2024

PHYSICS

B.Sc. First Semester End Examination - 2024

PAPER - MJ-101T

Full Marks : 40 *Time : 2 hours*

The figures in the right-hand margin indicate marks.
Candidates are required to give their answers in their own words as far as practicable.
Illustrate the answers wherever necessary.

Group - A

1. Answer any 5 (five) questions out of 8 (eight) questions: 2×5=10

(a) A projectile is fired horizontally with a velocity 500 m/s at 30°N latitude. Calculate the horizontal compoment of coriolis acceleration. 2

(b) Prove that for a particle moving under a central force, the motion of the particle is always confined to a plane. 2

(c) For a particle of mass 10 gm, the position vector $\vec{r} = 10\hat{i} + 6\hat{j}$ and velocity $\vec{v} = 5\hat{i}$ cm/s. Find the angular momentum at the origin. 2

(d) Show that, $r^n\vec{r}$ is solenoidal vector if n=–3. 2

(e) Calculate the percentage contraction of a rod moving with a velocity 0.8 times the velocity of light in a direction inclined at 60° to its own length. 2

(f) If $\vec{r}$ be he position vector of a point on a closed contour, prove that the line integral $\oint \vec{r}.d\vec{r} = 0$

(g) A 20 kg mass is suspended from a length of copper wire 1 mm in radius. If the wire breaks suddenly, calculate the change in temperature. [Given : $Y=12 \times 10^{11} N/m^2$; density of copper 9000 kg/m^3; specific heat = 0.42 J/gm/deg.K]

(h) Setup the equation of mothion of a sphrical body of radius r moving vertically downward through a viscous fluid.

Group -B

Answer any four out of six. **4×5=20**

2. (i) Find the angle between the surfaces $x^2+y^2+z^2=9$ and $z=x^2+y^2-3$ at (2,–1,2)

(ii) A mass of 25×10^{-2} kg is suspended from the lower end of a vertical spring having a force constant 25 Nm^{-1}. What should be the damping constant of the system so that the motion is critically damped? (3+2)=5

3. (i) If $\vec{w}$ is angular velocity of a rigid body rotating about a fixed axis and $\vec{v}$ is the velocity of a particle (body) then prove that, curl $\vec{v}$ is equal to twice the angular velocity.

(ii) If $\vec{A}+\vec{B}+\vec{C}=0$, prove that $(\vec{A}\times\vec{B})=(\vec{B}\times\vec{C})=(\vec{C}\times\vec{A})$ (4+1)=5

4. (i) Solve that, $\frac{dy}{dx}+y\tan x = \sin(2x)$, y(0)=1

(ii) If one litre of glycerine gets reduced in volume by 0.21 cm^3 under a pressure of 10 kg/cm^2, calculate bulk modulus of glycerine. (4+1)=5

5. (i) Show that the general equation of central orbit of motion, of a parcicle of mass m is–

$$\frac{d^2u}{d\theta^2}+u=-\frac{F(1/u)}{mh^2u^2}$$

[symbols have their usual meanings]

(ii) Show that $\vec{F} = (2xy + z^3)\hat{i} + x^2\hat{j} + 3xz^2\hat{k}$, is a conservative force field. Find the potential. 3+2=5

6. State Gauss's divergence theorem. If $\vec{F} = 2y\hat{i} - z\hat{j} + x^2\hat{k}$ and S is the surface of the parabolic cylinder $y^2=8x$ in the first octant bounded by a planes y=4 and z=6, evaluate $\iint \vec{F}.\hat{n}ds$. (1+4=5)

7. What is radius of gyration? If a rigid sphere of radius a and radius of gyratoin k rolls down withour slipping along a plane inclined at an angle θ with horizontal, then show that its acceleration will be $f = \frac{g\sin\theta}{1+\left(\frac{k}{a}\right)^2}$ (2+3=5)

Group - C

Answer any one question : 1×10=10

8. (a) If $\vec{A} = (ax)\hat{i} + (by)\hat{j} + (cz)\hat{k}$ evaluate $\oint \vec{A}.d\vec{s}$ over the surface S of a sphere of unit radius.

(b) A particle moving under a central force field describes a spiral orbit given by $r=ae^{b\theta}$ where a and b are

constants. Obtain the force law.

(c) Taking earth as rotating frame, show that the value of g at latitude λ decreases by a value $\omega^2 R\cos^2\lambda$, where R is the radius and ω is the angular velocity of earth. (4+3+3)

9. (i) Prove that if at any instant of motion kinetic energy is suddenly increased by a blow in the ration (1+β) :1. the amplitude of the swing is increased in the ratio,

$$\sqrt{1+\frac{\beta v^2}{\alpha^2\omega^2}}:1$$

[symbols have their usual meanings]

(ii) Starting from Lorentz transformation equations for space and time co-ordinates derive equations for relativistic addition of velocities. Hence prove that no material particle can move with a velocity greater than that of light.

(iii) Show that Newton's law are invariant under Gallilian transformation. (4+4+2=10)