Level of education: **Master**
Field of study: **16.04.01 Technical Physics**

Advanced Quantum and Nanophotonic Systems

ELECTRODYNAMICS OF METAMATERIALS

Credits: 3 ECTS		
Semester		**Assessment**
2nd semester	3 ECTS	Exam

Course developers: **Roman Savelev**

The main subject under study is the characteristics of the radiation of quasi-point sources placed near optical nanostructures. The classical description of the interaction of radiation sources with optical nanostructures is considered, emission properties of the sources interacting with such model objects as layered systems, waveguide structures, nanoparticles and metamaterials are considered; their common features and main differences are discussed. During the course, students must perform numerical calculations of the characteristics of some of the systems under consideration. In the case of the simplest structures, one will have to write their own code in the programming language of their choice, and in the case of more complex structures, one will have to build a numerical model in one of the software packages.

Requirements

Course prerequisites: classical electrodynamics.

Course structure

1. Interaction of quantum emitters with nanophotonics structures: classical description. Modification of emission properties due to interaction with environment: nanoantennas and Purcell effect.

2. Dyadic Green's function: general derivation, near-field and far-field, angular distribution, emission power, electric and magnetic dipoles, duality theorem.

3. Modification of dipole emission near layered structures: general formulation. Calculation of total emission rate for a dipole near an interface.

4. Modification of dipole emission near a dielectric/metal interface. Calculation of total emission rate for a dipole near an interface. Calculation of the power fraction coupled to plasmon. Lossy surface waves. Numerical examples.

5. Calculation of emission rate into cavity or waveguide modes. Example of a plasmon.

6. Modification of radiation patterns. Radiation pattern of a dipole near an interface. Numerical examples.

7. Emission properties of an arbitrarily polarized dipole coupled to different structures. Bianisotropic response induced by substrate.

8. Arrays of scatterers, summation techniques, discrete dipole method. Coupling of a dipole to nanoparticle arrays.

Assessment

Final grade is based mostly on the final exam; the maximum mark for the exam is affected by the results of the homework problems and the pre-exam test.

Faculty: **Faculty of Physics**

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Tags: **Nanoantennas; Purcell factor; Dyadic Green's function; modification of dipole emission near interfaces.**