D 131328 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2025

(CBCSS)

Physics

PHY IC 02—MATHEMATICAL PHYSICS–I

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

8 *Short questions answerable within* 7.5 *minutes.*
Answer **all** *questions, each question carries weightage* 1.

1. Show that the inverse of a unitary matrix is unitary.
2. Write down the relation between cartesian co-ordinate system and cylindrical co-ordinate system
3. What are pseudo tensors ?
4. How can you identify the singularities of a differential equations ?
5. Define the spherical harmonics.
6. Briefly explain diagonalization of matrices.
7. Obtain the recurrence formula, $H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x)$ from generating function.
8. Find Laplace transform of the function, $f(t) = 1$.

(8 × 1 = 8 weightage)

Section B

4 *essay questions answerable within* 30 *minutes.*
Answer any **two** *questions, each question carries weightage* 5.

9. Explain the Frobenius' method of finding solution to homogenous differential equation of second Order by taking the example of Bessel's equation
10. Derive Rodrigues formula for Legendre polynomials. Deduce first two Legendre polynomials.

Turn over

11. Define a Fourier transform and inverse Fourier transform. State and prove convolution theorem for Fourier transform.

12. Define an orthogonal matrix. Give an example. If A is orthogonal, show that its determinant is equal to ± 1.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.
Answer any **four** *questions.*
Each question carries 3 weightage.

13. Calculate $\nabla \times \left[f(r)\,\hat{r} \right]$.

14. Prove that $\beta(p, q) = \dfrac{\Gamma(p)\,\Gamma(q)}{\Gamma(p+q)}$.

15. If A_{ij} is antisymmetric tensor, find the component A_{11}.

16. Resolve the Cartesian unit vectors into their spherical polar components

17. Prove the recurrence relation $xP_n(x) - P_{n-1}(x) = nP_n(x)$.

18. Find the Fourier transform of the exponential decay function

$f(t) = 0$ for $t < 0$ and $f(t) = Ae^{-\lambda t}$ for $t \geq 0\ (\lambda > 0)$.

19. Prove that the given matrix is unitary :

$$\begin{pmatrix} \dfrac{1}{\sqrt{2}} & \dfrac{i}{\sqrt{2}} \\ -\dfrac{i}{\sqrt{2}} & -\dfrac{1}{\sqrt{2}} \end{pmatrix}.$$

(4 × 3 = 12 weightage)