Universitat Autònoma de Barcelona

2022/2023

Hospital Physics

Code: 106071
ECTS Credits: 6

Degree	Type	Year	Semester
2500097 Physics	OT	4	2

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Teachers

Carlos Domingo Miralles
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Prerequisites

It is very convenient to have previously performed the Radiation Physics course in order to know the physical principles of the interaction of radiation with matter and the principles of operation of radiation detectors.

Objectives and Contextualisation

Medical physics is concerned with providing the scientific basis for the use of diagnostic and therapy technologies (conventional radiology, computerized and digital radiology, magnetic resonance imaging, tomography, radiotherapy, particle accelerators, etc.), establishing criteria for the correct use of the physical agents used (ionizing radiation, microwaves, lasers, etc.), to set criteria for the radiological protection of workers and patients, to participate in the design of auxiliary instrumentation and establish standards for the measurement of many biological variables. Physicists perform specific healthcare tasks in hospitals, such as planning treatments with ionizing radiation, controlling radiology equipment, designing and controlling radiological facilities, or controlling staff and areas exposed to radiation.

The figure of the physicist working in hospitals performing this type of task is legislated since the program for access to resident internal physicist was created. Through this program, the physicist develops a training period of 3 years in a hospital, through which the specialty of Hospital Radiophysicist is obtained, which entitles him to the professional development of the aforementioned tasks.

Thus, the main objective of the subject is to provide knowledge in medical physics, as well as to train the students for the professional career of Hospital Radiophysicist. These objectives are specified in:

- To study the concepts of metrology and dosimetry of ionizing radiation
- To know the physical principles of diagnostic imaging
- To study the physical principles and practical applications of nuclear medicine
- To know the physical principles on which radiation therapy is based

- To study the principles of radiological protection, as well as the magnitudes and units used in the radiological protection system
- To study the effects of ionizing radiation on organisms
- To apply the concepts learned in a real hospital physics department

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Apply fundamental principles to the qualitative and quantitative study of various specific areas in physics
- Be familiar with the bases of certain advanced topics, including current developments on the parameters of physics that one could subsequently develop more fully
- Carry out academic work independently using bibliography (especially in English), databases and through collaboration with other professionals
- Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, and before both specialist and general publics
- Formulate and address physical problems identifying the most relevant principles and using approximations, if necessary, to reach a solution that must be presented, specifying assumptions and approximations
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Plan and perform, using appropriate methods, study, research or experimental measure and interpret and present the results.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Using appropriate methods, plan and carry out a study or theoretical research and interpret and present the results
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project
- Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.

Learning Outcomes

1. Carry out a hospital visit, visit the main medical services with radiation-emitting equipment and carry out some kind of test to understand the way they work.
2. Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, in front of both specialist and general publics.
3. Explain the explicit or implicit code of practice of one's own area of knowledge.
4. From the point of view of radiological protection, characterise a radioactive installation with medical applications (radio diagnostic, nuclear medicine, radiotherapy, etc.).
5. Identify situations in which a change or improvement is needed.
6. Identify the social, economic and environmental implications of academic and professional activities within one's own area of knowledge.
7. Plan radiation or exposure for the elimination or characterisation of different types of tumour.
8. Understand the bases of conventional therapy using radiation.
9. Understand the different types of accelerators, radiation-emitting equipment and radioactive sources for medical applications.
10. Understand the effects of ionizing radiation on living beings.
11. Understand the physical principles of diagnostic imaging techniques.
12. Understand the physical principles of nuclear medicine.
13. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments

14. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.
15. Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.
16. Carry out academic work independently using bibliography (especially in English), databases and through collaboration with other professionals

Content

- Metrology and dosimetry of radiation
  External exposure. Radionuclides incorporated into the body. Radiation-matter interactions.
- Fundamentals of radiobiology
  Radiobiology at the subcellular level. Radiobiology at the cellular level. Clinical radiobiology.
- Radiological protection
  Biological basis of radiological safety. Safety guides. Protection against external irradiation. Protection against internal irradiation. Radiation control measures. Radiological protection applied to X-ray equipment and nuclear medicine. Protection against non-ionizing radiation.
- Radiation therapy
  Introduction and history of radiotherapy. External radiotherapy with photons and electrons. External radiotherapy with ions. Brachytherapy. Treatment planning in radiotherapy. Other radiotherapy techniques.
- Diagnostic imaging
  Basic concepts. X-ray production. Radiography. Mammography. Fluoroscopy. Computed tomography (CT). X-ray dosimetry. Magnetic resonance. Ultrasounds.
- Nuclear medicine
  Introduction to nuclear medicine and production of radiopharmaceuticals. Gammagraphy and single photon emission computed tomography (SPECT). Positron emission tomography (PET). Image processing in nuclear medicine.

