KAMARAJ COLLEGE (Autonomous)

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(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)

(4 Pages) **Reg. No:……**

Question Code: 26E03301 **Course Code: 24PMPH11**

PG Degree - End Semester Examinations, April 2026

First Semester

M.Sc., PHYSICS

Mathematical Physics

(For those who joined in July 2024 onwards)

Time : 3Hours **Maximum : 75 Marks**

PART – A (10 × 1 = 10 Marks)

Answer ALL Questions

Choose the correct answer :

CO:1 K:1 1. What will be the angle between the vectors if the inner product between them vanish?

(a) 0 (b) 45°

(c) 90° (d) 60°

CO:1 K:5 2. Let $s = \{(-1,0,1), (2,1,4)\}$, then the value of k which the vector (3k+2, 3, 10) belongs to the linear span of S is _____

(a) 3 (b) 2

(c) -2 (d) -1

CO:3 K:1 3. If a function is Harmonics, then it must satisfy _____.

(a) Bessel (b) Poisson

(c) Laplace (d) Legendre

CO:3 K:5 4. The harmonic conjugate of $u(x, y) = x^2 - y^2 + xy$ is _____.

(a) $4xy + \frac{1}{4}(y^2 - x^2)$ (b) $4xy + \frac{1}{2}(y^2 - 2x^2)$

(c) $4xy + \frac{1}{2}(y^2 - x^2)$ (d) $4xy - \frac{1}{2}(y^2 - x^2)$

CO:2 K:5 5. Consider two matrices $A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ then which of the following statement is incorrect?

(a) A and B have same set of eigen values

(b) A and B commute with each other

(c) A and B have different sets of linearly independent eigenvectors.

(d) A is Diagonalizable

CO:2 K:1 6. What is the property of Eigen values of Hermitian Matrices?

(a) Real (b) Imaginary

(c) Complex (d) Both a and c

CO:4 K:1 7. What is the Fourier transform of a Gaussian Function?

(a) Gaussian Function (b) Parabolic Function

(c) Hyperbolic function (d) Linear function

CO:4 K:3 8. Apply the Laplace Transform to 1.

(a) s (b) $1/s$

(c) 0 (d) 0

CO:5 K:1 9. What is the order differential equation of Newton's Second law?

(a) First (b) Second

(c) Third (d) Zeroth

CO:5 K:1 10. What is the value of Legendre polynomial $P_1(x)$?

(a) $2\,x$ (b) 1

(c) -1 (d) x

PART – B (5 X 5 = 25 Marks)

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

Answer should not exceed 250 words.

CO:1 K:4 11. (a) Determine the Eigen values of a given matrix A= $\begin{bmatrix} 0 & i \\ -i & 0 \end{bmatrix}$

(OR)

(b) Deduce whether the vectors $\boldsymbol{v}_1 = (1,2,3)$, $\boldsymbol{v}_2 = (4,5,6)$, $\boldsymbol{v}_3 = (7,8,9)$ in R^3 are linearly independent.

CO:3 K:4 12. (a) Explain the term singular point of an analytic function

(OR)

(b) Explain Isomorphism and Homomorphism in groups.

CO:2 K:3 13. (a) Construct the adjoint and inverse of the matrix $\begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$

(OR)

(b) Identify the characteristic polynomial of the matrix $\begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$

CO:4 K:3 14. (a) Identify the Fourier Sine Transform of $2e^{-3x} + 3e^{-2x}$

(OR)

(b) Identify the Laplace Transform of t^2e^{-3t}

CO:5 K:4 15. (a) Using Hermite polynomial, prove that $\int_{-\infty}^{\infty} e^{-x^2} H_2(x) H_3(x) = 0$

(OR)

(b) Using Legendre polynomial, prove that $\int_{-1}^{+1} x^2 P_5(x) dx = 0$

PART – C (5 X 8 = 40 Marks)

Answer ALL Questions choosing either (a) or (b).
Answer should not exceed 600 words.

CO:1 K:4 16. (a) Illustrate the Gram-Schmidt orthogonalization procedure.

(OR)

(b) Illustrate the idea of bra and ket notation in dual space.

CO:3 K:5 17. (a) Evaluate the integral using contour integration $\int_0^{2\pi} \frac{d\theta}{5-3cos\theta}$

(OR)

(b) Explain the representation of reducible and irreducible groups with an example.

CO:2 K:6 18. (a) Diagonalize the matrix $A = \begin{bmatrix} 3 & 2 & 4 \\ 2 & 0 & 2 \\ 4 & 2 & 3 \end{bmatrix}$

(OR)

(b) Find the inverse of the given matrix by identifying its characteristic equation $A = \begin{bmatrix} 1 & 2 & 1 \\ 6 & -1 & 0 \\ -1 & 2 & -1 \end{bmatrix}$

CO:4 K:5 19. (a) Determine the Fourier Transform of the function

$$f(x)=\begin{cases}1+\frac{x}{a}, & -a<x<0\\ 1-\frac{x}{a} & 0<x<a\\ 0 & otherwise\end{cases}$$

(OR)

(b) Determine the Inverse Laplace transform of $\frac{1}{(s+1)(s+3)}$ and $\frac{1}{s(s+1)}$

CO:5 K:5 20. (a) Determine Hermite polynomials using Rodrigue's Formula and write $2H_4(x)+3H_3(x)-H_2(x)+5H_1(x)+6H_0(x)$ in powers of x

(OR)

(b) Using the series solution technique, obtain Legendre polynomials from Legendre differential equation.