



Roll No:

End Semester Examination, December 2024
B.Sc. (Hons./Hons. with Research) Physics-1st Semester
MATHEMATICAL PHYSICS-I (SCPH101)

Time: 2 hrs. 30 mins.

Max. Marks: 50

Note: *All Questions are compulsory. Marks are indicated against each question.*

PART-A

Q.1 Attempt any 5 questions:

5x2 = 10

- (a) What is Taylor Series? [CO-1] [L-1] 2
- (b) Find the area of a parallelogram whose adjacent sides are $\hat{i} - 2\hat{j} + 3\hat{k}$ and $\hat{i} - 2\hat{j} + 3\hat{k}$. [CO-2] [L-2] 2
- (c) Let $\vec{a} = \hat{i} + \hat{j} - \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$, $\vec{c} = \hat{i} - \hat{j} - \hat{k}$. Find the vector $\vec{a} \times (\vec{b} \times \vec{c})$. [CO-2] [L-2] 2
- (d) If $\phi = 3x^2y - y^3z^2$; find $\text{grad } \phi$ at the point (1, -2, -1). [CO-3] [L-3] 2
- (e) If a force $\vec{F} = 2x^2y\hat{i} + 3xy\hat{j}$ displaces a particle in the xy-plane from (0,0) to (1,4) along a curve $y = 4x^2$. Find the work done. [CO-3] [L-3] 2
- (f) If $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$, show that: [CO-4] [L-3] 2
 $\text{grad } r = \frac{\vec{r}}{r}$
- (g) Find the unit normal to the surface $x^2 + y^2 = z$ at a point (1,2,5). [CO-4] [L-3] 2

PART-B

Q.2

- (i) Solve the following linear differential equation [CO-1] [L-3] 5
$$\frac{dy}{dx} + y \cos x = \frac{1}{2} \sin 2x$$
- (ii) Solve the following linear differential equation [CO-1] [L-3] 5
$$\frac{dy}{dx} + y \tan x = \cos x, y(0) = 0$$

OR

- (i) Solve the following homogenous differential equation [CO-1] [L-3] 5
$$(y^2 + 2xy)dx + (2x^2 + 3xy)dy = 0$$
- (ii) Solve the following homogenous differential equation [CO-1] [L-3] 5
$$(x^2 + y^2)dy = xydx$$

Q.3

State Green's theorem. If a vector field $\vec{F} = \sin y \hat{i} + x(1 + \cos y) \hat{j}$, evaluate the line integral $\oint_C \vec{F} \cdot d\vec{r}$, where C is the circular path given by $x^2 + y^2 = a^2$. [CO-2] [L-3] 10

OR

A vector field is given by $\vec{A} = (x^2 + xy^2)\hat{i} + (y^2 + x^2y)\hat{j}$. Show that the field is irrotational and find the scalar potential. [CO-2] [L-3] **10**

Q.4

Find the directional derivative of $\frac{1}{r}$ in the direction $\vec{r}$, where $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. [CO-3] [L-3] **10**

OR

Determine $\vec{\nabla} \cdot \left(\frac{\vec{r}}{r^n} \right)$, $n > 0$ $\wedge$ $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. [CO-3] [L-3] **10**

Q.5

Apply Stoke's theorem to evaluate the value of [CO-4] [L-4] **10**

$$\oint_C (ydx + xdy + zdz)$$

Where C is the curve of intersection of $x^2 + y^2 + z^2 = a^2$ $\wedge$ $x + z = a$.

OR

What is Gauss's theorem of divergence?

[CO-4] [L-4] **10**

Evaluate $\oiint_S \vec{F} \cdot \hat{n} ds$, where $\vec{F} = 4xz\hat{i} - y^2\hat{j} + yz\hat{k}$ and S is the surface of the cube bounded by $x=0, x=1, y=0, y=1, z=0, z=1$.
