**SYLLABUS**

**regarding the qualification cycle FROM 2023TO2026**

1. Basic Course/Module Information

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| --- | --- |
| Course/Module title | *Optics* |
| Course/Module code \* |  |
| Faculty (name of the unit offering the field of study) | *College of Natural Science* |
| Name of the unit running the course | *Institute of Physics* |
| Field of study | Diagnostic systems in medicine |
| Qualification level | First-cycle studies |
| Profile | *General academic* |
| Study mode | *Full-time* |
| Year and semester of studies | *2nd year, winter semester* |
| Course type | *Directional course* |
| Language of instruction | English |
| Coordinator | Dr hab. Małgorzata Sznajder, prof. UR |
| Course instructor | *Dr hab. Małgorzata Sznajder, prof. UR* |

\* - as agreed at the faculty

1.1.Learning format – number of hours and ECTS credits

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Semester  (n0.) | Lectures | Classes | Colloquia | Lab classes | Seminars | Practical classes | Internships | others | **ECTS credits** |
| 3 |  | 30 |  |  |  |  |  |  | 6 |

1.2. Course delivery methods

Conducted in a traditional way

1.3. Course/Module assessment (exam, pass with a grade, pass without a grade)

Pass with a grade

2. Prerequisites

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| KNOWLEDGE OF GEOMETRIC AND WAVE OPTICS AT THE LEVEL OF SECONDARY SCHOOL. KNOWLEDGE OF FUNDAMENTALS OF PHYSICS AT THE ACADEMIC LEVEL IN THE FIELD OF MECHANICS, ELECTRICITY AND MAGNETISM. KNOWLEDGE FROM THE FUNDAMENTALS OF HIGHER MATHEMATICS. KNOWLEDGE OF DIFFERENTIAL AND INTEGRAL CALCULUS. |

3. Objectives, Learning Outcomes, Course Content, and Instructional Methods

3.1. Course/Module objectives

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| O1 | To familiarize students with the physical quantities used in geometric and wave optics, their definitions and units. |
| O2 | Indicating to the student examples from the surrounding world of phenomena described by the known physical laws and relationships. |
| O3 | Acquisition by the student of the ability to solve problems in the field of geometric and wave optics. |

3.2. Course/Module Learning Outcomes (to be completed by the coordinator)

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| --- | --- | --- |
| Learning Outcome | The description of the learning outcome  defined for the course/module | Relation to the degree programme outcomes |
| LO\_01 | The student knows and understands the basic concepts, principles and theories of wave and geometric optics, basic theorems and laws of geometric and wave optics, as well as knows and understands the phenomena related to the propagation of electromagnetic waves, | K\_W02 |
| LO\_02 | the student is able to analyze problems in optics and find their solutions based on known theorems and methods, | K\_U01 |
| LO\_03 | student potrafi w sposób przystępny przedstawić podstawowe fakty w ramach zastosowań optyki w medycynie i technice, | K\_U10 |
| LO\_04 | the student is able to prepare oral presentations and typical written works in Polish or a foreign language, concerning specific issues in optics, using basic theoretical concepts, as well as various sources, | K\_U11 |
| LO\_05 | the student is able to consciously design his/her educational path and independently update and integrate with related fields the knowledge acquired during studies, | K\_U15 |
| LO\_06 | the student is ready to understand the social aspects of the practical application of the acquired knowledge and skills and the associated responsibility, as well as to fulfil social obligations. | K\_K03 |

