Medical imaging technologies

Academic Year: (2023 / 2024) **Review date: 28-06-2023**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: ABELLA GARCIA, MONICA

Type: Compulsory ECTS Credits : 9.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Phisics, Electronics, Instrumentation and Image processing

OBJECTIVES

CB6 To have the knowledge and understanding that provide a base or opportunity to be original in the development and / or application of ideas
CB7 That students know how to apply the acquired knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study
CB8 That students are able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments
CB9 That students know how to communicate their conclusions and the knowledge and ultimate reasons that sustain them to specialized and non-specialized audiences in a clear and unambiguous way
CB10 That students have the learning skills that allow them to continue studying in a way that will be largely autonomous.
CG1 Ability to learn new methos and technologies, from the master of scientific and technical subjects specialized in Clinical Engineering, and to adapt to new situations.
CG2 Ability to apply advance knowledge about the human body and life science to the resolution of problemas specific for the Clinical Engineering. In particular, ability to identify medical problemasthat ca be treated with techniques that belong to the Clinical Engineering field.
CG3 Ability to design and carry out tecnological proje ctos in the application of the engineering to medicine, as well as to analyze the results.
CG4 Ability to evaluate medical equipment and instrumentation in complex multidisciplinary environments, assessing the needs of different clinical users and offering objective measures for decision making.
CE1 Ability to evaluate agorithms and data processing techniques in complex multidisciplinary environments, evaluating the needs of the different clinical users and offering objective measerements for decision making.
CE4 Ability to evaluate the functioning of electromedical systems through the analysis of complex data obtained from control/electronic/mechanical subsistems involved.
CE7 Ability to apply the knwoledge of the physical principles that gobern radiation generation and its interaction with matter to the use of radionuclides, radiotracers and shieldings, an the instrumentation for radiation detection.

DESCRIPTION OF CONTENTS: PROGRAMME

This course covers the main imaging modalities (X-ray, Nuclear Medicine, Ultrasound and Magnetic Resonace), understanding the essential physics and electronics involved in the acquisition of the data, including the new hybrid devices that combine the advantages of several techniques.
After the completion of this course the student should be able to understand the processes involved in the image acquisition for every modality, including how every aspect of the acquisition process can influence the final image quality. These concepts will be always learned linked to the clinical applications of every modality, so the student will be capable of understanding the areas in which every technique solves specific clinical needs.

Sessions:
1. Interaction of radiation and matter.
2. X-ray production: tubes and generators.
3. Radiography detectors.
4. Advanced Radiography.

5. Computed Tomography.
6. Magnetic Resonance Imaging: Physical principles.
7. Magnetic Resonance Imaging: Sequences and instrumentation.
8. Ultrasound: Physical principles, transducers, types of studies.
9. Nuclear Medicine: Radioactivity and Radionuclide production.
10. Nuclear Medicine: Radiation detection and Measurement.
11. Nuclear Medicine: SPECT and PET.
12. Radiation Protection: Dosimetry and Biology.
13. Hybrid systems: PET/CT and PET/MR.
14. Image Fusion.

LEARNING ACTIVITIES AND METHODOLOGY

Teaching methodology will be mainly based on lectures, seminars and practical sessions.
Students are required to read assigned documentation before lectures and seminars. Lectures will be used by the teachers to stress and clarify some difficult or interesting points from the corresponding lesson, previously prepared by the student. Seminars will be mainly dedicated to interactive discussion with the students and short-exams will be passed during the sessions.
Grading will be based on continuous evaluation (including short-exams, practical sessions, and student participation in class and Aula Global) and a final exam covering the whole subject. Help sessions and tutorial classes will be held prior to the final exam.
Attendance to lectures, short-exams or submission of possible homework is not compulsory. However, failure to attend any exam or submit the exercises before the deadline will result in a mark of 0 in the corresponding continuous evaluation block.
The practical sessions may consist on laboratory work or visits to research or clinical centers. A laboratory report will be required for each of them (in grpups). The attendance to practical sessions is mandatory. Failure to hand in the laboratory reports on time or unjustified lack of attendance will result in 0 marking for that continuous evaluation block.

ASSESSMENT SYSTEM

Continuous evaluation
It accounts for up to 40% of the final score of the subject, and includes three components:
1) Practical sessions with PC and imaging equipment: They will be assessed through a laboratory reports and/or questionnaires will have to be submitted (AulaGlobal) one week after the session. Attendance is mandatory, other wise otherwise the score will be 0 in the item.
3) Student participation: It includes contribution to seminars, forum in Aula Global, attitude, homework (quizzes or exercises to be solved in groups or individually), or other activities.

Final exam
The final exam will cover the whole subject and will account 60 % of the final score. The minimum score in the final exam to pass the subject is 4.0 over 10, notwithstanding the mark obtained in continuous evaluation.

Extraordinary call:
- The final grade for students who attend the extraordinary call may be:
(1) 40% of the extraordinary exam and 60% of the continuous evaluation, with the option of improving the grade of the latter by a new submission of the continuous evaluation activities.
(2) 100% of the extraordinary exam.
The minimum score in the extraordinary exam to pass the subject is 4.0 over 10, notwithstanding the mark obtained in continuous evaluation.

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

BASIC BIBLIOGRAPHY

- Jerry L. Prince, Jonathan Links Medical Imaging Signals and Systems, Prentice Hall, 2014
- Jirí Jan Medical Image Processing, Reconstruction and Restoration, CRC Press, 2005
- Paul Suetens Fundamentals of Medical Imaging, Cambridge University Press, 2009

ADDITIONAL BIBLIOGRAPHY

- Euclid Seeram Digital Radiography: An Introduction for Technologists, Cengage Learning, 2011
- Hsieh, Jiang Computed tomography : principles, design, artifacts, and recent advances, Wiley Interscience, 2009
- Ray H Hashemi, William G Bradley Jr, Christopher J Lisanti MRI: The Basics, LWW, 2010

- Willi A. Kalender Computed Tomography. Fundamentals, System Technology, Image Quality, Applications, Publicis, 3rd edition, 2011