Program	59SC – Telecommunications Systems Engineering B. Eng.

Course number and name	
Number	595010349
Name	Biomedical Digital Signal Processing
Semester	S7 [(September-January)]

Credits and contact hours	
ECTS Credits	4,5
Contact hours	45

Coordinator's name	Luengo García, David [david.luengo@upm.es]

Specific course information	
Description of course content	
Introducing the students to the digital signal processing of biomedical signals, with particular emphasis on electrocardiographic (ECG), electromyographic (EMG) and electroencephalographic (EEG) signal processing. The course will include a mixture of theoretical (around 60 %) and practical sessions (around 40 %). After an overview of the different types of biomedical signals, the course will focus on ECG and EEG signal processing. All the theoretical concepts will be reinforced through practical sessions in the simulation laboratory using Matlab. The students will work with real-world signals downloaded from the PhysioNet database and provided by the professors of the course, as well as with signals acquired by the students in the lab (with BIOPAC) or at-home (using Bitalino cards).	
List of topics to be covered	
1. Introduction to biomedical signals. 2. Main types of biomedical signals currently used for health assessment, their main characteristics and how they are recorded. 3. Electrocardiographic (ECG), Electromyographic (EMG) and electroencephalographic (EEG) signal processing. 4. Introduction to the digital signal processing of these signals: denoising, cancellation of artifacts and extraction of some relevant features for diagnostic applications from the signals. 5. Simulation laboratory using Matlab. 6. Work with real-world signals downloaded from the PhysioNet database and acquired by the students in the lab (with BIOPAC) or at-home (using Bitalino cards).	
Prerequisites or co-requisites	
Statistics and Stochastics Processes Digital Signal Processing	
Course category in the program	
__ R (required)	**_X_ E (elective)** *(elective courses may not be offered every year)*

Specific goals for the course
Specific outcomes of instruction
1. Know the different types of existing biomedical signals, their basic characteristics and the main signals in each class, with particular emphasis on bioelectrical signals (ECG, EMG and EEG). 2. Perform an introduction to digital signal processing techniques (focusing on noise/artifact removal and feature extraction) for the three main bioelectrical signals (ECG, EMG and EEG). 3. Become familiar with the main repository of biomedical signal world-wide (Physionet), learning how to download signals and work with them in Matlab. 4. Learn how to acquire signals in the lab and at home using the available equipment (BIOPAC and Bitalino cards).

Further reading and supplementary materials
– Leif Sörnmo and Pablo Laguna, “Bioelectrical Signal Processing in Cardiac and Neurological Applications”, Elsevier Academic Press, 2005. – John Enderle, Susan Blanchard y Joseph Bronzino, “Introduction to biomedical engineering”, Elsevier Academic Press, 2nd Ed., 2005. – Joseph D. Bronzino (ed.), “The biomedical engineering handbook”, CRC Press, 2000. – Metin Akay, “Biomedical signal processing”, Academic Press, 1994. – Willis J. Tompkins (ed.), “Biomedical digital signal processing”, Prentice Hall, 1993. – Kayvan Najarian y Robert Splinter, “Biomedical signal and image processing”, CRC Press, 2006. – George B. Moody, Roger G. Mark y Ary L. Goldberger, “Physionet: a web-based resource for the study of physiologic signals”, IEEE Engineering in Medicine and Biology, 70-75, May/June 2001. – R. J. Martis, U. R. Acharya y H. Adeli, “Current methods in electrocardiogram characterization”, Computers in Medicine and Biology 48: 133-149, 2014. – Luca Mainardi, Sergio Cerutti y Leif Sörnmo, “Understanding atrial fibrillation: the signal processing contribution”, Morgan and Claypool Publishers, 2008. – C. A. Teixeira et al., “EPILAB: a software package for studies on the prediction of epileptic seizures”, Journal of Neuroscience Methods, 257-271, 2011. – M.B.I. Reaz, M. S. Hussain y F. Mohd-Yasin, “Techniques of EMG signal analysis: detection, processing, classification and applications”, Biological Procedures Online 8(1): 11-35, 2006.

Teaching methodology			
_X_ **lectures**	__ **problem solving sessions**	_X_ **collaborative actions**	_X_ **laboratory sessions**
Other:			