Name of the Department	:	Physics
Name of the Course	:	B. Sc. (H) Physics – CBCS – NC - Core
Semester	:	I
Name of the Paper	:	Mathematical Physics I
Unique Paper Code	:	32221101
Question Paper Set Number	:	A
Maximum Marks	:	75

Instruction for Candidates

1. Attempt **FOUR** questions in all.
2. All questions carry equal marks.

1. Solve the following first order differential equations
   - **a.** $x\,dx + y\,dy = \frac{x\,dy}{x^2+y^2} - \frac{y\,dx}{x^2+y^2}$
   - **b.** $(x^2y^2 + xy)y\,dx + (x^2y^2 - 1)x\,dy = 0$
   - **c.** Show that standard deviation of a Poisson distribution is equal to square root of its mean. The number of admissions in a hospital follows a Poisson distribution with an average of 4 per day. What will be the probability that there is no admission on a given day?

2. Solve the following second order differential equations
   - **a.** $(D^2 - 2D + 4)y = e^x \cos x$
   - **b.** $(D^2 + n^2)y = \cot nx$
   - **c.** $(D^2 + 1)y = 2\cos x$ (Use the method of undetermined coefficients)

3. Find the projection of a vector $\vec{A} = 4\hat{\imath} - 3\hat{\jmath} + \hat{k}$ on the line passing through the points $(2,3,-1)$ and $(-2,-4,3)$.
   Find the volume of parallelepiped whose edges are represented by
   $$\vec{A} = 2\hat{\imath} - 3\hat{\jmath} + 4\hat{k}$$
   $$\vec{B} = \hat{\imath} + 2\hat{\jmath} - \hat{k}$$
   $$\vec{C} = 3\hat{\imath} - \hat{\jmath} + 2\hat{k}$$

4. Prove that, $\nabla^2(\phi\psi) = \phi\nabla^2\psi + 2\vec{\nabla}\phi \circ \vec{\nabla}\psi + \psi\nabla^2\phi$
   Show that, $\vec{A} = (6xy + z^3)\hat{\imath} + (3x^2 - z)\hat{\jmath} + (3xz^2 - y)\hat{k}$ is irrotational. Find ϕ such that $\vec{A} = \vec{\nabla}\phi$

5. Prove that,
   $$\iiint_V \frac{dV}{r^2} = \iint_S \frac{\vec{r} \circ \hat{n}}{r^2} dS$$
   Verify Stokes' theorem for, $\vec{F} = (y - z + 2)\hat{\imath} + (yz + 4)\hat{\jmath} - xz\hat{k}$. Here, S is the surface of the cube $x = 0, y = 0, z = 0,\ x = 2, y = 2,\ z = 2$ above the xy-plane

6. Prove that the cylindrical coordinate system is orthogonal.
   Transform the vector, $\vec{F} = \frac{1}{\rho}\widehat{e_\rho}$ into rectangular coordinates
   Evaluate $\iint_R \sqrt{x^2 + y^2}\,dx\,dy$ over region R in the xy-plane bounded by $x^2 + y^2 = 36$