

KAMARAJ COLLEGE (Autonomous)

Accredited with A+ Grade by NAAC

(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)

THOOTHUKUDI – 628 003

(6 Pages)

Reg. No:

Question Code No : 25003306

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PG Degree - End Semester Examinations, November 2025

First Semester

M.Sc. PHYSICS

Mathematical Physics

(For those who joined in July 2024 onwards)

Time : 3 Hours

Maximum : 75 Marks

PART- A ($10 \times 1 = 10$ Marks)

Answer ALL Questions

Choose the correct answer:

1. The scalar product of two orthogonal vectors is always
 - (a) 0
 - (b) 1
 - (c) -1
 - (d) Undefined
2. The Gram-Schmidt process is used for
 - (a) Diagonalizing matrices
 - (b) Orthogonalizing vectors

- (c) Finding eigenvalues (d) Solving differential equations
3. Cauchy–Riemann equations are the conditions for
- (a) Matrix to be Hermitian (b) Series to converge
(c) Function to be analytic (d) Function to be harmonic
4. Two groups are said to be isomorphic if they have
- (a) Same number of elements and same multiplication table
(b) Same number of elements but different multiplication table
(c) Same multiplication table but different number of elements
(d) Different number of elements and different multiplication table
5. The Cayley–Hamilton theorem states
- (a) Every matrix is diagonalizable
(b) Every matrix is Hermitian
(c) Every matrix satisfies its characteristic equation
(d) Every matrix is invertible
6. The trace of a square matrix is
- (a) The sum of its diagonal terms
(b) The sum of its non-diagonal terms
(c) The product of its diagonal terms
(d) The product of its non-diagonal terms

7. Laplace transform of e^{-at} is
- (a) $\frac{1}{s+a}$ (b) $\frac{1}{s-a}$
- (c) $\frac{a}{s^2+a^2}$ (d) $\frac{s}{s^2+a^2}$
8. The Fourier sine transform of function $f(x) = e^{-ax}$ is
- (a) $\frac{s}{s^2+a^2}$ (b) $\frac{s \sin ax}{\sqrt{s^2+a^2}}$
- (c) $\frac{a}{s^2+a^2}$ (d) $\frac{a \sin ax}{\sqrt{s^2+a^2}}$
9. The value of $H_2(x)$ is
- (a) $x^2 - 1$ (b) $2x^2 - 1$
- (c) $4x^2 - 2$ (d) $\frac{1}{2}(3x^2 - 1)$
10. Green's function method is useful to solve
- (a) Fourier expansions (b) Matrix diagonalization
- (c) Initial value problems (d) Boundary value problems

PART - B (5 X 5 = 25 Marks)

Answer ALL Questions choosing either (a) or (b).

Answer should not exceed 250 words.

11. (a) Show that the vectors $(1,2,-3)$, $(1,3,-2)$ and $(2,-1,5)$ are linearly independent.

(OR)

(b) Explain bra and ket notation in Dirac formalism.

12. (a) Derive Cauchy's integral theorem.

(OR)

(b) Compare isomorphism and homomorphism representations.

13. (a) Show that every square matrix can be uniquely expressed as the sum of a Hermitian and skew Hermitian matrix.

(OR)

(b) Find the eigen values and eigen vectors of the following matrix $\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$

14. (a) State and prove convolution theorem for Fourier Transforms.

(OR)

(b) Find inverse Laplace transform of $\frac{1}{s^2(s^2+w^2)}$

15. (a) Obtain the generating function of Hermite polynomials.

(OR)

(b) Derive Rodrigue's formula for Legendre's polynomials.

PART - C (5 X 8 = 40 Marks)

Answer ALL Questions choosing either (a) or (b).

Answer should not exceed 600 words.

16. (a) Describe Schmidt orthogonalization procedure of constructing an orthogonal set of functions from a non-orthogonal set.

(OR)

- (b) Differentiate between a linear operator and a projection operator by defining them and illustrating their key properties with suitable examples.

17. (a) State and prove Taylor theorem for complex function.

(OR)

- (b) a. Define the following with suitable examples:

- (i) Abelian group
- (ii) Subgroup
- (iii) Conjugate subgroup

- b. Distinguish between reducible and irreducible representations

18. (a) Find the characteristic equation of the following matrix and verify Cayley–Hamilton theorem.

$$\begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & 1 \end{bmatrix}$$

(OR)

(b) Find the eigenvalues, eigenvectors and diagonalise the

$$\text{matrix } \begin{bmatrix} 1 & 0 & 0 \\ 0 & 3 & -1 \\ 0 & -1 & 3 \end{bmatrix}$$

(a) State and prove the following:

19. (i) Parsevals theorem
(ii) Heavyside shifting theorem

(OR)

(b) Find the inverse Laplace transform of $\frac{1}{(s+1)(s^2+1)}$

20. (a) Obtain the polynomial solution of differential equation $y'' - 2xy' + 2ny = 0$ for integral values of n.

(OR)

(b) Discuss the orthogonal properties of Legendre's polynomials.