# LECTURE 5

Introductory Lecture on Section B

-Dielectric Materials

# Topics to be covered

- Behaviour of dielectric materials in static electric field
- Dipole Moments
- Polarization

# Introduction Dielectrics

These are the materials having electric dipole moment permantly Dipole: A dipole is an entity in which equal positive and negative charges are separated by a small distance.

DIPOLE moment : The product of magnitude of either of the charges and separation distance b/w them is called Dipole moment.

μe = q . x □ coul – m +q -q X All dielectrics are electrical insulators and they are mainly used to store electrical energy.

It stores with minimum dissipation power). Since, the e- are bound to their parent molecules & hence, there is no free charge .

Ex: Mica, glass, plastic, water & polar molecules…

# Important terms in dielectrics

1) Electric intensity or electric field strength

Def:- The force per unit charge “dq” is known as electric field strength (E). Where “dq” is point charge , E is electric field, F is force applied on point charge “dq”. $E= F/dq = Q / 4\pi\varepsilon r2$ where “ε” is permittivity.

What is permittivity?

It is a measure of resistance that is encountered when forming an electric field in a medium. “ In simple words permittivity is a measure of how an electric field effects and is effected by a dielectric medium”.

a) ε (permittivity of medium):- How much electric field generated per unit charge in that medium.

b) b) ε0 (permittivity of space) :- The electric field generated in vacuum. It is constant value ε0=8.85 x 10-12 F/m. Imp points:

1) More electric flux exist in a medium with a high permittivity(because of polarization).

2) Permittivity is directly related to " Susceptibility" which is a measure of how easily a dielectric polarize in a response of an electric field. "

permittivity relates to a materials ability to transmit an electric field" ε = εr . ε0 = (1+χ ) ε0 Relative permittivity Susceptibility

Electric Flux density or Electric displacement Vector:
The electric flux density or electric displacement vector “D” is the number of flux line’s crossing a surface normal to the lines, divided by the surface area.
D = Q/ 4π r2 where , 4π r2 is the surface area of the sphere of radius “r”.

Dielectric Parameters :a) Dielectric constant(εr ):- It is defined as the ratio of permittivity of medium(ε) to the permittivity of free space(ε0). εr = ε / ε0 b) Electric dipole moment (μ):- The product of magnitude of charges & distance of separation is known as electric dipole moment (μ ). μ = Q.r

Electric Polarization :- The process of producing electric dipoles by an electric field is called polarization in dielectrics.

“ In simple words polarization P is defined as the dipole moment per unit volume averaged over the volume of a cell” P = μ / volume

Polarizability :- When a dielectric material is placed in an electric field, the displacement of electric charge gives rise to the creation of dipole in the material .

The polarization P of an elementary particle is directly proportional to the electric field strength E. P∝E P = αE α → polarizability constant The unit of “α” is Fm2