U.G. 2nd Semester Examination - 2025
PHYSICS
[MAJOR]
Course Code : PHY-MJ-T-02
(Mechanics)
[NEP-2020]

Full Marks : 40   Time : $2\frac{1}{2}$ 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.

GROUP-A

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

   a)   State Galilean invariance and give one example.

   b)   Define conservative force. Give one condition to identify such a force.

   c)   What is the kinetic energy of rotation?

   d)   State the law of conservation of angular momentum with one practical example.

   e)   Define elastic potential energy.

   f)   What is geosynchronous orbit? State one of its applications.

   g)   What is Coriolis force?

   h)   State the principle of mass-energy equivalence.

[Turn over]

GROUP-B

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

   a) Derive the expression for the velocity of efflux of a liquid using Bernoulli's theorem.   5

   b) Define coefficient of restitution. Show that in an elastic collision, both momentum and kinetic energy are conserved.   1+2+2

   c) A thin uniform rod of length L and mass M rotates about one end perpendicular to its length. Calculate its moment of inertia and angular momentum when rotating with angular velocity ω.   5

   d) Derive the differential equation of damped oscillation and discuss the condition for critical damping.   5

GROUP-C

Answer any **two** questions :   10×2=20

3. a) Derive an expression for the moment of inertia of a solid sphere about a diameter.   4

   b) State and prove the perpendicular axis theorem.   4

   c) Explain why a ballet dancer spins faster when she folds her arms.   2

4. a) Derive Poiseuille's law for the steady flow of liquid through a capillary tube. 5

   b) Show that $Y = 3K(1 - 2\sigma)$, where Y is Young's modulus, K is Bulk modulus and σ is Poisson's ratio. 5

5. a) State Kepler's laws of planetary motion. Deduce the law of areas from Newton's law of gravitation. 2+3

   b) Derive an expression for the orbital period of a satellite revolving very close to the Earth's surface. Hence, calculate its orbital period in minutes. Given,

   Altitude of the satellite=800 km

   Universal Gravitational constant, $G=6.67 \times 10^{-11}$ (SI)

   Mass of the Earth, $M=5.9 \times 10^{24}$ kg. 3+2

6. a) State the postulates of Special Theory of Relativity. 2

   b) Why can no material particles travel faster than light according to Special Theory of Relativity? 2

   c) Show that relativistic kinetic energy tends to the classical expression when $v \ll c$. 2

   d) Starting from the Lorentz transformations, derive the time-dilation formula and explain the meaning of proper time. 4

201/Phs(N) (3)