Ref. No.: EX/1P/I/06/19(OLD)

Bachelor of Science Examination, 2019

First Year, First Semester

Physics (Paper- HO-01)

Time: Two hours | Full Marks: 50

Use Separate Answer Scripts for each group

Group A

Answer any **five** questions

1. (a) Define a homogeneous function of degree n in x and y.

   (b) If $u(x,y)$ be a homogeneous function of degree n then show that

$$x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}=nu.$$ (2+3)

2. Find the constant m and n such that the surface $mx^2-2nyz=(m+4)x$ at the point (1,–1, 2) will be orthogonal to the surface $4x^2+z^3=4$. (5)

3. (a) Prove that Div Curl $\vec{A}=0$.

   (b) If $\vec{r}$ be the position vector of a point, prove that $\vec{\nabla}r^n=nr^{n-2}\vec{r}$.

   ($2\frac{1}{2}+2\frac{1}{2}$)

4. (a) Given $\emptyset=2x^3y^2z^4$.

   Show that $\nabla.\nabla\emptyset=\nabla^2\emptyset$ where $\nabla^2\equiv\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}$.

   (b) Show that $\frac{\vec{r}}{r^3}$ is solenoidal. ($2\frac{1}{2}+2\frac{1}{2}$)

5. Use divergence theorem to evaluate $\int(yz\hat{\imath} + zx\hat{\jmath} + xy\hat{k}) \cdot d\vec{s}$ where S is the surface of the sphere $x^2 + y^2 + z^2 = a^2$ in the first octant. (5)

6. Solve completely the differential equation

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = e^{2x} + x^3 + \cos 2x \qquad (5)$$

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

(b) The product of a matrix A and its adjoint is equal to the unit matrix multiplied by the determinant of A. (2+3)

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BACHELOR OF SCIENCE EXAMINATION, 2019

(1st Year, 1st Semester)

PHYSICS (HONOURS)

Paper-HO-1

GROUP-B

Answer any *five* questions

1. Prove that for the motion of a particle in a plane

$$\vec{v} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta} \quad \text{and}$$

$$\vec{a} = (\ddot{r} - r\dot{\theta}^2)\hat{r} + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\hat{\theta}$$

where the symbols have their usual meanings. Find the modified form of the velocity $\vec{v}$ and acceleration $\vec{a}$, in case of uniform circular motion with $\dot{\theta} = \omega$, a constant. [(2+2)+1]

2. Find the displacement and velocity of a particle of mass m undergoing vertical motion in a medium having retarding force proportional to the velocity of the particle. Assume that at $t = 0$, velocity and displacement of the particle are zero and h respectively. Plot velocity vs time and show that velocity approaches a limiting value as the time becomes very long. [(2+2)+1]

3. Show that work-energy theorem is just a mathematical consequence of Newton's laws of motion. Use the above theorem to find escape velocity at the surface of the earth. [2+3]

4. What is the basic principle of rocket motion? Establish the following equation for a rocket motion under gravity

$$v = u\ln(\frac{m_0}{m}) - gt$$

The symbols have their usual meanings. [1+4]

5. What is meant by a central force? Show that if a particle in motion under central force, (a) the angular momentum of the particle is a constant and (b) the areal velocity of the radius vector is also a constant. [1+2+2]

6. State and prove the theorem of parallel axes as applied to moment of inertia. Use this theorem to evaluate moment of inertia of a circular disc about an axis perpendicular to the disc passing through a point on the edge. [3+2]

7. A reference frame S' rotates with respect to another reference frame S with an angular velocity $\vec{\omega}$. If the position, velocity and acceleration of a particle in frame S' are represented by $\vec{r}$, $\vec{v}$ and $\vec{a}$, find an expression relating acceleration of the particle in reference frames S' and S. Explain the terms involved in the expression. [4+1]