

**2019/TDC/ODD/SEM/
PHSHCC-101T/069**

TDC (CBCS) Odd Semester Exam., 2019

PHYSICS

(1st Semester)

Course No. : PSHHCC-101T

(Mathematical Physics—I)

Full Marks : 50

Pass Marks : 20

Time : 3 hours

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

UNIT—I

1. Answer any *two* of the following : 2×2=4

- (a) Explain transpose of a matrix with an example.
- (b) Show that any square matrix can be expressed as the sum of a symmetric and a skew symmetric matrix.
- (c) If A and B are non-singular matrices of same order, then show that

$$(AB)^{-1} = B^{-1}A^{-1}$$

2. Answer either [(a) and (b)] or [(c) and (d)] :

(a) Find the inverse of the matrix

$$A = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

(b) Solve the following equations by matrix method :

$$x + y + z = 6$$

$$x - y + z = 2$$

$$2x + y - z = 1$$

(c) Show that

$$(3x + 4y + 5)dx + (4x - 3y + 3)dy = 0$$

is an exact equation and hence solve it.

(d) Solve the differential equation :

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

UNIT—II

3. Answer any two of the following :

2×2=4

(a) If $\vec{A} + \vec{B} + \vec{C} = 0$, show that

$$(\vec{A} \times \vec{B}) = (\vec{B} \times \vec{C}) = (\vec{C} \times \vec{A})$$

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(b) Find the value of a such that the vectors $2\hat{i} - \hat{j} + \hat{k}$, $\hat{i} + 2\hat{j} - 3\hat{k}$ and $3\hat{i} + a\hat{j} + 5\hat{k}$ are coplanar.

(c) Show that $\vec{\nabla}\phi$ is a vector normal to the surface $\phi(x, y, z) = C$.

4. Answer either [(a) and (b)] or [(c) and (d)] :

(a) For any three vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$, show that

$$\vec{A} \cdot (\vec{B} \times \vec{C}) = \vec{C} \cdot (\vec{A} \times \vec{B}) = \vec{B} \cdot (\vec{C} \times \vec{A})$$

(b) Show that

$$\vec{\nabla} \times (\vec{\nabla} \times \vec{A}) = \vec{\nabla}(\vec{\nabla} \cdot \vec{A}) - \nabla^2 \vec{A}$$

(c) A vector field is defined as

$$\vec{A} = \frac{\vec{r}}{r^2}$$

where $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. Evaluate $\vec{\nabla} \cdot \vec{A}$

and $\vec{\nabla} \times \vec{A}$ and hence state whether the field is solenoidal or irrotational.

(1½×2)+1=4

(d) Show that

$$\vec{A} \times (\vec{B} \times \vec{C}) + \vec{C} \times (\vec{A} \times \vec{B}) + \vec{B} \times (\vec{C} \times \vec{A}) = 0$$

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(Turn Over)

UNIT—III

5. Answer any two of the following : $2 \times 2 = 4$

(a) Calculate the volume integral of $(\vec{\nabla} \cdot \vec{r})$ over the volume enclosed by a sphere of radius a , where $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$.

(b) If $\vec{F} = \vec{\nabla}\phi$ everywhere in a region R and ϕ is single-valued and has continuous derivatives in R , then show that

$$\int_A^B \vec{F} \cdot d\vec{r}$$

is independent of the path joining the points A and B .

(c) Calculate the work done when a force $\vec{F} = 3xy\hat{i} - y^2\hat{j}$ moves a particle in xy -plane from $(0, 0)$ to $(1, 2)$ along the parabola $y = 2x^2$.

6. Answer (a) or (b) :

(a) Verify Gauss divergence theorem for the vector $\vec{A} = x^2\hat{i} + y^2\hat{j} + z^2\hat{k}$ over the surface of a cube bounded by $0 \leq x, y, z \leq 1$.

(b) State and prove Stokes' theorem.

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UNIT—IV

7. Answer any two of the following : $2 \times 2 = 4$

(a) Write the expressions for line element and volume element in cylindrical coordinates.

(b) Write the expression for divergence of a vector in orthogonal curvilinear coordinates.

(c) Write the expression for Laplacian of a scalar in orthogonal curvilinear coordinates.

8. Answer (a) or (b) :

6

(a) Derive the expression for curl of a vector in orthogonal curvilinear coordinates.

(b) Describe the spherical coordinate system with necessary diagram to derive the expression for divergence of a vector in spherical coordinates.

UNIT—V

9. Answer any two of the following : $2 \times 2 = 4$

(a) What is meant by probability? Write the expression for probability function for binomial distribution.

1+1=2

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(Turn Over)

(b) Explain the term 'variance' with an example.

(c) The following set of data gives the diameter of a wire measured by a screw gauge for five different observations :

2.12 cm, 2.11 cm, 2.14 cm, 2.13 cm,
2.15 cm

Find the standard deviation.

10. Answer (a) or (b) :

6

(a) Derive the expressions for mean and variance for Poisson distribution.

(b) What is conditional probability? State and prove Bayes' theorem.
