Q1. Define oscillatory motion. Give few examples of it.

Q2. Describe the role of restoring force and inertia of motion in oscillatory motion.

Q3. What are undamped and damped harmonic oscillations? Mention few examples for each.

Q4. What do you mean by forced oscillations? Write few examples of it.

Q5. What do you mean by SHM? State its characteristics.

Q6. Distinguish between free, damped and forced oscillations with examples.

Q7. Establish the differential equation for SHM and find its solution.

Q7. What do you mean by damped oscillation? Set up the differential equation for this.

Q8. Establish the differential equation of motion of a damped harmonic oscillator. Hence obtain an expression for displacement. Write the conditions for over damping, critical damping and the under damping. Plot the same graphically.

Q9. What are forced oscillations? Obtain an expression for amplitude and phase of a body undergoing such oscillation.

Q10. Derive an expression to describe the behavior of a pendulum in a low viscous medium. Is its oscillation harmonic? Justify your answer

Q11. Discuss mean life time, relaxation time and quality factor of the damped harmonic oscillator. What is the significance of the quality factor?

Q12. Obtain an expression for the displacement of the damped harmonic oscillator where the damping force is proportional to the velocity. Discuss the effect of the damping on the displacement and frequency of the oscillator.

Q13. What is physical pendulum? Obtain an expression for the time period of angular SHM of a physical pendulum.

Q14. Define compound pendulum. Show that a compound pendulum executives SHM. Find its periodic time. Explain the concept of length of equivalent simple pendulum.

Q15. Derive an expression for the time period of a compound pendulum and show that it is minimum when the distance between the centre of gravity and suspension equals its radius of gyration about a horizontal axis passing through the centre of gravity of the pendulum.

Q16. Under what condition does the time period of a compound pendulum becomes maximum? What is the maximum value of the time period?

Q17. Define centre of suspension and centre of oscillation. Show that in compound pendulum they are interchangeable.

Q18. Distinguish between stationary and progressive wave.

Q19. What do you mean by coherent and incoherent superposition? Give examples.

Q20. Write two examples for non-mechanical oscillation.

Q21. A particle of mass 3 moves along the x-axis attracted toward origin by a force whose magnitude is numerically equal to 12x. The particle is also subjected to a damping force whose magnitude is numerically equal to 12 times the instantaneous speed. If it is initially at rest at x = 10, find the position and the velocity of the particle at any time.

Q22. A particle of mass 1 g moves along the x-axis under the influence of two forces: (i) a force of attraction toward origin which is numerically equal to 4x dynes, and (ii) a damping force whose magnitude in dynes is numerically equal to twice the instantaneous speed. Assuming that the particle starts from rest at a distance 10 cm from the origin, (a) set up the differential equation of motion of the particle, (b) find the position of the particle at any time, (c) determine the amplitude, period and frequency of the damped oscillation, and (d) find the logarithmic decrement of the problem.

Q23. In a damped oscillatory motion an object oscillates with a frequency of 1 Hz and its amplitude of vibration is halved in 5 s. Find the differential equation for the oscillation. Find also the logarithmic The energy of recoil of a rocket launcher of mass m = 4500 kg is absorbed in a recoil spring. At the end of the recoil, a damping dashpot is arranged in such a way that the launcher returns to the firing position without any oscillation (critical damping). The launcher recoils 3 m with an initial speed of 10 ms^{-1} . Find (a) the recoil's spring constant and (b) the dashpot's coefficient of critical damping.decrement of the problem.

Q24. A point performs damped oscillations with frequency ω and amplitude a_0 exp (–bt). Find the velocity amplitude of the point as a function of time t if at the initial moment t = 0 (i) its displacement is equal to a_0 , (ii) its displacement is zero.

Q25. A spring supports a mass of 5 g which performs damped oscillations. It is found to have successive maxima of 2.1 cm and 1.3 cm. If the damping coefficient β is 10 g s^{-1}, find the stiffness of the spring.

Q26. An automobile suspension system is critically damped and its period of oscillation with no damping is one second. If the system is initially displaced by an amount x_0 , and released with zero initial velocity, find the displacement at t = 2s

Q27. For a damped harmonic oscillator with equation m(d2x/dt2)+ β(d x/dt) + kx = 0 show that the work done against the damping force in an infinitestimal time dt is equal to the loss of energy of the mass m during the same time interval dt.

Q28. An LCR circuit has L = 10 mH, C = 1.0 μF, and R = 1 Ω. (a) After what time t will the amplitude of the charge oscillations drop to one-half of its initial value? (b) To how many periods of oscillation does this correspond?

Q29. In a damped LCR circuit show that the fraction of the energy lost per cycle of oscillation, ΔU/U, is given to a close approximation by 2 (π R) /(L ω). [Assume that R is small]

Q30. The displacement of two particles executing SHM are represented by y1=4sin (10t+θ) and y2=5cos10t. Find the phase difference between the velocities of these particles.

