Unit - 1.

2 marks:- Dielectric Materials and insulation

1. Define polarisation vector:-

It is defined as the average dipole moment per unit volume of a dielectric. If N is the number of atoms per unit volume and $\bar{\mu}$ is average dipole moment per atom, then polarisation vector $\bar{P} = N\bar{\mu}$, Its unit is; coulomb / m^2.

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2. Define polarisability:-

Polarisability is defined as the ratio of average dipole moment to the electrical field applied, $a = \frac{\bar{\mu}}{E}$. Its unit is farad m^2 or Fm^2.

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3. Define Dielectric constant of a material:-

It is the ratio b/w absolute permittivity of the medium and permittivity of free space (ε_0).

$$\text{Dielectric constant } (\varepsilon_r) = \frac{\text{Absolute permittivity } (\varepsilon)}{\text{permittivity of free space } (\varepsilon_0)}$$

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4. What is meant by dielectric polarisation?

The process of producing electrical dipoles inside the dielectric by application of an external electrical field is called polarisation in dielectrics.

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4 What is meant by electronic polarisation?

Electronic polarisation is due to the displacement of positively charged nucleus and negatively-charged electrons of an atom in the opposite directions on the application of an electrical field. This will result in the creation of dipole moment in the dielectric.

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5. What is meant by ionic polarisation?

Ionic polarisation is due to the displacement of cations and anions in opposite directions. This occurs in ionic

dielectric by the influence of external electrical field. When an electrical field (E) is applied on an ionic dielectric, there is a shift of one ion with respect to another from their mean positions.

6. What is meant by orientation polarization?

Orientational polarization takes place only in polar dielectric. polar dielectric have molecules with permanent dipole moments even in the absence of an electrical field. When the polar dielectric are subjected to an electrical field, the molecular dipoles are oriented in the direction of electric field is known orientation polarization.

7. What is meant by local field in a dielectric?

The local field in a dielectric is the space and time average of the electric field acting on a molecule or atom of the dielectric kept in an applied electric field. It is equal to $E_i = E + P/3\varepsilon_0$ for simple elements dielectricals.

8 What is meant by dielectric breakdown?

When the strength of electrical field applied to the dielectric exceeds a critical value, very large current flows through it. The dielectric loses its insulating property and becomes a conductor. This phenomenon is known as dielectric breakdown.

9. What is meant by Dielectric strength?

The electrical field strength at which dielectric breakdown occurs is known as dielectric strength. It is the breakdown voltage per unit thickness of the material.

$$\text{Dielectric strength} = \frac{\text{Dielectric breakdown voltage.}}{\text{Thickness of the dielectric}}$$

10. Name the four polarisation mechanisms?

* Electronic polarisation
* Ionic polarisation
* orientational polarisation
* Space - charge polarisation.

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11. What are the types of dielectric?

Types of Dielectrics.

Based on the applications, there are two types of dielectric materials.

(i) Active dielectrics

(ii) passive dielectrics

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12. What are active dielectrics?

Active dielectrics are the materials which are used to generate, amplify, modulate and convert the electrical signals. They are used to store electrical energy.

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13. What are passive dielectrics?

The function of the insulating material is to obstruct the flow of electric current.

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14. Mention the various breakdown mechanisms.

* Intrinsic breakdown and avalanche breakdown
* Thermal breakdown
* chemical and Electrochemical breakdown.
* Discharge breakdown.
* Defect breakdown.

15. What is defect breakdown?

The surface of the dielectric material may have defects such as cracks, porosity and blow holes. Impurities like dust or moisture may collect at these discontinuities. This will lead to a breakdown in a dielectric material.

2 marks

Unit - (2)

Magnetic properties of Materials.

1. What are the merits (success or uses) of classical free electron theory ?

* It is used to verify ohm's law.
* It is used to explain the electrical and thermal conductivity of metals
* It is used to derive wiedemann - franz law.
* It is used to explain the optical properties of metal.

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2. What are the demerits (drawbacks) of classical free electron theory ?

* It is a macroscopic theory.
* Contradiction in the absorption of supplied energy.
* Electrical conductivity of semiconductors and insulators could not be explained.
* By this theory photoelectric effect, compton effect and Black body radiation could not be explained.

