

M.Sc. DEGREE END SEMESTER EXAMINATION - NOVEMBER 2024**SEMESTER 1 : PHYSICS****COURSE : 241P1PHYT01 : MATHEMATICAL METHODS IN PHYSICS - I***(For Regular - 2024 Admission)*

Duration : Three Hours

Max. Weights: 30

PART A**Answer any 8 questions****Weight: 1**

1. Find the square of the element of arc length in cylindrical coordinates and determine the corresponding scale factors. (R)
2. Explain the physical significance of Unitary transformations. (U)
3. Prove that Kronecker delta is a mixed tensor of rank 2. (A)
4. State and explain Cayley - Hamilton's theorem. (R)
5. Show that Pauli spin matrices anticommute in pairs. (A)
6. Express position and velocity of a particle in cylindrical coordinates. (E)
7. Derive the transformation law for the Christoffel symbol of first kind. (U)
8. State the condition for the diagonalisability of a matrix. (U)
9. Explain Gaussian distribution with example. (R)
10. Give a physical interpretation of Gauss' divergence theorem. (An)

(1 x 8 = 8)**PART B****Answer any 6 questions****Weights: 2**

11. Determine the metric tensor in spherical polar coordinates. (A)
12. Applying Gauss divergence theorem,
 - a) If $\mathbf{H} = \text{curl } \mathbf{A}$, Prove that $\int_s \mathbf{H} \cdot \mathbf{n} ds = 0$
 - b) If \mathbf{n} is a unit outward normal to any closed surface of area S , show that $\int \int \int_v \text{div } \mathbf{n} dV = S$ (An)
13. Explain elementary probability theory. In a box, there are 8 red, 7 blue and 6 green balls. One ball is picked up randomly. What is the probability that it is neither red nor green? (A)
14. Find the mean and standard deviation of Gaussian distribution. (A)
15. Solve the following system of equations by Gauss elimination method.

$$3x + 2y + z = 11$$

$$2x + 3y + z = 13$$

$$x + y + 4z = 12$$

(A)

16. Write a note on gravitational potentials and centrifugal potentials. (U)
17. Explain the mathematical operations - (a) addition (b) subtraction (c) contraction and (d) inner product in tensor analysis. (R)
18. Define Unitary, Hermitian and orthogonal matrices. Explain their properties. (U)

(2 x 6 = 12)

PART C
Answer any 2 questions

Weights: 5

19. Establish the expression for curl of a vector field in general curvilinear coordinates and find curl A in cylindrical coordinates. (A)
20. Find the inverse of the given matrix using Cayley Hamilton theorem and verify it using Gauss Jordan method:
$$\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 2 \\ 1 & 1 & 3 \end{bmatrix}$$
 (A)
21. Obtain general expression for vector operators in general curvilinear coordinates and find Laplacian in spherical polar coordinates. (A)
22. Obtain a set of four orthonormal vectors from the following linearly independent vectors $(1, 1, 0, 1)$, $(1, 0, 0, 2)$, $(0, 1, 2, -3)$, $(1, 1, 1, 1)$. (A)

(5 x 2 = 10)

OBE: Questions to Course Outcome Mapping

CO	Course Outcome Description	CL	Questions	Total Wt.
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Cognitive Level (CL): Cr - CREATE; E - EVALUATE; An - ANALYZE; A - APPLY; U - UNDERSTAND; R - REMEMBER;