Ben – Gurion University of the Negev
Electrooptical Engineering

Name of the module: Integrated Photonics

Number of module: 377.2.5599

BGU Credits: 3

ECTS Credits: 4

Academic year: 2017-2018

Semester: Spring.

Class hours: 3

Day and time: Sunday 14:00-17:00.

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:

Mathematical principles in EO (377-2-5236).

Grading scale: 1-100.

Course description:

Driven by the dream of untapped device functionality, integrated photonics studies the emerging science of the interaction of light with matter while light is guided on a chip. The aim is to control light fast (within only a few oscillation cycles of the light wave), in a miniature device containing only a few layers of atoms using signals carried by only a few photons. Proposed course will encompass fundamental theoretical basics of integrated photonics circuitry, computational physics (numerical modeling of complex integrated systems), 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, manipulated on a chip by waveguides, with applications in biomedical devices and optics communication. (2) Light-matter interactions on nano-scale, with composite plasmonic waveguides.

Aims of the module:

1. Introduces the fundamentals of photonics waveguides as a basic element of Integrated Photonics circuitry.
2. Introduces the concepts of Integrated Photonics design considerations.
3. To equip the student with theoretical background to design, characterize and analyze the Integrated Photonics devices and systems.

Milestones of the module:

1. Acquire the students with the basics of integrated 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 composite plasmonic waveguides.
4. Acquire the students with main fabrication routines of Integrated Photonic devices.
5. Acquire the students with Maxwell Solver techniques for guided wave optics calculations, mode profiling, propagation constants, losses, evolution of the hybrid guided modes, evanescent fields distributions, surface intensity and transmitted power.

6. Recommended literature:

1. Light transmission optics by D. Marcusek 1982.
2. Fundamentals of optical waveguides by K. Okamoto 2006.
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

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Office hours:

Tuesday, 14:00-15:00

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: Mar. 2018

Learning outcomes of the module:

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

Assessments:

(20% -Scientific presentation + 20%-Scientific writing)=40%, 60%-Final exam.

Scientific work:

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

Scientific presentation task:

Scientific presentation: study and presentation of a recently published article: theory, design considerations, experimental apparatus and application demonstrated - 45 min. presentation.

Time required for individual work:

Scientific writing + presentation task: 21 hours.

Module Content\schedule and outlines:

Part 1: Electromagnetism of photonic waveguides (3 weeks).

1. Theory of photonics waveguides for optics communication.
2. Theory of composite plasmonic waveguides.

Part II Refractive index control (2 weeks).

3. Design considerations.
4. Fabrication techniques.

Part III Losses (3 weeks).

5. Coupling and propagation losses.
6. Absorption loss.
7. Loss around the bend.
8. Scattering loss.

Part IV Light sources on a chip: (2 weeks).

9. LASER
10. Light emitting diode

Part V Applications (3 weeks).

11. Integrated Optics for Optics communication.
12. Integrated Optics for Biomedical applications.