Question Paper

Exam Date & Time: 31-May-2023 (09:30 AM - 12:30 PM)

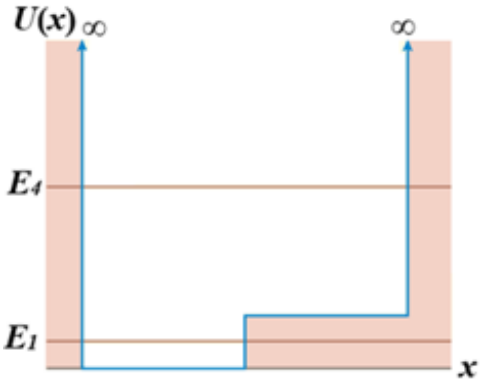
MANIPAL ACADEMY OF HIGHER EDUCATION

SECOND SEMESTER B.TECH. EXAMINATIONS - MAY/JUNE 2023
SUBJECT: PHY 1071-PHY/ PHY 1071-B/ PHY 1051-B - ENGINEERING PHYSICS

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

1A)	Explain why do we need coherent light source in Young's double slit experiment? Derive an expression for linear positions of bright and dark fringes in double slit interference pattern.	(5)
1B)	A screen is placed 50.0 cm from a single slit, which is illuminated with light of wavelength 690 nm. If the distance between the first and third minima in the diffraction pattern is 3.00 mm, what is the width of the slit?	(3)
1C)	How do you justify that the quantum harmonic oscillator never be at rest?	(2)
2A)	Explain the following terms with reference to lasers: i) Spontaneous emission ii) Stimulated emission	(5)
2B)	A step index optical fiber 63.5 μm in core-diameter has a core of refractive index 1.53 and a cladding of index 1.39. Determine (a) the numerical aperture for the fiber, (b) the critical angle for core-cladding interface, (c) the acceptance cone half-angle (the maximum entrance angle).	(3)
2C)	In the Lennard-Jones model of the hydrogen atom, the potential is given by $U = \frac{A}{r^{12}} - \frac{B}{r^6}$. In this model, the minimum internuclear separation is $r_o = \left(\frac{A}{2B}\right)^{1/6}$. State whether this statement is TRUE or FALSE; Justify your answer.	(2)
3A)	(i) What is the Compton effect? (ii) Sketch the graph of scattered X-ray intensity versus wavelength for scattered X-ray angle at θ = 0˚, θ = 45˚ and θ = 135˚. (iii) Derive an expression for Compton shift.	(5)
3B)	A FM radio transmitter operates at a frequency of 98.3 MHz, having a power output of 134 kW. Calculate the number of photons per second emitted by the transmitter. Also, calculate the total energy (in eV) transmitted by FM radio in 10 seconds.	(3)
3C)	The temperature of two perfect blackbodies, A and B, are 400 K and 200 K, respectively. If the surface area of A is twice that of B, then determine the ratio of total power radiated by A to that of B.	(2)
4A)	Solve the Schrodinger equation and derive an expression for the normalized wave function for a particle of mass m in an infinite one-dimensional potential well [box] of width L and potential zero inside the well. Sketch wave functions for the allowed quantum states n = 1 and n = 4 for the potential-energy well given in the figure below.	(5)



4B) An electron trapped in an infinite potential well of width 15 nm absorbs a photon of frequency 4.86×10^{12} Hz and jumps from an even-numbered excited state to the next higher even-number excited state. Find the two excited states. (3)

4C) What are intrinsic and extrinsic semiconductors? Can you explain the different types of extrinsic semiconductors with suitable examples? (2)

5A) Derive an expression for density-of-states function for an electron in metals. (5)

5B) The cesium iodide (CsI) molecule has an atomic separation of 0.127 nm. (a) Determine the energy of the second excited rotational state, with J = 2. (b) Find the frequency of the photon absorbed in the J = 1 to J = 2 transition. The atomic masses of cesium and iodine are 132.9u and 126.9u respectively. (Given: 1u = 1.66×10^{-27} kg.) (3)

5C) What is quantum confinement and how does it affect the properties of materials at the nanoscale? (2)

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