Question Paper

Exam Date & Time: 13-Jan-2024 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

FIRST SEMESTER B.TECH. DEGREE EXAMINATIONS -JANUARY 2024
SUBJECT: PHY 1071 / PHY-1071 - ENGINEERING PHYSICS

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

Answer all the questions.

1A)	Why shape of the interference fringes are circular in Newtons rings experiment? With a labelled diagram, obtain an expression for the radii of m^{th} dark rings.	(5)
1B)	The first-order diffraction maximum is observed at 12.6° for a crystal having a spacing between planes of atoms of 0.250 nm. a) What wavelength X-ray is used to observe this first-order pattern? b) At what angle, second order maximum is observed? c) How many orders can be observed for this crystal at this wavelength?	(3)
1C)	Show that the energy levels are equally spaced in a simple harmonic quantum oscillator.	(2)
2A)	Derive the relation between rate of spontaneous and rate of stimulated emission in terms of the Einstein's coefficients, A and B.	(5)
2B)	A step index optical fibre 63.5 mm 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 fibre, b) the critical angle for core-cladding interface, c) the acceptance cone half-angle (the maximum entrance angle)	(3)
2C)	What are superconductors? Draw a representative graph of resistance versus temperature for a superconductor.	(2)
3A)	What is Compton effect? Illustrate the results of the compton effect experiment using necessary diagrams.	(5)
3B)	Molybdenum has a work function of 4.2 eV. a) Find the cut off wavelength and cut off frequency for the photoelectric effect. b) What is the stopping potential if the incident light has wavelength of 180 nm? (1 eV = $1.6x10^{19}$ J and $h=6.63x10^{-34}$ J-s)	(3)
3C)	An electron has a kinetic energy of 3.0 eV. The corresponding wavelength of electrons is 413 nm. State whether it is true or false. Justify the statement.	(2)
4A)	By solving the Schrödinger equation, obtain an expression for the energy of a particle in an infinite potential well [box].	(5)
4B)	An electron is trapped in the 1-dimensional infinite potential well of width 15 nm. The electron requires 0.025 eV energy to jump between two consecutive excited states. Find both the quantum states.	(3)
4C)	A light-emitting diode (LED) made of the semiconductor GaAsP emits red light of wavelength 650 nm. Determine the energy-band gap for this semiconductor.	(2)
5A)	Derive the expression for the rotational energy of a diatomic molecule using a suitable diagram. Sketch the schematic of these rotational energy levels.	(5)

5B)	Determine the ratio of permissible energy levels for a system of confined electrons in a three-dimensional box at energy levels of 7.50 eV and 5.00 eV. Calculate the ratio of occupied energy levels at 7.50 eV to the number of energy levels at the Fermi energy. Given that Copper has a Fermi energy of 5.0 eV at 300 K.	(3)
5C)	Explain the concept of quantum confinement. How does quantum confinement influence the optical properties of nanomaterials?	(2)

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