U.G. 2nd Semester Examination - 2024

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 : $2\times5=10$

a) Define the centre of mass of a body and show that it is unique for a body.

b) What is geo-stationary satellite?

c) An elementary particle with a half-life of 2×10^{-5} *Sec* is moving with a velocity of $^{C}/_{4}$ *w.r.t* earth. What would be its half-life as measured by an observer on the earth?

d) What is strain energy? Define Poisson's ratio.

e) Explain what is meant by the radius of gyration of a body about an axis.

f) What is the *burnt out velocity* of a rocket?

g) What is spiral spring? Explain when it is *flat* and when *non-flat*.

h) What do you mean by *adhesion* and *cohesion*?

GROUP-B

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

a) What do you understood by collision? Does collision necessarily mean physical contact of the colliding particles? Show that the kinetic energies of two colliding particles in the centre of mass frame are inversely proportional to their masses. 1+1+3

b) Deduce the equation of motion of a particle executing simple harmonic motion. Find the resultant of two rectangular simple harmonic motions of same frequency, but differing in amplitude and phase. 2+3

c) Calculate the kinetic energy and the angular momentum of a rigid body spinning steadily about a fixed axis with angular velocity ω. Are the directions of ω and L are same? Explain. Find out the moment of inertia of a homogeneous thin rectangular plate having sides $2a$ and a about diagonal. 2+3

d) What do you understand by inertial and non-inertial frame? Find the kinetic energy of rotation of a rigid body *w.r.t* the principal axes in terms of Eulerian angles and interpret the result when $I_1 = I_2$. 2+3

GROUP-C

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

3. a) What do you understand by the ellipsoid of inertia at a point of the rigid body and its principal moments of inertia?

b) Find the moment of inertia of a rigid body about an axis making angles α, β, γ with the principal axes.

c) State and prove the theorem of parallel and perpendicular axes on moment of inertia.

d) In the case of rocket motion, show that the greater the ratio m_f/m_v, the greater is the maximum speed attained by the rocket, where m_f is the mass of the fuel at $t = 0$ and m_v is the mass of the vehicle. 2+3+2+3

4. a) What is stress-strain curve of an elastic material? Define from the curve, the terms: elastic limit, permanent set, ultimate stress, yield point and fracture point. Distinguish between elastic and plastic deformations. 2+2+1

b) Show that shear is equivalent to an elongational strain and an equal compressional strain at right angles to each other. 2

c) Deduce the relation between axial modulus, bulk modulus and modulus of rigidity. 3

5. a) What is capillary action? Explain why water rises in a narrow glass tube. Deduce an expression for capillary rise h of a liquid of density ρ (θ is the angle of contact). 1+2

b) Explain what do you mean by gravitational potential and intensity at a point. 2

c) State Kepler's law on the motion of planetary bodies. Deduce Kepler's law from Newton's law of gravitation. 2+3

6. a) Write down the postulates of special theory of relativity. 2

b) Write a short note on *Time dilation*. 3

c) Prove that if $u/c << 1$, the kinetic energy K of a moving particle will always be much less than its rest mass energy m_0c^2. 2

d) A 0.50 *MeV* electron moves at right angles to a magnetic field in a path whose radius of curvature is 2.0 *cm*. What is the magnetic induction B? By what factor does the effective mass of the electron exceeds its rest mass? 3