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S. No. of Question Paper : **7481**

Unique Paper Code : **32221101** **J**

Name of the Paper : **Mathematical Physics-I**

Name of the Course : **B.Sc. (H) Physics (OC)**

Semester : **I**

Duration : **3 Hours** Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *five* questions.

Question No. **1** is compulsory.

1. Do any *five* of the following :

(*a*) Check whether the functions x^2, e^x, e^{-x} are linearly dependent or independent.

(*b*) Show that the curl of the velocity field of a particle moving with a uniform angular velocity is twice the angular velocity.

(*c*) If $\vec{a}$ is any vector field, then prove that :

$$\vec{\nabla}.(\vec{\nabla} \times \vec{a}) = 0 \cdot$$

P.T.O.

(d) Prove that the cylindrical coordinate system is orthogonal.

(e) Evaluate $J\left(\frac{u, v}{x, y}\right)$; where $u = x^2$ and $v = y^2$.

(f) Find :

$$\vec{\nabla} \cdot (r^2 \vec{r})$$

(g) Show that $\delta(ax) = \frac{1}{a}\delta(x), a > 0$.

(h) Solve $(e^y + 1) \cos x \, dx + e^y \sin x \, dy = 0$. 5×3=15

2. (a) Find :

$$\nabla^2 r^n, r = \sqrt{x^2 + y^2 + z^2}.$$

(b) Prove :

$$\vec{\nabla} \cdot (\phi \vec{A}) = (\vec{\nabla} \phi) \cdot \vec{A} + \phi (\vec{\nabla} \cdot \vec{A}).$$

(c) Prove that :

$$(\vec{B} \times \vec{C}) \cdot (\vec{A} \times \vec{D}) + (\vec{C} \times \vec{A}) \cdot (\vec{B} \times \vec{D}) + (\vec{A} \times \vec{B}) \cdot (\vec{C} \times \vec{D}) = 0$$ 5,5,5

3. (*a*) Evaluate $\oint_c (3x+4y)dx+(2x-3y)dy$ where, C is a circle of radius two with centre at origin of the xy plane, and is traversed in the positive sense.

(*b*) Prove :

$$\oint \vec{dr} \times \vec{B} = \iint_S (\hat{n} \times \vec{\nabla}) \times \vec{B}\, ds$$ 8,7

4. (*a*) Evaluate $\iint \sqrt{x^2+y^2}\, dxdy$ over the region R in the xy plane bounded by :

$$x^2 + y^2 = 9.$$

(*b*) Verify the Divergence Theorem of Gauss for :

$$\vec{A} = 4x\hat{i} - 2y^2\hat{j} + z^2\hat{k}$$

taken over the region bounded by $x^2 + y^2 = 4$, $z = 0$ and $z = 3$. 5,10

5. (*a*) Express the vector :

$$\vec{A} = 2y\hat{i} - z\hat{j} + 3x\hat{k}$$

in cylindrical coordinates and determine A_ρ, A_θ, A_z.

(b) Obtain the expression for divergence of a vector in orthogonal curvilinear coordinates and express it in cylindrical coordinates. 8,7

6. (a) Solve the following differential equations :

$$\frac{dy}{dx}+\frac{y}{x}+x^3y^2 = 0$$

with a condition $y(1) = 1$.

(b) Using the method of variation of parameters, solve :

$$\frac{d^2y}{dx^2}+16y=32\sec 2x\,.$$ 5,10

7. Solve the following differential equations :

(a) $4\frac{d^2y}{dx^2}-y=e^{x/2}$

(b) $x^2\frac{d^2y}{dx^2}-3x\frac{dy}{dx}+4y=2x^2$

(c) Using the method of undetermined coefficient, solve :

$$\frac{d^2y}{dx^2}-4\frac{dy}{dx}+9y=10e^{2x}-12\cos x\,.$$ 4,5,6

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