Classical Mechanics I and Non-Linear Dynamics

- Analyze and apply Lagrangian and Hamiltonian formalism to classical mechanics problems, including rotations, rigid bodies, and classical scattering theory.
- Evaluate the principles of Hamilton's principle and calculus of variations in relation to Lagrange's equation and Hamilton's canonical equations.
- Create and solve canonical transformations using generating functions and understand the conservation theorems in the Poisson bracket formalism.
- Develop a deep understanding of action angle variables, Hamilton-Jacobi theory, and the application of the Hamilton Jacobi equation in solving problems such as the harmonic oscillator.
- Investigate the dynamics of rigid bodies, including orthogonal transformations, Euler angles, inertia tensor, and Euler's equations.
- Analyze nonlinear dynamical systems, including phase space, stability analysis, bifurcations, and Poincarè sections.
- Examine period doubling, universality, intermittency, and Lyapunov exponents in one-dimensional non-invertible maps.
- Explore two-dimensional systems, including the Henon map, attractors, and the Lorenz equations.
- Understand fractal geometry and the concept of dimensions in nonlinear dynamics.
- Introduce the concept of integrability in Hamiltonian systems and analyze its implications in dynamical systems.