B.Sc. 1st Semester (Honours) Examination, 2022 (CBCS)

Subject : Physics

Course : CC-II

Time: 2 Hours **Full Marks: 40**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
Abbreviations and symbols have their usual meaning.

1. Answer *any five* of the following: 2×5=10

(a) What is a 'Simple Harmonic Motion'?

(b) Show that under Gallilean Transformation Newton's Second Law remains invariant.

(c) Prove that $L^2 = 2EI$, where L, E and I are the angular momentum, kinetic energy of rotation and moment of inertia respectively of a rigid body.

(d) A particle of mass 'm' moving with velocity 'u' collides with a target particle of unknown mass initially at rest. If, after the collision the target particle travels forward with a velocity $\frac{u}{3}$ while the incident particle moves backward with a velocity $\frac{2u}{3}$, find the mass of the target particle.

(e) What do you mean by relativistic Doppler Effect?

(f) Show that path integral of force is equal to change in kinetic energy.

(g) Write a short note on Global Positioning system.

(h) Prove that for a particle moving under a central force, the torque about the centre of force is zero.

2. Answer *any two* of the following: 5×2=10

(a) (i) Show that rocket speed is twice the exhaust speed when $\frac{M_0}{M} = e^2$.

(ii) Find the centre of mass of a semi-circular disc of radius 'a'. 2+3

(b) (i) A body dropped from a height 'h' reaches the ground with speed of $2\sqrt{gh}$. Calculate the work done by air friction.

(ii) Prove that the angular momentum of a system of particles about a fixed point is equal to the angular momentum of the total mass of the system about the same point plus the angular momentum of the system about its centre of mass. (Assume mass of the system is concentrated at its centre of mass.) 2+3

(c) (i) The bulk modulus of water is $2{\cdot}3 \times 10^9$ N/m^2. Find its compressibility and how much pressure in atmosphere is needed to compress a sample of water by 0·1%.

(ii) Discuss the effect of temperature on elasticity. 3+2

(d) (i) Explain the correction necessary for Poiseuille formula.

(ii) Derive an expression for the terminal velocity of a body falling through a viscous liquid. 3+2

3. Answer *any two* of the following: 10×2=20

(a) (i) What is radius of gyration?

(ii) Assume that the earth were made of lead(Pb) of relative density 11·3. Then what would be the value of acceleration due to gravity on the earth surface?

(iii) Two solid spheres of radius 10 cm and masses 800 kg and 600 kg are at a distance 0·25 m apart. Calculate the magnitude of the gravitational field intensity at a point distance 0·2 m from the 800 kg sphere and 0·15 m from the 600 kg sphere and does not lie on the line joining their centres. ($G = 6{\cdot}67 \times 10^{-11}\ Nm^2kg^{-2}$)

(iv) At what height (in terms of earth radius) the gravitational field reduce by 75% of the gravitational field at the surface of the earth? 2+2+4+2

(b) (i) Show that for a particle moving under central attractive force field, the quantity $\vec{p} \times \vec{L}$ is conserved. (Symbol have their usual significance.)

(ii) Equation of the orbit of a particle is given as $r^2 = a^2 \cos 2\phi$. Find the nature of the force.

(iii) Show that the time derivative of a vector $\vec{A}$ in a fixed and in a rotating coordinate system are related as $\left(\frac{d\vec{A}}{dt}\right)_{\text{fixed}} = \left(\frac{d\vec{A}}{dt}\right)_{\text{rotating}} + \vec{\omega} \times \vec{A}$. 3+4+3

(c) (i) Write down Lorentz transformation equations in special theory of relativity.

(ii) A rocket accelerates quickly and moves at a uniform velocity. Calculate the velocity of rocket relative to earth such that it reaches a star at a distance 15 light years away in one year as measured by a clock at rest in rocket.

(iii) Calculate the length and orientation of a rod of length 5 m in a frame moving with velocity 0·75 C in a direction making an angle 30° with the rod. 2+4+4

(d) (i) What is the difference between transient and steady slates in oscillation?

(ii) What is metastable equilibrium?

(iii) Find the time period of a simple pendulum which is kept hanging from roof of a car, moving with acceleration a.

(iv) Determine the period of oscillations of a simple pendulum whose bob is suspended by a thread of $l = 20$ cm, such that it is located in a liquid whose density is three times less than that of the bob. (The resistance of the liquid is to be neglected.) 2+2+3+3