

Parul Institute of Engineering and Technology

Parul University

Engineering Physics (303192102)

B. Tech. Semester 2

Assignment 2

Date: 29/04/2024

LONG QUESTIONS

1. Classify the solid materials based on the band structure.
2. Prove that in an intrinsic semiconductor, Fermi level lies exactly at the middle of the band gap.
3. What is effective mass of electron? Derive an expression for the effective mass (m^*) of an electron in valance and conduction band.
4. Derive an expression for the carrier concentration in the n-type semiconductor.
5. Explain construction (with diagram), working, and applications of a PN Junction photodiode.
6. Explain construction (with diagram), working and applications of photoconductive cell.
7. Explain classification of nano-materials based on dimensionality with examples.
8. What are novel materials? Explain their applications in detail.

SHORT QUESTIONS

1. Explain P type semiconductors and N type semiconductor.
2. Draw and explain E-K diagram.
3. Write short note about direct bandgap material and indirect bandgap material.
4. What is a semiconductor and how does it differ from a conductor and an insulator?
5. Write applications of photodetectors (any five).
6. Explain construction, working and applications of LED with necessary diagram.
7. Write short note about photovoltaic cell/solar cell with the necessary diagram.
8. Explain physical and thermal properties of nanomaterial.
9. Explain quantum devices and their application.
10. Write examples of 0-D materials.
11. Write examples of 1-D materials.
12. State working principle of X-ray Diffractometer.
13. Distinguish between the following: nanoparticles, aggregates and agglomerates.

DEFINE below mentioned terms

1. Effective mass
2. Density of States (DOS) (with formula)

3. Bandgap
4. Intrinsic and Extrinsic semiconductors
5. Photoconductivity
6. Photodetector
7. Optocoupler
8. Schottky Junction and Ohmic junction
9. Quantum devices
10. Nanomaterials

MCQs

1. In PIN diode, “I” stands for
 - a. Insulator
 - b. Ionization
 - c. Intrinsic semiconductor
 - d. None of the above
2. How does density of states vary with energy E ?
 - a. E^2
 - b. $E^{1/2}$
 - c. E^3
 - d. None of above
3. Fermi energy level for intrinsic semiconductors lies _____
 - a. At middle of the band gap
 - b. Close to conduction band
 - c. Close to valence band
 - d. None
4. Fermi energy level for p-type extrinsic semiconductors lies
 - a. At middle of the band gap
 - b. Close to conduction band
 - c. Close to valence band
 - d. None
5. In _____ band gap materials, when electron makes transition from conduction band to valence band, the value of k changes.
 - a. Direct
 - b. Indirect
 - c. Direct as well as indirect
 - d. Large
6. Schottky junction is possible between
 - a) Metal and Metal
 - b) Semiconductor and Semiconductor
 - c) Metal and Semiconductor
 - d) Metal and Superconductor
7. Which of the following materials has the highest electrical conductivity?
 - a. Glass

- b. Ge
 - c. Copper
 - d. Silicon
8. Which of the following statements is true about the formation of energy bands in solids?
- a. Energy bands only form in metals
 - b. Energy bands only form in insulators
 - c. Energy bands are formed by the interaction of electrons in the crystal lattice
 - d. Energy bands are not present in semiconductors
8. Which type of semiconductor has an equal number of electrons and holes at room temperature?
- a. Extrinsic semiconductor
 - b. Intrinsic semiconductor
 - c. P-type semiconductor
 - d. N-type semiconductor
9. Optoelectronic couplers are commonly used as
- a. Signal converters
 - b. Source of light
 - c. Detector of light
 - d. None of the above
10. Which type of light interaction must be dominant in material to act as good and efficient material for an optoelectronic device
- a. Transmission
 - b. Absorption
 - c. Reflection
 - d. All of the above
11. The disadvantage of avalanche photo-diode is _____
- a. High operating voltage
 - b. Less gain
 - c. Purity of semiconductor
 - d. All of above
12. Which is not an optoelectronic device among the below mentioned devices,
- a. Photoconductive cell
 - b. LED
 - c. Capacitor
 - d. PIN Photodiode
13. SQUID stands for
- a. Supercapacitor Quantum Interference dots
 - b. Super-cooled Quantum Intrinsic Device
 - c. Superconducting Quantum Interface Device
 - d. None of above

14. The drifting electron with sufficient kinetic energy causes impact ionization process in _____.
- Avalanche photodiode
 - PIN photodiode
 - Photo transistor
 - None of above
15. A material with two dimensions in the nanometer range and a third dimension that is large is known as:
- Micromaterial
 - Quantum wire
 - Quantum well
 - Macromaterial
16. One can classify artificial nanomaterials as _____.
- Carbon-based and non-metallic based
 - Carbon-based only
 - Carbon-based and metal & semiconductor based
 - Carbon-based and dendrimers
17. Quantum confinement is the property which is realized when _____
- Material size is in the nano scale
 - Material size is not in the nano scale
 - Temperature is high
 - Physical strength is high
18. What is the temperature, above which a ferromagnetic substance shows no ferromagnetism called?
- Curie temperature
 - Critical temperature
 - Neel temperature
 - There exists no such temperature
19. _____ are materials that, after having been deformed, revert back to their original shapes when temperature is changed.
- Gold and silver
 - Shape memory alloys
 - Alloys
 - None of the above
20. _____ is the ability of a material to resist elastic deformation.
- Brittleness
 - Conductivity
 - Elasticity
 - resistivity
21. Grain size of nano-materials are typically

- a. $< 100 \text{ nm}$
- b. $< 10 \text{ pm}$
- c. $< 100 \text{ cm}$
- d. $< 10 \text{ \AA}$

FILL IN THE BLANKS

1. _____ is a mechanical property of a metal. (Ductility/ Heat capacity).
2. Quantum dots are examples of _____ nanomaterials. (0-D / 1-D)
3. CNTs stands for _____.
4. In the PIN photodiode, _____ semiconductor is placed in between two extrinsic materials. (intrinsic/ n-type)
5. Photodiode and phototransistor are _____. (photo-detectors/ photo-sources)
6. In 1-D nanomaterial, the electron is confined in the _____ dimension. (2 / 3)
7. Opto-couplers are made of an LED and a _____. (IR emitter/photo-detector).
8. LED stands for _____.
9. Two-dimensional material has confinement in __ dimensions and mobility in __ dimensions.