

Academic Year: ( 2021 / 2022 )

Review date: 07-07-2021

Department assigned to the subject: Bioengineering and Aerospace Engineering Department

Coordinating teacher: GOMEZ CID, LIDIA

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

**REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)**

Mandatory:

- Introduction to the design of biomedical instrumentation
- Electronic technology in biomedicine
- Measuring Instrumentation
- Systems and Signals
- Control Engineering

Recomended

- Physics I, II and III
- Differential Equations
- Robotics

**OBJECTIVES**

This is a project-based course in which the student will acquire a comprehensive understanding of the design of medical, surgical and interventional instrumentation. The students will have to apply their previous knowledge (electronics, signal processing, physiology, fluid mechanics, biochemistry, etc.) to design and build and validate functional medical devices that will be introduced during the course.

The lectures and seminars will serve to guide the construction of the instrumenst, and this will be done by means of different examples introduced in the guided practices.

**DESCRIPTION OF CONTENTS: PROGRAMME**

The program will cover descriptions, analysis and study cases related to medical devices, instruments and signal processing for application like the ECG and the EEG, light sensors for biomedical instrumentation, advanced electronics for laboratory instrumentation, diagnose and therapy, prosthesis, image-assisted treatment and therapy monitoring in real time, mathematical and computational models to aid diagnosis and to assist surgical devices with real time control and expert systems for image guided interventions among other. This is the specific syllabus implementation:

1. Introduction
2. Applications in Cardiology
  - a. ECG basic electronics
  - b. ECG signal processing fundamentals
  - c. ECG monitor design
3. Radiation Detectors and semiconductor light detectors
  - a. Semiconductor light detectors
  - b. Radiation detectors
  - c. Radiation Detectors Signal Procesing
  - d. Pulseoximetry
4. Image Guided Interventions
  - a. Image Guided Interventions and tracking systems
  - b. Patient to image registration
  - c. Point-based Rigid registration
5. Therapeutic devices: Radiotherapy
  - a. Intro to External Radiotherapy
  - b. Radiotherapy
  - c. Linear Accelerator

6. Surgical Robots
  - a. Computer- and robot-assisted medical interventions
  - b. Review of surgical robots for spinal interventions
7. Monitoring and respirators
8. Application in Neurology
  - a. EEG
  - b. EEG analysis
  - c. Myoelectric prosthesis
9. Hearing aids and cochlear implants
  - a. Hearing aids
  - b. Cochlear implants
  - c. Audio Processing
  - d. Speech Processing
10. Final system design
11. Laboratory Practices
  - a. Serial Port
  - b. Biological Signal Acquisition
  - c. User Interface Design
  - d. Pulseoximetry
  - e. Image Guided Interventions
  - f. EEG
  - g. EMG

## LEARNING ACTIVITIES AND METHODOLOGY

This is a project-based course in which the student has to deal with medical devices that will be tested and evaluated. To support the project design, the teaching methodology will be mainly based on lectures that will introduce the fundamental concepts, seminars where the device design will be analysed, and practical sessions in the laboratory. Students are required to read assigned documentation before lectures and seminars. Lectures will be used by the teachers to stress and clarify some difficult or interesting points from the corresponding lesson. Seminars will be mainly dedicated to interactive discussion with the students and short-exams will be passed during these sessions. Tutorship regime will be announced in Aula Global.

## ASSESSMENT SYSTEM

CONTINUOUS EVALUATION ASSESSMENT: 65% of the final mark, includes:

- 1) Partial exam (35% of the final mark): This exam will take place in a lecture session and will cover approximately half of the programme. If the grade is  $\geq 4.0$ , the students do not need to take the exam on this part in the final.
- 2) Practical sessions (15% of the final mark): They will be assessed through a questionnaire at the end of the practical sessions. Attendance to at least 80% of the practical sessions is mandatory; otherwise the score will be 0 in this item.
- 3) Exercises in class (10% of the final mark): It includes exercises and quizzes to be solved in class about previous lectures/seminars
- 4) Final project presentation (5% of the final mark)

Attendance to lectures, short-exams or submission of possible homework is not compulsory. However, failure to attend any exam or submit the exercises before the deadline will result in a mark of 0 in the corresponding continuous evaluation block.

Final exam: The final exam will cover the second part of the programme and will account for 35% of the final score. Additionally, the students will have another opportunity to pass the exam on the first half. The minimum score in the final exam to pass the subject is 4.0 over 10, notwithstanding the mark obtained in continuous evaluation.

Extraordinary exams: The mark for students attending any extraordinary examination will be the maximum between:

- a) 100% extraordinary exam mark, or
- b) 60% extraordinary exam mark and 40% continuous evaluation if it is available in the same course.

Academic conduct: All exams will be closed-book, closed-notes, no PC or mobile phone, or anything else other than a writing implement and the exam itself. Plagiarism, cheating or other acts of academic dishonesty will not be tolerated.

<b>% end-of-term-examination:</b>	35
<b>% of continuous assessment (assignments, laboratory, practicals...):</b>	65

#### BASIC BIBLIOGRAPHY

- J.G. Webster Principles of Applied Biomedical Instrumentation, John Wiley and Sons, Inc., 2009
- Leif Sörnmo, Pablo Laguna BIOELECTRICAL SIGNAL PROCESSING IN CARDIAC AND NEUROLOGICAL APPLICATIONS, Elsevier Academic Press, 2005

#### ADDITIONAL BIBLIOGRAPHY

- G.D. Baura Medical Device Technologies, Academic Press, 2012
- Glenn F. Knoll Radiation Detection and Measurement, Fourth Edition, Wiley, 2014
- Robert B. Northrop Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation, CRC Press, 2012