VNIVERSITAT DE VALÈNCIA

Course Guide
43077 Imaging systems for medical diagnosis

COURSE DATA

Data Subject	
Code	43077
Name	Imaging systems for medical diagnosis
Cycle	Master's degree
ECTS Credits	5.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
2140 - M.D. in Medical Physics	Faculty of Physics	1	Second term

Subject-matter

Degree	Subject-matter	Character
2140 - M.D. in Medical Physics	3 - The physics of diagnosis and therapy	Obligatory

Coordination

Name	Department
CIBRIAN ORTIZ DE ANDA, ROSA MARIA	190 - Physiology

SUMMARY

The physical principles and technological developments associated with the main medical imaging techniques are presented. The agenda is divided between those that use biologically ionizing radiation and those that use non-ionizing radiation. Thus, in the first group, radiographic techniques are studied from conventional radiography, digital radiography, and CT, evaluating the reconstruction algorithms and the doses associated with these imaging techniques. Within this section, Nuclear Medicine imaging techniques are also analyzed, emphasizing PET, as it is one of the techniques with the greatest potential and current development, due to its interest in the functional analysis of the living organism. Techniques that use biologically non-ionizing radiation include thermography, ultrasound techniques, and nuclear magnetic resonance.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

No existen requisitios previos

OUTCOMES

2140 - M.D. in Medical Physics

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Be able to access the information required (databases, scientific articles, etc.) and to interpret and use it sensibly.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Be able to access to information tools in other areas of knowledge and use them properly.
- Use the different exhibition techniques oral, written, presentations, panels, etc., to communicate the knowledge, proposals and positions.
- Project the knowledge on specific problems and know how to summarize and extract the most relevant arguments and conclusions for their resolution.
- To acquire a critical attitude that allows you to make reasoned judgments and defend them with rigor and tolerance.
- Critically analyze both his/her work and that of the colleagues.
- Acceder a herramientas en el área de Física que puedan ser susceptibles de aplicación a la Medicina y valorar su aplicabilidad e interés.
- Planificar y gestionar la utilización de las técnicas físico-médicas teniendo en cuenta los principios básicos de control de calidad, prevención de riesgos, seguridad y sostenibilidad.
- Seleccionar la instrumentación apropiada para el estudio a realizar y aplicar sus conocimientos para utilizarla de manera correcta.

- Valorar el binomio riesgo-beneficio asociado a las técnicas físicas aplicadas al diagnóstico y la terapia, buscando optimizar el beneficio y minimizar el riesgo.

- Manejar los métodos matemáticos de procesamiento de señales para la obtención de las diferentes modalidades de imágenes.
- Relacionar el fundamento físico con cada técnica de adquisición de imágenes y distinguir las peculiaridades de la información diagnóstica que permite obtener cada modalidad.
- Distinguir las diferencias y similitudes de los métodos de procesamiento y análisis de imágenes de ayuda al diagnóstico.

- Manejar las técnicas básicas de control de calidad de las diferentes modalidades de obtención de imágenes.
- Utilizar los aspectos teóricos y prácticos del procesado de señales eléctricas para su uso en señales e imágenes biológicas.

- Elaborar una memoria clara y concisa de los resultados de su trabajo y de las conclusiones obtenidas.
- Saber redactar y preparar presentaciones para posteriormente exponerlas y defenderlas en público.

LEARNING OUTCOMES

At the end of the teaching-learning process, the student must be able to:

- Know and develop the physical principles of the main imaging methods in medical diagnosis: conventional X-ray radiology, Digital Radiology, Computerized Axial Tomography, Helicoidal and multi-slice tomography, Ultrasound Imaging, Thermography, Magnetic Resonance Imaging and Images in Nuclear Medicine.
- Understand the technology associated with different imaging techniques.
- Recognize the importance of functional studies in Nuclear Medicine
- Know the mathematical methods that allow to reconstruct images of cuts or 3D images
- Handle the basic and advanced image treatments, and the quality control methods of the different imaging techniques.

