MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY
DEPARTMENT OF PHYSICS

EXAMINATION: End-Term Examination **MONTH & YEAR: December, 2024**

Course: B.Tech. **Semester: I** **Subject: Physics**
Time: 2 hr. **Subject Code: PHY24102**
Note: Attempt all questions **Max. Marks: 40**

Q. No.		Questions	Marks	COs
1.	a.	Derive an expression for the intensity distribution in the Fraunhofer diffraction pattern produced by a single slit. Discuss the conditions for principal maxima and minima.	5	CO5
	b.	Explain the missing order in double slit diffraction pattern. Deduce the missing orders for a double slit Fraunhoffer diffraction pattern, if the slit widths are 0.16 mm and they are 0.8 mm apart.	3	CO3
2.	a.	An electron is moving in a one-dimensional box of width $a = 1$ Å. If the wave function of the first excited state $\psi(x) = \sqrt{\frac{2}{a}}\, Sin\left(\frac{2\pi x}{a}\right)$, then determine the probability of locating an electron between $x = 0$ to $x = 0.5$ Å in that quantum state.	4	CO4
	b.	Establish the relationship between the phase velocity and group velocity in a dispersive medium.	3	CO2
	c.	Explain whether the wave functions $\Psi(x) = \mathrm{A}\tan(x)$ is allowed to describe the quantum behaviour of a particle or not.	1	CO2
3.	a.	Using the Fermi-Dirac distribution function find the temperature at which there is 1% probability that a state with energy 2 eV is occupied. Given that Fermi energy is 1.5 eV. ($k_B = 8.61 \times 10^{-5}$ eV)	3	CO4
	b.	Briefly mention the principle of operation of a photocell.	2	CO1
	c.	The current gain of an *n-p-n* transistor working in CB mode is 0.98. If the emitter current is 2 mA and the reverse saturation current (leakage current) is 10μA, calculate the base current and the collector current.	3	CO5
4.	a.	A cyclotron with its dees of radius 2 m has a magnetic field of 0.75 Wb/m^2, calculate the maximum energies to which a Proton can be accelerated. (Given: Mass of Proton = 1.67 x 10^{-27} kg, Charge on Proton = 1.6 x 10^{-19} C)	3	CO3
	b.	Elaborate the construction and working of the Bainbridge mass spectrograph.	4	CO2
	c.	What is the role of the time-varying magnetic field in the Betatron?	1	CO2
5	a.	Illustrate the working principle of a He-Ne laser with a labeled diagram.	3	CO1
	b.	A spaceship is moving at a speed of 0.8c relative to an observer on Earth. If 1 hour passes on the spaceship, calculate how much time has passed on Earth. (c = 3 × 10^8 m/s)	3	CO5
	c.	State and derive Bethe's Law. How is it analogous to Snell's law?	2	CO1