Appendix No. 1.5 to the Resolution No. 7/2023

of the Rector of the University of Rzeszów

**SYLLABUS**

**regarding the qualification cycle FROM ………TO…..**

**Academic year 2024/2025**

1. Basic Course/Module Information

|  |  |
| --- | --- |
| Course/Module title | Basic physical principles of X-ray diagnostics |
| Course/Module code \* |  |
| Faculty (name of the unit offering the field of study) | College of Natural Sciences |
| Name of the unit running the course | Institute of Physics |
| Field of study | Diagnostic systems in medicine |
| Qualification level | First-cycle studies |
| Profile |  |
| Study mode | Full-time |
| Year and semester of studies | 2, winter semester |
| Course type |  |
| Language of instruction | English |
| Coordinator | Wojciech Szajna, Dr. Sci. (Hab.), Associate Professor |
| Course instructor | Wojciech Szajna, Dr. Sci. (Hab.), Associate Professor |

\* - 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** |
| 4 |  | 30 |  |  |  |  |  |  | **2** |

1.2. Course delivery methods

☒ - conducted in a traditional way

☐ - involving distance education methods and techniques

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

☒ - pass without a grade

2. Prerequisites

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| --- |
| Fundamentals of atomic physics and nuclear physics.  Basics of mathematical analysis (differential and integral calculus). |

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

3.1. Course/Module objectives

|  |  |
| --- | --- |
| O1 | To familiarize students with the properties of X-rays and the methods of its production for use in X-ray diagnostics |
| O2 | To familiarize students with the mechanisms and effects of the interaction of X-rays with matter. |
| O3 | To familiarize students with the construction and principle of operation of modern X-ray diagnostics devices. |
| O4 | To familiarize students with the issues related to radiological protection with using X-rays for diagnostic purposes. |

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

|  |  |  |
| --- | --- | --- |
| Learning Outcome | The description of the learning outcome  defined for the course/module | Relation to the degree programme outcomes |
| LO\_01 | Student distinguishes and characterizes types of ionizing radiation. Can describe natural and artificial sources and methods of producing of X-rays. Characterizes the properties of X-rays. | K\_W02  K\_W04  K\_U10  K\_K03 |
| LO\_02 | Student knows, lists and characterizes the interaction of X-rays with matter. Lists and describes the positive and negative effects of exposure in the context of applications in X-ray diagnostics (and X-ray therapy). | K\_W04  K\_U01  K\_U10  K\_U15  K\_K03 |
| LO\_03 | Student describes the construction of modern X-ray diagnostics equipment and explains the physical and technical principles of their operation. | K\_W04  K\_U10  K\_K03 |
| LO\_04 | The student determines and calculates the permissible doses of X-rays in X-ray diagnostic examinations. He plans technical methods of reducing the intensity of X-rays to the desired and safe value. | K\_W02  K\_W04  K\_U10  K\_U14 |

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

1. Lectures

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| --- |
| Content outline |
| General characteristics of ionizing radiation - division and types. The history of the discovery of X-rays. Formation and properties of X-rays. The spectrum of electromagnetic waves - the energy range of X-rays. The continuous spectrum and the characteristic spectrum of X-rays. Interaction of X-rays with matter - description of mechanisms. Attenuation of X-ray beam intensity when passing through matter. Linear and mass attenuation coefficient. Half-value layer. |
| Natural and artificial sources of X-rays. Construction and principle of operation of an X-ray tube with a solid anode. X-ray tubes with a rotating anode - construction and technical solutions. Operating parameters of X-ray tubes. |
| Construction and principle of operation of devices for conventional X-ray diagnostics - X-ray apparatus, mammograph, pantomograph, densitometer. Theory of the X-ray image. Analog and digital image recording systems. |
| X-ray computed tomography (CT). Mathematical principles - Radon transformation. Construction of the CT tomography apparatus. Lamps and detectors used in CT devices. Generations of CT tomographs. Methods of tomographic image reconstruction. Directions of development of CT technique. |
| Safety of X-ray diagnostics examination. Legal regulations and acceptable standards. |

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

|  |
| --- |
| Content outline |
| Calculation of X-ray beam intensity attenuation when passing through matter. |
| Calculation of the linear and mass attenuation coefficient of characteristic X-rays for materials used in X-ray diagnostics techniques. |
| Calculation of the thickness of the half-value layer. |
| Calculation of radiation doses. |

3.4. Methods of Instruction

e.g.

*Lecture: a problem-solving lecture/a lecture supported by a multimedia presentation/ distance learning*

*Classes: text analysis and discussion/project work (research project, implementation project, practical project)/ group work (problem solving, case study, discussion)/didactic games/ distance learning*

*Laboratory classes: designing and conducting experiments*

Lecture: a problem-solving lecture/a lecture supported by a multimedia presentation

Classes: text analysis and discussion/group work (problem solving, case study, discussion)

4. Assessment Techniques And Criteria

4.1 Methods of evaluating learning outcomes

|  |  |  |
| --- | --- | --- |
| 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 | test, observation during classes | lectures, classes |
| LO-o2 | test, observation during classes | lectures, classes |
| LO-03 | test, observation during classes | lectures |
| LO-04 | test, observation during classes | classes |

4.2 Course assessment criteria

|  |
| --- |
| The condition for passing is:  a) passing a written test from lectures with a positive grade;  b) performing the calculation exercises and calculation problems provided for in the plan, passing the test with a positive grade. |

5. Total student workload needed to achieve the intended learning outcomes – number of hours and ECTS credits

|  |  |
| --- | --- |
| Activity | Number of hours |
| Scheduled course contact hours | 30 |
| Other contact hours involving the teacher (consultation hours, examinations) | 5 |
| Non-contact hours - student's own work (preparation for classes or examinations, projects, etc.) | 20 |
| Total number of hours | 55 |
| Total number of ECTS credits | 2 |

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

6. Internships related to the course/module

|  |  |
| --- | --- |
| Number of hours | ----- |
| Internship regulations and procedures | ----- |

7. Instructional materials

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| Compulsory literature:   1. D.R. Dance, S. Christofides, A.D.A. Maidment, I.D. McLean, K.H. Ng, *Diagnostic radiology physics: a handbook for teachers and students*, International Atomic Energy Agency, 2014. |
| Complementary literature:   1. Yoshio Waseda \_ Eiichiro Matsubara, Kozo Shinoda, „X-Ray Diffraction Crystallography”, Springer Heidelberg Dordrecht London New York, 2011. |

Approved by the Head of the Department or an authorised person