Question Bank

B.Sc Sem-I

Paper- Mechanics

UNIT I

1. Define Inertial and Non Inertial frames with example
2. Define conservative forces and Non conservative forces with example.
3. What is fictious force? Explain with example.
4. What is foucault pendulum?
5. In how much time will the oscillation of a foucault pendulum complete one turn when it is
   i. An equator
   ii. At north pole
   iii. At 45^0 north latitude
6. Write down Lorentz Transformation equations.
7. What is Galilean invariance principle?
8. Write the limitations of Galilean transformations.
9. State postulates of Special Theory of Relativity.
10. State work energy theorem.
11. What do you understand by potential energy curve? Explain the cases of stable equilibrium and unstable equilibrium.
12. Show that the displacement of bodies falling vertically downward on earth is given by

$$x' = \frac{2}{3} h w \cos\lambda \sqrt{\frac{2h}{g}}$$

13. Prove that the observed acceleration due to gravity at a place is given by

$$g_\lambda = \sqrt{(g\cos\lambda - w^2 R\cos\lambda)^2 + (g\sin\lambda)^2}$$

Where g is acceleration due to gravitational force, λ is attitude, and w is the angular velocity of earth of radius R. Derive the values of g_λ at poles and equator of earth.

14. Prove that the law of conservation of linear momentum remains valid in all inertial frames.
15. Prove that law of conservation of linear momentum and energy remains invariant under Galilean Transformation.
16. What is Coriolis acceleration? Find the expression for Coriolis acceleration in a rotating reference frame.
17. What is foucault pendulum? With its help prove that earth rotates along its own axis.
18. Show that the path of relative motion of one projectile to other projectile is straight line.
19. What are Galilean transformation?Prove that a reference frame moving with constant velocity with respect to an inertial frame is also inertial frame.

20. Give experimental verification of Time Dilation in special theory of relativity.
21. What do you mean by Time Dilation?Derive its expression.
22. What do you mean by Length contraction? Derive its expression.
23. Derive lorentz transformation equations.

UNIT II

24. Write an equation of centre of mass for two particle system.
25. Write down the working principle of a rocket?
26. Define processional motion with suitable example.
27. Find the reduced mass of deuteron.
28. Define Centre of mass.
29. Explain elastic and inelastic collisions.
30. Write Euler's equation for a rigid body motion.
31. Define radius of gyration of a rigid body.
32. What is rigid body?
33. Define inertial coefficient of a rigid body.
34. Obtain the expression for the final speed of the rocket.
35. Prove that the force

$$\vec{F} = [(2xy + z^2)i + x^2 j + 2xzk]$$

is conservative. Find the potential energy function of above force.

36. Find the x, y, z components of the force when the body is at a position (-2, 0, 5). The potential energy is given by

$$-u = 40 + 6x^2 - 7xy + 8y^2 + 32z$$

Where u is in joule and x, y, z is in meters.

37. A circular disc of radius 0.5m and m=25kg is rotating about its own axis with the speed of 120 rev/min, calculate the rotational kinetic energy of disc?
38. Describe the precessional motion of a spinning top and derive its precession angular velocity.also prove that the rate of precession is inversely proportional to the angular momentum of a spinning top.
39. In a system of three particles of same mass m are placed at points (a.0,0), (0, a,2a) and (1,2a, a) respectively. Calculate all inertial coefficients.
40. Mass of empty rocket is 5000 kg in which fuel of mass 40000 kg is filled up. If the exhaust velocity of the fuel is 2 km/s, then find the maximum velocity achieved by the rocket.
41. Discuss the motion of a particle under the influence of gravitational interaction and obtain the equations of orbits.
42. The position and velocities are r_1 and r_2 and v_1 and v_2 of two particles at any moment. Show that the particle will collide only when

$$(\overrightarrow{r_1} - \overrightarrow{r_2}) \times (\overrightarrow{v_1} - \overrightarrow{v_2}) = 0$$

43. Explain the rectilinear motion of a particle in a constant conservative force field.
44. Describe the principle of rocket. Establish the following relation for its final velocity

$$v=v_0+v_r\log_e(M_0/M)$$

where the terms have usual meaning.

45. Discuss the motion of a system of varying mass.
46. In a carbon monoxide molecule the distance between the carbon (m_c=12 units) and oxygen(m_o=16 units) is 1.12 A^O. Find out the position of center of massof the molecule with respect to carbon atom.

