1. **Classical mechanics**
    a) Lagrangian formalism: principle of least action, Euler-Lagrange equations, Noether theorem, cyclic coordinates, conservation laws, 1-dimensional system, Kepler problem, linear systems, rigid body.
    b) Hamiltonian formalism: Hamilton's equations, Poisson bracket and conservation laws, Liouville's theorem, canonical transformation, Hamiltonian flow, moment map, Hamilton-Jacobi theory, action angle variables, integrable systems, perturbation theory.
2. **Electrodynamics**
    a) Electrostatics and magnetostatics: fields, potentials, charges, electric and magnetic fields in matter, Coulomb's law, Lorentz force law, Biot-Savrat law, Gauss's law, Ampere's law
    b) Electrodynamics: Faraday's Law, Lenz's law, Maxwell's equation in the vacuum, Maxwell's equation in matter, electro-magnetic energy, Poynting vector, electromagnetic waves, radiation.
    c) Special relativity: Minkowski spacetime, Lorentz transformation, transformation of EM fields in different reference frames, Lorentz covariance of Maxwell equations.
    d) Methods of solving related partial differential equations: the method of images, separation of variables, Green's function, multipole expansion.
3. **Thermodynamics and statistical mechanics**
    a) Thermodynamics: laws of thermodynamics, entropy, temperature, heat capacity, thermodynamic potentials, thermal machines (Carnot heat engine and etc)
    b) Principles of statistical mechanics: statistical ensemble and probability theory, microcanonical, canonical, and grandcanonical ensembles, quantum systems, Boltzmann, Bose and Fermi statistical distributions.
    c) Applications: Ideal gas, degenerate Fermi gas, Bose-Einstein condensation, first order phase transition, mean field theory, Landau theory of phase transition, second order phase transition.
4. **Quantum mechanics**
    a) Formalism of quantum mechanics: states, Hilbert space, linear operators, unitary operators, eigenvalues and eigenstates, change of basis, observables, expectation values, uncertainties, Schrodinger equations, Schrodinger, Heisenberg and interaction pictures.
    b) Wave mechanics: Harmonic oscillator, 1d system, tunnelling, WKB approximation, Hydrogen atom, scattering.
    c) Symmetries in quantum mechanics: symmetries and conserved quantities, angular momentum, finite dimensional unitary representation of rotational symmetry. Discrete symmetries, CPT, Kramers degeneracy.
    d) Perturbation theory