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| Bon Secours College for Women Nationally Accredited with “A” Grade by NAAC (Affiliated to Bharathidasan University, Trichy-24) Recognized by UGC Under Section 2(f) & 12 (B)    Vilar Bypass, Thanjavur-613 006. |

**DEPARTMENT OF PHYSICS**

**CLASSICAL DYNAMICS AND RELATIVITY**

**UNIT I**

**2 marks**

1. Distinguish holonomic constraint from non-holonomic constraints.

2. Define scattering cross section.

3. Define constrained motion. Give an example.

4. State Hamilton’s principle.

5. What are generalized coordinates? Express displacement in generalized coordinates.

6. State the theorem of conservation of linear momentum.

7. How many generalized coordinates are needed to describe a system of two particles having rigid body constraints?

8. Why does always the central force motion take place in a plane?

9. What are holonomic constraint from non-holonomic constraints?

10. Explain the principle of virtual work.

11.What are the types of constraints.

12. Show that the conjugate momentum corresponding to a cyclic coordinate is conserved.

13. State the law of conservation of linear momentum for a particle.

**5marks**

1. Obtain the equation of motion of Atwood’s machine by Lagrangian formulation.
2. State and prove viral theorem.
3. Explain the mechanics of a system of particles.
4. Show that the orbit of a particle in a central force field is a conic.
5. State and explain D’Alembert’s principle.
6. Set up the Lagrangian of a single pendulum and obtain its equation of motion.
7. Explain the conservation of angular momentum and energy for a system of particles.
8. State and prove conservation laws for system of particles.
9. State the principle of virtual work and explain the D’Alembert’s principle.
10. Establish the viral theorem of central force motion

**10 marks**

1. Obtain Lagrangian equation of motion for conservation system using D’Alembert’s principle.
2. Deduce the Kepler’s laws.
3. Derive the equation of motion of a central force and obtain the condition for hyperbolic orbit of inverse square force in the case of attractive and repulsive force.
4. Deduce Lagrange’s equation of motion.
5. Discuss the theory of scattering in a central force field. Apply it to find the Rutherford α - scattering cross section.

**UNIT II**

**2 marks**

1. Obtain angular velocity of a rigid body in vector notation.
2. Differentiate between stable and unstable equilibrium.
3. Give the moment of inertia and product of inertia coefficient in Cartesian coordinates.
4. Define phase velocity and group velocity.
5. State D’Alemberts principle.
6. What are the ignorable coordinates?
7. How many independent coefficients are there in moment of inertia tensor?
8. What is called as dispersion relation?
9. Define precessional and nutational motions of a symmetric top.
10. Explain the term of precessional and nutation.
11. What is mean by normal coordinates?
12. What are the euler’s angle?
13. What do you mean by product of inertia?

**5marks**

1. Obtain the Euler’s equations of motion for a rigid body.
2. Discuss the theory of small oscillations.
3. Define the Eulerian angles and give their transformation matrix.
4. Obtain the Euler’s equations interms of Euler’s angle.
5. Derive eigenvalue equation for a small oscillations.
6. Obtain angular momentum of a rigid body and explain moments and products of inertia.
7. Define phase velocity and group velocity and obtain the relation between them.
8. Deduce the Euler’s angles.
9. Explain the principle axes inertia.
10. Write a short note on moments and products.

**10 marks**

1. Discuss in detail the theory of spinning symmetrical top under gravity.
2. Discuss the possible mode of vibration of linear triatomic molecule.
3. Explain Euler’s angle and work out the transformation through successive rotations.
4. Obtain the frequencies and normal modes of a linear symmetric triatomic molecule.
5. The Lagrangian of two coupled oscillator of mass m each is L=1/2m(x12+x22)-1/2mω02(x12+x22)+m ω02µ x1 x2  find the equations of motion and the normal mode frequencies.

