62101

Reg. No. [ ]

I Semester M.Sc. Degree Examination, March/April - 2025

PHYSICS

Mathematical Methods of Physics - I

(CBCS New Scheme 2019-20 Onwards)

Paper : PHY 101

Time : 3 Hours **Maximum Marks : 70**

Answer all questions. **(3×15=45)**

1. a) Verify Stoke's theorem for the vector field $A = (3x - 2y)\hat{i} + x^2 z\hat{j} + y^2 (Z+1)\hat{k}$ for a plane rectangular area with vertices (0, 0), (1,0), (1,2) and (0,2) in the X- Y plane.

   b) Find the components of a vector $\vec{A} = 2y\hat{i} - 3\hat{j} + 2z\hat{k}$ in cylindrical polar coordinate system. **(10+5)**

(OR)

2. a) Find the eigen values and eigen vectors of the matrix.

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix}$$

(OR)

   b) Show that the eigen vectors are orthogonal for unitary matrix. **(10+5)**

3. a) Find the general solution of Bessel's differential equation $x^2 \frac{d^2y}{dx^2} + x\frac{dy}{dx} + \left(x^2 - n^2\right)y = 0$ as a power series method.

   b) Using the generating function of Legendre polynomial, prove that $nP_n(x) = (2n-1)xP_{n-1}(x) - (n-1)P_{n-2}(x)$ **(10+5)**

(OR)

4. a) Show that the real and imaginary parts of the function log(z) satisfy the Cauchy-Riemann equations when z is not zero.

   b) Determine the analytic function $f(z) = u + iv$ where $v = 6xy - 5x + 3$ **(10+5)**

[P.T.O.

5. a) Find the Fourier integral of the function $f(x)=\begin{cases} 0 \text{ when } x<0 \\ \frac{1}{2} \text{ when } x=0 \\ e^{-x} \text{ when } x>0 \end{cases}$

b) Find the Fourier transform of the Gaussian distribution function $f(x)= Ne^{-ax^2}$ where N and α are constants. **(10+5)**

(OR)

6. a) Obtain the Laplace transform of a second derivate and apply it to solve the harmonic oscillator equation, $m\frac{d^2x(t)}{dt^2}+Kx(t)=0$

b) State and prove Parseval's theorem. **(10+5)**

7. **Answer any Five of the following:** (5x5=25)

a) Show that the product of orthogonal matrices is also orthogonal.

b) Prove that the vectors (1, 2, -3), (2, 5, 1) and (-1, 1, 4) are linearly independent.

c) Prove that the recurrence formula for Laguerre polynomial

$$(n+1)L_{n+1}(x)=(2n+1-x)L_n(x)-nL_{n-1}(x)$$

d) Using Cauchy's integral theorem, evaluate the integral $\oint_c \frac{1}{z}dz$ where C is a simple closed curve.

e) Find the Fourier series of the function e^x in the interval $-\pi < x < \pi$

f) Find the inverse Laplace transform of $\frac{1}{S^2+a^2}$