Instrumentation and multimodality imaging

Academic Year: (2022 / 2023) **Review date: 08-04-2022**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: ABELLA GARCIA, MONICA

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Phisics, Electronics, nstrumentation and Control and Image processing and reconstruction

OBJECTIVES

The goal of this course is to provide the students with a comprehensive understanding of medical imaging technology for the different modalities, understanding the essential physics and electronics involved. The clinical applications for every modality will also be covered, 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.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to medical imaging systems

2. X-ray imaging systems
2.1. X-ray production: tubes and generators
2.2. Interaction of radiation with matter
2.3. Conventional radiology
2.4. Special systems: Digital Tomosynthesis, Digital Subtraction Angiography, Dual Energy.
2.5. Computed Tomography

Nuclear Medicine
3.1. Radioactivity and radionuclide production.
3.2. Planar Image in Nuclear Medicine
3.4. Tomography in Nuclear Medicine: SPECT and PET

4. Radiation detectors

5. Magnetic Resonance Imaging
5.1. Physical principles
5.2. Instrumentation
5.3. Image acquisition: Sequences
5.4. Localization and reconstruction
5.5. Artifacts

6. Ultrasound
6.1. Physical principles
6.2. Transducers

7. Radiation Protection: Dosimetry and biology.

8. Hybrid systems: PET/CT and PET/MR.

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. 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 50% of the final score of the subject, and includes three components:
1) Practical sessions with PC: The initial steps will be guided during the seminars. The code will be finish at home and upload to AulaGlobal together with a report one week after the last seminar.
2) Practical sessions with 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 (10% of the continuous evaluation mark): 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 50 % 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 exams
The mark for students attending any extraordinary examination will be the maximum between:
a) 100% extraordinary exam mark, or
b) 50% extraordinary exam mark and 50% continuous evaluation if it is available in the same course.

Academic conduct
All exams will be closed-book, closed-notes, no PC or mobile phone, or anything else other than a writing implement and the exam itself. Plagiarism, cheating or other acts of academic dishonesty will not be tolerated. Any infractions whatsoever will result in a failing grade.

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

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, November 2, 2005
- Paul Suetens Fundamentals of Medical Imaging, Cambridge University Press, 2009

ADDITIONAL BIBLIOGRAPHY

- Ray H Hashemi, William G Bradley Jr, Christopher J Lisanti MRI: The Basics, LWW, 2010
- Euclid Seeram Digital Radiography: An Introduction for Technologists, Cengage Learning, 2011
- Frederick W. Kremkau Sonography Principles and Instruments, Saunders, 2010
- Hsieh, Jiang Computed tomography : principles, design, artifacts, and recent advances, Wiley Interscience, 2009
- Jerrold T. Bushberg, J.Anthony Seibert, Edwin M. Leidholdt y John M. Boone The Essential Physics of Medical Imaging, Lippincott Williams and Wilkins, 2011
- Richard R. Carlton, Arlene McKenna Adler Principles of Radiographic Imaging: An Art and A Science, Cengage Learning, 2013

- Robert Gill The Physics and Technology of Diagnostic Ultrasound, High Frequency Publishing, 2012

- Sidney K. Edelman Understanding Ultrasound Physics 4th Edition, E.S.P. Ultrasound, 2012

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