Medical instrumentation and devices

Academic Year: (2019 / 2020) **Review date: 08/06/2018 16:33:18**

Department assigned to the subject: Bioengineering and Aeroespace Engineering Department

Coordinating teacher: VAQUERO LOPEZ, JUAN JOSE

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 a functional medical devices from the several ones that will be introduced during the course.
The lectures and seminars will serve to guide the construction of the instrument, and this will be done by means of different examples introduced in the guided practices.
The resulting functional medical device evaluation will have a high impact in the final mark.

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
   a. Biomedical instrumentation
   b. PoC for primary care review
   c. Radiation Detectors and semiconductor light detectors
2. Applications in Cardiology
   a. ECG basic electronics
   b. ECG signal processing fundamentals
   c. ECG monitor design
3. Application in Neurology
   a. EEG
   b. EEG analysis

c. Brain hacking
4. Hearing aids
   a. Hearing aids
   b. Cochlear implants
   c. Audio Processing
   d. Speech Processing
5. Monitoring and respirators
   a. Pulsioxymetry
   b. Respirators
6. Image Guided Interventions
   a. Image Guided Interventions and tracking systems
   b. Patient to image registration
   c. Point-based Rigid registration
7. Therapeutic devices: Radiotherapy
   a. Intro to External Radiotherapy
   b. Radiotherapy
   c. Linear Accelerator
8. Surgical Robots
   a. Computer- and robot-assisted medical interventions
   b. Review of surgical robots for spinal interventions
9. Laboratory Practices
   a. ECG Processing using Matlab: ECG data analysis,
      ECG acquisition with the NI environment ECG signal processing
   b. Radiation detector
   c. Image Guided Interventions
10. Final system design

LEARNING ACTIVITIES AND METHODOLOGY

This is a project-based course in which the student has to build a medical device 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

% end-of-term-examination/test:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

Grading will be based on continuous evaluation (including short-exams, practical sessions, and student participation in class and Aula Global) and a final exam covering the whole subject. Help sessions and tutorial classes will be held prior to the final exam.
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.
The practical sessions may consist on laboratory work or visits to research or clinical centers. A laboratory report will be required for each of them. The attendance to practical sessions is mandatory. Failure to hand in the laboratory reports on time or unjustified lack of attendance will result in 0 marking for that continuous evaluation block.

Continuous evaluation
It accounts for up to 60% of the final score of the subject, and includes three components:
1) Short-exams (15% of the final mark): These exams will take place mostly during seminars, and will be announced at least one week in advance. Results of these exams will constitute the core of the continuous evaluation. It includes contribution to seminars, forum in Aula Global, attitude, homework (quizzes or exercises to be solved in groups or individually).
2) Practical sessions (40% of the final mark): They will be assessed through a laboratory notebook, laboratory reports and/or questionnaires that will be handed in at the end of each practical session. Attendance to at least 80% of the practical sessions is mandatory; otherwise the score will be 0 in this item.
3) Student participation (5% of the final mark): Active participación in seminars, laboratories or other

% end-of-term-examination/test:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

activities.

Final exam
The final exam will cover the whole subject and will account 40 % of the final score. 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) 40% extraordinary exam mark and 60% 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. Any infractions whatsoever will result in a failing grade.

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