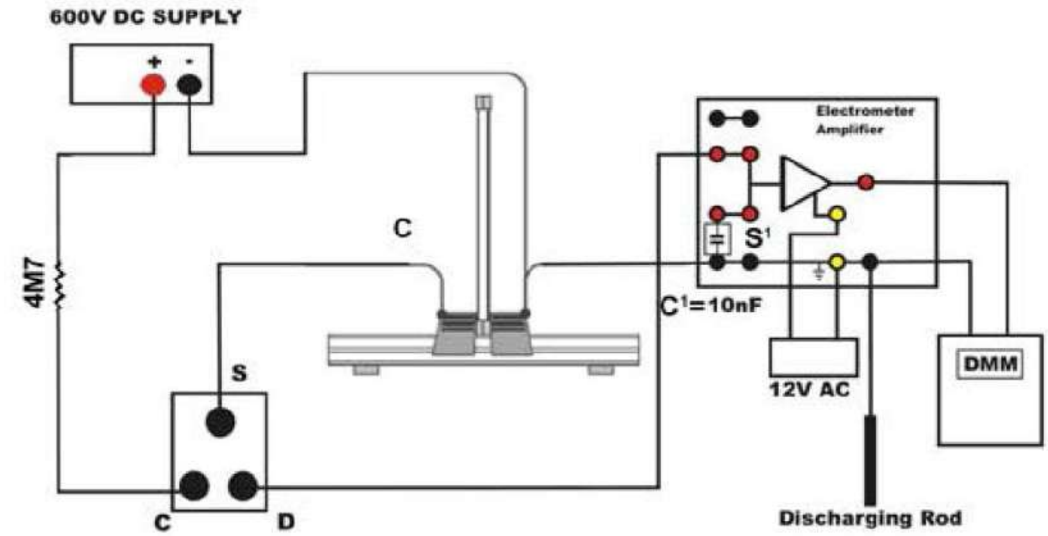
- Connect the 220 nF or 100 nF capacitor at Cref and the push switch at Switch.
- Connect photocell +ve & -ve terminal to input of electrometer amplifier ground.
- Connect the multimeter to the output of the electrometer amplifier.
- Connect the 0-12V AC power supply unit (12 V AC) to the electrometeramplifier via 100cm yellow leads.

Setup Procedure:-

The experimental setup is illustrated in fig.



Circuit Diagram:-



DIELECTRIC CONSTANT SETUPS

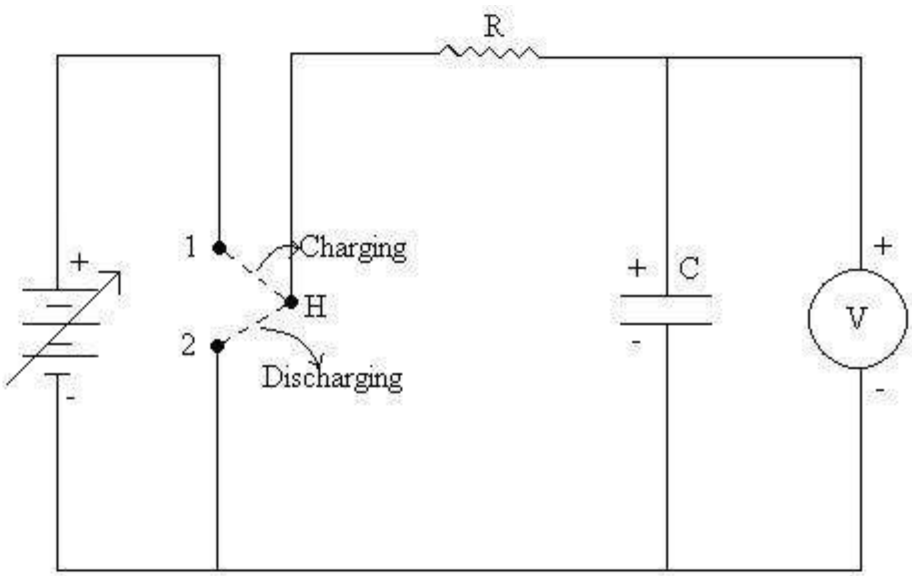


Figure 1

Mount the pair of small plates (A=400cm^2), and set the distance d between theplates to 4mm with the spacers

