



**SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY :: PUTTUR**  
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**QUESTION BANK (DESCRIPTIVE)**

**Subject with Code: SEMICONDUCTOR PHYSICS (18HS0851)**

**Course & Branch: B.Tech – ECE, CSE and CS&IT.**

**Year & Sem: I-B.Tech & II-Sem.**

**Regulation: R18**

**UNIT –I: Electronic Materials.**

**I. Two marks questions**

1. Define the term drift velocity. (2M)
2. Write the expression for Fermi - Dirac distribution function. (2M)
3. Define Fermi energy level. (2M)
4. State the Pauli's exclusion principle. (2M)
5. What are the merits of quantum free electron theory? (2M)

**II. Essay questions**

- 1 a) What are the salient features of classical free electron theory? Derive an expression for electrical conductivity in a metal? (7M)
- b). Mention its drawbacks (3M)
- 2 a) Describe the electrical conductivity in a metal using quantum free electronic theory. (7M)
- b) Write advantages quantum free electron theory over classical free electron theory. (3M)
- 3 a) Using classical free electron model derive an expression for electrical conductivity in metal. (7M)
- b) Find relaxation time of conduction electron in metal if its resistivity is  $1.54 \times 10^{-8} \Omega\text{-m}$  and it has  $5.8 \times 10^{28}$  conduction electron/ $\text{m}^3$ . Given  $m = 9.1 \times 10^{-31} \text{ kg}$ ,  $e = 1.6 \times 10^{-19} \text{ C}$ . (3M)
- 4 a) Write brief note on origin of energy bands in solids with neat sketch? (5M)
- b) Explain the existence of allowed and forbidden bands in solids using E-K diagram. (5M)
- 5 a) Distinguish between direct and indirect band gap semiconductors. (5M)
- b) Define mean free path? Calculate the mean free path of electron in copper of density  $8.5 \times 10^{28} \text{ m}^{-3}$  and resistivity  $1.6 \times 10^{-8} \Omega\text{-m}$ . Given  $m = 9.1 \times 10^{-31} \text{ kg}$ ,  $e = 1.6 \times 10^{-19} \text{ C}$ ,  $T = 300 \text{ K}$ ,  $K_B = 1.38 \times 10^{-23} \text{ JK}^{-1}$ . (5M)
- 6 a) Classify the solids into conductor, semiconductor and insulators based on band theory. (6M)
- b) For the metal having  $6.5 \times 10^{28}$  conduction electron/ $\text{m}^3$ . Find the relaxation time of conduction electrons if the metal has resistivity  $1.43 \times 10^{-8} \Omega \text{ m}$ . Given  $m = 9.1 \times 10^{-31} \text{ kg}$ ,  $e = 1.6 \times 10^{-19} \text{ C}$ . (4M)
- 7 a) Define effective mass and derive the expression for effective mass of an electron in periodic potential field. (7M)
- b) Evaluate Fermi Function for energy  $K_B T$  above Fermi level? (3M)
- 8 a) Write brief note on Fermi Dirac distribution? (5M)
- b) What is the effect of temperature on Fermi Dirac distribution function? (5M)

- 9 a) What are Brillouin zone? Write the corresponding K (wave vector) values of first and second Brillouin zone? (4M)  
 b) Define Fermi energy level? Find the temperature at which there is 1% probability that a state with energy 0.5 eV is above Fermi energy? (6M)
10. a) Define the terms i) Mean free path ii) Relaxation time iii) Mobility. (6M)  
 b) Find the mobility of electrons in copper if there are  $9 \times 10^{28}$  valence electrons/m<sup>3</sup> and the conductivity of copper is  $6 \times 10^7$  mho/m? (4M)

## UNIT –II: SEMICONDUCTORS.

### I. Two marks questions

1. State Hall effect? (2M)
2. Write the applications of P-N junction. (2M)
3. Write examples for trivalent and pentavalent dopants? (2M)
4. Write the relation between mobility and Hall coefficient? (2M)
5. Define the word depletion layer? (2M)

