Title:	Physical basis of nuclear medicine
Lecture hours:	15
Study period: (summer/winter)	winter
Number of credits:	3
Assessment methods:	Visits to specialized laboratories on selected issues
Language of instruction:	English
Prerequisites:	Knowledge: K_W01 - has knowledge of the basic branches of physics and general knowledge of basic concepts, principles and theories in the field of physics and related disciplines K_W04 - can independently reproduce basic physical laws and theorems K_W10 - has basic knowledge of legal and ethical conditions related to scientific and teaching activities Skills K_U01 - is able to analyze problems and find their solutions based on the known theorems and methods; K_U02 - is able to perform quantitative analyzes and formulate qualitative conclusions on this basis K_U08 - is able to present basic facts in the field of physics in an accessible way Competencies K_K01 - understands the need for lifelong learning, is able to inspire and organize the learning process of other people; K_K02 - is able to cooperate and work in a group, taking on various roles in it
Course content:	**Introduction.** **Concept of nuclear medicine.** Types of nuclear medicine. Radioactive isotopes. Radio-pharmaceutics and their roles. **Radioactivity. Nuclear reactions**. Nuclear transformations (reactions). Radioactivity. The basic law of radioactive transformations. The decay law and half-life time. Alpha decay. Beta decays. Gamma radiation. **Nuclear reactions.** Basic principles in nuclear reactions. **Nuclear fusion reactions**, and their examples. Threshold energy and splitting energy, their components. Guided and unguided nuclear reactions. Nuclear energy, based on nuclear fussion reactions. **Nuclear synthesis reactions**. Examples of such reactions. Hydrogen and carbon-nitrogen cycle. Undirected thermonuclear reaction. Problems of nuclear fusion reactions and approaches to their solution. 2. **Interaction of ionizing radiation with matter.** Basic processes occurring in atoms and nuclei as a result of interaction with quanta and particles. **Absorption and emission of photons.** Photoelectric effect, its main features. Compton effect. Wave shift. Waves of matter and de Broglie's hypothesis. Creation of electron-positron pairs. Dominance of various interaction mechanisms depending on photon energy. **Effects of the interaction of X and γ radiation from matter.** Quantitative description of the interactions of ionizing radiation with matter. Absorption range of electrons. Ionization by fast electrons. Ionization by heavy charged particles. Characteristics of neutron radiation. **Stopping ability and linear energy transfer LET** for various particles. Stopping ability and dose distribution in matter for various particles. **3. Imaging in medicine. Scintigraphy.** Types of imaging in medicine and their characteristics. Nuclear medicine and its functions. Isotopes used in nuclear medicine, their types and functions. Quantities characterizing nuclear transformation. **Scintigraphy.** Physical basis of scintigraphy. Photon emission tomography (SPECT). Scintigraphy devices. Imaging and non-imaging banana scintigraphy. Dynamic scintigraphy. The concept of clearance. X-ray image fusion. 4. **Imaging in medicine. Positron emission tomography (PET).**

	Physical principles of the PET method. Construction of a PET scanner. PET detectors and scintillators. The course of the PET examination. Types of radiopharmaceuticals in the PET method. Cyclotrons and the production of radiopharmaceuticals for PET. Advantages of the PET method and its application. PET in Bydgoszcz and whole /Poland. **5. Particle therapy.** Physical basis of particle therapy. Conventional particle therapy and its types. Advantages and disadvantages of quantum and particle therapy. LETs for different particles. Radiobiological coefficients for various particles. **Proton cancer therapy.** Proton therapy procedure. Proton beam modification (SOBR). Proton therapy in Poland. **Alpha particle therapy.** Types of alpha particle emitters. LET and radiobiological coefficients for alpha particles. **Carbon cancer therapy.** Advantages and disadvantages of carbon ion therapy compared with protons. **6. New particle therapy methods.** Targeted alpha particle therapy (TAT) and its advantages over other methods. Emitters in the TAT method. **Boron-Neutron capture therapy (BNCT).** Physical basis of the BNCT method. Advantages of the BNCT method compared to other methods. **Fast neutron cancer therapy.** LET and fast neutron radiobiological coefficients. Recommended cancer types for neutron therapy.
Learning outcomes:	Example: 5 questions from different parts of the course
Name of lecturer:	prof. dr hab. Yuriy Zorenko
Email address:	zorenko@ukw.edu.pl