Reg. No .... Name **17P104**

M Sc DEGREE END SEMESTER EXAMINATION - NOVEMBER 2017

SEMESTER 1 : PHYSICS

COURSE : **16P1PHYT01 - MATHEMATICAL METHODS IN PHYSICS - I**

(For Regular - 2017 Admission)

Time : Three Hours Max. Marks: 75

Section A (Objective type)

Answer all the questions (1 Mark each)

1. If $\vec{r}$ is the position vector, then $\nabla \times \vec{r}$

   (a) 0 (b) 3 (c) $r^2\vec{r}$ (d) $r^{3/2}$

2. The sum of eigen values of the matrix $\begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$

   (a) 5 (b) 7 (c) 9 (d) 18

3. If AY = PY then Y =

   (a) PYA (b) PYA^{-1} (c) $A^{-1}PY$ (d) PYP^{-1}

4. If A^{ij} is a contravariant tensor, then its symmetric tensor is

   (a) A_{ij} (b) A_{ji} (c) A^{ij} (d) A^{ji}

5. Cos x will be

   (a) $J_0(x) + 2J_2(x) + 2J_4(x) + ...$ (b) $2J_1(x) - 2J_3(x) + 2J_5(x) + ...$

   (c) $2J_0(x) - 2J_1(x)$ (d) None of these

(1 x 5 = 5)

Section B (Short answer type)

Answer any Seven (2 Marks each)

6. What are the properties of Hermitian operators?
7. Obtain the expression for $\nabla \times \vec{A}$ in cylindrical coordinates by assuming the scale factors.
8. Discuss least square fitting and its application.
9. Show that Eigen values of a Hermitian matrix are real and Eigen vectors are orthogonal.
10. Show that eigen value equation is invariant under similarity transformation.
11. Explain the covariant fundamental tensor.
12. Explain geodesics.
13. Show that $\epsilon_{ijk}\epsilon_{pqk} = \delta_{ip}\delta_{jq} - \delta_{iq}\delta_{jp}$, where ϵ_{ijk} is the Levi – Cevita symbol.

14. Show that β(m,n) = β(n,m)
15. Write any two recurrence relation of Legendre's polynomials.

(2 x 7 = 14)

Section C (Problems / Short Essays)
Answer any Four (5 Marks each)

16. Write a note on gravitational potentials and centrifugal potentials.
17. Find the inverse of the given matrix by Gauss–Jordan method:
$$\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 2 \\ 1 & 1 & 3 \end{bmatrix}$$
18. Determine the eigen values of the following matrix:
$$\begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$
19. Show that Levi – Civita symbol is a third rank tensor.
20. Determine the metric tensor in spherical polar coordinates.
21. Express sin(x) in terms of $J_n(x)$.

(5 x 4 = 20)

Section D (Essays)
Answer all questions (12 Marks each)

22(a) Obtain general expression for vector operators in general curvilinear coordinates and find Laplacian in cylindrical coordinates.

OR

(b) State and prove Stokes theorems. Verify it for vector field A = (3x – 2y) $\mathbf{i}$ + x^2z $\mathbf{j}$ + $y^2(z+1)$ $\mathbf{k}$ in the rectangular plane with vertices (0, 0), (2, 0), (2, 3), (0, 3).

23(a) Find the inverse of the given matrix using Cayley Hamilton theorem and verify it using Gauss Jordan method:
$$\begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$$

OR

(b) Explain the mathematical operations - 1) addition and subtraction 2) open product 3) contraction 4) Inner product and 5) quotient law in tensor analysis.

24(a) What are associated Legendre polynomials? Obtain the series solution of associated Legendre differential equation.

OR

(b) Derive Rodrigues formula, generating function and any two recurrence relation of Hermite polynomials.

(12 x 3 = 36)