

Total No. of Printed Pages—6

1 SEM TDC PHYH (CBCS) C 1

2021

(Held in January/February, 2022)

PHYSICS

(Core)

Paper : C-1

(**Mathematical Physics—I**)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

1. Choose the correct answer : 1×5=5

(a) The partial derivative of $ye^{2x} + 2xy^2$ is

(i) $2(ye^{2x} + xy^2)$

(ii) $2(ye^{2x} + y^2)$

(iii) $(ye^{2x} + 2y^2)$

(iv) None of the above

(2)

(b) The degree and order of the differential equation

$$\frac{d^2y}{dx^2} - 3\left(\frac{dy}{dx}\right)^2 + 2y = e^{3x}$$

are

(i) 2 and 2

(ii) 2 and 1

(iii) 1 and 2

(iv) None of the above

(c) If \vec{A} is an irrotational vector, then

(i) $\vec{\nabla} \cdot \vec{A} = 1$

(ii) $\vec{\nabla} \times \vec{A} = 0$

(iii) $\vec{\nabla} \vec{A} = 0$

(iv) None of the above

(d) By Gauss divergence theorem,

$\int_V \vec{\nabla} \cdot \vec{A} dV$ equals to

(i) $\int_S \vec{A} \cdot d\vec{S}$

(ii) $\oint_C \vec{A} \cdot d\vec{r}$

(iii) $\oint_C \vec{A} \cdot d\vec{S}$

(iv) None of the above

(3)

(e) A normal to the surface $\phi(x, y, z) = c$ is given by

(i) $\vec{\nabla} \cdot \phi$

(ii) $\vec{\nabla} \times \phi$

(iii) $\vec{\nabla} \phi$

(iv) None of the above

2. Answer the following questions : $2 \times 5 = 10$

(a) Show that $\lim_{x \rightarrow 0} \sin \frac{1}{x}$ does not exist.

(b) For what values of a , \vec{A} and \vec{B} are perpendicular if $\vec{A} = a\hat{i} - 2\hat{j} + \hat{k}$ and $\vec{B} = 2a\hat{i} + a\hat{j} - 4\hat{k}$?

(c) What is a Wronskian? How is it used to find the linear dependence of two functions?

(d) Show that \vec{B} is perpendicular to \vec{A} , if $|\vec{B}| \neq 0$ and $\vec{B} = \frac{d\vec{A}}{dt}$.

(e) Evaluate using the property of Dirac delta function :

$$\int_{-\infty}^{+\infty} x \delta(x-4) dx$$

3. Answer any five questions from the following : $4 \times 5 = 20$

(a) What do you mean by linearly dependent and linearly independent solutions of a homogeneous equation? If $y_1(x) = \sin 3x$ and $y_2(x) = \cos 3x$ are two solutions of $y'' + 9y = 0$, then show that $y_1(x)$ and $y_2(x)$ are linearly independent solutions. $1+3=4$

(b) If $z(x+y) = x^2 + y^2$, then show that

$$\left(\frac{\partial z}{\partial x} - \frac{\partial z}{\partial y} \right)^2 = 4 \left(1 - \frac{\partial z}{\partial x} - \frac{\partial z}{\partial y} \right) \quad 4$$

(c) Solve the differential equation

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

Hence find the solution for

$$\frac{d^2 y}{dx^2} - 3 \frac{dy}{dx} + 2y = e^{3x} \quad 3+1=4$$

(d) What is directional derivative? Find the directional derivative of $\phi = x^2 - 2y^2 + 4z^2$ at $(1, 1, -1)$ in the direction $2\hat{i} + \hat{j} - \hat{k}$. $1+3=4$

(e) State Bayes' theorem of probability. 6 cards are drawn from a pack of 52 cards. What is the probability that 3 will be red and 3 black? $1+3=4$

(f) State Green's theorem in a plane. Starting from Green's theorem, show that the area bounded by a closed curve is given by

$$\frac{1}{2} \oint_C (x dy - y dx) \quad 1+3=4$$

4. Answer any three questions from the following : $6 \times 3 = 18$

(a) What are complementary function and particular integral of a differential equation? Solve the differential equation

$$\frac{d^2 y}{dx^2} + 4 \frac{dy}{dx} + 4y = x^2$$

if $y(0) = 0$ and $y'(0) = \frac{1}{2}$. $1+5=6$

(b) Define line integral and surface integral. Find the total work done in moving a particle in a force field given by $\vec{F} = 3xy\hat{i} - 5z\hat{j} + 10x\hat{k}$ along a curve $x = t^2 + 1$, $y = 2t^2$, $z = t^3$ from $t = 1$ to $t = 2$. $2+4=6$

(c) Show that $F = (2xy + z^3)\hat{i} + x^2\hat{j} + 3xz^2\hat{k}$ is a conservative force field. Find the scalar potential. Also find the work done in moving an object from (1, -2, 1) to (3, 1, 4). 2+2+2=6

(d) What are curvilinear coordinates? Describe the term 'scale factor' in curvilinear coordinates. Derive the expression for divergence of a vector in curvilinear coordinates. Hence write its expression in spherical polar coordinates. 1+2+3=6
