ITMO University

Photonics

Course Workload		Assessment form (examination/ graded test/ ungraded test)
ECTS	Hours	
6	216	Exam

The issues of generation, control and detection of photons in the visible, ultraviolet and near optical ranges are considered. Photonics covers a wide range of optical, electro-optical and optoelectronic devices and their diverse applications. Indigenous fields of photonics research include fiber and integrated optics, including nonlinear optics, physics and technology of semiconductor compounds.

Course structure:

1. Theory of waveguides

1.1. Waveguide as a quantum well for photon. Geometrical theory of waveguides. Parallel plate hollow waveguide with metal claddings
1.2. Parallel plate dielectric waveguide. Frequency cut-off. Asymmetric waveguides
1.3. Cylindrical waveguides and optical fibers
1.4. Goos-Hanchen shift. Losses in waveguides. Propagation length

2. Theory of optical resonators

2.1. S-matrix and its properties. Reciprocity
2.2. Fabry-Perot resonator. Eigenmodes. Quasi-normal modes. Quality factor and finesse. Resonant transmission. Impedance matching and absorption
2.3. Whispering gallery mode resonators

3. Photonic Crystals

3.1. Bragg reflector. T-matrix
3.2. Band structure of 1D, 2D and 3D photonic crystals. Photonic band gap and quarter-wave condition
3.3. Width of photonic gap. Weak contrast approximation. Coupled mode theory
3.4. Effective medium approximation for multilayer structures. Hyperbolic metamaterials
3.5. Photonic crystal cavity

4. Coupled mode theory

4.1. Reciprocity theorem. Orthogonality of waveguide modes
4.2. Coupling between two parallel waveguides. Power exchange. Eigenmodes
Topic
5. Scattering theory

5.1. Lippmann-Schwinger equation. Dyadic Green’s function. Optical cross sections. Scattering in the dipole approximation
5.2. Vector spherical harmonics. Mie theory. Multipole expansion. Kerker effect
5.3. Optical theorem