Reg. No.															

B.Tech/ M.Tech Integrated DEGREE EXAMINATION, MAY 2024
First and Second Semester

21PYB102J – SEMICONDUCTOR PHYSICS AND COMPUTATIONAL METHODS
(For the candidates admitted from the academic year 2022-2023 onwards)

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

PART – A (20 × 1 = 20 Marks)
Answer **ALL** Questions

	Marks	BL	CO	PO
1. According to Quantum free electron theory, the free electrons move with _____ potential. (A) Zero (B) Constant (C) Infinite (D) Different	1	1	1	1
2. As stated in band theory of solids, which of the following has a zero band gap. (A) Metal (B) Semi conductor (C) Insulator (D) Both insulator and semi conductor	1	1	1	1
3. The range of wave number (k) for the first Brillouin zone is _____ (A) $-\pi/a$ to π/a (B) 0 to π/a (C) $-2\pi/a$ to $2\pi/a$ (D) 0 to $2\pi/a$	1	1	1	1
4. Which of the following method uses primitive cell approach to compute electronic band structure computationally? (A) Weigher – seitz method (B) APW method (C) Pseudopotential method (D) Tight bonding method	1	2	1	1
5. The fermi level in a N-type semi conductor _____ with increase in temperature. (A) Becomes zero (B) Decreases (C) Remain unchanged (D) Increases	1	2	2	1
6. For a PN junction diode, the current in reverse bias may be _____ (A) Few milliamperes (B) Several amperes (C) Few microamperes to nanoamperes (D) Few milliamperes to several amperes	1	1	2	1
7. Which process of the electron hole pair is responsible for emitting of light? (A) Generation (B) Ionisation (C) Recombination (D) Diffusion	1	1	2	1

8. Photodiode operate on ____ 1 1 2 1
   (A) Reverse bias (B) Forward bias
   (C) Without bias (D) Ohmic junction

9. Optical processes directly involve _____ absorption and emission 1 2 3 3
   (A) Photon (B) Electron
   (C) Hole (D) Neutron

10. 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

11. 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

12. The optical joint density of states is proportional to 1 1 3 3
   (A) The square root of the energy (B) Square of the energy
   (C) Independent of energy (D) Cube of the energy

13. Two probe technique is suitable for measuring electrical resistivity of ____ samples. 1 1 4 1
   (A) Low resistivity (B) High resistivity
   (C) Magnetic (D) Biological

14. A _____ is a method of determining quickly whether a semiconductor sample is n typer (or) p type. 1 1 4 1
   (A) Two point probe (B) Four point probe
   (C) Hot point probe (D) Capacitance – voltage

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

16. TCAD is a computer simulation technique that is widely used in the semiconductor industry. TCAD is an acronym for 1 1 4 1
   (A) Technology Computer Aided Design (B) Technology Computer Aided Development
   (C) Technology Computer Advances Design (D) Technology Computer Applications Design

17. Nanostructures have sizes in between _____ 1 1 5 3
   (A) 1 and 100 Å (B) 1 and 100 nm
   (C) 100 and 1000 nm (D) 1 and 1000 mm

18. Carbon nanotube reactivity is related to _____ 1 1 5 3
   (A) Volume (B) Length
   (C) Diameter (D) Breadth

19.	In chemical vapour deposition, the precessors are introduced to the reaction chamber in the _____ state. (A) Liquid (B) Solid (C) Gaseous (D) Semisolid	1	1	5	3
20.	AFM tip should have a radius of curvature of _____ (A) Greater than 20 – 50 nm (B) Less than 20 – 50 nm (C) 100 nm (D) 100 to 100 nm	1	2	5	3

PART – B (5 × 8 = 40 Marks)
Answer **ALL** Questions

		Marks	BL	CO	PO
21. a.	What are the assumptions of classical free electron theory? Write any two merits and demerits of this theory.	8	3	1	1
	(OR)				
b.	Analyze the occupation probability of a given energy level using the Fermi-Dirac distribution with a neat diagram.	8	4	1	1
22. a.i.	Discuss about the diffusion current and obtain the equation for diffusion current.	4	2	2	1
ii.	Calculate the wavelength of light emission from GaN whose band gap is 3.4 eV.	4	3	2	1
	(OR)				
b.	What is OLED? Describe the structure of OLED with necessary diagram.	8	4	2	1
23. a.i.	Explain the concept of optical transition in bulk semiconductors with neat diagram.	6	8	3	3
ii.	Determine the conversion efficiency of the solar cell, it short – circuit current (Isc) = 3.5 A, open – circuit voltage (Voc) = 0.6 V, Fill Factor (FF) = 0.7 and Input power (P_{in}) = 10 W.	2	4	3	3
	(OR)				
b.	Derive the expression for density of states of photon.	8	4	3	3
24. a.	Discuss the four point collinear probe method for bulk material and thin sheet resistance.	8	2	4	1
	(OR)				
b.	Explain the Hall effect with necessary diagram. Derive the expression for Hall coefficient of a N-type semiconductor.	8	3	4	1
25. a.	Explain the working concept of physical vapour deposition method (PVD) with neat sketch.	8	3	5	3
	(OR)				
b.	Analyse the working concept, specimen interaction and utilization of Transmission Electron Microscopy (TEM) with neat diagram.	8	2	5	3

PART – C (1 × 15 = 15 Marks)

Answer **ANY ONE** Question

		Marks	BL	CO	PO
26.i.	What is Density of states? Derive an expression for density of states of a bulk semiconducting material with neat diagram.	10	4	1	1
ii.	Illustrate the variation of Fermi-level with temperature of N-type semiconductor.	5	3	2	1
27.	Explain working and construction of a photovoltaic cell. Describe in detail solar cell characteristics curve also relate the below terms used to measure the efficiency of solar cells. i. Short circuit current ii. Open circuit voltage iii. Fill factor iv. Power maximum.	15	3	3	1

* * * * *