



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Optoelectronic and photonic elements and technology [S1EiT1E>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

English

Form of study

full-time

Requirements

elective

### Number of hours

Lecture

15

Laboratory classes

15

Other

0

Tutorials

0

Projects/seminars

0

### Number of credit points

3,00

### Coordinators

dr inż. Jan Lamperski

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### Lecturers

### Prerequisites

Basic knowledge of mathematics, EM field theory, optics and optocommunications. Programming in Matlab. Ability to work in a group.

### 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 constraints 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 multilevel 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.

Laboratory problems follow the lecture material.

## 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 practical projects:

Reflection on the materials interface

Properties of fiber and bulk Bragg periodical structures  
 Optical filters  
 Wavelength multipleksers  
 OADM  
 Selected spectral properties of optical amplifiers  
 Properties of optical resonators  
 DFB, DBR semiconductor lasers  
 Electro-optical effect

## 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](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	75	3,00
Classes requiring direct contact with the teacher	31	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	44	1,00