POZNAN UNIVERSITY OF TECHNOLOGY
EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Optoelectronic and photonic elements and technology [S1EiT1>TiEOiF]

Course

Field of study
Electronics and Telecommunications

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr inż. Jan Lamperski
jan.lamperski@put.poznan.pl

Lecturers

Prerequisites

Basic knowledge of mathematics, EM field theory, optics and optocommunications.

Course objective

In-depth knowledge and understanding of the design, operation and features of various optical devices used in optical transmission systems and equipment for the processing of optical signals.

Course-related learning outcomes

Knowledge:
The student has knowledge of the physical behavior of passive and active optical components
Has knowledge of the features and possible applications of optical and optoelectronic materials
Understands physical principles of operation and construction of the selected optical elements and optoelectronic devices (directional couplers, modulators, photodiodes, lasers, optical amplifiers, optical filters, acousto-optical cell)
Understands the applications in which advanced photonics devices and sub-modules are used

Skills:

Can define requirements and select appropriate optical elements for the specific application
Can calculate the basic parameters of optoelectronic components
Has design skills to define problems, identifies constrains propose solutions for specific applications to fulfill performance and required specification

Social competences:
Has awareness of the necessity of professional approach to solving of technical problems
Understands the role of photonics in next-generation systems for signal processing and transmission
3. Is aware of the advantages of optical technology and necessity of transition from electronics to photonics

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Assessment of lecture material - written and/or oral form of 2-3 selected problems. Assessment of laboratory projects - presentation of lab group results.

Programme content

Duality of light: rays, waves, electromagnetism, quanta. Polarization of light. Electro- and acousto-optic effects. Nonlinear optics. Fundamentals of quantum mechanics.
Selected components of integrated optics: planar waveguides, directional couplers, EAM (Franz-Keldysh), MZM, AOM.
Photonic crystal fibers. PCF supercontinuum.
Fabry-Perot resonator.
Optoelectronic semiconductor materials: electrical carriers, energy band-gap structure, direct indirect semiconductors.
Interaction of radiation with atoms.
Basic principles of light detection and emission in semiconductors. LED electrical and optical features.
Semiconductor optical amplifiers. Properties of F-P, DFB, DBR semiconductor lasers. Mode locked lasers.
Modulators for advanced modulation formats: PSK, QPSK, DQPSK, PolSK. Coherent detection. Detection of multileve optical signals. SOA: Wavelength conversion and regeneration. Nonlinear based all optical signal processing and regeneration (NOM, SL, SPM-MZI, XPM-MZI). Optical switching: MEMS, OE, LC, CI technology. Optical control loops: OIL, OPLL. Optical computers.
Optical comb generation. Optical frequency standards.

Course topics

Lectures:

Duality of light: rays, waves, electromagnetism, quanta. Polarization of light. Electro- and acousto-optic effects. Nonlinear optics. Fundamentals of quantum mechanics.
Selected components of integrated optics: planar waveguides, coupled mode waveguides, electro-optic modulators, electro absorption (Franz-Keldysh) modulators, Mach-Zehnder type modulators, acousto-optic modulators.
Photonic fibers.
Optical resonators.
Optoelectronic semiconductor materials: electrical carriers, energy band-gap structure, direct indirect semiconductors.
Interaction of radiation with atoms.
Basic principles of light detection and emission in semiconductors. LED spectral characteristics. Optical amplifiers. Classification and properties of semiconductor lasers. Mode locked lasers.
Advanced modulation formats of optical signals. Wavelength conversion. All optical signal regeneration.
Optical switching. All-optical signal processing. Optical frequency standards.

Examples of exercises include:
Reflection on the materials interface
Properties of fiber and bulk Bragg periodical structures
Selected spectral properties of LEDs

Properties of optical resonators
F-P, DFB semiconductor lasers
Electro-optical effect
Pockels, Kerr modulator
Modulator/swich based on a directional coupler
Acousto-optical effect. AO Bragg cell
Mode-Locked Laser

Teaching methods

Lectures are conducted in the multimedia form, problem oriented with students interaction.
Laboratoies focus on numerical exercises concerning specific optical effects, and simultaneously students work in groups on the assigned more complex problems concerning photonic devices.

Bibliography

Basic
The RP Photonics Encyclopedia: http://www.rp-photonics.com/encyclopedia.html
Optoelektronika, B. Ziętek, UMK, Toruń, 2004
Optical Electronics in Modern Communications, A. Yariv, Oxford University Press, N. York, 1998
Jan Lamperski, Optoelectronics and Photonics, lecture notes
Additional
Jan Lamperski, http://www.invocom.et.put.poznan.pl/~invocom/C/P1-9/swiatlowody_en/index.htm

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	40	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	60	2,00