Universidad Zaragoza

Year : 2019/20

60938 - Biomedical signal processing

Syllabus Information

Academic Year: 2019/20
Subject: 60938 - Biomedical signal processing
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 533 - Master's Degree in Telecommunications Engineering
ECTS: 5.0
Year: 2
Semester: First semester
Subject Type: Optional
Module: ---

1.General information

1.1.Aims of the course

The subject and its expected results respond to the following approaches and objectives:

In the course "Treatment of Biomedical Signals" students will have understood the electrical origins of bioelectrical signals, and the relation of the different types of signals on the surface of the body (ECG, EEG, EP, EMG). Always with the clinical objectives in mind, in this subject, signal processing techniques are presented for both detection and estimation in each application domain.

We introduce the optimal estimators, and particularization of adaptive filtering, orthogonal representations and time frequency methods in each application domain. The subject should lead the student to know a range of techniques of processing, particularly statistical, biomedical signals, and be able to use them to obtain clinical information of the signals, taking into account the particularities of each case and type of signal, as well as The possibilities and limitations of such techniques.

Consequently, the overall objective of the subject is for the student to understand and know how to use a set of signal processing tools to extract clinically useful information from the different types of biomedical signals.

1.2.Context and importance of this course in the degree

The Degree in Telecommunications Engineering aims, in addition to giving the fundamentals, positioning the tools of information and communication treatment in the context of their applications. In the context of this subject the application is the biomedical field, with applications for both diagnosis, therapies, interventions, follow-ups, etc. For this, an important part of the Engineering tries to exploit to the maximum the different sources of information that emanate of the alive systems to take, based on her, to take subsequent actions and / or decisions. Biomedical signals, and more specifically bio-electric, are a rich source of information about the organs or systems that generate them (cardiac, neurological, etc.). This subject puts at the service of professionals both deterministic techniques and statistics of treatment and detection of events in discrete signals, for use on biomedical signals in biomedical contexts where these signals may have some interest

1.3.Recommendations to take this course

The teachers responsible for teaching are in the area of Signal Theory and Communications.

This elective course of the spring semester requires both basic and advanced signal processing skills that have typically been obtained in the following grade: Digital signal processing; Applications of digital signal processing, Signal and communications laboratory, or in some obligatory subject of the Master as, Signal processing for communications.

2.Learning goals

2.1.Competences

By passing the course, the student will be more competent to ...

CE15: Capacity for the integration of Telecommunication Engineering technologies and systems, in general, and in broader and multidisciplinary contexts such as bioengineering, photovoltaic conversion, nanotechnology, telemedicine.

CB7: Students will be able to apply acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of ??study

CG1: Ability to project, calculate and design products, processes and facilities in all areas of telecommunication engineering.

CG4: Capacity for mathematical modeling, calculation and simulation in technological centers and engineering of company, particularly in research, development and innovation tasks in all fields related to Telecommunication Engineering and related multidisciplinary fields.

CG7: Capacity for the start-up, management and management of manufacturing processes of electronic and telecommunications equipment, with guarantee of the safety for people and goods, the final quality of the products and their homologation.

CG11: Ability to communicate (oral and written) the conclusions - and the ultimate knowledge and reasons that support them - to specialized and non-specialized audiences in a clear and unambiguous way.

CG12: Possess continuous, self-directed and autonomous learning skills.

2.2.Learning goals

The student, to overcome this subject, must demonstrate the following results ...

R1. Be able to design a biomedical signal conditioning system, taking into account the characteristics of those signals and the requirements of the subsequent processing, with the restrictions that it imposes not to deform the useful information present in the signals.

R2. To be able to solve problems of detection or estimation of clinical parameters of interest, posing them optimally within the framework of the theory of detection / estimation. Particularly in the field of Electrocardiology, Electroencephalography and Electromyography.

R3. To be able to interpret the sources of temporal and spatial information for the design of systems of information compaction, either with the aim of compression and communication, or with the aim of classification / monitoring and decision making with respect to the underlying system (diagnosis / therapy).

R4. Be able to extrapolate concepts of signal processing to the biomedical context, interpreting spatial and temporal mixtures / separations of sources, non-uniform sampling, time-varying systems, extraction and interpretation of static and dynamic information, etc.

2.3.Importance of learning goals

The ability to interpret signals of bioelectric origin, design signal quality improvement systems, model them and apply the estimation and detection techniques studied are relevant for a Telecommunications Engineer working in Biomedical applications, since it is expected With problems of acquisition, filtering, interpretation, automation in a large number of contexts in diagnostic, therapeutic, monitoring, etc. environments.

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate that he / she has achieved the expected learning outcomes through the following assessment activities

E1: Presentations and oral debates

- Students should prepare during the course the presentation of specific topics, or the resolution of specially selected exercises, which will be presented orally to the class as a whole. The evaluation of this activity supposes 10% of the final note of asignatura.

