# Unit-I

Q.1 One word/Fill in the Blanks (1 Mark)

1) A particle is constrained to move along the inner surface of a fixed hemisphere bowl. The number of degrees of freedom of the particle is_________.
2) A rigid body moving freely in space has degrees of freedom _______.
3) Constraint in a rigid body is__________.(Holonomic/Rheonomic)
4) If the generalized is angle θ, the corresponding generalized force has the dimensions of___________.
5) If generalised coordinate has the dimensions of velocity, generalized velocity has the dimensions of_________.
6) The homogeneity of time leads to the law of conservation of___________.

Q.2 (1.5 Marks)

1. Discuss the D Alembert's principle.
2. What do you mean by degrees of freedom?
3. What are holonomic and non-holonomic constraints?
4. Show that the work done by constraint forces in a rigid body is zero
5. What are generalized coordinates? What is the advantage of using them

Q.3 (2.5 Marks)

1. Write the Lagrange's equations ii presence of non-consecutive forces.
2. For a non-conservative system obtain Lagrange's equations.
3. Write the Lagrangian aid equation of motion for a mass M suspended by a spring of force constant k.
4. What is Hamilton's principle?

Q.4 (5 Marks)

1) What are constraints? Classify the constraints with some examples.
    a. What type of difficulties arise due to the constraints in the solution of mechanical problems and now these are removed?
    b. Write a note on "holonomic and non-holonomic constraints with two examples of each type.
2) What do you understand by holonomic and nonholonomic constraints? Obtain differential equations of constraints in case of a disc of radius R. rolling on the horizontal xy plane and constrained to moves that plane of the disc is always vertical.
3) Write down the generalized coordinates for a simple pendulum and explain why Cartesian c0ord1nates are not suitable here.
4) What are generalized coordinates and generalized velocities? Set up the Lagrangian for a pendulum spherical.
5) State and prove D 'Alembert's principle. What is D 'Alembert's principle? Give its one application. Derive Lagrange's equations from D 'Alembert's principle.
6) What is D'Alembert's principle? Derive Lagrange's equations of motion from it for conservation system. How will the result be modified for non-conservative system?

7) Discuss the superiority of Lagrangian approach over Newtonian approach.
8) Define Lagrangian function for conservative and non-conservative systems.
9) Explain what is meant by generalized coordinates, holonomic constraints and the principle of virtual work. Obtain the D Alembert's principle in generalized coordinates and use it to obtain the Lagrange's equations of motion for a holonomic conservative system.
10) Derive Lagrangian expression for a charged particle in an electromagnetic field.
11) What is Hamilton's principle? Derive Lagrange's equation of motion from it. Find the Lagrange's equation of motion for a L-C circuit and also deduce the tine period.
12) What is Hamilton's principle? Derive equation of motion for a particle moving under central force.

# UNIT-II

Q.1 One word/Fill in the Blanks (1 mark)

1) In the absence of a given component of applied force, the corresponding component of linear momentum is_______.
2) Whenever the Lagrangian function does not contain a coordinate $q_k$ explicitly, the generalized momentum pk is a _________ of motion.
3) The generalized momentum $p_k$ of a particle of mass m with velocity $v_x$ in an electromagnetic field is _________.
4) Hamilton canonical equations of motion for a conservative system are_________.
5) The product of generalized coordinates and its conjugate momentum has the dimensions of _____.

Q.2 (1.5 Marks)

1) What is generalized momentum?
2) What is cyclic or ignorable coordinate?
3) Prove that the generalized momentum conjugate to a cyclic coordinate is conserved.
4) What is the Hamiltonian function?
5) Prove that the Hamiltonian H of a conservative system is equal to the total energy of the system.

Q.2 (2.5 Marks)

6) Write the Hamilton's equations of motion.
7) Explain physical significance of Hamiltonian.
8) Whenever the Lagrangian function does not contain coordinate q, explicitly, the generalized momentum $P_k$ a constant of motion. Explain.

   What is Hamiltonian for á simple pendulum? Obtain its equation of motion.

Q.4 (5 Marks)

1) Prove that the generalized momentum conjugate to a cyclic coordinate is conserved. Show that the theorems of conservation of linear and angular momentum are contained in this general theorem.

2) Define generalized momentum and cycle coordinates. Show that the generalized momentum corresponding to a cyclic coordinate remains conserved. Hence prove the law of conservation of momentum for a system of particles. What is the relation between this law and symmetry properties of the system?
3) State and prove the conservation theorems for linear momentum, angular momentum and energy for a system of N particles.
4) What is a cyclic coordinate? Illustrate with examples.
5) Whenever the Lergrangian function does not contain the coordinate 4, explicitly, the generalized momentum p, is a constant of motion. Explain.
6) Prove that the total energy of the system is constant: if for a conservative system, the Lagrangian does not depend explicitly on time.
7) Define Hamiltonian H. Give its physical significance.
8) Why is the Hamiltonian formulation is preferred over the Lagrangian formulation
9) What is the Hainitonian function? Derive Hamilton's equations of motion for a system of particles. Hence write down the equations of motion of a particle in a central force field.

