D1APH2502 **(2 Pages)** **Name.............................**
Reg.No..........................

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2025
(Regular/Improvement/Supplementary)

PHYSICS
FPHY1C02- MATHEMATICAL PHYSICS I

Time: 3 Hours **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage

1. Show that the matrix $\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$ is orthogonal.
2. What is meant by similarity transformation? Explain its significance.
3. What is a Hermitian matrix? Give an example.
4. Define the quotient rule for tensors.
5. Solve the differential equation $\frac{d^2y}{dx^2} + 4y = 0$ using the method of Frobenius.
6. What do you mean by singular point of a differential equation?
7. Evaluate the Gamma function $\Gamma(1)$\ and $\Gamma(\frac{1}{2})$.
8. What is the Fourier transform of $e^{-\alpha x^2}$?

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.

9. Derive the expression for the gradient, divergence, and curl in cylindrical coordinates.
10. Explain the Schmidt orthogonalization process and apply it to vectors in R^3.
11. Solve the Bessel differential equation using the Frobenius method and derive the first solution.
12. Define the Fourier transform and inverse transform. Show that the Fourier transform of a Gaussian function is also Gaussian.

(2 × 5 = 10 weightage)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage.

13. Solve Laplace's equation in spherical coordinates using the separation of variables.

14. Show that the direct product of two vectors forms a second-rank tensor. Prove that the divergence of the curl of any vector field is zero.

15. Find the eigenvalues and eigen functions of the operator $\frac{d^2}{dx^2}$ with boundary conditions f(0)= 0 and f(L)= 0.

16. Show that $L_{n+1}(x)=2\, L_n(x) - L_{n-1}(x)$.

17. Derive Rodrigues' formula for the Legendre polynomials and state its importance.

18. Discuss the properties of Hermite polynomials and derive the recurrence relation from their generating function.

19. Find the Fourier series of the function $f(x)= x^2$ over the interval $[0, 2\pi]$.

(4 × 3 = 12 weightage)