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MSCPH-501

Mathematical Physics

M.Sc. Physics (MSCPH)

1st Semester Examination, 2023 (June)

Time : 2 Hours] **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 answer to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

SECTION–A

(Long Answer Type Questions)

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.

(2×19=38)

1. Suppose that $\vec{U}, \vec{V}$ and $\vec{f}$ are continously differentiable fields then prove that. 19

$$div\,(\vec{U} \times \vec{V}) = \vec{V} \cdot \text{curl } \vec{U} - \vec{U} \cdot \text{curl } \vec{V}$$

2. (a) Obtain tensor form of divergenes and Laplacian. 9

(b) Define unitary and orthogonal matrices giving one example of each. 10

3. Solve the differential equation : 19

$$\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = e^{3x}.$$

4. (a) Prove that : 9

$$J_{½}(x) = \sqrt{\frac{2}{\pi x}}\,\text{Sin}\,x.$$

(b) Show that the Hermite polynomials defined through a suitable generating function statisfy its differential equation. 10

5. Express the function :

$$f(x) = \begin{cases} l & \text{when } |n| \leq l \\ 0 & \quad\quad\; |n|\, l \end{cases}$$

as a fourier integral. Hence evaluate $\int_0^\infty \frac{\sin\lambda\cos\lambda x}{\lambda}\,d\lambda$.

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SECTION–B

(Short Answer Type Questions)

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. (4×8=32)

1. Express Δ^2V in curvilinear coordinates and hence obtain it in cylindrical polar coordinates.

2. State and explain cauchy residues theorem.

3. Show that Kronecker delta is a mixed tensor of rank 2.

4. Explain contravarient, covarient and mixed tensors.

5. Evaluate : $\int_{-\infty}^{+\infty} e^{-x^2/2} \mathrm{H}n(x)dx.$

6. Solve the differential equation :

$$2y'' + 5y' = e^{-2t},\ y(0) = 1,\ y'(0) = 1$$

using Laplace transforms.

7. Show that :

$$\int x\, J_0^2(x)\, dx = \frac{1}{2} x^2 [J_0^2(x) + J_1^2(x)]$$

8. Find the finite fourier sine transforms of $f(x) = 2x$ in $(0, 4)$.