Reg. No .... Name **23P104**

M. Sc. DEGREE END SEMESTER EXAMINATION : NOVEMBER 2023

SEMESTER 1 : PHYSICS

COURSE : **21P1PHYT01 : MATHEMATICAL METHODS IN PHYSICS - I**

(For Regular -2023 Admission and Improvement/Supplementary -2022/2021 Admissions)

Duration : Three Hours Max. Weights: 30

PART A

Answer any 8 questions **Weight: 1**

1.	Write a note on scalar potentials.	(R, CO 1)
2.	Write short notes on projection operators.	(R, CO 3)
3.	Show that curl of a vector is always sinusoidal in nature.	(U, CO 1)
4.	Show that product of two unitary matrices are also unitary.	(A, CO 5)
5.	Give the expression for segmental length in cylindrical coordinates.	(A, CO 2)
6.	Show that Pauli spin matrices anticommute in pairs.	(A, CO 5)
7.	What is Levi Civita tensor? Discuss its properties	(R, CO 6)
8.	Show that Eigen values of a Hermitian matrix are real and Eigen vectors are orthogonal.	(U, CO 5)
9.	What is a linear vector space?	(U, CO 3)
10.	Show that any tensor of rank 2 can be expressed as the sum of a symmetric and anti-symmetric tensor of rank 2.	(A, CO 6)

(1 x 8 = 8)

PART B

Answer any 6 questions **Weights: 2**

11.	$K_{ij}A_{jk} = B_{ik}$ holds for all orientations of the coordinate system. If A and B are second rank tensors, show that K is a second rank tensor also.	(An, CO 6)
12.	Write short notes on Hermitian and unitary operators.	(R, CO 3)
13.	Explain the differences between Binomial, Poisson and normal distributions.	(U, CO 4)
14.	Prove that $\nabla \times \nabla\phi = 0$ and $\nabla \times (\phi A) = \phi(\nabla \times A) + (\nabla\phi) \times A$	(U, CO 1)
15.	If $\mathbf{F} = xy^2\,\mathbf{i} + yz^2\,\mathbf{j} + zx^2\,\mathbf{k}$, verify Gauss theorem over the sphere $x^2 + y^2 + z^2 = 4$.	(A, CO 1)
16.	Define the direct product of a matrix. Find out the direct product of $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ and $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$.	(A, CO 5)
17.	Find the inverse of the given matrix by Gauss-Jordan method $\begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & 1 \end{bmatrix}$	(A, CO 5)
18.	What is Levi – Civita Symbol? Explain its properties.	(R, CO 6)

(2 x 6 = 12)

PART C

Answer any 2 questions **Weights: 5**

19. State and prove Greens theorem. Using Green's theorem find the area of an ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1.$ (A, CO 1)

20. Establish the expression for curl of a vector field in general curvilinear coordinates and find curl A in cylindrical coordinates. (A, CO 2)

21. Illustrate Schmidt’s orthogonalisation procedure. Hence orthogonalize (1, 0, 0, 1), (2, 1, 0, 0), (1, 2, 1, 0), (0, 1, 1, 3). (A, CO 3)

22. Find the inverse of the given matrix using Cayley Hamilton Theorem and verify it using $\frac{AdjA}{DetA}$:

$$\begin{bmatrix} 3 & 1 & 1 \\ 1 & 3 & 2 \\ 2 & 2 & 3 \end{bmatrix}$$

(A, CO 5)

(5 x 2 = 10)

OBE: Questions to Course Outcome Mapping

CO	Course Outcome Description	CL	Questions	Total Wt.
CO 1	Understand the basic theory of Vector analysis and to apply it to various Theorems	U	1, 3, 14, 15, 19	11
CO 2	Transformation of co-ordinates systems	A	5, 20	6
CO 3	understand the principals linear vector space	U	2, 9, 12, 21	9
CO 4	apply Probability concepts and remember distribution theory's	A	13	2
CO 5	analyze various Matrices	An	4, 6, 8, 16, 17, 22	12
CO 6	understand and apply tensor calculus to various physicals situation	U	7, 10, 11, 18	6

Cognitive Level (CL): Cr - CREATE; E - EVALUATE; An - ANALYZE; A - APPLY; U - UNDERSTAND; R - REMEMBER;