Course Announcement

Photonic Crystals

EECS 598, Section 002, Fall 2007

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Meeting schedule. M W 1:30pm – 3:00pm, 1121 LBME

Course Content

As a result of recent remarkable theoretical advances in understanding and technological progress in fabricating artificial periodic structures, engineerable control of fundamental optical properties of an optical medium is becoming practically possible. Apart from providing "designer" materials with desired and significantly enhanced optical characteristics these photonic crystals are exhibiting a variety of novel and unusual phenomena, which are leading to completely new technologies and unexpected applications.

This course is an introduction to this flourishing and rapidly expanding field. Topics include:

- Fundamentals of electromagnetic wave propagation in periodic structures (Bloch's theorem, eigenmodes of propagation, symmetries and photonic band structure in 1D, 2D and 3D, origin of photonic bandgaps)
- Confinement and guiding of electromagnetic waves by 1D and 2D defects in the periodicity of photonic crystals, unique properties of resonant cavities and optical waveguides formed by these defects, analogies to donor and acceptor levels in electronic crystals
- Novel optical phenomena associated with in-band propagation effects such as superprisms, negative refraction, superlenses, multirefringence etc.
- Controllable enhancement and prohibition of spontaneous emission in photonic crystals
- Nonlinear Optics in photonic bandgap structures, gap solitons, enchancement of nonlinear interactions on the band edge
- Nonlinear Photonic Crystal structures using 2D quasi-phase-matched nonlinear interactions and nonlinear physical optics in such structures
- Photonic Crystal fabrication techniques
- Emerging new devices and applications associated with photonic crystals, integrated optics based on photonic crystals, photonic crystal and Bragg fibers
- Computational methods of modeling electromagnetic wave propagation in periodic structures,

Prerequisites: EECS 537 (Classical Optics), EECS 538 (Optical Waves in Crystals) or permission by the instructor. A solid background in optics is essential.

Credits: 3 Units.

Coursework:

(a) 2 homework assignments at the beginning of the course (during the first ~4 weeks).

(b) Midterm project – write a report and present it in class on a literature survey on a particular topic. Topic will be suggested either by a student or by the instructor.

(c) Term Project: using available software, each student will model/explore a particular photonic crystal problem (selected either by a student or by the instructor), write a report, and present it in class.

Reference books: No textbook exists for this course. Course will be based on a combination of published papers and a few existing books on photonic crystals. The book that will be used as the main text, since it provides the broadest available coverage, is:

Photonic Crystals: Physics, Fabrication and Applications, K. Inoue and K. Ohtaka (Eds.), Springer-Verlag 2004