COURSE DATA

DATA SUBJECT

Code: 43077
Name: Imaging systems for medical diagnosis
Cycle: Master's Degree
ECTS Credits: 5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2140 - Master's Degree in Medical Physics	Facultat de Física	1	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2140 - Master's Degree in Medical Physics	The physics of diagnosis and therapy	COMPULSORY

COORDINATION

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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

COMPETENCES / LEARNING OUTCOMES

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Acceder a herramientas en el área de Física que puedan ser susceptibles de aplicación a la Medicina y valorar su aplicabilidad e interés.

Be able to access the information required (databases, scientific articles, etc.) and to interpret and use it sensibly.

Be able to access to information tools in other areas of knowledge and use them properly.

Critically analyze both his/her work and that of the colleagues.

Distinguir las diferencias y similitudes de los métodos de procesamiento y análisis de imágenes de ayuda al diagnóstico.

Elaborar una memoria clara y concisa de los resultados de su trabajo y de las conclusiones obtenidas.

Manejar las técnicas básicas de control de calidad de las diferentes modalidades de obtención de imágenes.

Manejar los métodos matemáticos de procesamiento de señales para la obtención de las diferentes modalidades de imágenes.

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.

Project the knowledge on specific problems and know how to summarize and extract the most relevant arguments and conclusions for their resolution.

Relacionar el fundamento físico con cada técnica de adquisición de imágenes y distinguir las peculiaridades de la información diagnóstica que permite obtener cada modalidad.

Saber redactar y preparar presentaciones para posteriormente exponerlas y defenderlas en público.

Seleccionar la instrumentación apropiada para el estudio a realizar y aplicar sus conocimientos para utilizarla de manera correcta.

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.

Students should possess and understand foundational knowledge that enables original thinking and research in the field.

To acquire a critical attitude that allows you to make reasoned judgments and defend them with rigor and tolerance.

Use the different exhibition techniques oral, written, presentations, panels, etc., to communicate the knowledge, proposals and positions.

Utilizar los aspectos teóricos y prácticos del procesado de señales eléctricas para su uso en señales e imágenes biológicas.

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

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

1. Introduction
- What is nuclear medicine?
- Radiotracers: Use and production
- Anatomical VS functional imaging
2. Diagnosis in Nuclear Medicine
- Equipment in NM: Activimeters, SPECT/CT, PET/CT/MRI, advances and new developments.
- Quality control
3. Therapy in nuclear medicine
- Radiopharmaceuticals and treatments in NM
- Dosimetry in radioisotope therapy
- Waste management

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 detectionNMR technique: RF excitation and signal detection
- TNMR 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
- Functional magnetic resonance imaging.

7. Use of PACS and the DICOM Format in Healthcare

¿ Definició i generalitats.
¿ Sistema d¿emmagatzematge d¿imatges: PACS
¿ Format DICOM, com a format d¿informació en Medicina

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

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	30,00
Laboratory	20,00
Total hours	**50,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	8,00
Independent study and work	30,00
Preparation of lessons	20,00
Preparation for assessment activities	10,00
Resolution of case studies	7,00
Total hours	**75,00**

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

Attendance at face-to-face practical sessions is mandatory in order to pass the subject, both in the first and second exam periods.

First and second exam period:

- Written exam covering the content taught in both theoretical and practical sessions. **60%**
  Exam: 4 short reasoning questions (4 points) and 10 multiple-choice questions (2 points)

- Evaluation of practical and problem-solving reports and active participation in theoretical and practical classes **40%**

The minimum grade required in the written exam to be averaged with the practicals is **2 out of 6**.

The minimum passing grade is 5.

Evidence of copying or plagiarism will result in failure to pass the subject and in appropriate disciplinary action being taken. Please note that, in accordance with article 13. d) of the Statute of the University Student (RD 1791/2010, of 30 December), it is the duty of students to refrain from using or participating in dishonest means in assessment tests, assignments or university official documents.

In the event of fraudulent practices, the **Action Protocol for fraudulent practices at the University of Valencia** will be applied (ACGUV 123/2020):

https://www.uv.es/sgeneral/Protocols/C83sp.pdf

REFERENCES

- 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 (Available in electronic format at the library)
- Basics of Image Processing : The Facts and Challenges of Data Harmonization to Improve Radiomics Reproducibility. A¿ngel Alberich-Bayarri and Fuensanta Bellvi¿s-Bataller, editors. Cham, Switzerland : Springer Nature Switzerland AG, [2023] (Available in electronic format at the library)