

U.G. 1st Semester Examination - 2020**PHYSICS****Course Code : BPHSCCHC 102****Course Title : Mechanics**

Full Marks : 30

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.*

1. Answer any **ten** questions: 1×10=10
- A particle of unit mass moves according to the equation: $\vec{r} = \hat{i}(2 + 3t^2) + \hat{j}5t^2 + \hat{k}t$. Find the force acting on it.
 - What is 'pseudo force'?
 - What do you mean by 'Inertial Mass'?
 - Find the impulse developed by the force $4t\hat{i}$ from time $t=0$ to $t=2$ sec.
 - Write the transformation relations between cartesian and spherical polar coordinates.
 - Why is centre of mass frame also called 'Zero momentum reference frame'?

- What is the condition of 'stable equilibrium'?
 - A ring of mass M and radius R is rolling down inclined plane starting from rest. Find the expression for its kinetic energy.
 - What do you mean by 'Geosynchronous orbits'?
 - What do you mean by time dilation?
 - Write down the differential equation of damped harmonic oscillator explaining different symbols used.
 - What is the significance of Q-factor?
 - When a force is called 'Central force'?
 - What is 'Coriolis force'?
 - What is the 'Newtonian Principle of Relativity'?
2. Answer any **five** questions: 2×5=10
- What are the postulates of special theory of Relativity?
 - Is velocity invariant under Galilean Transformation? Justify your answer.
 - Find the centre of mass of a thin uniform wire bent in the form of a semicircle.

- d) The motion of a particle under the influence of a central force is described by: $r = a \sin \theta$. Find an expression for the force.
- e) For a perfectly elastic collision, prove that the relative velocity of approach of particles before collision is same as relative velocity of separation after collision.
- f) Show that the Galilean transformation equations are the special case of Lorentz transformation equations.
- g) Is $y = \sin kt + \cos kt$ an equation of simple harmonic motion? If so, find the time period and amplitude.
- h) Why is the results of Michelson-Morley experiment called negative? How it was resolved?

3. Answer any **two** questions: 5×2=10

- a) State perpendicular axis theorem. Find the moment of inertia of a uniform solid cylinder (radius R, height H, mass M) about the axis passing through its centre of mass and perpendicular to it's height. 1+4

- b) Show that the equation of motion for a rocket projected vertically upward in a uniform gravitational field, neglecting atmospheric resistance is $m \frac{d\vec{v}}{dt} = \mu \vec{v}' - mg \hat{k}$

where $\mu = -\frac{dm}{dt}$, m is the mass of the rocket,

\vec{v}' is the velocity of the escaping gases relative to the rocket, \hat{k} is the unit vector in the vertically upward direction. 5

- c) Show that $E^2 - P^2 C^2$ is invariant under Lorentz Transformation. Also show that a particle with zero rest mass always moves with velocity of light. 3+2