Quantum Electronics 5 ECTS credits

Lecturer: Prof Bożena Jaskorzyńska

Quantum electronics is a fast growing field of research and a major enabling technology playing an increasingly central role in our high-tech society. It offers a broad variety of applications in the area of information technology, life science, optical sensing, lightning, energy, and manufacturing. This course will provide selected concepts of quantum electronics in the semi-classical approximation, and will focus on integrated components for optical communications.

5 ECTS credits assigned to the courses can only be given to the participants who pass the final exam.

Tentative topics:

1: Course formalia, introduction, résumé of Electromagnetic theory
Semi-classical approach, Maxwell equations, plane waves, light polarization, birefringence, wave properties in uniaxial crystals, phase and group velocities, optical coherence.

2: Dielectric waveguides, optical resonators
Transverse resonant condition, Faby Perot resonator, modes in dielectric slab waveguides, Effective Index Method, coupled mode theory, directional coupler, mode interference.

3: Laser systems
Absorption and emission of light, principle of operation for a laser and requirements for lasing, mode-locking, Q-switching, techniques for compensation of GVD (Group Velocity Dispersion), types of lasers.

4: Introduction to nonlinear (NL) optics
Nonlinear polarization -physical origin, complex notation for wave mixing, conservation laws for elastic NL interactions, phase matching problem, three wave mixing, second harmonic generation, birefringence and Quasi-Phase Matching.

5: Electro-optic (EO) modulation of light
Light modulation, electro-optic (EO) modulation, linear EO effect, phase retardation, amplitude, phase modulation, traveling wave modulators

6: Ligth propagation in periodic media
General properties of periodic media, Bragg diffraction, Photonic bandgap, Bloch waves, periodic layered media –analytic treatment, periodic structures by coupled-mode theory, Bragg waveguide and fiber gratings.

7: Photonic crystals
Properties of photonic crystals, potential applications. Comparison of photonic crystals and photonic wires.

Examination
The written exam will consist of questions based on the lecture material. 50% right answers are required to pass.

Recommended literature
Fundamentals of Photonics, Saleh & Teich, **2nd** Ed.

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