1. Hamilton’s principle, Euler-Lagrange equations, Noether theorem and conservation laws.
2. Center of mass, work and energy, Hamilton’s equations.
3. Continuity equation for probability density, Liouville’s theorem.
4. Statistics of isolated systems and subsystems. Microcanonical and canonical ensembles.
5. Entropy: definition and properties. 2d law of thermodynamics.
6. Internal energy, temperature and pressure.
7. Legendre transform and thermodynamic potentials.
8. Gibbs probability distribution: derivation.
9. Partition function and free energy. Computation for the ideal gas.
10. First and second order phase transitions: phenomenological description.
11. Equilibrium of phases. Clausius-Clapeyron relation.
12. Multi-component systems. Gibbs’ phase rule.
13. Reactions. Maxwell distribution and Arrhenius’ law.
14. Role of linear and angular momenta in thermodynamic relations.
15. Ideal flow: continuity and Euler equations
16. Ideal flow: entropy equation, isentropic motion, energy conservation equation.
17. Derivation of the Naiver-Stokes equations.
18. Dissipative terms in the energy conservation equation, the corresponding entropy equation.
19. Boussinesq and heat equations for incompressible flow.
20. Diffusion.
21. Multicomponent and multi-phase flow equations: general idea.