Program of the Fisica 2 course

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Detailed course program:

- Electric field in vacuum
  - Structure of matter and electric charge

    Coulomb force and the measurement unit of the Coulomb charge. Superposition principle
  - Coulomb force as a conservative field; associated potential energy
  - Electrostatic field; field lines
  - Electric fields of given charge distributions: electric dipole; line charge; electric field on the axis of a ring of charge; electric field on the axis of a disk of charge; spherical charge distributions
  - Force and torque on a rigid electric dipole
  - Charged particles motion in electric fields: electrostatic accelerator; mass spectrometer; Thomson's experiment; Rutherford's atom; measurement of the elemental electric charge
- Equations of Electrostatics
  - Flux of a vector field; divergence theorem

    Gauss theorem
  - Applications of the Gauss theorem: equilibrium in electrostatic fields; Dirac's δ function
  - Stokes theorem; equations of the electrostatic field; boundary equations for the electrostatic field
  - Electrostatic potential
  - Electrostatic potential of given charge distributions: dipole potential; potential of a line charge; potential on the axis of a disk of charge; potential on the periphery of a disk of charge; potential of spherical charge distributions; multipoles expansion

  - Electrostatic energy; its calculation for give charge distributions

- Electrostatics with conductors
  - Electric fields and charges in conductors: equipotentiality of a conductor; electrostatic screen; surface charge density; electrostatic pressure

    General problem of Electrostatics in vacuum: Laplace equation; harmonic functions; the image charge method
  - Capacitance and capacitors
  - Electrostatic energy and force
- Electrostatic with insulators
  - Electric polarisation

    The three electric vectors
  - Linear dielectrics
  - Electric field, polarisation and potential in the presence of dielectrics: plane capacitor with two dielectric layers; dielectric rigidity; plane capacitor with two dielectric blocks; conducting sphere in a dielectric medium; conducting sphere with a dielectric layer; dielectric sphere uniformly polarised; spherical cavity in a polarised dielectric
  - Electrostatic energy density and forces with dielectrics
- Electric current
  - Current intensity and current density

    Conservation of electric charge
  - Ohm's law; Joule effect
  - Classical model of conduction in metals
  - Electromotive force generators
  - Circuits in a stationary regime: Kirchhoff's laws; Wheatstone's bridge; Thvenin's theorem
  - Charging and discharging capacitors
- Magnetic field in vacuum
  - Hints of the history of Magnetism

    Equations of Magnetostatics
  - Ampre's law and applications
  - Vector potential: vector potential of line current; vector potential of a plane current; vector potential outside an infinite solenoid; vector potential of a current loop
  - First elementary law of Laplace: magnetic field of a line current; magnetic field of a current ribbon; magnetic field on the axis of a circular current loop; magnetic field on the axis of a solenoid; magnetic field in a toroidal solenoid
- Magnetostatic forces and energy

  - Lorentz force

    Charged particles in a magnetic field: circular motion; helical motion; Hall effect; Lorentz force in moving dielectrics
  - Second elementary law of Laplace: forces between current bearing circuits; magnetic moment of a current loop
  - Magnetic energy of current loops; interaction energy and total energy
  - Vector potential and magnetostatic energy
- Magnetism in matter
  - Magnetic materials: magnetisation

    The three magnetic vectors
  - Linear magnetic materials
  - Magnetic fields in the presence of magnetic materials: indefinite straight solenoid; magnetic disk perpendicular to the field; magnetic needle parallel to the field; toroidal solenoid; uniformly magnetised bodies
  - Microscopic magnetisation mechanisms: atomic angular and magnetic momentum; paramagnetism; diamagnetism
  - Ferromagnetism
  - Magnetic circuits; electromagnets
- Electrodynamics
  - Electromagnetic induction: moving circuits; third Maxwell's equation

    Inductance: mutual inductance; autoinductance
  - RL circuit
  - Energy and forces in a circuits system
  - Induction phenomena: examples
  - Maxwell's equations: boundary conditions; hints to the electromagnetic waves
- Sinusoidally driven circuits
  - RC and RL filters

    RLC series circuit with complex notation
  - Complex impedances
  - Transformers
  - Power in the sinusoidal regime