### II. Essay questions

1. a) What is intrinsic semiconductor and explain the formation extrinsic semiconductors through doping? (5M)  
 b) Derive the expression for intrinsic carrier concentration. (5M)
2. a) Explain n-type semiconductor. (5M)  
 b) Derive the expression for current generated due to drifting of charge carriers in semiconductors in the presence of electric field. (5M)
3. a) Obtain the conductivity of intrinsic semiconductor with relevant expressions? (5M)  
 b) The following data are given for an intrinsic Ge at 300K. Calculate the conductivity and resistivity of the sample? ( $n_i = 2.4 \times 10^{19} \text{ m}^{-3}$ ,  $\mu_e = 0.39 \text{ m}^2 \text{ V}^{-1} \text{ S}^{-1}$ ,  $\mu_p = 0.19 \text{ m}^2 \text{ V}^{-1} \text{ S}^{-1}$ ). (5M)
4. a) Distinguishes between intrinsic and extrinsic semiconductors? (5M)  
 b) Explain effect of temperature on Fermi energy level of an extrinsic semiconductor? (5M)
5. a) What is Fermi level? Prove that the Fermi level is lies exactly in between conduction band and valance band of intrinsic semiconductor. (5M)  
 b) Derive Einstein's relation in semiconductors?
6. a) Explain the formation of p-n junction. (5M)  
 b) Describe the variation of width of depletion layer under forward and reverse bias. (5M)
7. a) Explain P-type semiconductor. (4M)  
 b) Derive the expression for current generated due to diffusion of charge carriers in semiconductors in the absence of electric field. (6M)
8. a) Describe the Hall Effect in a semiconductors. (7M)  
 b) Write the applications of Hall Effect. (3M)
9. a) Explain the concept of charge carriers generation and recombination. (5M)  
 b) Find the diffusion co-efficient of electron in Si at 300 K if  $\mu_e = 0.19 \text{ m}^2 \text{ V}^{-1} \text{ S}^{-1}$ . (5M)
10. a) What are metal semiconductor junctions and its classifications? (5M)  
 b) Write differences between Ohmic contact and Schottky barriers in junction diodes. (5M)

**UNIT-III: LIGHT EMITTING DIODE (LED) AND PHOTODETECTORS****I. Two marks questions**

- 1 What is direct band gap semiconductor? (2M)
- 2 What is meant by luminescence of optical materials? (2M)
- 3 Write applications of photo diode. (2M)
- 4 Write the principle of solar cell. (2M)
- 5 Write any four optoelectronic devices. (2M)

**II. Essay questions**

- 1 a) Elucidate broadly radiative and non-radiative mechanisms in semiconductors (5M)  
b) Explain the construction and working mechanism of solar cells with suitable diagrams (5M)
- 2 a) What are the materials are used for fabrication of LED's? (4M)  
b) Explain the structure and mechanism of LED's (6M)
- 3 a) What are the characteristics of LEDs? (5M)  
b) Write a brief note on figure of merits and de-merits of LED's? (5M)
- 4 a) Describe the charge carrier separation mechanism in photo detectors? (5M)  
b) What are the optimist materials for fabrication photo detectors (5M)
- 5 a) Explain the principle and characteristics of PIN diode. (5M)  
b) Write brief note on structure and mechanism of PIN diode (5M)
- 6 a) Explicate the principle and characteristics of Avalanche diode. (6M)  
b) Engrave the brief note on structure and mechanism of Avalanche diode. (4M)
- 7 a) Designate the charge carrier generation and separation mechanism in solar cells with respect to the solar light illumination? (5M)  
b) Suggest the suitable semiconductors with optimum band gap for fabrication of solar cells (5M)
8. a) What are the characteristics of solar cells? (5M)  
b) Explain the principle involved in working of solar cells? (5M)
9. a) Describe the construction and working mechanism of solar cells. (6M)  
b) Broadly explain the differences between light emitting diodes and photo detectors (4M)
10. a) Illustrate the applications of LEDs, Solar Cell, PIN diode and photo detectors toward society in terms of medical, research and development and information technology? (7M)  
b) Determine the wavelength of LED fabricated by the CdS material with band gap of 2.42 eV (3M)

