Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING
END TERM EXAMINATION - MAY/JUNE 2024

SET - B

Semester : Semester II - 2023
Course Code : PHY1002
Course Name : Optoelectronics and Device Physics
Program : B.Tech

Date : June 13, 2024
Time : 01:00 PM - 04:00 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. Give two examples of materials that exhibit type I superconductivity
(CO1) [Knowledge]
2. How are solids classified based on band theory.
(CO1) [Knowledge]
3. Write any two applications of semiconductors.
(CO1) [Knowledge]
4. Name the device which emits light when forward biased.
(CO2) [Knowledge]
5. Write one application of Zener diode.
(CO2) [Knowledge]
6. Define Fermi Level.
(CO1) [Knowledge]
7. Find the de Broglie wavelength of the electron when it is accelerated through a potential difference of 100V.
(CO3) [Knowledge]
8. According to Heisenberg's Uncertainty Principle, the product of uncertainty in position and momentum is greater than or equal to which factor?
(CO3) [Knowledge]
9. What are matter waves ?
(CO3) [Knowledge]

10. What happens if light travels from optically denser to rarer medium with angle of incidence more than critical angle?

(CO4) [Knowledge]

11. How long an atom can stay in normal excited energy state?

(CO4) [Knowledge]

12. In which energy state atoms can stay for millisecond duration?

(CO4) [Knowledge]

PART B

ANSWER ANY EIGHT QUESTIONS **8Q X 5M=40M**

13. It is possible to shift a superconductor to normal conductor below Tc by applying magnetic field. Explain the concept with suitable diagram.

(CO1) [Comprehension]

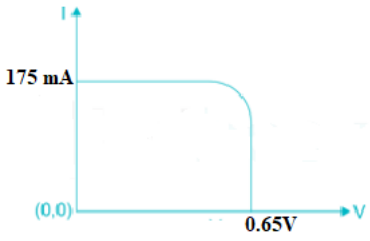
14. A semiconducting crystal with $12mm$ long, $5mm$ wide, and $1mm$ thick has a magnetic flux density $0.5Wbm^{-2}$ applied from front to back perpendicular to the largest faces. When a current of $20mA$ flows lengthwise through the specimen, the voltage measured across its width is found to be $37\mu V$. What is the Hall coefficient of this semiconductor?

(CO1) [Comprehension]

15. The band gap between the valence and the conduction band in zinc oxide (ZnO) is 3.05 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. The following figure shows the I- V characteristics of a solar cell illuminated uniformly with a solar light of power 120 mW/cm^2. The solar cell has an area of 5 cm^2 and a fill factor of 0.62. What is the maximum efficiency of the device?



(CO2) [Comprehension]

17. Paricles A and B having masses ‘m’ and ‘4m’ are moving with same kinetic energies, Calculate the ratio of de Broglie wavelength of particle A to B.

(CO3) [Comprehension]

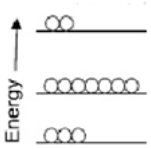
18. According to de Broglie hypothesis, all the material particles in motion should exhibit wave nature. Based on this, show that, the wavelength for an electron accelerated by a potential difference of V volt is $\lambda = 1.226/\sqrt{V}$ *nm.* .

(CO3) [Comprehension]

19. Find the population of the two states in a diode laser that produces a light of wavelength 528 nm at 32°C.

(CO4) [Comprehension]

20. Explain the concept represented in the following figure.



(CO4) [Comprehension]

21. Calculate the uncertainty in the momentum of an electron if uncertainty in its position is 1.3 Å.

(CO3) [Comprehension]

22. The following interaction was found to result in the emission of monochromatic, highly intense light waves.

$A^* + h\upsilon = A + 2h\upsilon$

Identify the interaction and explain.

(CO4) [Comprehension]

PART C

ANSWER ANY FOUR QUESTIONS **4Q X 10M=40M**

23. a) When a current-carrying conductor or a semiconductor is introduced to a perpendicular magnetic field, a voltage can be measured at the right angle to the current path. Identify and explain the concept.

b) Estimate the fraction of electrons in the conduction band at 220 K for a material whose energy band gap is 0.92 eV.

(CO1) [Application]

24. It is observed that, an optoelectronic device creates a significant voltage when exposed to sunlight. Identify the device and explain its construction, principle, working and VI characteristics.

(CO2) [Application]

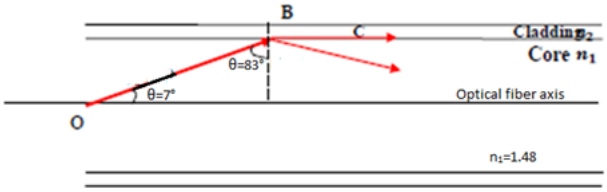
25. a) Assume that the accuracy of an electron's velocity within an atom is$1.8 \times 10^3 ms^{-1}$. What is the minimum uncertainty in position of the electron and how does it compare to the atom's approximate size of 0.2 nm?

b) Compare the energy of a photon with that of an electron when both are associated with a de Broglie wavelength of 2.2 Å.

(CO3) [Application]

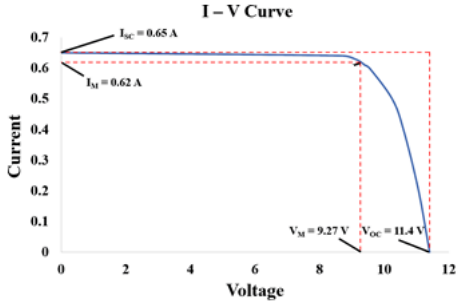
26. a) The ratio of population of two energy levels in a laser system is 1.3×10^{-32}. Calculate the temperature of the system at which the wavelength of light emitted is 6234 Å.

b) Analyze the following figure and calculate the cladding refractive index and numerical aperture.



(CO4) [Application]

27. Analyse the following figure and calculate the ideal power, maximum power, efficiency and fill factor.



(CO2) [Application]

28. It is observed that light signal can be used to transfer information over long distances with negligible energy loss. With a neat labelled block diagram explain the concept.

(CO4) [Application]