B.Sc. Semester I (Honours) Examination, 2021 (CBCS)

Subject: Physics

Paper: CC- II (Mechanics)

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

The questions are of equal value. Candidates are required to give their answers in their own words as far as practicable. *You must define all the symbols you use.*

Answer any **eight** questions: 5x8=40

1. (a) Define inertial frame. A plate rotating with a constant angular velocity about its own axis. Explain whether this constitutes an inertial frame or not?
   (b) A river of width d flows southward with a speed v_0 at a co-latitude λ in the northern hemi-sphere. Prove that the difference (H) between water levels of the two banks due to coriolis force is given by H= $(2D\omega v_0 Cos\lambda)/g$, where symbols have their usual significance.

2. (a) Examine whether Coulomb force is conservative or not.
   (b) Define stable and unstable equilibrium with suitable examples.

3. (a) A 15kg ball is thrown at a velocity 20 km/h to a 60 kg person who is at rest on ice. The person catches the ball and subsequently slides with the ball across the ice. Determine the velocity of the person and the ball after the collision.
   (b) Show that for a system of particles the total energy is conservative when internal and external forces are conservative.

4. (a) Define 'theorem of parallel axes' and prove it for plane laminar body.
   (b) Calculate moment of inertia of a solid sphere of diameter 'a' about a diameter as axis. Hence calculate moment of inertia for a hollow sphere whose inner and outer radii are r_1 and r_2 respectively about any of the diameters.

5. (a) Calculate the angular momentum of the earth rotating about its own axis of rotation. Given: mass of earth= 6×10^{24} kg and radius= 6.4×10^6 m.
   (b) Find the moment of inertia of two masses m and M about an axis passing through centre of mass and perpendicular to the line joining between them. The distance between m and M is d.

6. (a) A wire of length 1m can withstand a mass of 5kg. If the wire is reduced to half of its original length, how much load it can withstand now?

(b) How do you define kinematic viscosity?

(c) Show that if the earth is not rotating about its own axis, the acceleration due to gravity at the equator would exceed its present value by 3.36×10^{-2} m/s^2. Given: radius of earth= 6.37×10^6m and angular velocity of the earth=7.27×10^{-5} rad/s.

7. (a) Writing $r = \frac{1}{u}$, show that the conservation of energy equation for central force becomes
$$\left(\frac{du}{d\theta}\right)^2 + u^2 = \frac{2(E-V)}{mh^2}.$$
(b) Prove that the motion of a particle subject to a central force field is confined to a plane.

8. (a) State the fundamental postulates of special theory of relativity.

(b) Explain the null result of Michelson-Morley experiment by Lorentz length contraction hypothesis.

(c) The proper life time of an unstable particle is 25ns. At what velocity will it appear to have mean life time 250ns?

9. (a) Deduce Einstein's mass-energy equivalence relation.

(b) What is the speed of an electron whose kinetic energy equals its rest energy?

10. (a) Show that uniform motion in a circle is equivalent to two S.H.M. at right angle to each other.

(b) In a 1-Dimensional motion a mass of 10^{-2}Kg, is acted on by a restoring force 10^{-6} N/m and a resisting force 2×10^{-7} N-sec/m. Find

(i) Whether the motion is periodic or oscillatory.

(ii) The value of mass for which the given forces will make the motion critically damped.