1. Connect the earthing of mains inlet socket with the earth terminal of theelectrometer amplifier.
2. Connect negative terminal of the dc power supply to the right plate and to theearth of the electrometer amplifier. Connect the connection

rod.

3. Connect the positive side of the power supply to the socket C (means chargingposition) of the two-way switch.
4. Connect socket S of the two-way switch to the left plate and socket D (i.edischarging position) to the input of the electrometer amplifier.
5. Connect the reference capacitor cref = 220nF at the electrometer amplifier imputterminals, and connect the digital multimeter to its output, set 20V DC position.
6. Connect the digital multimeter to 0-600V DC power supply and set 600V DCposition.
7. Connect 12V AC Power supply to electrometer amplifier.
8. Hold the discharging rod in your hand to get static charge, at each time whencharging & discharging processes.

Procedure / Carrying out the Experiment:-

A. CHARGE MEASUREMENT FOR DIFFERENT AREAS OF PLATES:

1. Establish the connection set (S) to discharging (D) position with the two-way switch; discharge the plate capacitor with the discharging rod check the zero at output.
2. Hold the discharging rod in your hand (to store the charge), change to the connectionset (S) to charging (C) position) with the two-way switch, and set the charging voltage Eto 50 V.
3. Change back to the connection S to D, measure the charge Q with the electrometeramplifier, and note down the charge reading displayed in multimeter & repeat the procedure of discharging to discharge the plate charge.

Note: During discharging measurement the output voltage of electrometer amplifier will very, therefore wait for 30-60sec to read out stable reading. Each measurement should betaken for same time interval.

4. Repeat the measurement with other voltages (E).
5. Replace the pair of small plates with the pair of large plates (A = 800 cm2, d = 4 mm) &repeat the steps no. 1 to 3 to record readings.
6. Establish the connection S to D, and discharge the capacitor with the connection rod.
7. Hold the connection rod in your hand, repeat the procedure of charging & discharging and record the series of measurements with different applied voltages using large plates(A = 800 cm2).

Table 1: the charge *Q* recorded as a function of the appliedvoltage *U* with different areas *A* of the plates:

$\frac{U}{V}$	$\frac{Q}{nAs}$ (A = 400 cm^2)	$\frac{Q}{nAs}$ (A = 800 cm^2)
50	5	10.5
100	10.5	20
150	16	30
200	21.5	41
250	26.5	51
300	33	59

B. CHARGE MEASUREMENT FOR DIFFERENT DIELECTRICS:

1. Place the polystyrene sheet between the pair of small plates, and take care about thesurfaces of plates are in complete touch with the sheet.
2. Establish the connection S to D in the two-way switch, and discharge the capacitor withthe connection rod. Change back the connection to the S to C to charge to charge the plates & change back to the S to D for discharge.
3. Hold the connection rod in your hand, and measure the charge Q as a function of the voltage E.
4. Now, replace the polystyrene plate with the glass plate, establish the connection S & D,and discharge the capacitor with the connection rod.
5. Hold the connection rod in your hand, charge the plate by making connection to S to C & S to D back to get charge reading and record the series of measurements with glasssheet as dielectric.

