QP Code:PH1T01A-8 **(Pages: 3)**

Reg No : .... Name : ....

MAR ATHANASIUS COLLEGE OF ENGINEERING, KOTHAMANGALAM

(Govt. Aided Autonomous Institution)

Second Semester B.Tech. Degree Examination, May, 2026

Course Code: B24PH1T01A

Course Name: ENGINEERING PHYSICS (A)

(For EEE Branch)

Max. Marks: 100 Duration:3 Hours

PART - A: 30 Marks (10 Qns x 3 Marks)

Answer all questions

1. Why is numerical aperture important in optical fibers?
2. Estimate the number of photons emitted per second from a 2.5mW laser working at a wavelength of 632.8 nm.
3. Compare the de-Broglie wavelengths of an electron and a proton, traveling at identical, low speeds. (Hint: $m_p \approx 2000 m_e$)
4. Write the expression for the probability of finding a particle inside an interval of length Δl around a point x_0 if the wavefunction for the particle is given by $\psi(x)$. Assume that $|\psi|^2$ remains a constant within the interval.
5. Define Fermi energy.
6. Write the expression for the intrinsic carrier concentration in a semiconductor in terms of the bandgap energy.
7. Explain the variation of Fermi level with acceptor concentration. Write the relevant equation.
8. What happens to the Fermi level at absolute zero in an n type semiconductor? Write the relevant equation.
9. How does the built-in potential of the pn junction help in generating a current when a solar cell is illuminated?
10. What is the role of holes and electrons in the charge flow across a forward-biased pn junction?

PART - B: 70 Marks (5 Qns x 14 Marks)

Answer any One full question from each module.

Module 1

11. a. Outline the working of Ruby laser. (10 Marks)

    b. Mention the applications of optical fibre. (4 Marks)

OR

12. a. Establish the relation between Einstein's coefficients. (10 Marks)

b. List the conditions for sustained lasing. (4 Marks)

Module 2

13. a. Show that the energy levels of an electron in a one dimensional potential well are discrete. (10 Marks)

b. An electron is accelerated through a potential difference of 300V. Find the de-Broglie wavelength. (4 Marks)

OR

14. a. Derive Schrodinger's time independent equation for a one dimensional system. (10 Marks)

b. Find the speed of a neutron that has a de-Broglie wavelength of $1.0 \times 10^{-10} m$. Given, the mass of neutron $= 1.675 \times 10^{-27} kg$. (4 Marks)

Module 3

15. a. State the law of mass action for semiconductors. Prove that the product $n_e n_h$ does not depend on E_F. (10 Marks)

b. Fermi energy of Potassium is 2.1eV. What are the energies for which the probability of occupancy at 300K are 0.99 and 0.01 respectively? (4 Marks)

OR

16. a. Derive the density of holes in the valance band of an intrinsic semiconductor. Explain the significance of parameters like the effective density of states, and temperature. (10 Marks)

b. Given that the band gap energy of an intrinsic semiconductor is 1.1 eV and the temperature is 300K, calculate the position of the Fermi level with respect to the midgap. Assume (a) $m_e^* \approx m_h^*$, (b) $m_e^* = 0.8 m_h^*$ (4 Marks)

Module 4

17. a. Derive the equation for the temperature dependence of the electron concentration in an n-type semiconductor. (10 Marks)

b. Find the position of Fermi level at $300K$ for n-type silicon relative to the conduction band edge. Given $N_d = 10^{16} cm^{-3}$, $N_c = 2.8 \times 10^{19} cm^{-3}$. (4 Marks)

OR

18. a. Prove that the density of holes in the valance band is proportional to the square root of the acceptor concentration. (10 Marks)

b. In an extrinsic semiconductor the number density of holes is $5 \times 10^{20} m^{-3}$. If the intrinsic carrier concentration is $1.3 \times 10^{15} m^{-3}$, find the number density of electrons. (4 Marks)

Module 5

19. a. Explain the principle of operation of a light emitting diode. (10 Marks)

b. Determine the wavelength of light from an LED fabricated with CdS with bandgap of $2.42eV$. (4 Marks)

OR

20. a. Describe the depletion region and its significance using an energy band diagram. (10 Marks)

b. Describe the diffusion of charge carriers across a pn junction, based on the energy band diagram. (4 Marks)

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