**UNIT-IV: LASERS AND FIBER OPTICS****I. Two marks questions**

- 1 Define population inversion? (2M)
- 2 Mention the important components of laser device? (2M)
- 3 What are characteristics of laser light? (2M)
- 4 Define Numerical aperture and acceptance angle of an optical fibre? (2M)
- 5 Mention the basic principle in the propagation of light signal through the optical fibre (2M)

**II. Essay questions**

- 1 a) Describe the important characteristic of laser beam? (6M)  
b) Explain the difference between spontaneous and stimulated emission of radiation? (4M)
- 2 a) Derive the relation between the various Einstein's coefficients of absorption and emission of radiation. (6M)  
b) Explain population inversion? (4M)
- 3 a) Describe 1)spontaneous emission 2) stimulated emission 3) stimulated absorption (7M)  
b) Calculate the wavelength of emitted radiation from GaAs which has a band gap of 1.44eV (3M)
- 4 a) Describe the construction and working principle of laser diode with the help of a neat diagram. (7M)  
b) Mention the important components of laser device. (3M)
- 5 a) Explain the different pumping mechanisms in laser. (5M)  
b) Mention the application of laser in different fields. (5M)
- 6 a) What is the acceptance angle of an optical fibre and derive an expression for it. (7M)  
b) An optical fibre has a core refractive index of 1.44 and cladding refractive index of 1.40. Find its  $\theta_a$ . (3M)
- 7 a) What is the numerical aperture of an optical fibre and derive an expression for it. (7M)  
b) An optical fibre has a numerical aperture of 0.20 and cladding refractive index of 1.59. Determine the refractive index of core and the acceptance angle for the fibre in water has a refractive index of 1.33. (3M)
- 8 a) Differentiate step index and graded index fibers. (5M)  
b) Write brief note on attenuation in optical fibers. (5M)
- 9 a) Describe the construction and the working principle of optical fibre. (5M)  
b) Mention the application of optical fibre in medicine. (5M)
- 10 a) Describe optical fibre communication system. (6M)  
b) Mention the application of optical fibre in sensors. (4M)

**UNIT-V: PHYSICS OF NANOMATERIALS****I. Two marks questions**

- 1 Define top down and bottom up process? (2M)
- 2 What is the principle in the Ball milling synthesis process of nanomaterial? (2M)
- 3 What is Quantum Confinement? (2M)
- 4 What are the various structures of carbon nanotubes? (2M)
- 5 What are the advantages of sol-gel process? (2M)

**II. Essay questions**

1. a) What is nanomaterial? Write the classification of nanomaterials (4M)  
b) Explain the basic principle of nanomaterials. (6M)
2. a) Explain the concept of Quantum Confinement in nano materials. (4M)  
b) Write the applications of nanomaterial in industries and information technology. (6M)

3. a) Explain why surface area to volume ratio very large for nano materials? (6M)  
b) Find the surface area to volume ratio of Sphere using surface area and volume calculation for the given radius is 5 meter? (4M)
4. a) What are the techniques available for synthesizing nano materials? (3M)  
b) Explain ball milling technique for synthesis of nanomaterial? (7M)
5. a) Explain Sol-Gel technique for synthesis of nanomaterial? (7M)  
b) Write advantages of sol-gel process? (3M)
6. a) What is Graphene? Write brief note its properties. (6M)  
b) Write applications of graphene in various fields (4M)
7. a) What are carbon nanotubes? Mention its structures? (5M)  
b) Write brief note on applications of Carbon nanotubes? (5M)
8. a) What is nanotechnology? Give applications of carbon nanotubes (CNT'S) in biomedical field? (5M)  
b) What are allotropes? Write allotropes of Carbon? (5M)
9. a) Define Condensation, Crystal growth and Calcination. (6M)  
b) Describe graphene based FET. (4M)
10. a) Write the physical properties of carbon nanotubes . (4M)  
b) Write the applications of nanomaterial in various fields. (6M)

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