COURSE DATA

DATA SUBJECT

Code: 44770
Name: Biomedical imaging techniques
Cycle: Master's Degree
ECTS Credits: 4.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2231 - Master's Degree in Biomedical Engineering	Facultat de Medicina i Odontologia	1	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2231 - Master's Degree in Biomedical Engineering	Bridging courses	ELECTIVES

COORDINATION

VILA FRANCES JOAN

SUMMARY

This course presents the technological and scientific foundations of the different techniques of imaging for medical diagnosis. Biomedical imaging systems use different techniques to obtain the diagnosis of a disease from the different tissue or pathological functions response to a particular excitation source.

The content of the subject covers X-ray imaging systems, nuclear medicine systems, magnetic resonance imaging and ultrasound systems. Within each technology, both planar imaging systems and those that allow obtaining tomographic images are detailed.

The course also discusses the hybrid systems that integrate several different image technologies in the same equipment. Finally, the standardized digital image storage format (DICOM) is reviewed and all aspects of quality control and radiological safety required for the correct use of these technologies are discussed.

The contents of this course are summarized in the following points:

- Introduction to medical imaging. Physical background.
- Production of X-rays. Interaction with matter.
- Conventional RX, Digital Imaging, Computed Tomography.
- Reconstruction of slices, 2D and 3D visualization.
- Images in Nuclear Medicine. Radiopharmaceuticals, gamma camera, SPECT and PET.
- Magnetic Resonance Imaging.
- Ultrasound imaging.
- Hybrid imaging equipment. SPECT / TAC, PET / CT and PET / RMI.
- State of the art in medical imaging.
- DICOM medical image storage standard.
- Quality management in imaging equipment.
- Radiological safety.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

As an introductory course, this subject does not require specific knowledge of bioengineering. However, the course presents concepts that require some basic background in the fields of electronics, physics and mathematics.

COMPETENCES / LEARNING OUTCOMES

DESCRIPTION OF CONTENTS

1. Introduction

Topic 1. Introduction to diagnostic images
Basic concepts
Historical Introduction
The different modalities for diagnostic medical images

Topic 2: Physical Foundations of X-Rays
Fundamentals of RX
Production of RX
Formation of the radiological image
Risks associated with the use of ionizing radiations

2. X-ray images

Topic 2: Physical Foundations of X-Rays
Fundamentals of RX
Production of RXTopic 3: X-Ray Images
Analog Radiology
o Picture on film
o Image Intensifier
Digital Radiology
Computed Radiology
Indirect Flat Panel Digital Radiology
Direct flat panel digital radiology
Topic 4: Computed Axial Tomography
Data collection according to the type of equipment and reconstruction of slices.
Characteristics of the TAC image: CT numbers, Hounsfield units.

Topic 5: Picture Archiving and communication systems (PACS)
PACS architecture
DICOM format
Digital storage of medical images

3. Nuclear Medicine

Topic 6: Images in Nuclear Medicine
Radiopharmaceuticals: fundamentals and use.
Radiation detectors for imaging.
Counting statistics.
Basic imaging equipment: the gamma camera.
Single Photon Emission Computed Tomography: SPECT.
Positron emission tomography: PET.
Risks associated with the use of radioactive elements.
Topic 7: Dosage and risk
Radiation exposure and radiation dose
Estimated dose received
TAC dose reduction
Biological effects of radiation
Radiation protection
Radioactive activity meters

Topic 8: Magnetic Resonance Imaging
The phenomenon of nuclear magnetic resonance (NMR): physical background.
Generation and detection of the NMR signal.
Relaxation times.
Types of pulse sequences for generating the NMR image.
Image characteristics of NMR.

4. Magnetic Resonance Imaging

Topic 8: Magnetic Resonance Imaging
The phenomenon of nuclear magnetic resonance (NMR): physical background.
Generation and detection of the NMR signal.
NMR equipment.
Risks associated with the use of NMR

5. Ultrasound

Topic 9: ultrasound
Ultrasound production and detection equipment.
Types of 2D ultrasonic images: use of the Doppler effect.
3D and 4D ultrasonic imaging.
The echocardiograph.
Risks associated with the use of ultrasound.

6. Advanced concepts in medical imaging

Topic 10: State of the art in digital imaging
Dual energy TAC
Multi-slice PET / TOF (Time of Flight)
Molecular imaging
Topic 11: Fusion of medical images
Co-registration of image
Hybrid imaging equipment:
o PET-CT Equipment
o PET-RMI Equipment
o SPECT-CT Equipment

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	30,00
Classroom practices	15,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	10,00
Independent study and work	30,00
Preparation of lessons	35,00

Preparation for assessment activities	20,00
Resolution of case studies	5,00
Total hours	**100,00**

TEACHING METHODOLOGY

The course will follow the methodology of master classes; The classes will be supported by all existing audiovisual media, as presentations and multimedia documents, depending on the subject. Students will have prior to the class all the material that will be given in that class. As for the duration of these lectures, it is planned to distribute them in blocks of 2 hours.

During the course the students will be presented with a set of assignments, that the student can choose voluntarily, and develop in teams of 2 or 3 people. The assignment will be presented throughout the course, prior to the exam.

Combined with the theoretical classes, a series of practical classes will be developed in which the following tasks will be carried out: a) resolution of the problems described in the theoretical classes, b) demonstration of use of software for visualization of medical images, c) development of the assignments; In these classes the students will be able to solve any doubts that arise.

If possible, a visit to a hospital will be conducted within normal school hours to view various medical imaging equipment in actual use.

EVALUATION

The final grade of the subject will be obtained with the following computation: 30% corresponding to the note of the work done and 70% corresponding to the note of a written test that will consist of 5 questions. It will be necessary to get a minimum grade of 4 in the written test to pass the course. In the case the student do not present any assignment, the grade will correspond exclusively to the result of the exam, up to a maximum of 7 points.

REFERENCES

- Referencia b1: Fundamentals of Medical Imaging, Paul Suetens. Cambridge University Press Referencia b2: Introduction to Biomedical Imaging, Andrew Webb. John Wiley & Sons. Referencia b3: Computed Tomography, W. A. Kalender. Ed. Publicis Corporate Publishing

- Referencia c1: The Essential Physics of Medical Imaging, J.T. Bushberg, J.A. Seibert, E. M. Leidholt, JR., J. M. Boone. Ed. Lippincott Willians & Wilkins Referencia c2: "Biomedical Digital Signal Processing". W. J. Tompkins Ed. Prentice Hall Referencia c3: Texto referencia