«APPROVED BY»
Head oft he General Physics Department
_____Lider A.M.
« ____» _____ 2016 г.

COURS ANNOTATION

1. Title of the discipline **«Theoretical Physics. Electrodynamics»**

2. Code **ДИСЦ.Б**

3. Speciality (ООП) **03.03.02 Physics**

4. Specialization Program
Physics of Condensed Matter

5. Qualification degree - **bachelor**

6. Provided by **General Physics Department**

7. Professor **Bekhtereva E. S.**, phone. **+79138865074**
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9. Objectives:
Knowledge main principles of classical electrodynamics, definitions of physical values using in different original processes in the nature and modern technics.
Relativistic invariant formulation of main laws of electrodynamics. Tensorial mathematics.
Skills to be able to present oral speech and/or to support a discussion by using the knowledge of basic knowledge of classical electrodynamics. Can be able to estimate the order of magnitude of different phenomena and to apply practical calculations. Be able to use lexical recourse of scientific vocabulary. Ca be able to use special literature both of Russian and English editions.
International Experience the detailed analysis of different resources including Internet materials providing by leading European and US Universities.

10. Content.
Introduction to electrostatics. (4 hours) Coulomb's law. Electric field. Gauss's law, differential form of Gauss's law. Surface distribution of electric charges and dipoles. Discontinuities in the electric fields and potential. Poisson and Laplace equations. **Boundary-value problems in electrostatics. (4 hours)** Phonons. Point charge in presence of a grounded/insulated conducting sphere. Method of images. Orthogonal functions and expantions. Separation of variables. Laplace equation in spherical coordinates. Spherical harmonics. Solution of potential problems with the spherical Green functions expansion. **Magnetostatics. (4 hours)** Differential

equations of magnetostatics and Ampere's law. Vector potential. Magnetic fielda of a current distribution. Magnetic moment. Macroscopic equations, boundary conditions on $\vec{B}$ and $\vec{H}$. Uniformly magnetized sphere in an external fields. Permanent magnets. Faradey's law of induction. Energy in the magnetic field. Quasi-static magnetic fields in conductors. **Maxwell equations, macroscopic electromagnetism, conversation laws. (4 hours)** Maxwell's Displacement current. Maxwell equations. Vector and scalar potentials. Gauge transformations, Lorenz gauge, Coulomb gauge. Derivation of equations of macroscopic electromagnetism. Poynting's theorem and conversation energy and momentum for a system of charged particles and electromagnetic fields. Polarization potentials (Hertz vectors). **Tensorial formulation**. **(4 hours)** Special theory of relativity. Lorentz transformations and basic kinematic results of special relativity. Addition of velocities; 4-velocity. Relativistic momentum and energy of particle. Mathematical properties of the space-time of special relativity. Matrix representation of Lorenz transformations, infinitesimal generators. Invariance of electric charge; covariance of electromagnetic fields. Transformation of electromagnetic fields. Relativistic equation of motion for spin in uniform slowly varying external fields. **Dynamics of relativistic particles and electromagnetic fields. (4 hours)** Lagrangian and Hamiltonian for a relativistic particle in external electromagnetic fields. Motion in a uniform, static magnetic field. Motion in combined, uniform, static and magnetic field. Particle drifts in nonuniform, static magnetic fields. Canonical and symmetric stress tensor. Conservation laws. **Radiation by moving charges (4 hours)** Lienard-Wiechert potentials and fields for a point charge. Total power radiated by an accelerated charge: Larmor's formula and its relativistic generalization. Angular distribution of radiation emitted by an accelerated charge. Frequency spectrum of radiation emitted by a relativistic charged particle in instantaneously circular motion. Undulators and wigglers for synchrotron light sources. **Mini-conference. (2 hours)**

11. Course is developed for four-year students. Should be provided during the 7^{th} semester.

12. Prior knowledge requires: Mathematics: Analysis, Differential, Integration Calculus, Linear Algebra, General Physics

13. Correspondence: Physics of Condensed Matter, Research Work.

14. Type of attestation exam

Developed by, Prof. Bekhtereva E. S.