Methodology

The course has presential classes divided into theory, problems, laboratory practices and field trips. It is highly recommended to attend the theory and problem classes, and it is mandatory to attend and perform the laboratory practices and attend field trips.

During the course, the realization of directed activities will be considered, both of a more theoretical nature (bibliographic research and realization of works) and of a practical nature (problem solving and research of experimental data).

The student will have to dedicate an important part of the time in the extension of the knowledge given in the lectures and in the personal study.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory demonstrations	6	0.24	4, 2, 3, 6, 5, 7, 13, 15
Problems solving at the classroom	10	0.4	4, 2, 3, 6, 5, 7, 13, 14
Theory lectures	27	1.08	4, 9, 10, 12, 11, 8, 3, 6, 5

Type: Supervised			
Filed visits: visiting real premises related to Hospital Physics	6	0.24	4, 9, 10, 12, 11, 8, 3, 16, 1, 6, 7, 13, 14, 15
Type: Autonomous			
Bibliographic tasks and problems	21	0.84	4, 2, 9, 10, 12, 11, 8, 16, 13, 14, 15
Preparing the practical reports and the field visit report	16	0.64	4, 9, 16, 1, 6, 5, 7, 13, 14, 15
Search for information and studying	61	2.44	9, 10, 12, 11, 8, 16, 6, 5, 14, 15

Assessment

Given the eminently applied nature of the subject and the fact that the problems to be solved require time and information that is difficult to have in a classroom, the existence of "classic" partial exams (of questions and problems) is NOT considered.

The evaluation of the subject will be done with three types of activities:

1.- Tests of control and continuous evaluation that will be made during the course. By its nature, replay is not possible. Typically 3 tests will be performed throughout the course. The overall weight of this activity is 40%. They can be done virtually, through the Virtual Campus.

2.- Evaluation of the laboratory and field practices. Based on the corresponding reports and the evaluation carried out by the teachers during the practises. The realization of the practices is an indispensable requirement to pass the course. The weight of this activity is 20%.

3.- Evaluation of the works and directed problems. With an overall weight on the grade of 40%. The directed problems that will have to be delivered during the course will have a weight of 10% and a work that will have to be delivered at the end of the course will have a weight of 30%.

In order to pass the course it is mandatory to have a mark of all the evaluable activities.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Control tests during the course	40%	3	0.12	9, 10, 12, 11, 8
Evaluation of demonstrations and field visits	20%	0	0	4, 2, 9, 3, 16, 1, 6, 5, 7, 13, 14, 15
Evaluation of supervised tasks and problems	40%	0	0	4, 2, 16, 5, 7, 13, 14, 15

Bibliography

J.T. Bushberg, J.A. Seibert, E.M. Leidholdt Jr., J.M. Boone. *The Essential Physics of Medical Imaging* (3rd edition). Wolters Kluwer. Lippincott Williams & Wilkins, 2012. ISBN: 978-0-7817-8057-5

H. Cember, T.E. Johnson. Introduction to Health Physics (4th edition). Mc. Graw Hill Medical. 2009. ISBN: 978-0-07-164323-8

F.M. Khan. *The Physics of Radiation Therapy.* Lippincott Williams & Wilkins, 2003. ISBN: 0-78 17-3065-1

E. Podgorsak. *Radiation Oncology Physics: A Handbook for Teachers and Students*. International Atomic Energy Agency (IAEA), Vienna, 2005. ISBN: 92-0-107304-6. Accesible throug the IAEA webpage: https://www-pub.iaea.org/mtcd/publications/pdf/pub1196_web.pdf

Software

Specific software is not required.