# U.G. 5th Semester Examination - 2020

# PHYSICS

**Course Code : BPHSDSHT2 [DSE2]**

**Course Title : Classical Dynamics**

Full Marks : 40 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) What are generalized coordinates?

b) What is a non-holonomic system?

c) Write down Hamilton's equation of motion.

d) A point particle of mass $m$ is travelling in a constant electric field, $E$. Write down Newton's equation of motion for this particle.

e) Draw schematic diagrams to show stable and unstable equilibrium.

f) What are normal modes of oscillations?



g) Write down continuity equation related with fluid dynamics.

h) A particle with momentum ($px$, $py$, 0) is moving in a circle with radius $r$ in x-y plane. Calculate its angular momentum in Cartesian coordinates.

i) Write some properties of central force field.

j) Write down the Lagrangian of a charged particle in an electromagnetic field.

k) What do you mean by 'proper time'?

l) What will be time period of a second pendulum measured by an observer moving with speed of 0.8c?

m) Mention a phenomenon in support of Doppler effect in light.

n) The continuity equation ensures conservation of _________. (Fill in the blank).

o) What is a streamline motion and turbulent motion?

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

a) Write down the relation between Lagrangian and Hamiltonian of a system.

b) Discuss shortly about Galileo's role in the field of astronomy and astrophysics.

c) How Hamiltonian mechanics related with quantum mechanics?

d) Show that if a coordinate is cyclic in Lagrangian, it will also be cyclic in Hamiltonian.

e) Two equal masses ($m$) coupled by two equal spring in series whose potential and kinetic energy is given as

$$U(x_1, x_2) = K\left(x_1^2 + \frac{1}{2}x_2^2 - x_1x_2\right) \text{ and } T = \frac{1}{2}m\left(\dot{x}_1^2 + \dot{x}_2^2\right).$$

Find the characteristic frequencies of this system.

f) Find the speed of a particle when its kinetic energy equals its rest mass energy.

g) Write down the Navier-Stoke's equation and explain the source of each term.

h) Why two streamlines can't intersect each other?

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

a) Write down the Hamiltonian and derive Hamilton's equations of motion for a linear harmonic oscillator.

b) An observer sees two spaceships flying apart with speed 0.99c. What is the speed of one spaceship as viewed by the other? What is effective potential in central force motion? Write down postulates of special theory of relativity. 2+2+1=5

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

4. Answer any **one** question: 10×1=10

a) Define central force. When a particle moves in a central force field then prove the following properties:

i) The particle moves in a plane.

ii) The angular momentum of the particle is conserved.

iii) The time rate of change in area covered by the particle is constant.

b) Consider the one-dimensional elastic collision of two balls of masses $m_1$ and $m_2$ with $m_2$=3$m_1$. Suppose that the balls have equal and opposite velocities $v$ before the collision;

the problem is to find the final velocities.
A particle of mass 50 g moves under an attractive central force of magnitude $4r^3$ dynes. The angular momentum is equal to 1,000 $g\ cm^2/s$.

i) Find the effective potential energy.

ii) Indicate on a sketch of the effective potential the total energy for circular motion.

iii) The radius of the particle's orbit varies between $r_0$ and $2r_0$. Find $r_0$.

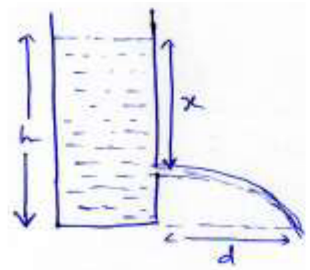
3+3+2+2=10

c) i) Prove that the velocity of efflux of a liquid through an orifice at a depth $h$ below the liquid surface is given by $V = \sqrt{2gh}$.

ii) Water stands at a depth $h$ in a large open tank whose side walls are vertical. A hole is made in one of the walls at a depth $x$ below the water surface. Calculate the horizontal distance $d$ from the wall at which the emerging stream of water strikes the ground and show that $d$ will



be maximum when $x = \frac{h}{2}$. 5+5

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