Q31. Two harmonic wave of the same amplitude and frequency, but travelling in opposite direction are superposed. Obtain an expression for the resultant amplitude. Plot the resultant amplitude with respect to position.

Q32. An object moves on the x-axis in such a way that its velocity and displacement from the origin satisfy the relation $v = – kx$, where k is a positive constant. Show that the object does not change its direction and the kinetic energy of the object keeps on decreasing.

Q33. Show that the quality factor Q in a damped harmonic motion is defined as

$Q = 2 \pi$ (average energy stored per cycle/Average energy dissipated per cycle)

Q34. An object of mass 0.1 kg moves along the x-axis under the influence of two forces: (i) a force of attraction towards origin which is numerically equal to 85 x N and (ii) a damping force whose magnitude is 0.07 dx/dt N. (a) What is the period to the motion? (b) How long does it take for the amplitude of the damped oscillations at drop to half its initial value? (c) How long does it take for the mechanical energy to drop to one-half its initial value?

Q35. The wavelength in a stationary wave is 30cm. Find the distance between a node and the adjacent anti-node.

Module-3

What do you mean by gradient of scalar field? Write its significance.

Define divergence of a vector field and calculate the divergence of a position vector.

What is curl of a vector field in Cartesian coordinate system? Evaluate curl of the position vector.

What are line-, surface-, and volume integrals of vector fields?

State Gauss divergence theorem and mention it in mathematical notation.

State Stokes's theorem and mention it in mathematical notation.

State and prove Gauss's Law. Express it in differential form. Show that $\nabla .E=\rho/\varepsilon 0$

Use Amperes circutal law to find the magniture of the magnetic field B at a point due to a straight, infinitely long conductor carrying a steady current.

Show that Ampere Maxwell law is consistent with the equation of continuity.

What is Maxwell's equation? Derive the Maxwell's equations in differential form.

Derive the Maxwell's equations in integral form.

Distinguish between conduction current and displacement current.

Write electromagnetic wave equations for electric and magnetic fields in a non-conducting medium;

Write electromagnetic wave equations for electric and magnetic fields in a conducting medium and locate the dissipative terms.

Obtain the wave equation for electric field in vacuum from appropriate Maxwells equation.

Obtain the wave equation for magnetic field in vacuum from appropriate Maxwells equation.

Establish the transverse nature of electromagnetic waves.

Module-4

State de Broglie hypothesis for matter wave.

What do you mean by matter wave? Write the expression for the wave length of matter wave.

Write down the expression for de-Broglie wavelength of

A particle of given mass moving with non-relativistic speed.

Particle of given mass moving with relativistic speed

A particle of given mass and energy

A charged particle moving in an electrostatic potential

A thermal neutron at temperature T

What do you mean by phase velocity and group velocity

How is phase velocity of matter wave associated with a particle related to the particle velocity for (a) a non-relativistic particle (b) relativistic particle.

Two particles of masses m1 and m2 move with the same kinetic energy. Find the ratio of their de Broglie wave lengths.

What is the physical meaning of wave function in quantum mechanics?

Mention the characteristic of the wave function in quantum mechanics.

How the wave function is is related to probability?

Why the wave function is called the probability amplitude?

What are the conditions on quantum mechanical wave functions so that Scrondingers equation can have meaningful solution?

What is the dimension of the wave function for (i) one dimensional (ii) three dimensional problems.

Write the relation between the wave function of a particle in given state and the probability Per unit volume of finding the particle in the given state.

Derive the time dependent Schrödinger's equation in quantum mechanics

Derive the time independent Schrödinger's equation in quantum mechanics.

Calculate the de Broglie wavelength of a particle of mass 10g moving with a speed of 300m/s.

What do you mean by operators in quantum mechanics?

Mention the quantum mechanical operators for position, momentum, energy, and time independent Hamiltonian in quantum mechanics

What is one dimensional box problem in quantum mechanics?

Write down the time independent Schrodingers equation for a particle in box.

Explain how does the energy depend on its energy depend on its mass and width of the box.

What do you mean by a free particle in quantum mechanics?

Write the expression for energy of the free particle in quantum mechanics.

Module-5

What do you mean by laser and its working principle?

Discuss the salient characteristics of Laser light?

What are the necessary conditions for lasing action?

Discuss different processes that occur during the light- matter interaction.

Explain the terms induced absorption, spontaneous and stimulated emission.

Discuss Einstein's Coefficients? Derive a relation between them.

What is meant by population inversion and how it is achieved practice.

What are the different components of laser, Draw a neat block diagram of it.

Describe various applications of lasers.

What do you mean by pumping? Describe various mechanism of pumping.

Explain different levels of lasing systems.

With the help of a neat diagram, explain the principle and working of Ruby laser.

With the help of a neat diagram, explain the principle and working of He-Ne laser.