UNIT III

47. Define central forces with example.
48. Define law of conservation of angular momentum.
49. Write kepler's law of planetory motion.
50. What is meant by Anharmonic oscillator? Give one example.
51. State kepler's second law for planetory motion
52. What is meant by damped harmonic oscillator?
53. Define resonant frequency.
54. Explain the potential well in potential energy curve.
55. Define quality factor of harmonic oscillator.
56. Define impact parameter.
57. What is the distance of closest approach of a charged particle around the nucleus?
58. Prove that central force is an example of conservative force.
59. What are the values of eccentricity for various conic sections?
60. What do you mean by areal velocity? Prove that when a particle moves under the action of central force its areal velocity remains constant.
61. Define damping constant and relaxation time.
62. Write the general equation of damped simple harmonic oscillator?
63. Discuss the path of particle under Central force and explain circular and elliptical orbit.
64. Define angular momentum and torque of a particle system. Derive expression for the relation between angular momentum and torque.
65. Discuss the over damping, critical damping and low damping for a damped simple harmonic oscillator.
66. What is anharmonic oscillator? Derive the expression for displacement and time period.
67. Prove that when any particle does the motion under the effect of central force, then
    a) Particle's angular momentum remains conserved.
    b) Particle's total energy remains conserved.
68. Prove that the average kinetic and potential energy of simple harmonic oscillator are

    1/3 $MW_o^2a^2$ and 1/6 $MW_o^2a^2$

69. Show that the damping reduces the frequency of an oscillator by $12.5/Q^2$ percent, where Q is the quality factor.

70. A spring is elongated by 2 cm when a body of mass 100 gm is suspended at one end of a spring. If relaxation time is 1 second, calculate the time period of damped oscillations.
71. Calculate the impact parameter for an alpha particles of energy 5 MeV scattered by Cu foil(Z=29) at an angle of 60^0. (Where $\cot 30^0 = 1.73$)
72. Define Rutherford scattering. Deduce the relation between scattering angle and impact parameter of alpha scattering.
73. Derive expression for total energy, average power dissipation and quality factor of a damped harmonic oscillator.
74. What do you mean by damped harmonic oscillator? Derive the expression of displacement for the low damped harmonic oscillator.
75. Give Kepler's laws for planetary motion. Derive Kepler's area law.
76. Distance of two planets from the sun is 10^{13} and 10^{12} m respectively. Find out time periods and velocities of these planets.
77. If the earth is suddenly contracted so that changed radius becomes half the present radius of the earth, then what will be the duration of a day?

UNIT IV

78. Define any three properties of normal modes.
79. What are coupled oscillators?
80. In a Ballistic galvanmeter, the coil is wound over a non-metallic frame. Why?
81. What are forced harmonic oscillations?
82. In an LCR circuit if L =2MHz, C=2F and R=0.2ohm, calculate the resonant frequency and quality factor of LCR circuit.
83. Describe normal modes of coupled simple harmonic oscillator.
84. What do you understand by the resonance in parallel resonance circuit?
85. Define forced oscillator.
86. Calculate the logarithmic decrement for ballistic galvanometer.
87. Write the three main differences between series and parallel resonant circuit.
88. What is forced oscillator? Write a differential equation for this and prove that in condition of resonance its amplitude is given as

$$(X_0)_{Max} = \quad F_0 . \frac{Q}{W_0} . \left(1 + \frac{1}{8Q^2}\right)$$

89. Amplitude of oscillation of driven oscillator of 10 gm mass at low frequency is 0.01 cm. At frequencies 512 Hz it is increased to 1 cm. Find the quality factor Q and damping coefficient of driven oscillator.
90. In a series LCR circuit L=10 mH, C= 100 μF and R=100 ohm. Find the resonance frequency of the circuit and the band width corresponding to half power points.
91. Two harmonic oscillators A and B of mass m and force constants K_A and K_B respectively are coupled together by a spring constant K_C. Find the normal mode frequencies.
92. Write differential equation of motion of a driven oscillator and solve it.
93. What are coupled oscillators? If the natural frequencies of two coupled oscillators are same, then explain energy exchange between them.
94. In a parallel LCR circuit if L=1 mH, C= 10 μF and R=0.4 ohm, calculate quality factor?.