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3. Define drift velocity and give its formula :

The average velocity acquired by the free electron in a particular direction, due to the applied electric field is called drift velocity. It is denoted by,

$$v_d = \frac{\lambda}{\tau_c}$$

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4. Define Mobility of Electrons :

The magnitude of the drift velocity per unit electric field is defined as the mobility of electrons (μ)

$$\mu = \frac{v_d}{E}$$

5. Define Electrical conductivity:-

Electrical conductivity is the amount of electrical charge (Q) conducted per unit time (t) across unit area (A) of the metal for unit applied electric field.

$$\sigma = \frac{Q}{t_{AE}} = \frac{I}{E} \Omega^{-1} m^{-1}$$

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6. Define thermal conductivity:-

The thermal conductivity is defined as the amount of heat flowing through a unit area per unit time maintain at unit temperature gradient.

$$K = -\frac{Q}{A\left[\frac{dT}{dx}\right]} Wm^{-1}K^{-1}$$

The negative sign indicates that heat flows hot. end to cold end, where K is the thermal conductivity of metal, Q is the amount of heat energy, dT/dx is the temperature gradient.

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7. Define fermi distribution function:-

The probability F(E) of an electron occupying in the given energy level at temperature (T) is known as Fermi distribution function.

$$F(E) = \frac{1}{1 + e^{(E-E_F)/k_B T}}$$

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8. Define density of energy states in metal:-

It is defined as the number of available electron states per unit volume in an energy interval E and E+dE. It is denoted by $z(E)\,dE$.

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9. Define band gap. Valence band & conduction band.

* Band gap is the energy difference b/w the minimum energy of conduction band and the maximum energy of valence band. Those energies lying in the band gap are not allowed to occupy by the electrons of that solid

* Valence band is the region of energy levels where the Valence electrons occupy their positions

* conduction band is the region of energy levels where the conduction electrons or free electrons occupy their position.

10. What are holes?

Holes are the vacant sites in the valence band of solid. There will behave like positive charge carriers having the mass of electron in the presence of applied electric field.

11. What is Bloch function:-

A Bloch wave named after swiss physicist felix Bloch, is a type of wave function for a particle in a periodically-repeating environment most commonly an electron in a crystal.

12. What is Brillouin zone:-

It is defined as the set of points closer to the origin that to any other reciprocal lattice point. The whole reciprocal space may be covered without overlap.

13. Define effective mass of electron:-

Effective mass of electron 'm*' is the mass of the.

Electron when it moving through the periodic lattice Example: In copper $m^* > m$ where m is the rest of an electron.

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14. What are ferromagnetic materials?

The materials which exhibit ferromagnetism are called as ferromagnetic materials

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15. What is curie constant? or what is curie law?

It is found that susceptibility (χ) is inversely proportional to the temperature (T)

$$\chi \propto \frac{1}{T}$$

$$\chi = \frac{C}{T}$$

where 'C' is constant and it is known as curie constant. This relation is known as curie law.

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16. What is saturation magnetisation?

The maximum magnetisation in a ferromagnet when all the atomic magnetic moments are aligned is called Saturation magnetization.

Unit - III

2 marks **Semiconductors and Transport physics**

1. What are elemental semiconductors? Give some important elemental semiconductors.

Elemental semiconductors are made from single element of the fourth group elements of the periodic table Example :- Germanium and silicon.

2. What are the properties of semiconductors?

* They are formed by covalent bond
* They have empty conduction band
* They have almost filled valence band
* These materials have comparatively narrow energy gap.

3. What are compound semiconductors? Give some important compound semiconductors.

Semiconductors which are formed by combining third and fifth group elements or second and sixth group elements in the periodic table are called compound semiconductors.

4. What is a semiconductor?

Semiconductor is a special class of material which behaves like an insulator at 0K and acts as conductor at temperature other than 0K. Its resistivity lies in between a conductor and an insulator.

5. What is an intrinsic semiconductor?

Semiconductor in an extremely pure form is known as intrinsic semiconductor

12. Mention the uses of Hall effect?

* It is used to find type of semiconductor
* It is used to measure carrier concentration.
* It is used to find mobility of charge carrier.

13. What is meant by donor energy level?

A pentavalent impurity when doped with an intrinsic semiconductor donates one electron which produces an energy level called donor energy level.

14. What is meant by acceptor energy level?

A ~~tri~~ trivalent impurity when doped with an intrinsic semiconductor accepts one electron which produces an energy level called acceptor energy level

15. What is a Hall device?

The device which uses the hall effect for its application is known as Hall device.

16. What are different types of Hall devices?

There are three types of Hall devices.

They are * Gauss Meter
* Electronic Multiplier
* Electronic Wattmeter.

Unit - IV

Optical properties of Materials

2 marks:-

1. What are optical materials?

The materials which are sensitive to light are known as optical materials. These optical materials exhibit a variety of optical properties.

