A–1174

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MSCPH-501

M.Sc. Physics (MSCPH)

Mathematical Physics

Examination February, 2026

Time : 2:00 Hrs. Max. Marks : 70

Note* :–** This paper is of Seventy (70) marks divided into Two (02) Sections 'A' and 'B'. Attempt the questions contained in these Sections according to the detailed instructions given therein. ***Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

Section–A

(Long Answer Type Questions) (2×19=38)

***Note* :–** Section 'A' contains Five (05) Long-answer type questions of Nineteen (19) marks each. Learners are required to answer any *two* (02) questions only.

1. What is Cauchy Residues Theorem ? Prove it for any function which is analytic. By using Cauchy residues theorem evaluate the integral :

$$\int_0^{2\pi} \frac{\cos 3\theta}{5-4\cos\theta} d\theta$$

2. (i) Define symmetric and skew-symmetric tensors. Prove that a symmetric tensor of rank two has at most $\frac{N(N+1)}{2}$ different components in N-dimensional space V_N.

   (ii) Define a metric or fundamental tensor. Determine the components of the fundamental tensor in cylindrical co-ordinates.

3. Obtain the recurrence formula for the Legendre differential equation. Also obtain the generating function for Legendre polynomial.

4. Define Bessel's Function (J_n). Find out the following recurrence relations :

   (i) $xJ_n' = nJ_n - xJ_{n+1}$

   (ii) $xJ_n' = -nJ_n + xJ_{n-1}$

5. Obtain the Laplace transform of the following functions,

   (i) $\cos^2 t$

   (ii) $\sin^2 t \cos^3 t$

   (iii) $t \sin at$

Section–B

(Short Answer Type Questions) (4×8=32)

***Note* :–** Section 'B' contains Eight (08) Short-answer type questions of Eight (08) marks each. Learners are required to answer any *four* (04) questions only.

1. Prove that :

   (i) $div\, curl\, \vec{A} = 0$

   (ii) $curl\, grad\, \theta = 0$

2. Deduce the Gauss Law with the help of Gauss divergence theorem and also write down the differential form of Gauss law.

3. Define Hermitian and Skew Hermitian Matrix.

4. Solve the following equations by using change of variable method :

$$\frac{dy}{dx} = e^{x-y}(x^x - e^y)$$

5. Write down the Cauchy-Riemann equation for analytic functions. Also mention the polar forms of Cauchy-Riemann equation.

6. Show that :

$$H_n''(x) = 2xH_n''(x) - 2nH_n(x)$$

7. Prove the condition of orthogonality for Laguerre polynomial :

$$\int_0^\infty e^{-x} \frac{L_m(x)}{m!} \frac{L_n(x)}{n!} dx = \delta_{mn}$$

8. Discuss the following properties of Fourier transforms :

   (i) Linear Property

   (ii) Change of Scale Property

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