

**M. Sc. DEGREE END SEMESTER EXAMINATION : NOVEMBER 2024****SEMESTER 1 : PHYSICS****COURSE : 21P1PHYT01 : MATHEMATICAL METHODS IN PHYSICS - I***(For Supplementary /Improvement 2023/2022/ 2021 Admissions)*

Duration : Three Hours

Max. Weights: 30

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

1. State and explain Cayley - Hamilton's theorem. (R, CO 5)
2. Obtain the expression for  $\nabla \cdot \vec{A}$  in spherical polar coordinates by assuming the scale factors. (R, CO 2)
3. What is a normal matrix? What are its properties? (R, CO 5)
4. State and explain expansion theorem for basis in a linear vector space. (U, CO 3)
5. Show that every square matrix can be uniquely written as the sum of a symmetric and skew symmetric matrices. (U, CO 5)
6. Find differential length  $dS$  in spherical polar coordinates. (A, CO 6)
7. Write a note on gravitational potentials. (R, CO 1)
8. Express position and velocity of a particle in cylindrical coordinates. (E, CO 2)
9. Four cards are drawn from a pack of cards. Find the probability that two are king and two are queen. (A, CO 4)
10. Write the conjugate metric tensor in spherical polar coordinates. (A, CO 6)  
**(1 x 8 = 8)**

**PART B****Answer any 6 questions****Weights: 2**

11. Deduce the set of orthonormal basis for  $(1, 1, 1)$ ,  $(1, 0, 1)$  and  $(1, 1, 0)$  using Schmidt orthogonalization procedure. (A, CO 3)
12. Derive the transformation law for the components of a vector under rotation about z- axis. (An, CO 6)
13. 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)
14. What are Pauli spin matrices? Explain any three properties of them. (R, CO 5)
15. Find the unit vectors in spherical polar coordinate system (A, CO 2)
16. Determine the conjugate metric tensor in cylindrical coordinates (A, CO 6)
17. Obtain the general expression for Laplacian in general curvilinear coordinate system and find  $\nabla^2 \phi$  in cylindrical coordinate system. (U, CO 2)
18. 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, CO 4)

(2 x 6 = 12)

**PART C**  
**Answer any 2 questions**

**Weights: 5**

19. Define line, surface and volume integrals. Explain the theorems connecting these integrals (A, CO 1)
20. Determine the Eigen values and normalized Eigen vectors.  
$$\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 2 \\ 1 & 1 & 3 \end{bmatrix}$$
 (A, CO 5)
21. Establish the expression for gradient and divergence in general curvilinear coordinates and find Div A and Grad V in spherical polar coordinates. (A, CO 2)
22. (a) Explain Gram- Schmitz orthogonalisation process.  
(b) Find the distance from the point  $y = (0, 0, 0, 1)$  to the subspace  $V \subset R^4$  spanned by vectors  $x_1 = (1, -1, 1, -1)$ ,  $x_2 = (1, 1, 3, -1)$ , and  $x_3 = (-3, 7, 1, 3)$ . (A, CO 3)

(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	7, 19	6
CO 2	Transformation of co-ordinates systems	A	2, 8, 15, 17, 21	11
CO 3	understand the principals linear vector space	U	4, 11, 22	8
CO 4	apply Probability concepts and remember distribution theory's	A	9, 18	3
CO 5	analyze various Matrices	An	1, 3, 5, 13, 14, 20	12
CO 6	understand and apply tensor calculus to various physicals situation	U	6, 10, 12, 16	6

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