Topics

I.) Basic Theory

a.) Principle of Least Action, Generalized Coordinates, Lagrange's Equations
b.) Symmetries and Conservation Laws, Noether's theorem
c.) mechanical similarity, virial theorems
d.) Constraints and constraint forces
e.) Fermat's Principle, Eikonal Theory
f.) Hamiltonians and Hamilton's equations
g.) Phase space flow, Liouville's Theorem, Poincare Recurrence Theorem
h.) paths, paths vs. trajectory, abbreviated action

II.) Hamilton-Jacobi Theory

a.) Describing the evolution of the Action
b.) Hamilton-Jacobi Equation
c.) Solution by separation, relation to integrability, role of symmetry
d.) Application to eikonal theory, self-focusing

III.) Applications

i.) Oscillations

a.) coupled oscillators, normal coordinates and modes, etc., intuition from symmetry
b.) Parametric oscillators and instability
c.) Pondermotive potential and force
d.) Adiabatic Invariants

ii.) Continuua

a.) chains: modes, continuum limit, acoustic and optical modes
b.) Lagrange equations for string, continuum, reduction to wave equation
c.) Energy theorem, wave energy and momentum, wave momentum evolution
d.) Symmetry in continuum dynamics
e.) Basics of Elasticity
f.) Elastic Waves
g.) Applications of Elasticity Theory

iii.) Nonlinear Oscillators

a.) Duffing Equation, Reductive Perturbation Theory
b.) Forced Duffing Equation, Resonance and Bifurcation
c.) Noisey Oscillator