Optical Waves at Nano-photonic Planar Structures

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The course is aimed at students who intend to apply methods of optics in exploring contemporary problems of nano-photonics. The first three sections provide elementary description of electromagnetics and optics of multi-layers, as well as basics of beams and wave packets. The three subsequent sections introduce fundamentals of plasmonics, meta-materials and nano-visualisation.

Main topics:

1. Electromagnetic field:
   1.1Maxwell's equations,
   1.2Boundary conditions,
   1.3Hertz potentials,
   1.4Field polarisation frames,
   1.5Monochromatic plane waves,
   1.6Field integral representations.
2. Layered structures:
   2.1Reflection and refraction of waves,
   2.2Waves in layered media,
   2.3Absorption and attenuation of waves,
   2.4Bragg diffraction and scattering,
   2.5Waves at double periodic media.
3. Beams and wave packets:
   3.1Monochromatic Hermite-Gaussian beams,
   3.2Monochromatic Laguerre-Gaussian beams,
   3.3Non-monochromatic wave packets,
   3.4Monochromatic Bessel-Gaussian beams.
4. Plasmonic structures:
   4.1Surface plasmon polaritons
   4.2Localised plasmons,
   4.3Resonances of plasmonic structures,
   4.4Enhanced light transmission and sensing.
5. Meta-material structures:
   5.1Double-negative materials,
   5.2Negative refraction,
   5.3Perfect lenses and invisible objects,
   5.4Anisotropic and hyperbolic meta-materials.
6. Visualisation of nano-material structures:
   6.1Evanescent and leaky waves,
   6.2Atomic Force Microscopy,
   6.3Scanning Near-field Optical Microscopy.

The total number of lecture hours: 60 h, laboratory exercises: 8 h, self-teaching: 90 h, direct tutoring and consultations: 20 h.

ECTS Points: 6