B.Sc.(Honours)Examination, 2018

Semester–I (CBCS)
Physics (Core)
Core Course: CC-2
(Mechanics)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.
Answer***anyfour***questions

1. a) What is an inertial frame? Explain with example. Explain whether an uniformly rotating frame is an inertial frame or not. Hence find out the expression for Coriolis force. 2+4
   b) A particle 'A' suffers an elastic oblique collision with a particle *B* of the same mass initially at rest. The angles of scattering and recoil are θ and φ respectively. Show that the sum of these angles is 90^o. 4

2. a) Distinguish between "inertial" and "gravitational" mass. 2
   b) State Einstein's principle of equivalence? Elucidate it by Einstein's thought experiments. 3
   c) Show that for a particle moving in the central force field the angular momentum is conserved. Also show that the path lies on a plane. 3+2

3. a) The path of a particle moving in a central force field is in the form of a conic section of the form,
$$r = \frac{P}{1 + \epsilon cos\theta}$$
where symbols have their usual meaning. If the force field is conservative, find out the value of eccentricity "ϵ" in terms of the total energy "E" and show that the path will be an ellipse depending upon the nature of "E". 4
   b) Explain what you understand by Gravitational potential deriving the appropriate expression. 2
   c) Find out the gravitational potential and intensity due to a solid sphere at an internal point. 4

4. a) Derive an expression for the torsional rigidity of an uniform solid cylinder of length "l" and radius "r". What will happen if the cylinder is hollow of external radius "r_1" and internal radius r_2. 4+1
   b) Write the interrelationships between "y", "n", "σ" and "y", "k", "σ" (where symbols have their usual meaning) and hence find out the limiting values of Poisson's ratio "σ".
   The Young's Modulus "y", and rigidity modulus "n" are 11.25×10^{11} dynes/cm^2 and 4.55×10^{11} dynes/cm^2 respectively. What will be the change in volume of 1000 c.c. of the substance when subjected to a pressure of 10 atm? (1 atm = 10^6 dynes/cm^2). 2+3

5. a) A cylindrical vessel of radius 7 cm, is filled with water upto a height of 50 cm. A capillary tube of length 16 cm and radius 0.8 mm is connected horizontally at the bottom of the vessel, then find out how long it will take for the height of water to fall to 25 cm. Density of water is 1 gm/cc and viscosity is 0.01 poise. Derive the formula used. 4
   b) What are the Lorentz transformation equations? What do you understand by length contraction? 3
   c) Obtain the relativistic expression for u in terms of u' and v, where $v \cong c$, is the velocity of the S' frame with respect to the S frame. (Symbols have their usual meaning). 3

6. a) What do you understand by cyclic coordinates? Explain with example how a mechanical quantity associated with a cyclic coordinate is conserved. 3

P.T.O.

b) What are Legendre transformations? Using Legendre transformations obtain the Hamilton's canonical equations. 4

c) Obtain the equation of motion for compound pendulum using Lagrange's equation. 3

7. a) Write the differential equation for a simple harmonic oscillator and obtain its solution. Hence show that the total energy of a S.H.O. is conserved and proportional to the square of the amplitude. 4

b) A body having mass 4 gms executes S.H.M. the force acting on the body F is 24 gm. weight, when its displacement "x" is 8 cm. Find the time period T. If the maximum velocity "wa" is 500 cm/sec, find the amplitude of oscillations. 3

c) In a damped harmonic oscillator where the natural frequency is "w_0" and the damping constant is "b" show that the time period "T" is given by,

$$T = \frac{2\pi}{w} = \frac{2\pi}{\sqrt{w_0^2 - b^2}}$$

when the oscillator is underdamped (i.e. $b < w_0$). 3

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