E2: Tutored works

- Tutored works represent 50% of the final grade. The qualification will assess the student's analytical and critical ability to study a problem or specific aspects in a biomedical signal treatment application, making use of the theoretical and practical tools learned in the subject. In addition, the originality of the solutions, the ability to work in a group, the ability to coordinate the work and to communicate relevant information in an oral and written form will be evaluated, as the work done will be presented through a common report to the group and Of an oral presentation.

E3: Final examination

- The final exam will consist of a written test that represents 40% of the final grade. The test is divided into two parts:
    - - E3.1: Theoretical-practical issues:
    - - E3.2: Practical problems:

The student must obtain a grade of at least 4 out of 10 in the final exam grade (E3) to pass the subject.

The student will have an overall test in each of the calls established throughout the course. The dates and times of the tests will be determined by the School.

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The methodology followed in this course is oriented towards achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as

- **M1 Participatory Lectures** (36 hours). Presentation of the main course contents combined with the active participation of students. This activity will take place in the classroom. This activity will take place in the classroom. This methodology, supported by the the student's autonomous work (M14) is designed to provide the students with the necessary theoretical aspects of the course.
- **M4 Practice sessions** (10 hours). Sessions of problem-solving and practical cases proposed by the teacher, related to the lectures. It is expected that the students will present individually or in groups their results. This public presentation will take place in the classroom.
- **M9 Lab sessions** (4 hours). 2 sessions of 2 hours each will be held in the Signals and Systems Laboratory Building 2.02 Ada Byron. This activity will be done in small groups, with the aim to consolidate the theoretical concepts of biomedical signal acquisition developed in the lectures.
- **M13 Guided assignment** (20 hours). In groups, students will prepare a practical case, guided by the teacher and based on the course contents.
- **M14 Autonomous work and study** (52 hours). Individual study related to the lectures' contents and the course (exams, library-related work, further reading, problem and exercise solving, etc.).
- **M10 Tutorials.** Teacher's office hours aimed at answering doubts, and reviewing and discussing the materials and topics presented in both lectures and practice sessions.
- **M11 Assessment**. (3 hours). The student's progress is evaluated with theoretical and practical written tests.

Students are expected to attend and participate actively in the class throughout the semester.

4.2.Learning tasks

The course includes the following learning tasks:

- **Lectures**. Sessions introducing the concepts, the physiological basis of each signal type and the objectives of their study including the particularities, or new signal processing developments, required in these contexts.
- **Problem-solving tasks** given to the student individually, which after completion, are presented by the student to the class.
- **Laboratory sessions**. Sessions where students practice some of the applications presented in class. It takes place in the computer room. Students will submit a written report containing the main findings of the work done.
- **Guided assignment**. Individually or preferably in groups, students prepare a case study with actual data and develop its appropriate application with a specific clinical purpose.
  - It consists on the understanding, preparation and implementation of parts of a biomedical signal processing system proposed by the teacher.
  - It will be assessed by a written report and an oral presentation.

4.3.Syllabus

The course will address the following topics:

Topic 1. Introduction to the biological signals origin, types of signals, characteristics and objectives that ICT can afford in this context.

Topic 2. Electrocardiogram (ECG): Description, parameters of clinical interest, interpretation; Event detection (beats); interference cancellation; analysis of heart rate variability; averaged of recurrent signals; Data compression and time-variant analysis (time-frequency representations); invasive signals (electrograms), their use and singularities.

Topic 3. Electroencephalogram (EEG): Interpretation and clinical information, frequency bands; cancellation of artifacts; spectral estimation; Analysis of evoked potentials (visual, auditory, etc.).

Topic 4. Electromyogram (EMG): Origin and interpretation; parameters of interest and best estimate; applications.

Topic 5. Other biomedical signals: Photoplestimograma (PPG), blood pressure (BP); Their interactions and physiological implications; relations estimates (causality, correlations, etc) Multimodal (different types of signals) of clinical parameters.

4.4.Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the EINA website.

The subject is taught in spring semester. Among the main activities planned are the presentation of theoretical contents, problem solving and problem solving, laboratory practice and practical tutorial work related to the contents of the subject.

The dates of beginning and end of the theoretical classes and problems, as well as the dates of accomplishment of laboratory practices and the tests of global evaluation will be those fixed by the School of Engineering and Architecture and published in the web page of the school Https://eina.unizar.es/. The dates of delivery and follow-up of the practical tutored works will be made known in advance in class and in the web page of the subject in the digital ring teacher, https://moodle.unizar.es/.

4.5.Bibliography and recommended resources

http://psfunizar7.unizar.es/br13/egAsignaturas.php?codigo=60938&Identificador=C70298