Electronic circuits and optics for clinical engineering

Academic Year: (2023 / 2024) **Review date: 21-04-2023**

Department assigned to the subject: Bioengineering Department, Electronic Technology Department

Coordinating teacher: HERNANDEZ CORPORALES, LUIS

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Phsycs, Electronic technology in biomedicine, Measuring Instrumentation

OBJECTIVES

COMPETENCES THAT THE STUDENT ACQUIRES WITH THIS MATTER
CB6 Possess and understand knowledge that provides a base or opportunity to be original in the development and / or application of ideas
CB7 That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of ¿¿study
CB9 That students know how to communicate their conclusions and the technical knowledge and the ultimate reasons that sustain them to specialized and non-specialized audiences in a clear and unambiguous way
CG1 Ability to learn new methods and technologies, from the domain of scientific and special techniques of Clinical Engineering, as well as for new situations.
CE2 Ability to understand and use advanced statistical methods for conducting scientific studies, evaluating equipment from the point of view of the effectiveness of the practice, accreditation for medical use or the study of comparative effects in patients.
CE4 Ability to evaluate the functioning of electromedical systems by analyzing complex data from the control / electronic / mechanical subsystems involved.

LEARNING RESULTS THAT THE STUDENT ACQUIRES
After studyng this matter, students may be able to:
- Describe the bases of maintenance and repair of electrical equipment in the hospital environment.
- Understand and design analogue and digital electronic systems with special emphasis on aspects related to the design of biomedical instrumentation.
- Cite and use the electronic components used in the development of biomedical instrumentation.
- Identify the most characteristic circuits and the most extensive applications related to biomedical instrumentation.
- Manage electronic instrumentation equipment and perform measurements with them.
- Apply visual and electrical visualization and visualization techniques, describe equipment and analyze the procedures used.
- Determine the characteristics and applications of type analog circuits, identifying their functional blocks and analyzing the interrelation of their components.
- Determine the structure of instrumentation circuits, identifying their application and analyzing the interrelation of their components.
- Verify the operation of electronic and optical circuits, interpret diagrams and apply visualization techniques.

DESCRIPTION OF CONTENTS: PROGRAMME

This course provides knowledge about the purpose and operation of analog and digital electronic systems, as well as optical systems, with special emphasis on the aspects related to the design of biomedical instrumentation. The laboratory practices will allow to know and use the electronic components used in the development of biomedical instrumentation and to gain experience in the handling of basic electronic instrumentation equipment.
The subject is divided into three thematic blocks:

Block I Analog Subsystems (2 ECTS)
Topic I.1 Amplifiers for medical instrumentation
I.1.1 Review of basic circuits with operational amplifiers
I.1.2 Instrumentation amplifiers

I.1.3 Isolation amplifiers
I.1.4 Noise in amplifier circuits
Topic I.2 Frequency response of amplifiers. Filters and Oscillators
I.2.1 Definition of bandwidth and cutoff frequencies of an amplifier
I.2.2 Filters active in continuous time
I.2.3 Oscillators
Topic I.4 Power amplifiers and power converters
I.3.1 Linear power amplifiers
I.3.2 Switching amplifiers in class D
I.3.3 Linear power supplies
I.3.4 DC / DC converters
Topic I.5 Data converters
I.4.1 Basic definitions on data conversion
I.4.2 Digital / Analog Converters
I.4.3 Analog / Digital Converters
I.4.4 Sigma-Delta Converters
Block II Digital Subsystems (2 ECTS)
Topic II.1 Embedded systems
II.1.1 General architecture of a recessed system
II.1.2 Types of embedded systems
II.1.3 Microcontrollers
II.1.4 Peripherals
II.1.5 Examples of biomedical application
Topic II.2 Capture and generation of signals
II.2.1 General purpose inputs and outputs (GPIO)
II.2.2 Interruptions
II.2.3 Timers
II.2.4 Generation of timed signals
II.2.5 Capture of timed signals
Topic II.3 Interfaces
II.3.1 Parallel interfaces
II.3.2 Serial interfaces
II.3.3 Interfaces with A / D and D / A conversion circuits
Block III: Optical subsystems (2 ECTS)
III.1 Basic components of optical measurement circuits
III.2 Laser and photonic detector technology.
III.3 Optical systems of analysis in laboratories and hospitals (ELISA, FACS, etc).
III.4 Advanced systems of optical microscopy (confocal, multiphoton, flat laser beam microscopy, optical coherence tomography, etc.).

LEARNING ACTIVITIES AND METHODOLOGY

TRAINING ACTIVITIES OF THE SYLLABUS REFERRED TO SUBJECTS
AF1 Theoretical class
AF2 Practical classes
AF3 Theoretical and practical classes
AF4 Laboratory practicals
AF5 Tutorials
AF6 Group work
AF7 Individual student work
AF9 On-site evaluation tests

Activity	# total hours	# classroom hours	% Student attendance
AF1	75	75	100%
AF2	6	6	100%
AF3	10	10	100%
AF4	14	14	100%
AF5	15	3	20%
AF6	60	0	0
AF7	262	0	0
AF9	8	8	100%
TOTAL SUBJECT	450	116	25.77%

TEACHING METHODOLOGIES TO BE USED IN THIS COURSE

MD1 In-class lectures by the professor with the support of computer and audiovisual media, in which

the main concepts of the subject are developed. and the bibliography is provided to complement the students' learning.
MD3 Resolution of practical cases, problems, etc. posed by the teacher individually or in group.
MD5 Preparation of papers and reports individually or in groups.

ASSESSMENT SYSTEM

ASSESSMENT SYSTEMS OF THE CURRICULUM REFERRED TO SUBJECTS
SE2 Individual or group work carried out during the course
SE3 Final exam
System of
evaluation Minimum weight (%) Maximum weight (%)
SE2 30% 30%
SE3 70% 70%

The grade for the course will be divided into Theory and Laboratory. The theory mark will correspond to the qualification of the exam of the subject with a weight of 70%. The laboratory grade will be obtained from the evaluation of the laboratory practice work and will have a weight of 30% of the subject.

The final grade for students who attend the extraordinary call may be:
(1) 70% of the extraordinary exam and 30% of the laboratory of the continuous evaluation.
(2) 100% of the extraordinary exam.

% end-of-term-examination:	70
% of continuous assessment (assigments, laboratory, practicals…):	30

BASIC BIBLIOGRAPHY

- Adel S. Sedra Kenneth Carless Smith Circuitos Microelectronicos, Mc Graw Hill, 2006
- David Boas, Constantinos Pitris and Nimmi Ramanujam Handbook of Biomedical Optics, CRC press, 2011
- Miguel Angel Perez Garcia Instrumentacion Electronica, Paraninfo, 2014
- Renk, Karl F. Basics of Laser Physics For Students of Science and Engineering, Springer, 2017
- Wang, K.C.. Embedded and Real-Time Operating Systems, Springer, 2017