SIR PADAMPAT SINGHANIA UNIVERSITY

End Term Examination, February 2022

Programme/Branch: B. Tech/All | Semester: I

Subject: Semiconductor Physics | Subject Code: PH- 1007

Time: 03:00 Hrs | Maximum Marks: 100

Instruction for candidates: Write enrollment number on the right-side top edge of the page and signature at right side bottom edge of every page.

Section - A

There are total **TWELVE** parts in Q1 in Section-A. Each part carries **TWO** marks. Attempt any **NINE** parts. Answer each part in about 45-60 words.

[9 X 2 = 18]

Q1. (a) What is photo-voltaic effect? What is its application?

(b) Calculate the Fermi temperature and Fermi velocity for material with Fermi energy 3.2eV.

(c) Write the expression of Fermi distribution, explain symbols and show its temperature dependence using an appropriate diagram.

(d) Define current density and drift velocity. What is the relationship between them?

(e) Draw the energy band diagram showing Fermi level for the intrinsic, n-type and p-type semiconductors.

(f) Define the following in the context of metal-semiconductor junction: (i) work function, (ii) work function difference

(g) What do you mean by exciton? mention its properties.

(h) Draw a labelled E-k diagram depicting the stimulated emission process.

(i) What are the various parameters we may measure using the capacitance-voltage measurements.

(j) What is the main difference between ohmic and Schottky contacts?

(k) Distinguish between interband and intraband transitions.

(l) What do you understand with phonon?

Section - B

There are total **NINE** questions in Section-B. Each question carries **SIX** marks. Attempt any **SEVEN** questions. Answer each question in about 135-180 words.

[7 X 6 = 42]

Q2. Assuming the electron to be free calculate the total number of states below E=5eV in a cubical box of volume 10^{-5} meter^3

Q3. Describe the Fermi Golden rule and write the expression of transition probability. Explain all the symbols.

Q4. Describe the drift and diffusion currents in semiconductors, also write their expressions for both majority and minority charge carriers and explain all the symbols.

Q5. Calculate the number of energy states lying in an energy interval of 0.02eV above the Fermi level of energy 3.22eV for a material of unit volume.

Q6. Describe the three semiconductor devices which are based on absorption, spontaneous emission and stimulated emission, draw relevant circuit diagrams also.

Q7. Calculate the temperature at which there is a one percent probability that a state with an energy 0.5eV above the Fermi level will be occupied.

Q8. What is the Hall effect? Describe theoretically the origin of Hall's effect using appropriate diagrams and expressions.

Q9. Two semiconductor materials have an energy bandgap of 1.67eV and 1.82eV respectively. What should be the wavelength and frequency of electromagnetic radiation to stimulate the emission process in these semiconductors. What are the colours of these radiations?

Q10. What is the hot point probe method? How is it used to distinguish between n-type and p-type semiconductors?

Section-C

There are total **FIVE** questions in Section-C. Each question carries **TEN** marks. Attempt any **FOUR** questions. Answer each question in about 225-300 words.

[4 X 10 = 40]

Q11. Define the term density of states. Derive the expression of density of states for a conductor of cubical shape having side L.

Q12. Prove that the Fermi level in intrinsic semiconductors lies exactly at the centre of the energy bandgap.

Q13. Draw and explain the energy band diagram for unbiased and biased pn junction (in forward as well as reverse bias conditions, including the Fermi Level) also explain the various terms barrier potential, depletion region.

Q14. Derive the conditions for the optical gain and loss in any optical /semiconductor materials. and discuss on which factors the optical gain loss depends in optical /semiconductor materials

Q15. Describe the colinear four-point probe method used to obtain the resistivity of semiconductor materials using appropriate diagrams and expressions. How is it different for bulk and thin materials?
