Reg. No.															

B.Tech / M.Tech (Integrated) DEGREE EXAMINATION, JULY 2023

First / Second Semester

21PYB102J - SEMICONDUCTOR PHYSICS AND COMPUTATIONAL METHODS

(For the candidates admitted from the academic year 2021-2022 & 2022-2023)

Note:

(i) **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40th minute.

(ii) **Part - B** and **Part - C** should be answered in answer booklet.

Time: 3 Hours Max. Marks: 75

	Marks	BL	CO	PO

PART – A (20 × 1 = 20Marks)

Answer **ALL** Questions

1. Choose the correct expression for the band gap (E_g) of materials from the following? — 1 | 1 | 1 | 1

   (A) $E_g = E_c + E_v$ (B) $E_g = E_c - E_v$

   (C) $E_g = (E_c - E_v)/2$ (D) $E_g = (E_c + E_v)/2$

2. The range of wave number (k) for the first Brillouin zone is _____. — 1 | 1 | 1 | 1

   (A) $-\pi/a$ to π/a (B) 0 to π/a

   (C) $-2\pi/a$ to $2\pi/a$ (D) 0 to $2\pi/a$

3. In a metal, the electron always move _____ in the absence of electric field. — 1 | 2 | 1 | 1

   (A) With constant velocity (B) In the direction of electric field

   (C) With drift velocity (D) Randomly

4. Phonon is a quantum of . — 1 | 2 | 1 | 1

   (A) Lattice vibrations (B) Electromagnetic energy

   (C) Magnetic energy (D) Gravitational energy

5. In LED, what is the shape of domes made from plastics used to minimize the losses caused by bulk absorption thereby increasing the external efficiency? — 1 | 1 | 2 | 1

   (A) Spherical (B) Octahedral

   (C) Hexagonal (D) Hemi spherical

6. Auger generation/recombination is also known as _____. — 1 | 1 | 2 | 1

   (A) Two particle transitions (B) Three particle transitions

   (C) Four particle transitions (D) Single particle transitions

7. If "n" and "p" denotes the number of electrons in the conduction and holes in the valence band, for an intrinsic semiconductor _____. — 1 | 2 | 2 | 1

   (A) $n > p$ (B) $n < p$

   (C) $n = p$ (D) $n \geq p$

8. To obtain an p-type semiconductor, an intrinsic semiconductor is doped with which of the below? 1 2 2 1
   (A) Phosphorous (B) Nitrogen
   (C) Arsenic (D) Boron

9. If the number of upward transition per seconds exceeds the number of downward transition, _____ is achieved 1 2 3 3
   (A) Optical gain (B) Optical loss
   (C) Equilibrium (D) Absorption

10. Which of the below is an inter band transition? 1 1 3 3
   (A) Impurity to band transition (B) Band to band transition
   (C) Free carrier transition (D) Phonon transition

11. The generation of electron-hole pairs by the incidence of light followed by their radiative recombination is known as 1 2 3 3
   (A) Photoluminescence (B) Electroluminescence
   (C) Thermoluminescence (D) Cathodoluminescence

12. The Fermi's golden rule helps to identify the _____ 1 1 3 3
   (A) Momentum of electrons (B) Velocity of light
   (C) Absorption energy of electron (D) Transition rate per unit volume

13. If the Hall voltage is positive in, the sample is a _____. 1 2 4 1
   (A) Insulator (B) n-type semiconductor
   (C) Conductor (D) p-type semiconductor

14. If the measured voltage is positive in hot point probe method, the sample is a _____. 1 2 4 1
   (A) n-type semiconductor (B) p-type semiconductor
   (C) Insulator (D) Conductor

15. The resistance of a material is inversely proportional to the _____. 1 2 4 1
   (A) $Length^2$ (B) Length
   (C) Area of cross section (D) Area×Length

16. In four probe method, the outer two contacts are connected to _____. 1 2 4 1
   (A) Galvanometer (B) Variable resistor
   (C) Voltmeter (D) Current source

17. The notation for arm chair carbon nanotube can be written as _____. 1 1 5 3
   (A) (n, 0) (B) (n, n)
   (C) (n, m) (D) (0, m)

18. High resolution Transmission electron microscopy helps us to see the _____ of the sample. 1 1 5 3
   (A) Inside (B) Surface texture
   (C) Atoms/Planes (D) Electrons

19. In a 1D material, the density of states is _____. 1 2 5 3
   (A) Proportional to $E^{-1/2}$ (B) Proportional to $E^{1/2}$
   (C) Independent of E (D) Proportional to E^2

		Marks	BL	CO	PO
20.	The material size is reduced in one direction and the electron can move freely only in two directions in _____. (A) Bulk (B) Quantum dot (C) Thin sheets (D) Quantum wire	1	1	5	3

PART – B (5 × 8 = 40 Marks)

Answer **ALL** Questions

		Marks	BL	CO	PO
21. a.	Deduce an expression of the density of states (DOS) of electrons in a 3-dimensional material.	8	3	1	1
	(OR)				
b.	What are the assumptions of classical free electron theory? Write any two merits and demerits of this theory.	8	3	1	1
22. a.	What is continuity equation? Derive the continuity equations for electrons in one dimensional semiconductor.	8	4	2	1
	(OR)				
b.	What is OLED? Describe the structure of OLED with necessary diagram.	8	4	2	1
23. a.	What are spontaneous and stimulated emissions? Obtain the relation between Einstein coefficients of spontaneous and stimulated emissions.	8	3	3	3
	(OR)				
b.	Define optical joint density of states. Derive the expression for optical joint density of states.	8	3	3	3
24. a.	What is Four point probe method? Explain how to measure the resistivity of a given material using linear four-probe technique with neat schematic.	8	3	4	1
	(OR)				
b.	Explain the Hall effect with a schematic diagram. Derive the expression for Hall coefficient of a p-type semiconductor.	8	3	4	1
25. a.	Discuss the classifications of carbon nanotubes according to the geometry. Also write their applications.	8	3	5	3
	(OR)				
b.	Discuss in details about the preparation of nanomaterials using chemical vapour deposition (CVD) technique with appropriate schematic.	8	3	5	3

PART – C (1 × 15 = 15 Marks)

Answer **ANY ONE** Question

		Marks	BL	CO	PO
26.	Explain the construction and working principle of scanning electron microscope (SEM) with neat schematic. Differentiate between SEM and TEM.	15	4	5	3
27.	Discuss about Fermi's golden rule. Deduce the expression for the net upward transition rate (R_n) in a semiconductor using Fermi's golden rule.	15	4	3	3

* * * * *