DESCRIPTION OF CONTENTS

1. Image quality

- Spatial resolution
Point, line and edge spreading function
The frequency domain: modulation transfer function
- Contrast resolution
Noise and its spectral distribution
noise contrast ratio

signal to noise ratio

2.
Radiological image

- Physical foundations of the conventional radiological image.
- Registration of the radiological image:
Conventional radiography.
Digital image registration systems.
Dynamic acquisition of images with X-rays
- Adaptation of systems to clinical application:
General radiology. Mammography. Interventional radiology. Dental equipment (intraoral and orthopantomography). Bone densitometry
- Quality control in radiological imaging systems.

3. CT images

TAC fundamentals: generations
Reconstruction of cuts: image treatment.
Helical CT and multislice CT
ConeBeam

4. Imaging in Nuclear Medicine

Introduction to nuclear medicine. Functional imaging
- What is nuclear medicine? Functional vs. anatomical imaging
- Radionuclides
- Radiological characteristics of tracers
- Production of radionuclides: generators and preparation of radiopharmaceuticals.
Applications of unencapsulated sources in a nuclear medicine service.
- Nuclear medicine studies
- Techniques and equipment
- Diagnostic applications
- Therapeutic applications
Instrumentation in nuclear medicine
- Activimeters
- Gamma camera and spect
- Pet and hybrid equipment
- New generations
Quality control in nuclear medicine
- Legal bases: royal decrees and national protocols.
- Quality control in nuclear medicine: tests, material, periodicity and tolerances.
- International standards

5. Ultrasonographic images

Physical properties of US: Interaction with matter,
US generation and detection: US transducers, beam properties
Therapeutic applications of the US
Diagnostic applications I: Generalities, principle of ultrasound
Diagnostic applications II: B, TM, Doppler, Doppler Duplex and 3D ultrasound.

6. Nuclear magnetic resonance

Basis of Nuclear Magnetic Resonance (NMR).
NMR technique: RF excitation and signal detection
NMR signal. Characteristic parameters: Phase cycles. Field gradients, relaxation and T1 and T2 times
Applications of MRI in Medicine: Applicability of T1 and T2 weighted images, Contrast elements in the MRI image

8. Practical sessions

1- Obtaining and evaluating thermographic images Fac. Medicine
2.- Numerical exercises of Thermography and US
3.- Clinical application of ultrasound: echocardiographic study at the Clinical Hospital.
4- Image in Nuclear Medicine. ASCIRES
5.- Instrumentation in Molecular Image and US. i3M: institute of instrumentation for molecular imaging (CSIC-UPV)
6- IRIS. IFIMED
7.- Visit MICROPET-TAC. UCIM.
8.- Practical visit to the NMR. IVO

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Development of group work	4,00	0
Development of individual work	4,00	0
Study and independent work	25,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	10,00	0
Resolution of case studies	7,00	0

TOTAL	**125,00**

TEACHING METHODOLOGY

MD1 - Theoretical classes of master class recorded and visualized via on-line.

MD2 - Laboratory practical classes. MD3 - Videoconferences of problem classes.

MD4 - Videoconferences from subject experts.

MD5 - Videoconferences to resolve doubts about the issues

EVALUATION

- Written exam on the contents developed in the theoretical and practical classes of the subject. 60%
  - 4 Reasoning questions (4 points) 10 test questions (2 points)
- Evaluation of written memories of practices and problems 40%

REFERENCES

Basic

- Scientific Basis of Medical Imaging. Edited by P.N.T.Wells. Ed. Longman Group Limited 1982
- Fundamentos de Física para profesionales de la Salud. Alberto Najera, Enrique Arribas, Juan de Dios Navarro, Lydia Jiménez. Ed. Elsevier 2015 (Disponible en formato electrónico en la biblioteca)