**UNIT III**

**2marks**

1. State principle of least action.
2. Define poission bracket of two dynamical variables.
3. State hamiltons variational principle.
4. Define canonical transformation.
5. Why do we say that Hamiltonian formulation describe the system point in phase space?
6. How does the generating function of the transformation act as a bridge between two sets of canonical variables?
7. State Hamilton’s principle.
8. Explain velocity dependent potential and dissipation function.
9. Give the connection of the principle of least action to Fermat’s principle
10. Show that F2=∑qipi, generates the density transformation.
11. State Hamilton canonical equations of motion.
12. Find the value of the Poisson bracket [X,Y+Z].

**5marks**

1. Obtain the equation of motion on Poisson bracket form.
2. Explain briefly the action and angle variable.
3. Explain the Hamilton equation of motion from variational principle.
4. How that the transformation q =2sin Q and p = cos Q is canonical.
5. Deduce Hamiltons equations of motion.
6. Solve the Kepler problem applying the method of action and angle variables.
7. Show that for circular orbits H = -22mk2/J32
8. Discuss Hamilton –Jacobi method.
9. Discuss briefly the principle of least action.
10. Prove that the Poisson brackets are invariant under canonical transformation.

**10marks**

1. Discuss Kepler’s problem in action angle variables.
2. Establish the principle of least action.
3. Obtain the solution of Hamilton Jacobi equation and discuss about the Hamiltons principle function.
4. Obtain the canonical transformation equation for corresponding to all possible generating function.

**UNIT IV**

**2marks**

1. Define non linearity.
2. What are the linear waves?
3. How does the nonlinear oscillator equation before from that of a linear oscillator?
4. What are the solitary waves?
5. Differentiate between linear and nonlinear forces.
6. what are solitans?
7. State the linear superposition principle.
8. What are linear dispersive wave?
9. Define phase trajectory.
10. What are limit cycles?
11. Define 'fixed point'.
12. Give two characteristics of solitons.
13. Define limit cycles.
14. Give the phase trajectory of a linear oscillator.
15. What are the nonlinear waves?

**5marks**

1. Write down the equations of motion for the damped and driven non-linear oscillators.
2. Explain how the numerical experiments of kruskal and zabusky lead to solitons.
3. Discuss the phase trajectory of a nonlinear oscillator.
4. Discuss the period doubling phenomenon in logistic map.
5. How do solitary waves of kdv equation interact mutually?
6. Explain free and damped oscillations of non linear oscillators.
7. Outline the free oscillations.
8. Briefly explain the forced oscillations.
9. Explain the phase plane and phase trajectories.
10. Explain the non linear oscillations and bifurcations.

**10marks**

1. Derive an expression for Kortewag-de-vries equation.
2. Explain the numerical experiments of Zabusky and Kruskal.
3. Explain period doubling phenomenon in Duffing oscillator.
4. Discuss chaos in doffing oscillator.
5. Show that the composition of two Lorentz transformation with non parallel velocities leads to Thomas Precession rotation.

**UNIT V**

**2marks**

1. What do you mean by Minkowski space.

2. Explain Thomas precession.

3. State the postulates of special theory of relativity?

4. Define ‘four vectors’.

5. How is general theory of relativity different from special theory of relativity?

6. What are four velocities?

7. Write down the energy momentum four vectors.

**5marks**

1. Explain the Minkowski’s space.
2. Outline the compositions of Lorentz transformation about two orthogonal directions.
3. Explain the Lorentz transformation in Minkowski’s four dimensional space.
4. Explain the Thomas precession.
5. Give the elements of general theory of relativity.
6. Give an account of the basic ideas of special theory of relativity.
7. Deduce the components of energy momentum four vector.
8. Express Maxwell’s equations on covariant form.
9. Obtain four velocity and Energy-momentum four vector. Show that the Lorentz transformation can be considered as rotation in Minkowski’s space.
10. Explain the invariance of Lorentz transformation in Maxwell’s equation.

**10 marks**

1. Give KdV equation .Obtain its solution. How does it lead to solitary wave?
2. Obtain the Lorentz transformation equation in special theory of relativity.
3. Show that Maxwell’s equations are invariant under Lorentz transformation.
4. Explain the Minkowski four dimensional spaces and laws transformation as rotation in Minkowski space.
5. Show that the Lorentz transformation are equivalent to rotation of axes in four dimensional space.