(FOR THE CANDIDATES ADMITTED DURING THE ACADEMIC YEAR 2025-26 ONLY)

SUBJECT CODE 25 PPS 101

REG.NO. :

N.G.M.COLLEGE (AUTONOMOUS) : POLLACHI

END-OF-SEMESTER EXAMINATIONS : NOVEMBER – 2025

M.Sc. – PHYSICS **MAXIMUM MARKS: 75**

SEMESTER : I **TIME : 3 HOURS**

MATHEMATICAL PHYSICS

SECTION – A (10 X 1 = 10 MARKS)

ANSWER THE FOLLOWING QUESTIONS. (K1)

1. What is the differential equation satisfied by Legendre polynomials $P_n(x)$?

   a) $(1-x^2)y''-2xy'+n(n+1)\ y=0$ b) $x^2y''+xy'+(x^2-n^2)\ y=0$

   c) $y''+y=0$ d) $xy''+y'+x=0$

2. Why is the residue theorem useful for real integrals?

   a) It gives series expansions
   b) It applies only to polynomials
   c) It helps evaluate real integrals using complex contour integrals
   d) It converts complex numbers to real numbers

3. Which method is commonly used to solve the heat equation?

   a) Runge-Kutta b) Separation of variables
   c) Euler's backward method d) Newton-Raphson

4. If f(x) = x f(x) = x on $[0,\pi]$, then the finite Fourier sine transform is……

   a) $\frac{2(-1)n}{n}$ b) $\frac{n}{\pi}$ c) π^2 d) 0

5. Which tensor satisfies the condition $T_{ij}=T_{ji}$?

   a) Rank-3 tensor b) Skew-symmetric tensor
   c) Identity tensor d) Symmetric tensor

ANSWER THE FOLLOWING IN ONE (OR) TWO SENTENCES. (K2)

6. Write the difference between Bessel functions of the first and second kind
7. State when residue calculus is used in real integrals.
8. Tell an example of steady two-dimensional heat flow using Laplace's equation.
9. Identify the Modulation Theorem for Fourier Transforms.
10. State the Quotient Law in tensor analysis.

SECTION – B (5 X 5 = 25 MARKS)

ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS. (K3)

11. a) Express $f(x)=4x^3-2x^2-3x+8$ in terms of legendre polynomials

(OR)

   b) Prove that, $H_{2n}(0)=(-1)^n\ 2^{2n}(1/2)^n$

12. a) Expand the cos z in a Taylor`s series about $z=\frac{\pi}{4}$

(OR)

b) Evaluate using Cauchy integral formula

$$\int \frac{2z+1}{z^2+z}dz \text{ where } c \text{ is the circle } |z| = \frac{1}{2}.$$

13. a) Compute the solution of Laplace's equation in cylindrical coordinates for axisymmetric steady-state heat flow.

(OR)

b) Construct the diffusion equation and describe its physical significance

14. a) Illustrate and sketch the Infinite Fourier sine and cosine transforms.

(OR)

b) Express and prove Parseval's theorem for Fourier transforms.

15. a) Describe the concept of dummy and free indices in the indicial notation.

(OR)

b) Discuss the Symmetry and anti-symmetry of tensors.

SECTION – C (5 X 8 = 40 MARKS)

ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS.

(K4/K5)

16. a) Show that $x^4 = \frac{1}{35}[8P_4(x) + 20P_2(x) + 7P_0(x)]$using legendre polynomial.

(OR)

b) Solve the Bessel differential equation and derive expressions for $J_{\pm\frac{1}{2}}(x)$ and $J_{\pm\frac{3}{2}}(x)$.

17. a) Evaluate $\oint \frac{e^z}{(z-1)(z-4)}dz$, where C is the circle $|z|$=2 by using cauchy's integral formula.

(OR)

b) Justify the use of the Residue Theorem in evaluating definite real integrals of rational functions. Evaluate the integral $\int_{-\infty}^{\infty} \frac{x^2}{x^4+1}\,dx$ using the method of residues.

18. a) Solve Laplace's equation in Cartesian coordinates an explain with an example of steady two-dimensional heat flow.

(OR)

b) Develop the governing equation for variable linear flow in one dimension and solve it under appropriate initial conditions.

19. a) Explain and prove the Convolution Theorem for Fourier Transforms. Use it to evaluate a convolution integral.

(OR)

b) Prepare and prove the Addition and Similarity (Scaling) Theorems of Fourier Transform.

20. a) Discuss the Kronecker delta symbol and the Generalized Kronecker delta. Discuss their properties and applications with examples.

(OR)

b) Derive the relation between the Beta and Gamma functions. Evaluate the Beta function using this relationship and interpret its significance in special function theory.

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