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M.Sc. (First Semester), Examination, 2025

PHYSICS

Paper : First

(Mathematical Physics)

Time : Two Hours ]

[ Maximum Marks : 75

Note : Attempt all sections as per instructions.

Section-A

(Very Short Answer Type Questions)

Note : Attempt all the (05) five questions.

Each question carries 02 (two) marks and answer of each question should not exceed 50 words.  $5 \times 2 = 10$

1. (a) Define the square matrix.  
(b) Discuss about the anti-Hermitian matrices.

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(c) Find A, so that  $f(x,y) = x^2 + 2xy + Ay^2$  is harmonic.

(d) If  $A^{\mu}$  and  $B_{\nu}$  are any two vectors, one contravariant and the other covariant, then prove that  $A^{\mu}B_{\mu}$  is invariant.

(e) Write the Rodrigue's formula of Legendre Polynomial.

Section-B

(Short Answer Type Questions)

Note : Attempt any 05 (Five) questions out of the 08 (Eight) questions. Each question carries 05 (five) marks and answer of each question should not exceed 100 words.  $5 \times 5 = 25$

2. (a) Show that every square matrix can be uniquely expressed as the sum of a Hermitian and Skew-Hermitian matrix.  
(b) Discuss about the adjoint of matrix and find out the adjoint of the following matrix.

$$\begin{bmatrix} 1 & 2 & 3 \\ 5 & 0 & 4 \\ 2 & 6 & 7 \end{bmatrix}$$

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- (c) Determine the analytic function, whose real part is  $x^3 - 3xy^2 + 3x^2 - 3y^2 + 1$
- (d) State and prove the Cauchy's Integral theorem.
- (e) Show that any Tensor of rank two can be expressed as a sum of a symmetric and an anti symmetric tensor of rank both of rank two. <https://www.validcollege.com>
- (f) What is meant by invariant? Show that the contraction of the outer product of tensors  $A^p$  and  $B_q$  is invariant.
- (g) Prove that  $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}} \sin x$
- (h) Find out Fourier Sine Transform of  $e^{-\alpha x}$  where  $\alpha$  is a positive integer.

### Section-C

#### (Long Answer Type Questions)

**Note :** Attempt any **02 (Two)** questions out of total **04 (four)** questions. Each question carries **20 (twenty)** marks and answer of each question should not exceed **400** words.

2 × 20 = 40

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3. (a) Explain the diagonalization of matrices and diagonalize the following matrix

$$A = \begin{bmatrix} 1 & 3 & 3 \\ -3 & -5 & -3 \\ 3 & 3 & 1 \end{bmatrix}$$

- (b) Find the poles and residues at the poles for the following functions.

(i)  $\frac{z}{\cos z}$

(ii)  $\frac{z+1}{z^2-2z}$

- (c) If  $A_i$  is the arbitrary contravariant vector and  $C_{ij}A^iA^j$  is an invariant vector, Then show that  $(C_{ij}+C_{ji})$  is a covariant tensor of rank two.
- (d) Prove the orthogonality condition of Hermite polynomial.

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