COURSE DATA

Data Subject	
Code	44770
Name	Biomedical imaging techniques
Cycle	Master's degree
ECTS Credits	4.5
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
2231 - M.D. in Biomedical Engineering	Faculty of Medicine and Odontology	0	First term

Subject-matter

Degree	Subject-matter	Character
2231 - M.D. in Biomedical Engineering	15 - Bridging courses	Optional

Coordination

Name	Department
VILA FRANCES, JOAN	242 - Electronic Engineering

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.

OUTCOMES

LEARNING OUTCOMES

The main learning outcome is the understanding of the physical foundations and operating principles of the different medical imaging modalities. As a result of this knowledge, the student must know what uses are recommended for each modality of image, trading-off the advantages and disadvantages of each method.

As results of the learning in this subject the student must:

- Understand the operation of X-rays and their precautions for use.
- Know the use of radiopharmaceuticals to obtain functional images of the human body.
- Understand the operation of magnetic resonance imaging (MRI) devices and their use.
- Understand the operational fundaments of ultrasound.
- Know all medical imaging modalities and their combined use in hybrid equipment.

Skills to be acquired:

At the end of the course the student should be able to develop these skills:

- Concepts:
  - The student must understand the importance of medical images in the extraction of information relevant to medical diagnosis. After studying the subject, the student will know which image techniques are most appropriate according to the type of diagnosis to be made.
  - The physical foundations of each imaging technique and the peculiarities of the diagnostic information that allows obtaining each modality.
  - The fundamentals of the technology involved in the production and subsequent detection of the energy beams involved in each mode of imaging, both in the fields of chemistry, physics, electronics and engineering.
  - Practical:
    - Management of the mathematical methods involved in obtaining, reconstructing, displaying and storing the images in the different modalities.
- Attitude:
  - Ability to analyse the basic parameters of operation and control of the different modalities of obtaining images.

After having completed the subject, the student must have acquired a series of social skills, these social skills can be classified as instrumental, personal and systemic:

Instrumentals

- Capacity for critical analysis and synthesis.
- Ability to organize and plan.
- Appropriate use of scientific and technical terms.
- Ability to handle texts about medical images.
- Oral and written communication skills.
- Ability to manage information.
- Decision making.

Personal

- Ability to work in a multidisciplinary team.
- Ability to work in an international context.
- Ability to communicate with experts from other areas.
- Skills in interpersonal relationships.
- Critical thinking.
- Ethical commitment.

Systemic

- Ability to apply knowledge in practice.
- Ability to learn and work autonomously.
- Adapt to new situations.

Creativity. Ability to explore new solutions.

DESCRIPTION OF CONTENTS

1. Introduction

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

2. X-ray 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
Topic 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

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.
- Relaxation times.
- Types of pulse sequences for generating the NMR image.
- Image characteristics of NMR.
- 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

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Classroom practices	15,00	100
Development of group work	10,00	0
Study and independent work	20,00	0
Readings supplementary material	10,00	0
Preparation of evaluation activities	20,00	0
Preparing lectures	20,00	0
Preparation of practical classes and problem	15,00	0
Resolution of case studies	5,00	0
TOTAL	**145,00**	

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

Basic

- 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

Additional

- 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

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

English version is not available