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T.Y.B.Sc. (NCF-NCP) (Sem.-V) Examination March - 2026

Physics-Mathematical Methods And Quantum Theory (PH-MJ3-503)

[Total Marks: 25

સૂચના : / Instructions

(1) ઉપરોક્ત દર્શાવેલ વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fill up strictly the above details on your answer book
(2) Draw neat diagrams wherever necessary.
(3) Symbols used in the paper have their usual meaning.
(4) Figures to the right indicate full marks of the question.
(5) Scientific non-programmable calculator may be used.

Seat No.:

Student's Signature

Q.1. Answer any five of the following questions in short: **05**

i. What do you mean by degree of a differential equation?
ii. What do you mean by a series solution?
iii. State the difference between an ordinary differential equation and a partial differential equation.
iv. What is the normalization condition in the spherical polar coordinate system for the radial part of the wave function of an electron in a hydrogen atom?
v. What is the principal quantum number (n) and the orbital quantum number (l) for an electron in the 2s state?
vi. What is Zeeman effect? What is its significance?

Q.2. A. Attempt any one of the following questions : **07**

i. What is the method of separation of variables? Discuss the method of separation of variables for solving a partial differential equation in the cartesian coordinate system.
ii. What do you mean by boundary conditions with reference to ODEs and PDE? Discuss the various forms of these boundary conditions.

B. Attempt any one of the following. **03**

i. Show that the Poisson's equation $\nabla^2\phi = -f(x)$ is an elliptic partial differential equation.
ii. In an ac circuit having an inductor and a capacitor in series, show that the current $i = A\cos\left(\frac{1}{\sqrt{LC}}\right)t + B\sin\left(\frac{1}{\sqrt{LC}}\right)t$ is a solution to the differential equation $\frac{d^2i}{dt^2} + \left(\frac{1}{LC}\right)i = 0$. Here A and B are arbitrary constants.

Q.3. A. Attempt any one of the following questions: **07**

i. Derive the Schrodinger's equation for a hydrogen atom in the spherical polar coordinates and discuss it.
ii. Write the differential equation for the radial part **R(r)** of the wave function Ψ for an electron in the hydrogen atom and hence show that the magnitude of electron angular momentum is given by $L = \sqrt{l(l+1)}\,.\hbar$ where l is the orbital quantum number.

B. Attempt any one of the following. **03**

i. Show that $\Phi(\varphi) = A.e^{i.m_l\varphi}$ is a solution of the azimuthal part of the Schrodinger's equation $\frac{d^2\Phi}{d\varphi^2} + m_l^2\Phi = 0$ in the spherical polar coordinates.

ii. Show that the azimuthal probability density $|\Phi|^2$ for an electron in a hydrogen atom is a constant.