Ben – Gurion University of the Negev
Electrooptical Engineering

Name of the module: Advanced topics in silicon photonics

Number of module: 377.2.ZZZZ

BGU Credits: 3

ECTS Credits: 4

Academic year: 2017-2018

Semester: Autumn.

Class hours: 3

Day and time:

Class location:

BGU Marcus Family Campus, Beer-Sheva.

Teaching language:

Hebrew (or English for foreign students).

Lectures slides: in English.

Cycle: Annually.

Position: Advanced specialization, could be taken by students with basic background in guided wave optics.

Field of Education: Electrooptics.

Responsible department: Electro-Optics Eng.

General prerequisites:

Integrated Photonics (377-2-5599).

Grading scale: 1-100.

Course description:

Silicon photonics enables the design of photonic systems in a much more streamlined manner, and the resulting designs can be fabricated by highly evolved silicon manufacturing facilities. The aim is to control light on all-dielectric materials such as silicon. Proposed course will encompass advanced topics in silicon photonics, computational physics, concepts of design and fabrication routines of actual devices and principles of experimental verifications of their performances. The course program relays on two major directions: (1) Physical phenomena. (2) Light-matter interactions at sub-wavelength regime.

Aims of the module:

1. Introduces the advanced topics of silicon photonics.
2. Introduces the analysis techniques such as multipole decomposition.
3. To equip the student with theoretical background to design, characterize and analyze the Silicon Photonics devices and systems.

Milestones of the module:

1. Acquire the students with the advanced hot topics of silicon photonics in terms of electromagnetism under electrostatic approximation.
2. Nurture the students with the principles of the design considerations.
3. Acquire the students with the theory of high order multipole moments excited in silicon particles multipole decomposition.
4. Acquire the students with main fabrication routines of Silicon Photonic devices.
5. Acquire the students with Maxwell Solver techniques for numerical investigations.

6. Recommended literature:

1. Silicon photonics design by D. Lukas Chrostowski, Michael Hochberg 2015.
2. Roger E Raab and Owen L De Lange. Multipole theory in electromagnetism: classical, quantum, and symmetry aspects, with applications, volume 128. Oxford University Press on Demand, 2005.
3. Optical waveguide theory by Snyder and Love 1983.
4. Principles and Techniques of Applied Mathematics by Bernard Friedman 1956.

Lecturer: Dr. Alina Karabchevsky.

Contact details: Room 207, building 41

Office phone: 08-6479720

Email: alinak@bgu.ac.il

Office hours:

Module evaluation: At the end of the semester the students evaluate the module, in order to draw conclusions, and for the university internal needs.

Confirmation: The syllabus was confirmed by the faculty academic advisory committee

Last update: Dec. 2018

Learning outcomes of the module:

1) Ability to study the electric and magnetic fields' evolution.
2) Ability to study and design novel silicon photonic devices.
3) Acquired knowledge to characterize the silicon photonic devices in terms of coupling efficiency and propagation losses.
4) Acquired knowledge of fabrication.
5) Acquired knowledge of experimental demonstration.

Assessments:

(50% -2 Scientific presentations + 20%-Scientific writing +30%-Simulation task.)=40%, 60%-Final exam.

2 Scientific presentations:

Scientific presentation: study and presentation of a course topic - 2.5 hr. presentation.

Scientific work:

Scientific writing on a topic agreed with the Lecturer which is of relevance to silicon photonics.

Simulation task:

Numerical simulation of on-chip device based on the silicon photonics principles discussed with the Lecturer.

Time required for individual work:

Scientific writing + Presentations + Simulation task: 21 hours.

Module Content\schedule and outlines:

Part 1: Silicon photonics (4 weeks).

1. Technical challenges and the state of the silicon photonics science.
2. Waveguides and passive components.
3. Device engineering
4. Photonic system engineering

Part II High order multipoles (3 weeks).

5. Multipole theory in electromagnetism.
6. Classical multipole decomposition.
7. Quantum multipole decomposition.

Part III Modelling and design approaches (2 weeks).

8. Optical waveguide mode solver.
9. Wave propagation.
10. Physical layout.

Part IV Optical materials and waveguides: (2 weeks).

11. Silicon-on-insulator wavelength and temperature dependence
12. Waveguides design

Part V Fabrication and applications (2 weeks).