Table 2: The charge *Q* recorded as a function of the applied voltage *U* for different dielectrics (*A* = 800 cm^2)

$\frac{U}{V}$	$\frac{Q}{nAs}$	$\frac{Q}{nAs}$
	polystyrene	glass
50	15	40
100	32	84
150	46	126
200	62	164
250	78	208
300	95	249

C.CAPACITANCE MEASUREMENT AS A FUNCTION OF THE DISTANCE BETWEEN THE PLATES:

1. In this case, we will be varying distance between plated and maintain the chargingvoltage at a constant value.
2. Set voltage E to 300 V.
3. Remove the glass plate and set the distance d between the plates to 1 mm with thespacers.
4. Establish the connection S to D in the two-way switch, and discharge the capacitor withthe connection rod.
5. Hold the connection rod in your hand, change to the connection S to C to charge thecapacitor, and then change back to the connection S to D for the charge measurement.
6. Read the charge Q and record it.
7. Keep reduce the distance between the plates subsequently to4,3,2, and 1 mm

Recharge the capacitor and measure the charge.

Table (4) determining the capacitance as a function of distance between the plates. The charge Q (at E=300V) & the capacitance C as a function of the distance ‘d’ betweenthe plates.

$\frac{d}{\text{Mm}}$	$\frac{Q}{\text{nAs}}$	$\frac{C}{\text{pF}}$
1	100	333
2	52	173
3	35	116
4	26	86
6	16	53

CHAPTER 4- RESULT,GRAPH & APPLICATIONS

The Result Tables of the Different Dielectric Constant

MEASURING THE CHARGE AS A FUNCTION OF THE VOLTAGE FOR DIFFERENTDIELECTRICS

Record the charge as a function of applied voltage for different dielectrics (A=400cm2) is shown in the above graph. Make a difference that the change of materials as a dielectric thechange in the charge at the plates. In air dielectric the lowest the charge & at the glass asdielectric the charge is maximum, which directly affect the capacitance.

DIELECTRIC	AREA A CM2	CAPICITANCE C IN PF
AIR	400	111
AIR	800	198
POLYSTYRENE	400	316
GLASS	400	824

Permittivity of the polystyrene & glass can be determined from the measuring values.Polystyrene εr= C3/C2 Since value of C2 is at A=400cm2
Glass εr = C4/C2 Since value of C2 is at
A=400cm2
For polystyrene εr = 1.6 for glass εr = 4.2

Table 1:- DIELECTRIC MEDIUM = AIR

E(in volt)	Vo at A= 400 cm^2	Q in nC (nano Coulomb)
30	0.06	6
60	0.09	9
90	0.13	13
120	0.17	17
150	0.21	21
180	0.25	25
210	0.29	29

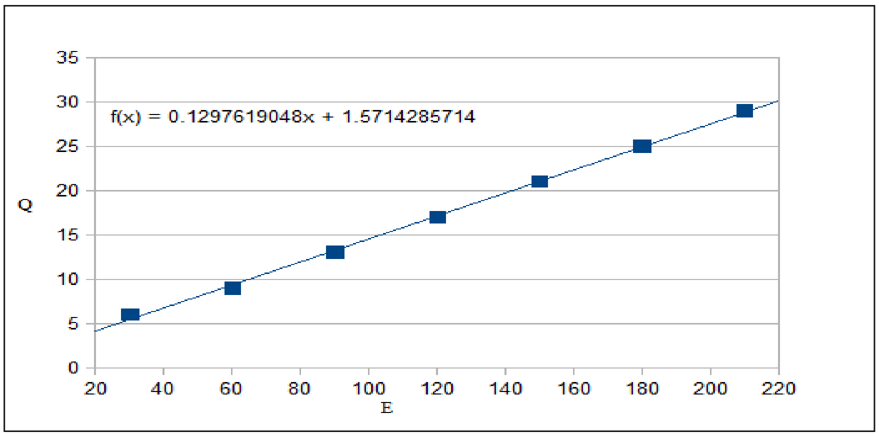


Table 2:- DIELECTRIC MEDIUM = POLYSTYRENE

E(in volt)	Vo at A= 400 cm^2	Q in nC (nano Coulomb)
30	0.08	8
60	0.13	13
90	0.18	18
120	0.25	25
150	0.32	32
180	0.39	39
210	0.43	43

