Course Title

Photonic Crystals and Light Emission

Course Description

In this short course, interaction of photons with periodic nanostructures will be reviewed, following a brief introduction of photonic crystals. Firstly the enhanced light emission from photonic crystal structures that do not have physically-defined cavities will be explained, using the examples of microstructure LEDs and OLEDs. And physics of cavity-less photonic band edge lasing phenomena will follow. Then the recent efforts toward the smallest possible laser will be summarized. The ultra-small photonic crystal can be interpreted as a two-dimensional embodiment of the one-dimensional VCSEL. Following brief summary of various forms of photonic crystal lasers, nondegenerate, single-cell, monopole and hexapole mode photonic crystal lasers will be discussed in more detail. The issues relevant to 'practical' nanolasers are to be addressed with several suggestions. Recent results on finding high-Q small mode volume resonators, electrically-driven photonic crystal lasers and microfiber-coupled reconfigurable photonic crystal lasers will be explained. The nontrivial issues of photon collection and quantum dot incorporation will also be reviewed.

Benefits and Learning Objectives

This course should enable you to:

- Introduce photonic crystals and photonic crystal microresonators
- Explain the mechanism of enhanced light extraction from LEDs
- Describe band edge photonic crystal lasers
- Identify high Q/V resonators
- Describe wavelength-scale photonic crystal laser structures
- Explain laser structures compatible for electrical pumping
- Justify the importance of photon collection
- Define the critical issues of practical nanolasers

Intended Audience

This course is intended for those interested in physics, opportunities, problems associated with ultra-small photonic crystal lasers for very short reach interconnect and/or single photon sources for quantum information.

Instructor Biography

Yong-Hee Lee is a professor of Physics at KAIST, Korea. Yong-Hee pioneered 850-nm proton-implanted VCSELs when he was in AT&T Bell Laboratories in 1990. Then in the Physics Department of KAIST, he directed the National Research Laboratory on VCSEL and started investigating new theme of very small photonic crystal resonators. He demonstrated various wavelength-scale photonic crystal lasers. He received the National Academy of Sciences Award in 2002 and *IEEE LEOS Distinguished Lecturer Award* in 2003. He was elected as an *IEEE Fellow* in 2007. He co-authored more than 130 international journal papers related to VCSELs and photonic crystals.