COURSE DATA

Data Subject	
Code	43076
Name	Information and communication technology
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	First term

Subject-matter

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

Coordination

Name	Department
GONZALEZ MILLAN, VICENTE	242 - Electronic Engineering
VILA FRANCES, JOAN	242 - Electronic Engineering

SUMMARY

This subject is divided into two blocks: the first deals with electronic technology for radiation detectors, and the second describes the principles of scientific programming.

In the first block, basic analog and digital circuits are studied, as well as signal conditioning for the most used transducers in radiation detectors. The basic conditioning elements are presented: load preamplifiers, RC-CR filters operating as shapers and the 1-bit digitization stages (leading-edge discriminators and constant fraction discriminators) and multilevel.

Finally, time reference circuits, mean-timers and TDCs are analyzed. This block has a practical part in which some of the circuits studied are shown.

The second block of the course introduces the principles of scientific programming using the Python language. With this programming language it is possible to perform statistical analysis on a set of data obtained in a scientific experiment, to represent graphs or to process medical images to extract the most relevant information, among others. First, the basics of Python programming (semantics, data types, control statements) are introduced. Next, the handling of advanced data structures is described, and then applied to the creation of graphics, statistical analysis, and digital image processing, introducing the necessary packages.

This block introduces the basic concepts that the student must understand to satisfactorily approach the subject of Medical Diagnostic Imaging Systems, where the acquisition and characteristics of each medical imaging modality are explained in depth.

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.
- 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.
- Manejar los métodos matemáticos de procesamiento de señales para la obtención de las diferentes modalidades de imágenes.
- 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.
- Manejar la instrumentación básica en un laboratorio de electrónica de comunicaciones.
- Utilizar generadores de pulsos y analizadores de espectros y aplicarlos a la visualización de señales.
- Realizar medidas de señales en el dominio frecuencial con el analizador de espectros.
- Realizar la simulación de un sistema de comunicación de datos.
- 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

After studying the subject, the student should be able to:

Translate signals between the time or space domain and its equivalent frequency domain.

Explain the principles analogue and digital electronics and the use of signal conditioning circuits.

Design basic digital filters in one and two dimensions, and predict their effects.

Know the basics of Digital Image Processing and its application to data interpretation.

Manage digital tools for advanced image processing

Apply image filter in the spatial and frequency domain.

DESCRIPTION OF CONTENTS

1. Radiation detection electronics

Time and frequency domain signals. Signals in Nuclear Physics
Electronics for analogue signal processing: pulse selection, matching techniques and methods for measurement of time intervals

2. Basic electronics

This subject describes the basic circuits of analog and digital electronics, including semiconductor components, operational amplifiers, oscillators, logic gates, combinational circuits, sequences and timing.

3. Fundamentals of Python programming

Introduction to object-oriented programming. Python language: semantics, data types, control sequencies, functions

4. Data structures

NumPy and Pandas libraries. Arrays and matrix operations with numPy. Use of Series and DataFrames with Pandas.

5. Graphics

Graphic libraries. Generation of univariable and multivariable graphs.

6. Statistical analysis

Introduction to probability. Estimation of statistics. Hypothesis testing.

7. Digital image processing

Image processing libraries. Load and visualization of images. Intensity processing. Spatial processing.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Development of individual work	15,00	0
Study and independent work	10,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	15,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	15,00	0
TOTAL	**125,00**	

TEACHING METHODOLOGY

In the first part of the subject, we will introduce the radiation detectors technology with theoretical lectures with the support of media materials. This part will be completed by the realization of two practical sessions in an electronics laboratory.

The scientific programming techniques will be introduced with lectures supported by slideshows and online computer demonstrations using Python. The lectures will be complemented by a practical part, consisting of the realization of a series of guided exercises using the Python programming language.

EVALUATION

Students' knowledge will be assessed by conducting a written exam regarding the concepts explained in the lectures (75% of the final mark) and an evaluation of the laboratory sessions (25% of the final mark). It will be necessary to achieve a minimum value of 4 over 10 in each one of the parts for averaging.

It will be necessary to obtain a minimum grade of 4 out of 10 in each part of each of the tests in order to average.In the second call, the grade of each part (exam or laboratory) passed in the first call (grade equal or higher than 5) will be maintained.

REFERENCES

Basic

- Leo, Techniques for Nuclear and Particle Experiments. Springer-Verlag
- Knoll, Radiation Detection and Measurements. Wiley
- Horowitz. The art of Electronics. Cambridge
- Jake VanderPlas, Python Data Science Handbook. O'Reilly Media, Inc. ISBN: 9781491912058
- Wes McKinney, Python for Data Analysis, 2nd Edition. O'Reilly Media, Inc. ISBN: 9781491957660
- Ravishankar Chityala and Sridevi Pudipeddi, Image Processing And Acquisition Using Python. Chapman & Hall/CRC Press. ISBN: 9780367198084

Additional

- Suetens. Fundamentals of Medical Imaging. Cambridge University Press
- Birkfellner. Applied Medical Image Processing. CRC Press