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POLLACHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

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DEPARTMENT OF SCIENCE AND HUMANITIES (ENGINEERING PHYSICS)

REGULATION 2021

I YEAR / II SEM

PH3254 PHYSICS FOR ELECTRONICS ENGINEERING

Unit - I

Crystallography

2 mark :-

1. What are crystalline materials ? Give example.

Crystalline materials are materials in which the atoms are arranged in an orderly fashion throughout in a three dimensional space. Example: Copper, silver, etc.

2. What is an amorphous solid ? Give example :

It is a type of solid in which the atoms are not arranged in an orderly fashion. (randomly)

3. What is a crystal ?

A crystal is a three dimensional solid composed of a periodic and regular arrangement of atoms.

4. What are lattice points ?

The points in the space to represent position of atom or group of atoms of the crystal are called lattice points.

5. What is basis ?

The crystal structure is formed by associating with every lattice point a unit assembly of atoms or molecules. This unit assembly is called the basis or pattern.

6. What are the differences between crystalline and non-crystalline material.

S.no	crystalline material	Non-crystalline material
1)	They have a definite and regular geometrical shapes which extend throughout the crystal	They don't have definite geometrical shape

ii)	They are anisotropic	They are isotropic
iii)	They are most stable	They are less stable
iv)	Example: NaCl, KCl, Cu, Al, etc.	Example: Plastic, glass, rubber etc.

7. What are the lattice parameters of an unit cell?

The intercepts on the axes a, b and c and interfacial angles α, β and γ are called lattice parameters of an unit cell.

8. Define inter-atomic distance and interplanar distance.

Interatomic distance: It is the distance between the centres of any two nearest atoms.

Inter-planer distance: It is the prependicular distance between any two parallel planes.

9. Define diamond structure Give example:

Germanium, silicon and diamond posses a structure which is a combination of two interpenetrating FCC sub-lattices shifted along the body diagonal by 1/4 th of cube edge. It is loosely packed structure with packing factor 34%.

10. What is crystal defect?

The deviation from the regularity of arrangement of atoms is called crystal imperfection or crystal defect

11. What is impurity defect? What are types of impurity defects?

A foreign substance added to a crystal is called impurity. The impurity atom may fit in the structure

in two ways giving rise to two kinds of impurity defects.

* Substitution impurity defect
* Interstitial impurity defect

12. What is Frenkel defect?

A vacancy associated with interstitial impurity is called Frenkel defect.

13. What is schottky defect?

If an atom is missing from its lattice site, the vacancy is called schottky defect.

14. What is line defect? What are its type?

The defect along a line is called line defect, There are two types of line defects.

* Edge dislocation and
* Screw dislocation.

15. What is burger's vector?

The magnitude and the direction of the displacement due edge dislocation are defined by a vector called Burger's vector.

16. What are twin boundaries?

If the atomic arrangement on one side of the boundary is the mirror image of the arrangement on the other side the defect is called twin boundaries

17. What is stacking fault?

This defect arises due to defect in the stacking of atomic planes. In some cases a part of certain atomic plane will be missing where as in some other cases a portion of extra atomic plane is present, changing the sequence of arrangement of atoms.

Unit - (2)

2 marks

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. These 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 is 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 constard. This relation is known as curie law.

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16. What is saturation magnetization?

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 process 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 LED's?
* 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 carrier 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.