**3.3. Course content (to be completed by the coordinator)**

1. Lectures

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| Content outline |
| **Wave optics:** Wave motion - a recollection of the basic concepts. One-dimensional waves, differential wave equation, harmonic waves, phase, phase and group velocity. The superposition principle. The wave equation in three dimensions, plane waves, spherical and cylindrical waves. Basic laws of the electromagnetic theory, electromagnetic waves, Maxwell's equations, derivation of the wave equation for the electromagnetic field, proof of the transversality of electromagnetic waves, energy and momentum of the electromagnetic wave, light intensity, optical power, flux density of light intensity. Velocity of light in media, index of refraction. Behavior of the electromagnetic field at the border of two media. Spectrum of electromagnetic waves, photons. |
| **Geometrical optics**: Laws of geometric optics, Fermat's principle, reflection and refraction, real and imaginary images, total internal reflection. Elliptical mirrors, parabolic mirrors, spherical mirrors. Prisms and dispersion. Thin lenses (refraction on a single spherical surface, thin lenses, magnification, cylindrical lenses, determining the focal length of the lens, lens formula). Aberrations (spherical aberration, astigmatism, chromatic aberration). Design of optical systems (systems of lenses, calculation formulas for tracing rays, correction of aberrations, examples of optical systems). Optical instruments (microscopes, mirror systems). Selected applications of optical devices in medicine: optical fibers. Examples of optical elements in MOEMS technology. |
| **Polarisation**: Boundary conditions for plane wave amplitudes. Fresnel equations, wave polarization by reflection, polarizers, polarization in birefringent crystals. |
| **Interference and diffraction**: Wave interference, Young's experiment, coherence of light, interference in thin layers, interferometers. Diffraction on single and double slits, diffraction on a circular aperture, resolving power of the lens, diffraction grating and its characteristics. |
| **Light dispersion**: Visible, infrared, and ultraviolet radiation. Spectral instruments (spectroscopes, spectrographs, spectrometers, spectrophotometers). Basic knowledge of spectral analysis (emission spectra, absorption spectra). Selected applications of optical devices in medicine: lasers. |

1. Classes, tutorials/seminars, colloquia, laboratories, practical classes

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| Content outline |
| The same as above |
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3.4. Methods of Instruction

*A Lecture supported by a multimedia presentation.*

*Classes: group work (problem solving, discussion).*

4. Assessment techniques and criteria

4.1 Methods of evaluating learning outcomes

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| Learning outcome | Methods of assessment of learning outcomes (e.g. test, oral exam, written exam, project, report, observation during classes) | Learning format (lectures, classes,…) |
| LO-01 | Observation during classes, exam, colloquium | L, c |
| LO-o2 | Observation during classes, exam, colloquium | L, c |
| LO-o3 | Observation during classes, exam, colloquium | L, c |
| LO-o4 | Observation during classes | c |
| LO-o5 | Observation during classes | c |
| LO-o6 | Observation during classes | c |

4.2 Course assessment criteria

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| Passing the course takes place as a result of achieving positive grades from colloquia, active participation in classes and participation in discussions. Verification of the achieved learning outcomes is controlled on an ongoing basis during the classes through colloquia and tests. The grade obtained from completing the course will allow you to assess the degree of achieved effects.  Lecture - In order to pass the written exam for a positive grade, you must obtain min. 51% of the points from the questions asked.  Classes - No unexcused absences from classes. In order to pass, you must solve two announced tests that will take place during the semester. The test is considered passed with a positive grade when the student has obtained min. 51% points from the questions asked. The final credit of the calculation exercises in the course will be the average of the grades obtained in the colloquia and the answers from the discussion at the blackboard. |

5. Total student workload needed to achieve the intended learning outcomes

– number of hours and ECTS credits

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| --- | --- |
| Activity | Number of hours |
| Scheduled course contact hours | 30 |
| Other contact hours involving the teacher (consultation hours, examinations) | 6 |
| Non-contact hours - student's own work (preparation for classes or examinations, projects, etc.) | 90 |
| Total number of hours | 126 |
| Total number of ECTS credits | 6 |

\* One ECTS point corresponds to 25-30 hours of total student workload

6. Internships related to the course/module

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| --- | --- |
| Number of hours | *Not applicable* |
| Internship regulations and procedures |  |

7. Instructional materials

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| Compulsory literature:  1. E. Hecht, Optics, Global edition, London, Pearson Education Limited 2017 https://edisciplinas.usp.br/pluginfile.php/5054148/mod\_resource/content/1/Hecht-optics-5ed.pdf  2. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, 12th Edition, Wiley, 2021  3. Samuel J. Ling, Jeff Sanny, William Moebs, University Physics: Volume 3, 12th Media Services, 2016 |
| Complementary literature:  1. Feynman R.P., Leighton R.B., Sands M. The Feynman lectures on physics, vol. 2, The New Millennium Edition, Pearson, India, 2012 |

Approved by the Head of the Department or an authorised person