No. of Printed Pages : **2**

21PHY1C1L

Sl. No.

M.Sc. I Semester Degree Examination, April/May - 2024

PHYSICS

Mathematical Methods of Physics

(NEP)

Time : 3 Hours | Maximum Marks : 70

Note : *Answer **any five** of the following questions with Question No. **1** (Q1) is **compulsory,** each question carries **equal** marks.*

1. (a) Solve the Legendre differential equation $(1-x^2)y''-2xy'+n(n+1)y=0$, by power series method; where n is a constant. **10**

(b) Prove the following Hermite recurrence relation **4**

$H_{n+1}(x)=2xH_n(x)-2nH_{n-1}(x)$

2. (a) Find the Fourier series of the following function : **5**

$$f(x)=\begin{cases}0 \text{ when } -\pi \le n \le 0\\ k \text{ when } 0 \le n \le \pi\end{cases}$$

(b) What are cosine and sine series ? Give an example of an even function and find its cosine series. **3**

(c) Find the inverse Fourier transform of $F(s)=\dfrac{s^2}{(s^2+a^2)^2}$ **6**

3. (a) What is a Hilbert space ? Explain its properties, including completeness and the existence of an orthonormal basis. **5**

(b) Define complex vector space and show that $S=[(i, 0, 0), (0, i, i), (0, 0, 1)]$ is a function of C^3. **5**

(c) What are Unitary and Hermitian matrices ? Give an example of each. **4**

4. (a) Define an analytic function. Show that $f(z)=|z|$ is not analytic. **5**

(b) State and prove Cauchy's integral theorem for a simply connected region. **6**

(c) What is vector analysis ? Explain the difference between Cartesian and Curvilinear coordinate systems. **3**

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5. (a) Explain the reducible and irreducible representations of a group with an example. **7**

(b) What are Christoffel Symbols ? Obtain the Christoffel's Symbols of I and II kind. **7**

6. (a) What are Fourier transforms ? Give the properties of Fourier transforms. **2**

(b) What is the convolution theorem for Laplace transforms ? Explain how it is used to solve integral equations. **6**

(c) Explain the Algebra of linear operators. **6**

7. (a) What are the functions of the complex variable ? Explain. **4**

(b) State and prove Gauss divergence theorem. **6**

(c) Discuss about covariant and contravariant tensors with an example. **4**

8. (a) Obtain the Laplace transform of the function $f(t) = \sinh at \sin at$. **5**

(b) Find the work done in moving a particle in the force field $\vec{F} = 3x^2 \hat{i} + (2xz - y) \hat{j} + z\hat{k}$ along the curve defined by $x^2 = 4y$ and $3x^2 = 8z$ from $x = 0$ to $x = 2$. **5**

(c) What is the three-dimensional rotation group SO(3) and show how it is related to the group SU(2) ? **4**

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