Bachelor of Science Examination, 2018
(1st Year, 1st Semester)
PHYSICS (Honours)
Paper - HO-01

Time : **Two hours**

Full Marks : **50**

(25 marks for each group)

Use separate Answer Scripts for each group

GROUP - A

Answer any five questions

1. (a) Show that $\overline{\nabla}\phi$ is perpendicular to $\phi(x, y, z) =$ constant surface.

   (b) Show that $\overline{\nabla} \times (\overline{\nabla}\phi) = 0$, where ϕ is a scalar function.

3+2

2. (a) Find the Fourier series representation of

$$f(x) = \begin{cases} 0 & -\pi < x \leq 0 \\ x & 0 \leq x < \pi \end{cases}$$

   (b) Hence show

$$\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \ldots$$

3+2

3. (a) Show that $(AB)^T = B^T A^T$ where A and B are square matrices.

   (b) Show that every square matrix can be uniquely expressed as the sum of a symmetric and a skew symmetric matrix.

   (c) If A and B are two symmetric matrices, then show that AB is symmetric only if A and B commute.

2+2+1

4. Solve
$$\frac{d^2y}{dx^2}+5\frac{dy}{dx}+6y=\sin x$$

5

5. (a) Show that
$$\delta z=(x^2+y^2)dx+2xydy$$
is a perfect differential.

(b) If
$$\overline{A}=(3x^2+6y)\hat{\imath}-14yz\hat{\jmath}+20xz^2\hat{k}$$
then show that
$$\int_C \overline{A}.d\vec{r}=\frac{13}{3}$$
where C is a straight line joining $(0,0,0)$ and $(1,1,1)$.

2+3

6. (a) 'tanθ $(0\leq\theta\leq\pi)$ cannot be expanded in Fourier series' - explain.

(b) Show that
$$(\overline{A}\times\overline{B})^2=A^2B^2-(\overline{A}.\overline{B})^2$$

2+3

7. (a) Define homogeneous function with example.

(b) If $f(x,y)=x^2+y^2$, then show that
$$x\frac{\partial f}{\partial x}+y\frac{\partial f}{\partial y}=2f$$

3+2

Subject: HO1 **Time:** 1 hour **Full Marks:** 25

Group: B

Answer any **five** *questions*

1. (a) An automobile is moving along the $x-$ direction with velocity v_0 on a smooth frictionless surface when its engine is suddenly shut off. Assuming the air resistance is proportional to its instantaneous velocity calculate its velocity and displacement as a function of time.

   (b) Find the time and distance covered by the engine to come to rest. Justify your answer.

   3+2

2. (a) A bead moves along the spoke of a wheel at constant speed u. The wheel rotates with uniform angular velocity ω about a fixed axis. At $t = 0$, the spoke is along the $x-$axis and the bead is at the origin. Find the velocity and acceleration of the bead in polar co-ordinate system.

   (b) Sketch velocity of the bead for several positions of the wheel.

   (2+2)+1

3. (a) Show that work-energy theorem is just a mathematical consequence of Newton's laws of motion.

   (b) Use the above theorem to find escape velocity at the surface of the earth. Show that it is independent of launch direction.

   2+(2+1)

4. (a) What is meant by a central force?

   (b) A particle of mass m moves under the influence of a central force field which varies inversely as the cube of its distance from the centre. Find the equation for the orbit.

   1+4

5. (a) Using Newton's 2nd and 3rd laws show that the linear momentum of a system of particles is a constant.

   (b) Define centre of mass of a system of particles. Find the centre of mass of a non-uniform rod of length L where mass per unit length of the rod is $\lambda = \lambda_0 x/L$, λ_0 is a constant.

   2+(1+2)

6. (a) Show that the time derivative of a vector $\vec{A}$ in a fixed and in a rotating co-ordinate systems are related as

$$\left(\frac{d\vec{A}}{dt}\right)_{\text{fixed}} = \left(\frac{d\vec{A}}{dt}\right)_{\text{rotating}} + \vec{w} \times \vec{A}$$

(b) What is meant by a fictitious or pseudo force? Give examples.

3+2

7. (a) State and prove parallel axes theorem of moment of inertia for a 3-dimensional body.

(b) Define moments of inertia and product of inertia for a rigid body. Under what circumstances products of inertia of a rigid body become zero?

2+(2+1)