

Roll No



**PRESIDENCY UNIVERSITY
BENGALURU**

**SCHOOL OF ENGINEERING
END TERM EXAMINATION – MAY/JUNE 2024**

SET-A

Semester : Semester II -2023

Course Code : PHY1002

Course Name : Optoelectronics and Device Physics

Program : B.Tech

Date: June 13, 2024

Time: 1:00 PM - 4:00 PM

Max Marks: 100

Weightage: 50%

Instructions:

- (i) Read all questions carefully and answer accordingly.
- (ii) Question paper consists of 3 parts.
- (iii) Scientific and non-programmable calculator are permitted.
- (iv) Do not write any information on the question paper other than Roll Number.

PART A

ANSWER ANY TEN QUESTIONS

10Q X 2M=20M

1. Draw the energy band diagram of extrinsic Semiconductors. (CO1) [Knowledge]
2. Define the Hall effect. (CO1) [Knowledge]
3. Define Fermi energy. (CO1) [Knowledge]
4. What is a PN junction diode? (CO2) [Knowledge]
5. Define knee voltage and break down voltage in zener diode. (CO2) [Knowledge]
6. What is a solar cell? (CO2) [Knowledge]
7. What are the properties of matter waves? (CO3) [Knowledge]
8. Electron and proton are moving with same momentum, find the relation between their de Broglie wavelengths. (CO3) [Knowledge]
9. What is the de-Broglie wave length of a particle at rest? (CO3) [Knowledge]
10. What is population inversion? (CO4) [Knowledge]

11. Write two advantages of optical fiber communication.

(CO4) [Knowledge]

12. What happens if light travels from optically denser to rarer medium with angle of incidence at critical angle?

(CO4) [Knowledge]

PART B

ANSWER ANY EIGHT QUESTIONS

8Q X 5M=40M

13. A semiconducting crystal with 10mm long, 3mm wide, and thick has a magnetic flux density 0.5 Wbm^{-2} applied from front to back perpendicular to the largest faces. When a current of flows lengthwise through the specimen, the voltage measured across its width is found to be $47 \mu\text{V}$. What is the Hall coefficient of this semiconductor?

(CO1) [Comprehension]

14. In between electron and electron, there exists attraction instead of repulsion. Identify the theory behind this concept and discuss it with a neat diagram.

(CO1) [Comprehension]

15. The band gap between the valence and the conduction band in Tin oxide is 3.2 eV. An electron in the conduction band combines with a hole in the valence band and the excess energy is released in the form of electromagnetic radiation. Find the maximum wavelength that can be emitted in this process. Also mention the color.

(CO2) [Comprehension]

16. It has been noted that, a pn junction device can be used as a voltage regulator. Name the device and describe its V-I characteristics.

(CO2) [Comprehension]

17. Compute the de Broglie wavelength for a neutron moving with one eighth part of velocity of light, given mass of neutron is $1.674 \times 10^{-27} \text{ kg}$.

(CO3) [Comprehension]

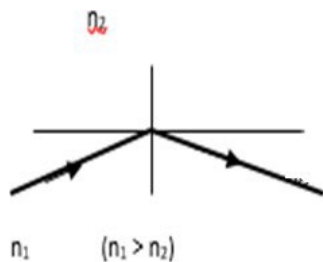
18. What is the minimum uncertainty in the velocity of an electron if the uncertainty in its position is located within 1 \AA ?

(CO3) [Comprehension]

19. Calculate the numerical aperture, and acceptance angle in an optical fiber. Given, the refractive indices of core and cladding are 1.43 and 1.42 respectively.

(CO4) [Comprehension]

20. Explain the concept represented below.



(CO4) [Comprehension]

21. The position and momentum of a 12 keV electron are determined simultaneously. If its position is located within 1.1 \AA , what is the percentage uncertainty in its momentum?

(CO3) [Comprehension]

22. The following interaction was found to result in the emission of light waves.

$$A^* = A + h\nu$$

Identify the interaction and explain.

(CO4) [Comprehension]

PART C

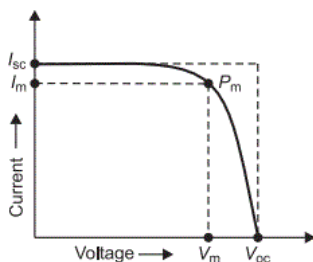
ANSWER ANY FOUR QUESTIONS

4Q X 10M=40M

23. a) A superconducting tin has a critical temperature of 3.9 K at zero magnetic field and a critical field of 0.038 Tesla at 0 K. Find the critical field at 5.2 K.
 b) The Hall coefficient of certain silicon specimen was found to be $-6.35 \times 10^{-5} \text{ m}^3 \text{ C}^{-1}$ at 100K. Calculate the number of charge carriers and determine the nature of the semiconductor.

(CO1) [Application]

24. The V-I characteristics of a certain pn junction device is given below.



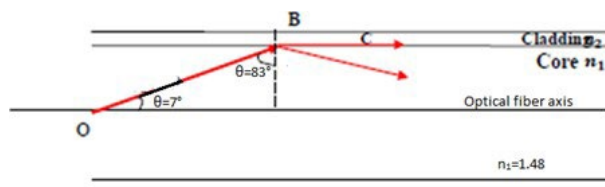
- a) Identify the device and explain its construction, principle and working.
 b) Calculate the fill factor if $I_{SC} = 20 \text{ mA}$, $V_{OC} = 0.7 \text{ V}$ and a maximum power output of 14 mW.

(CO2) [Application]

25. a) Compare the energy of a photon with that of a neutron when both are associated with a de Broglie wavelength of 1.4 Å. Given mass of neutron is $1.67 \times 10^{-27} \text{ kg}$.
 b) It is noticed that there is equal uncertainty in the velocities of two particles, A and B, with masses of $1.3 \times 10^{-26} \text{ kg}$ and $1.5 \times 10^{-32} \text{ kg}$, respectively. What is the minimum amount of uncertainty that their positions will have?

(CO3) [Application]

26. a) The ratio of population of two energy levels in a laser system is 1.3×10^{-32} . Calculate the temperature of the system at which the wavelength of light emitted is 638 nm.
 b) Analyze the following figure and calculate the cladding refractive index and numerical aperture.



(CO4) [Application]

27. It is observed that, a pn junction device emits light when forward biased. Identify the device and explain its construction, principle, working and VI characteristics.

(CO2) [Application]

28. It is observed that, a light source emits high intense, coherent and monochromatic light continuously. With suitable diagrams, explain the principle behind this emission.

(CO4) [Application]