2. What are the type of optical materials?

Generally, optical materials are classified into three types based on the nature of propagation of light namely.

i) Transparent
ii) Translucent
iii) opaque

3. Define Scattering of light?

It is a proces by which the intensity of the wave attenuates as it travels through a medium.

4. Define carrier generation and recombination.

The carrier generation is the process whereby electrons and holes are created. The recombination is the process whereby electrons and holes are annihilated.

5. What are types of carrier generations?

i) photo generation
ii) Phonon generation
iii) Impact ionization

6. What are types of recombination process?

(a) Radiative Recombination, (b) Shockley - Read - Hall Recombination, (c) Auger Recombination.

7. What is solar cell?

It is a p-N junction diode which converts solar energy into electrical energy.

8. What is LED?

It is a p-n junction diode which emits light when it is forward biased.

9. What are the disadvantages of LEDs?

* They require high power
* Their preparation cost is high when compared to LCD

10. What is an organic light emitting diodes?

Organic light emitting diodes are solid state devices made up of thin films of organic molecules that produce light with the application of electricity.

11. What is a laser diode?

It is a specially fabricated p-n junction diode. This diode emits laser light when it is forward-biased.

12. What is Franz-keldysh effect?

The change in absorption in a semiconductor in the presence of a strong electric field is called franz-Keldysh effect.

13. What is stark effect?

The change in atomic energy upon the application of an electric field is called the stark effect. The electric field affects the higher order, or outer orbits of electrons and splitting of energy states occurs. This reduces the bandgap.

14. What is meant by electroabsorption?

Both Franz - keldysh and stark effects results in absorption of photons with energies smaller than the bandgap with application of an electric field. This phenomenon is known as electroabsorption.

15. What are pockel's effect and kerr effect?

Due to electro optic effect the refractive index of a material changes with applied field as.

$$\Delta\left[\frac{1}{n^2}\right] = rE + PE^2$$

where r is the linear electro optic coefficient. P is the quadratic electro optic coefficient. The linear variation of the refractive index is called pockels effect and quadratic variation is called kerr effect.

Unit - V

2 marks

Nano Devices

1. Define nano materials?

Nanophase materials are newly developed materials with grain size at the nanometre range (10^{-9}m), i.e, in the order of 1-100nm. The particle size in a nano material is 1-100nm.

2. Define density of states?

It is defined as the number of available electron states per unit volume in an energy interval E and E+dE. It is denoted by Z(E).

3. Define fermi energy?

It is defined as the highest energy level occupied by the electron at 0K in metal.

4. What is a quantum confinement?

It is a process of reduction of the size of the solid such that the energy levels inside become discrete.

5. What is quantum structure?

When a bulk material is reduced in its size, atleast one of its dimension, in the order of few nanometres, then the structure is known as quantum structure.

6. What is single electron phenomena?

Present day, transistors require 10,000 electrons. Rather than moving many electrons through transistors. it may very well be practical and necessary to move

electrons one at a time. The phenomena is known as single electron phenomena.

7. Define Coulomb - Blockade effect.

The charging effect which blocks the injection or rejection of a single charge into or from a quantum dot is called coulomb blockade effect.

8. What is single electron tunneling?

The quantization of charge can dominate and tunneling of single electrons across leaky capacitors carries the current. This is called single electron tunneling.

9. What is a single Electron Transistor?

SET is three - terminal switching devices which can transfer electrons from source to drain one by one.

10. What is a carbon nano tube?

The carbon nanotubes are the wires of pure carbon like rolled sheets of graphite or like soda straws.

11. What are the types of carbon nano tube structure?

Three types of nanotube structures are considered by rolling a graphite sheet with different orientations about the axis.

They are, Armchair structure, zig-zag structure, chiral structure.

12. How carbon nanotubes are classified.

Based on the number of layers, the carbon nanotubes are classified as (i) single-walled (SWNTs), (ii) Multi-walled (MWNTs)

13. What is quantum size - effect?

When the size of a nanocrystal becomes smaller than the debroglie wavelength, electrons and holes get spatially confined electrical dipoles got generated the discrete energy levels are formed.

14. What is single electron phenomena?

Transistors require 10,000 electrons, Rather than moving many electrons through transistors, it may very well be practical and necessary to move electrons one at a time. The phenomena is known as single electron phenomena

15. What are the applications of single electron transistor?

* It is used for mass data storage
* It is used in highly sensitive electrometer
* SET is a suitable measurement set-up for single electron spectroscopy.