B.Tech. 1st Semester

(Artificial Intelligence & Data Science) H Scheme

Examination, December-2025

Semiconductor Physics

Paper : 25BSC-PHY-103H

Time allowed : 3 Hours] *[Maximum marks : 70*

Note: *Attempt **five** questions in total. **Question No. 1 is compulsory** and contains 10 short-answer questions, out of which any **seven** are to be attempted. For the remaining four questions, attempt **one** question from each unit. All questions carry equal marks.*

1. Attempt any **seven** sub-questions : 7×2=14

(i) Write limitations of classical physics.

(ii) State de Broglie's hypothesis.

(iii) Define the Compton Effect.

(iv) Draw the E-k diagram for a one-dimensional periodic potential.

(v) Define Fermi energy. Also sketch the Fermi-Dirac distribution at different temperatures.

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(vi) Differentiate drift current and diffusion current.

(vii) Write a short note on LED.

(viii) Define population inversion.

(ix) If a He-Ne laser emits light of wavelength 632.8 nm. calculate the energy of a single photon. (Given h = 6.626×10^{-34} J.s.)

(x) What do you mean by Black body?

Unit-1

2. (a) Derive the time-independent Schrodinger wave equation. 10

(b) State the physical significance of the wave function and list its important properties. 4

3. **(a) Obtain the allowed energy levels and the wave functions for a particle confined in a one-dimensional box.** 10

(b) An electron of mass 9.1×10^{-31} kg is confined in a one-dimensional box of length 2×10^{-10} m. Calculate its ground-state energy (n = 1). (Given h = 6.626×10^{-34} J.s.) 4

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Unit–II

(a) Describe Drude's classical theory of free electrons in metals and use it to explain Ohm's law. 10

(b) Write short notes on direct and indirect band gaps. 4

Write a detailed note on the Kronig-Penney model for electrons in periodic potentials and explain the main conclusions. 14

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Unit–III

(a) Derive expressions for charge-carrier concentration and the Fermi energy for n-type semiconductor. 10

(b) Explain the working of a P-N junction diode under forward and reverse bias. 4

Write short notes an any **two** : $2\times7=14$

(a) Solar cell

(b) Light-emitting diode (LED)

(c) Photoconductive cell

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Unit–IV

8. (a) Discuss the phenomena of stimulated absorption, spontaneous emission and stimulated emission, and derive the relations between Einstein's coefficients B_{12}, B_{21} and A_{21}. 10

(b) State the important properties of laser radiation. 4

9. (a) Discuss the construction, working and energy-level diagram of the He-Ne laser. 10

(b) List the important applications of laser radiation. 4

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