Ref.No. EX/UG/Sc/PHY/CORE-5/A/23/2019

BACHELOR OF SCIENCE INTER-B.SC EXAMINATION, 2019

(2nd Year, 1st Semester)

Subject : PHYSICS

Paper : CORE - 5

Time : Two hours **Full Marks : 50**

(25 marks for each group)

Use a separate Answer-Script for each part.

GROUP - A (Mathematical Methods)

Answer any *five* questions.

1. Use the generating function for Hermite polynomials to establish the recurrence relation $H_{n+1}(x) - 2xH_n(x) + 2nH_{n-1}(x) = 0$. Use this relation along with the orthonormality relation of Hermite polynomials to find the value of the integral $\int_{-\infty}^{\infty} dx.x.e^{-x^2}H_n(x)H_m(x)$. 2+3=5

2. Find the radius of convergence of the equation $(1-x^2)y'' - 2xy' + p(p+1)y = 0$, where p is a positive number and the primes denote derivatives with respect to x, and show that $x = 0$ is an ordinary point of this differential equation. 3+2=5

3. (a) Find the eigenvalues and eigenvectors of the matrix $P = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$.

   (b) Let M denote the matrix whose columns are the eigenvectors of the matrix P. Show that the matrix $D = M^{-1}PM$ is diagonal and the diagonal elements are the eigenvalues of matrix P. 2+3=5

4. Show that the eigenvalues of a Hermitean matrix are real and the eigenvectors belonging to two distinct eigenvalues are orthogonal. 2+3=5

5. Given that $\frac{1}{x}$ is a root of the differential equation $x^2y'' + xy' - y = 0$, find the other root. 5

6. Use the generating function for Legendre polynomials to evaluate $P_n(0)$. 5

GROUP-B

Answer any **FIVE** questions (5×5=25 Marks)

1. State superposition theorem as applied to network analysis. Consider a two-port resistive T-network supplied with two ideal dc sources, one at the input port and another at the output port. Using superposition theorem find the current through the resistor common to the input and output meshes in terms of the circuit parameters.

2. The four arms of a Wheatstone bridge have resistances $r_1 = 2\Omega$, $r_2 = 1\Omega$, $r_3 = 4\Omega$ and $r_4 = 3\ \Omega$. A galvanometer of resistance $10\ \Omega$ is connected between the juncions (r_1, r_4) and (r_3, r_4). An ideal cell of *emf* 2 V is connected between the junctions (r_1, r_3) and (r_2, r_4). Apply Thevenin's theorem to find the current through the galvanometer.

3. Find the mutual potential energy of two dipoles of equal moment 6×10^{-30} C.m lying along the same line at a separation of 3×10^{-10} m. Derive the formula you are to use.

4. Show that the electrostatic potential due to an arbitrary charge distribution of finite extent at a large distance can be expressed as a sum of multipole potentials.

5. State and prove uniqueness theorem in electrostatics.

6. A point charge q of mass m is released from rest at a distance d from an infinite grounded conducting plate. Find the time taken by the charge to hit the plate.

7. Starting from Biot-Savart law show that $\vec{\nabla}.\vec{B} = 0$. What does this equation imply physically?

8. What do you mean by hysteresis in a ferromagnetic substance? The core of a transformer is made of soft iron of total mass 10 kg and specific density 7.5. Calculate the hourly loss of energy when the transformer is used for operation in ac of frequency 50 Hz. Given that the area enclosed by the B-H loop of soft iron is 250 J. m^{-3}.$cycle^{-1}$.