U.G. 1st Semester Examination - 2021
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) For a body of mass M thrown with velocity $\vec{v}$ at an angle θ with the ground, find the maximum height that the body will attain.

b) Why does a gun recoil on firing a bullet?

c) A particle moves in a potential energy field $U = 3x^2 - x + 9$. Find the point of equilibrium.

d) What are the conditions for a satellite to become 'Geostationary'?

e) Write down some properties of central force.

f) What is 'length contraction"?

g) What is the change of mass of a particle moving with a speed of 0.8C?

h) Write down the Lorentz Transformation Equations.

i) What are Lissajous figures?

j) What is 'Proper time'?

k) When does the Coriolis force comes into play?

l) What is 'Doppler Effect'?

m) Define gravitational potential energy.

n) State the parallel axes theorem for a laminar body.

o) Define logarithmic decrement of a damped oscillatory system.

2. Answer any **five** questions: 2×5=10

a) How does centre of mass differ from centre of gravity? A particle 'A' with mass '*m*' is moving with velocity $\vec{v}_1 = \left(2\hat{i} - 3\hat{j}\right) m/s$ whereas another particle 'B' with mass double as that of 'A', has velocity $\vec{v}_2 = \left(a\hat{i} + b\hat{j}\right) m/s$. The velocity of centre of mass of these two particle systems is $\vec{v}_{CM} = 3\hat{j}\, m/s$. Find out values of 'a' and 'b'.

b) If force is given by $\vec{F} = -\vec{\nabla}V$, where V is single-valued, then prove that the work done in moving a particle from point $P(x_1, y_1, z_1)$ to

$Q(x_2,y_2,z_2)$ is independent of the path joining these two points.

c) Find the average energy of a weakly damped oscillator.

d) A radioactive nucleus of half life $1\,\mu s$ moves through the laboratory at $2.7\times10^{10}\,cm/s$. What will be the half life as measured by an observer in the laboratory?

e) Determine the limiting values of the Poisson's ratio.

f) If the orbit described under a central force given by $r = a(1+\cos\theta)$ with centre at the origin, find the law of force.

g) Find the potential of a conservative force given by $\vec{F} = \left(2xy + z^3\right)\hat{i} + x^2\hat{j} + 3xz^2\hat{k}$.

h) Prove the relation $E^2 - p^2c^2 = m_0^2c^4$.

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

a) i) Derive expression for gravitational potential due to a spherical shell for points both inside and outside the sphere.

ii) The gravitational potential within two homogeneous spherical shells of same

surface density of mass are in the ratio 1:2. Calculate the ratio of their radii. 3+2

b) i) Show that the angle of scattering in Laboratory frame is maximum when the angle of scattering in centre of mass frame is $\cos^{-1}\left(\frac{-m_2}{m_1}\right)$; m_1 and m_2 being the masses of the bodies participating in the process.

ii) A rocket of mass 20 kg has 180 kg of fuel when it starts from rest. The exhaust velocity of fuel is 1.60km/sec. Calculate the ultimate speed gained by the rocket when the rate of consumption of fuel is 2kg/sec. 3+2

c) Deduce Poiseuille's formula for the flow of liquid through a narrow horizontal tube. 5

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