Lecture of Theoretical Physics II: Electrodynamics

1. **Einsteinian Fundamental Postulates of Special Relativity**

2. **Special Theory of Relativity - Basic Kinematic Results**
   Lorentz transformations - light cone - causality - length contraction and time dilation - time interval - four-vector of velocity - addition of velocities - transformation of acceleration

3. **Relativistic Mechanics**
   stationary principle - momentum and energy - relativistic equation of motion

4. **Relativistic Lagrangian of a Charged Particle in an Electromagnetic Field**
   action integral - equation of motion - gauge invariance - electromagnetic field tensor - Lorentz transformation of fields - invariants

5. **Covariant Formulation of Electrodynamics**
   first group of Maxwell's equations - Lagrangian for fields - continuity equation - second group of Maxwell's equations - energy momentum tensor - symmetric stress tensor - conservation laws - Maxwell's equations in SI units

6. **Time-Independent Electromagnetic Field**
   Electrostatics: scalar potential, Poisson equation - field and potential of a point charge - Green's function - charge distributions and electric multipole expansion;
   magnetic field of steady currents: vector potential, gauge transformations, Biot-Savart's law, current distributions - magnetic dipole

7. **Electromagnetic Waves and Wave Propagation**
   wave equation - plane waves - harmonic time dependence - polarization - abberation of light - Doppler effect - Fourier decomposition - fundamental modes - spheric waves - geometrical optics, Eikonal equation - coherence and interference of electromagnetic waves - Kirchhoff's theory of diffraction and Huygen's principle - Fraunhofer and Fresnel diffraction

8. **Electromagnetic Fields of Moving Charges and Time-Dependent Currents**
   quasi-stationarity - retarded potentials - Liénard-Wichert potentials - radiation of a relativistic accelerated charge - electric dipole radiation

9. **Maxwell's Equations for Continuous Media**
   averaging microscopic Maxwell equations - polarization and magnetization - boundary conditions at the interface between different media

10. **Electrostatics of Conductors and Dielectrics**
    energy of the electromagnetic fields of conductors - selected techniques for the solution of problems in electrostatics (image method, conformal transformations) - electrostatic field in insulators

11. **Magnetostatics of Macroscopic Media**
    magnetic materials - quasi-stationary currents (energy, self- and mutual-inductance) - magnetic shielding

12. **Electromagnetic Waves in Matter**
    normal and anomalous dispersion - analytic properties of the dielectric function - Kramers-Kronig relations - sum rules - propagation of electromagnetic waves in dielectric materials - reflection and diffraction - Fresnel's formula, wave propagation in dissipative media - surface impedance - Skin effect - reflection by an imperfect conductor - cylindrical wave guides - cavity resonators