## Unit-III

Q.1 One word/Fill in the Blanks (1 mark)

1) The expression for the relativistic energy of a particle is ___________.
2) An electron gains energy so that its mass become $2m_0$. Its speed________.
3) The annihilation of electron and positron results in the production _________.
4) The transformation of energy from one inertial frame to another is_________.

Q.2 (1.5 Marks)

1. State the fundamental postulates of Special theory or relat1vity.
2. Show that Lorentz transformation equations are superior to Galilean transformations. Prove that at low velocity (v<< c), Lorentz transformation reduces to Galilean one.
3. What do you understand by Lorentz-Fitzgerald contraction?
4. What is time dilation? Explain the time dilation effect for u-mesons falling towards earth from sky.
5. What do you understand by proper length and proper time interval?
   Write down velocity transformation equations at relativistic velocities. What can be the maximum velocity of a particle?
6. Moving clock appears to go slow. Explain.
7. What is aberration of light? Explain in brief.
8. The spectral line of A = 5000 Ä in the light coming from a distant star is observed at 5100 A. What is the recessional velocity of the star?

Q.2 (2.5 Marks)

9. What is principle of relativity? Explain.
10. What do understand by the covariance of physical laws?
11. How does the principle of relativity lead the constancy of speed of light in all inertial frames?
12. . Why were Michelson Morley experiments performed?
13. Discuss the importance of negative results of Michelson-Morley experiments.
14. Why is interferometer related by $\pi/2$ angle in Michelson-Morley experiment?

Q.4 (5 Marks)

1. What do you understand by frame of reference? What is an inertial frame? Show that a frame of reference having a uniform rectilinear motion relative to an inertial frame is also inertial.
2. What are Galilean transformations?
   A frame of reference S' moving with constant velocity relative to another frame. Write down the transformation of x, y, 2, t to x', y, z, t in the Galilean form. At time t = 0, both frames are coincident.
   Obtain also the transformations of velocity and acceleration.
3. Discuss the basic assumptions implied in the Galilean transformations. Use these transformations to show that the distance between two points is in-variant in two inertial frames.
4. 4 Discuss the principle of relativity and the invariance of speed of light. Use this principle to deduce Lorentz transformations. Discuss the relativity of simultaneity.
5. Describe the Michelson-Morley's experiment. What was the purpose of this experiment and what was the conclusion? What significant change this experiment could introduce in the Galilean theory of relativity?
6. Enunciate the principle of the special theory of relativity and derive Lorentz transformations.
7. What do you understand by time dilation? What is proper interval of time? Briefly discuss one Experiment in support of time dilation in special relativity.
8. 11. Obtain Einstein's formula for addition of velocities.
9. 12. Derive the relativistic law of addition of velocities. (i) Hencè show that c is the ultimate speed
10. Prove that the law is in conformity with the principle of constancy of speed of light.

# Unit-IV

Q.1 One word/Fill in the Blanks (1 mark)

1. For space-like interval, the time separation between two events is __________than the time taken by light in covering the distance between them.
2. The value of square of the space-time interval is_________on the surface of the sight cone.
3. `The current four vectors is $j_\mu$ =( ________ )
4. The fourth component of the Force-density four vector is___________.
5. For gauge transformation the electric and magnetic field vectors do not change.(Yes/No)

Q.2 (1.5 Marks)

1. What is Minkowski Space?
2. What are world point and world line?
3. What is space-time interval? Show that this interval is invariant under Lorentz transformation.
4. What are space-like and time-like intervals?
5. Show that for space-like interval, any two events cannot be connected by any real physical process. What are world regions?
6. What do you understand by light cone? What are absolute future and absolute past?

Q.2 (2.5 Marks)

1. Write the transformation equations for momentum four-vector.
2. What is Minkowski force equation.
3. Discuss the conservation of four-momentum in two-particle collision.
4. Using the idea of conservation of four-momentum, show that the value of minimum kinetic energy to

Q.4 (5 Marks)

1. What is Minkowski space? Show that the Lorentz transformations can be regarded as transformations due to a rotation of axes in the four-dimensional Minkowski space. Hence deduce the Lorentz transformations.
2. Discuss the principle of relativity and the invariance of speed of light. Use this principle to deduce the Lorentz transformations in tour dimensional space. Discuss the relativity of simultaneity.
3. Discuss Minkowski four-dimensional space. Write velocity acceleration and momentum as four-vectors and hence write Lorentz transformations or these four-vectors. Discuss the conservation of four momentums.
4. Discus Space-like and time-like intervals. Discuss the time order of two events in the two cases of intervals.

5. Define a four-vector. What are velocity, momentum and force four vectors. Define a four-vector. How the components of the four-momentum vector are related to the three- momentum a particle.
6. Discuss the principle of conservation of four momentums. Discuss its use in collision problem.
7. What is a four-vector? Show that the scalar product of two four vectors is invariant under Lorentz.