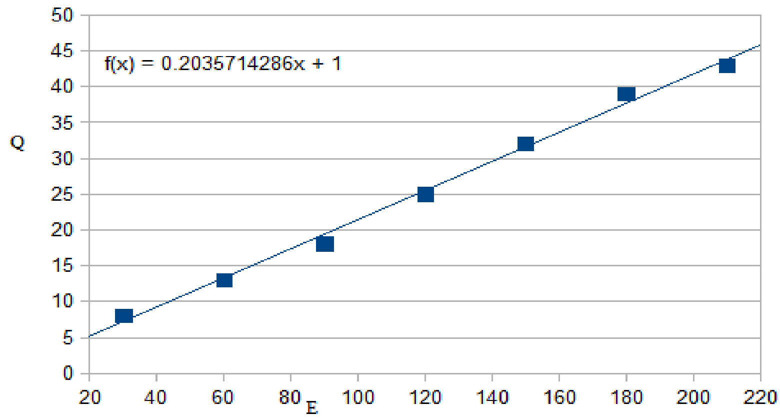
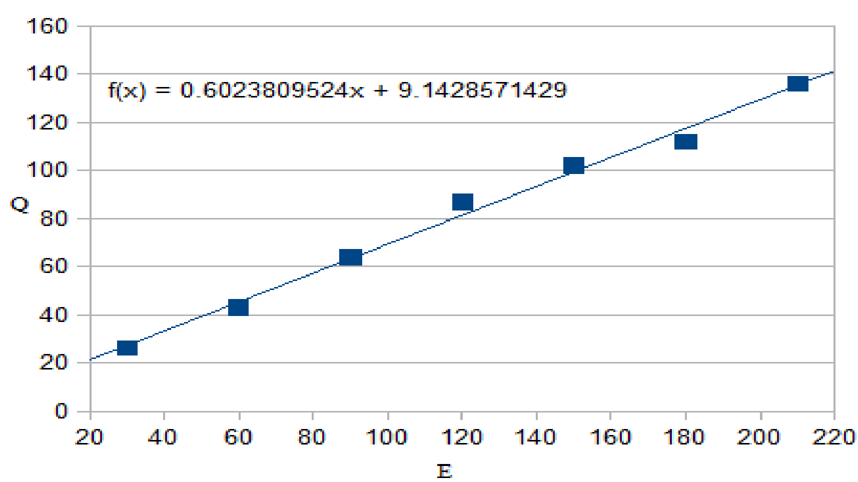


Table 3:- DIELECTRIC MEDIUM = GLASS

E(in volt)	Vo at A= 400 cm^2	Q in nC (nano Coulomb)
30	0.26	26
60	0.43	43
90	0.64	64
120	0.87	87
150	1.02	102
180	1.12	112
210	1.36	136



APPLICATIONS:-

Dielectric materials are used in many applications such as:

- Electronic components such as capacitors (responsible for energy storage properties of the device)
- High-K / low-K materials widely used in Semiconductors to enhance performance and reduce device size (where K refers to permittivity or dielectric constant)
- Dielectric materials are also used in Display applications (e.g. LCD liquid crystal displays)
- Piezoelectrics/Ferroelectrics/MEMs materials are also dielectrics
- Ceramics and Polymers also often exhibit dielectric properties
- Many other materials / applications

CONCLUSION:-

A dielectric material is used to separate the conductive plates of a capacitor. This insulating material significantly determines the properties of a component. The dielectric constant of a material determines the amount of energy that a capacitor can store when voltage is applied. A dielectric material becomes polarized when it is exposed to an electric field. When polarization occurs, the effective electric field is reduced. Since the permittivity of a material is dependent on frequency and temperature, the dielectric constant is usually given at specific conditions, usually at low frequencies. Moreover, the dielectric constant of a material is usually given relative to the permittivity of free space.

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