COURSE DESCRIPTION CARD - SYLLABUS

Course name
Photonics

Course

Field of study
Technical Physics

Year/Semester
2/3

Area of study (specialization)

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes

Other (e.g. online)

Tutorials

Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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Wydział Inżynierii Materiałowej i Fizyki Technicznej

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Prerequisites

Fundamental knowledge of wave optics, physics of lasers, quantum physics, fundamentals of quantum engineering. Ability of solving elementary problems in the aforementioned fields, ability of obtaining information from indicated sources. Understanding of necessity of extending one's own competences, ability of systematic work.

Course objective

1. Transferring to students the fundamental knowledge in the field of fiber optics, nonlinear optics and

quantum optics, within the frame described in program contents, necessary for further independent development.

2. Developing the skills of solving simple problems on the basis of the knowledge acquired, necessary for designing experimental setups with the use of functional modules in fiber optics, nonlinear optics and quantum optics.

3. Developing the abilities of systematic self-education.

Course-related learning outcomes

Knowledge

1. student can define fundamental concepts in the field of fiber optics and fiber-optic technology, as well as can discuss generally polarization and nonlinear effects essential for light propagation in optical fibers within the frame of program contents - [K2_W05], [K2_W10].

2. student can explain quantum optical effects, as well as functions of the elements, modules and optical systems based on these effects - [K2_W07, K2_W10, K2_W05].

Skills

1. student can use with understanding the indicated sources of knowledge (the list of basic literature references), as well as obtain knowledge from other sources (including sources in English language) - [K2_U02].

2. student can perform simple calculation of the parameters of optical fibers with defined specifications, nonlinear optics systems, as well as configure the systems with intended purpose on the basis of ready components - [K2_U05], [K2_U13], [K2_U18].

3. student can determine the result of transformation of quantum light modes, realized by optical elements and function modules - [K2_U1], [K2_U5].

4. student can perform analysis of optical systems, consisting of the elements and function modules, operating on the basis of quantum optical effects, with assessment of advantages and limitations resulting from application of these effects - [K2_U7], [K2_U2].

Social competences

1. student can unaided develop and extend his/her competences - [K2_K01], [K2_K04].

2. student understands the necessity of independent work - [K2_K04].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Outcome	Assessment form	Assessment criteria
W01, W02,	Components of the grade:	96% - (5,0)
U01, U02, U03, U04	- written exam (80%)	86%- 95% (4,5)

K01, K02	- oral exam (20%)	76%-85%	(4,0)
	- supplementary gratification for active formulation	66%-75%	(3,5)
	of relevant questions and comments, as well as solution	51%-65%	(3,0)
	of contest problems concerning the lecture (+20%)	< 50%	(2,0)

Programme content

1. Fundamentals of propagation of classical light in optical fibers. Linear fiber-optic components. Mode coupling in fiber-optic transmission lines

2. Polarization controllers and analyzers in fiber-optic transmission lines. Fiber-optic polarization components

3. Light propagation in peridic media, fiber-optic Bragg gratings

4. Fundamentals of nonlinear optics. General properties of nonlinear fiber-optic media, in particular those applied in fiber-optic technology

5. Nonlinear second- and third order frequency conversion (second and third harmonic generation, four-wave mixing)

6. Nonlinear effects dependent on the light intensity, optical Kerr effect, self-focusing and self trapping, self phase modulation, cross phase modulation

7. Propagation of optical pulses in dispersive media. Solitons in fiber-optic transmission lines. Supercontinuum generation

8. Multimode states of light. Mode functions. Rotational and irrotational components of electromagnetic field

9. Energy, momentum, spin and orbital momentum of light

10. Manipulation of microparticles with light

11. Modes of light with non-zero orbital momentum. Mode conversion with the use of a spiral plate (s-plate)

12. Generation of the states of ligth with the use of a q-plate. Functions of the systems composed of q-plates and retarders.

13. Hybrid states of light. Conversion between the spin and orbital angular momentum of light

14. Quantization of multimode states of light. Spin and orbital angular momentum of light in quantum description

Teaching methods

Lecture: multimedia presentation illustrated with examples presented on the blackboard

Bibliography

Basic

1. B.E.A.Saleh, M.C.Teich Fundamentals of Photonics (2 ed.) Wiley Series in Pure an Applied Optics John Wiley & Sons, 2007

2. M.Karpisz, E.Weinert-Rączka Nieliniowa optyka światłowodowa Wydawnictwo Naukowo-Techniczne, Warszawa, 2009

3. P.Kok, B.W. Lovett, Introduction To Optical Quantum Information Processing, Cambridge University Press 2010

4. Ch.C. Gerry, P.L. Knight , Wstęp do optyki kwantowej, Wydawnictwo Naukowe PWN 2007

Additional

1. G.P.Agrawal, Nonlinear Fiber Optics (4 ed.), Elsevier Inc., Academic Press, 2007

2. G.P.Agrawal, Applications of Nonlinear Fiber Optics, Elsevier Inc., Academic Press, 2001

3. D.S.Simon, G.Jaeger, A.V.Sergienko, Quantum Metrology, Imaging and Communication, Springer 2017

4. Selected articles from scientific periodicals

Breakdown of average student's workload

	Hours	ECTS
Total workload	92	4,0
Classes requiring direct contact with the teacher	50	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	42	2,0

[1] delete or add other activities as appropriate