

QP CODE: 25050512



Reg No :

Name :

MSc DEGREE (CSS) EXAMINATION, DECEMBER 2025

First Semester

Core Courses - PH010101 - MATHEMATICAL METHODS IN PHYSICS - I

M Sc PHYSICS, MSc SPACE SCIENCE.

2019 Admission Onwards

5D6BCDD8

Time: 3 Hours

Weightage: 30

Part A (Short Answer Questions)

*Answer any **eight** questions.*

Weight 1 each.

1. Explain the physical significance of divergence of a vector field.

2. State Stoke's Theorem.

3. Obtain the scale factors in spherical polar co-ordinates.

4. In the three dimensional linear vector space, with basis vectors $|\phi_1\rangle = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$, $|\phi_2\rangle = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$,

$|\phi_3\rangle = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$, find a vector $|\psi\rangle$ such that $\langle\phi_i|\psi\rangle$ for $i = 1, 2, 3$.

5. What are the conditions under which a normal distribution is applicable?

6. What do you mean by direct sum of matrices?

7. Prove that the necessary and sufficient condition for a square matrix A to possess an inverse is that it is non-singular.

8. Show that the modulus of each eigen value of a unitary matrix is unity.

9. What is a contravariant vector? How is it different from a covariant vector?

10. What are Christoffel symbols? Are they tensors?

(8×1=8 weightage)





Part B (Short Essay/Problems)

Answer any **six** questions.

Weight 2 each.

11. Find $\nabla \times \vec{V}$ in orthogonal curvilinear coordinates.
12. Express $\nabla \cdot \vec{A}$ in orthogonal curvilinear coordinates. Hence obtain its form in cylindrical polar coordinates.
13. Find the inner product of the two vectors $\begin{pmatrix} 1 \\ i \\ -2 \end{pmatrix}$ and $\begin{pmatrix} -2i \\ 3 \\ 5 \end{pmatrix}$
14. If 3% of the gearwheels produced by a company are defective, determine the probabilities that in a sample of 80 gearwheels (a) two and (b) more than two will be defective.
15. Check the matrix $\begin{bmatrix} 3 & -4 \\ 4 & 3 \end{bmatrix}$ is normal.
16. Verify Cayley- Hamilton theorem for the matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$.
17. Show that the tensors g_{pq} , g^{pq} and δ_q^p are associated tensors.
18. Prove $(g_{jk} A_n^{km})_{,q} = g_{jk} A_n^{km}_{,q}$.

(6×2=12 weightage)

Part C (Essay Type Questions)

Answer any **two** questions.

Weight 5 each.

19. Prove that a spherical coordinate system is orthogonal. Express the velocity and acceleration of a particle in spherical coordinates.
20. Using the Gram-Schmidt orthonormalization, find an orthonormal set of functions from the set $U_1 = 1$, $U_2 = x$, $U_3 = x^2$ over the interval $(0, 2)$.
21. Show that the equations $x + y + z = a$, $3x + 4y + 5z = b$, $2x + 3y + 4z = c$,
 (i) have no solution if $a = b = c = 1$ and
 (ii) have many solutions if $a = b/2 = c = 1$.
22. Find (a) g and (b) g^{jk} corresponding to $ds^2 = 3(dx^1)^2 + 2(dx^2)^2 + 4(dx^3)^2 - 6dx^1 dx^3$.

(2×5=10 weightage)

