

# BioMedical Instruments and Equipment

3 ECTS -> 75 h. 15h theory and 15h seminars (2h/week). 45h, Lab Project and related activities.

## Coordinator

Dr. Jordi Colomer-Farrarons

## Course Overview

Electronic equipment is a key factor in modern medicine and the term "Medical Electronics" is growing popularity and becoming an interesting area in Biomedical Engineering. Nowadays, these Medical Electronics cover a wide range of applications like medical diagnosis and therapy devices, research equipment and bioanalytical investigation modules. The course will present the important aspects to understand this medical electronic equipment from the system point of view to more detailed aspects. Devices like EEG, ECG, etc... or Instruments like electroscalpel will be introduced during the curs. Moreover, the theoretical aspects will be supported by a laboratory project with hardware and software development to design a complete medical system.

## Objectives (Goals)

The course will teach the schematic and system level identification of Medical Instruments. Students will understand the design considerations of a Medical instrument. Students will gain knowledge regarding physiological system dedicated equipment, cardiovascular and respiratory systems and surgical equipment. Students will increase their hands-on in circuit design, electronic circuit implementation and testing and laboratory skills. The course will teach a basic guide of medical product implementation in terms of reliability, safety design, regulations and standards and other product related questions. The course will increase the background of students in graphical environment programming software, basically LabView.

## Background

The interdisciplinary field of this course requires certain previously acquired skills:

- Good background in analog electronic fundamentals: operational amplifiers, filters, etc... (Electrònica Aplicada)
- Basics in biosignals and transducers. Knowledge of signal noise and filtering, (many bioelectric signals are in the microvolt range)
- Fundamentals of biomedical amplifiers, from basic differential amplifier to the Lock-in Amplifier. (Instrumentació I Senyals Biomèdiques)
- Basic background in graphical environment programming. (Lab View or similar) (Instrumentació I Senyals Biomèdiques)
- Knowledge of physiological system and clinical applications.

## Material Covered (Structure)

The course is comprised of 5 modules. Each module contains several chapters organized as follow:

Module 1: BioSignals Measurements.

Chapter M1.1. Biopotentials and Electrodes.

Chapter M1.2. Cardiovascular systems Measurements: Electrocardiography, blood pressure, Blood oxygen, etc...

Chapter M1.3. Nervous and muscular system Measurements: Electroencephalogram, Electromyography.

Module 2: Respiratory and Digestive Measurements.

Chapter M2.1 Basics of Human Respiration and Digestive systems.

Chapter M2.2. Respiratory system Measurements: Spirometers, Apnea monitoring, Capnography, etc...

Chapter M2.3: Digestive Measurements: Gastroscopy, Colonoscopy, etc...

Module 3: Non-electrical Measurements.

Chapter M3.1: Ultrasound equipment Magnetic Resonance Introduction.

Chapter M3.2: X-Ray based Measurements (Basics): Radiography, Computed Axial Tomography (CAT), etc...

Chapter M3.3: Temperature Measurements: Thermistors, Integrated sensors, Infrared sensors, etc ...

Module 4: Therapeutic and Surgery Devices.

Chapter M4.1: Cardiac Pacemakers and Ventilators.

Chapter M4.2: Dialysis Equipment Overview and Drug Delivery Systems.

Chapter M4.3: Surgery Devices: Electrosurgical, Laser Applications, etc...

Module 5: Patient and Electrical Safety in BioMedical Instruments.

Chapter M5.1: Regulations and Standards when designing Biomedical Devices and Systems.

Chapter M5.2: Electrical/Electronic Security: ECM (Electromagnetic Compatibility), shock hazards, etc...

Chapter M5.3: Patient bed isolation and grounding example.

**Tentative course Schedule**

Chapter	Scheduling (30 h)		LAB Project
Module 1: BioSignals Measurements			
M1.1	1		
M1.2	3		Starting Project
M1.3	3		
Module 2: Respiratory and Digestive Measurements.			
M2.1	1		
M2.2	3		
M2.3	2		First Deliverable
Module 3: Non-electrical Measurements.			
M3.1	2		
M3.2	2		
M3.3	1		
Module 4: Therapeutic and Surgery Devices.			
M4.1	2		Second Deliverable
M4.2	2		
M4.3	2		
Module 5: Patient and Electrical Safety in BioMedical Instruments.			
M5.1	2		
M5.2	1		
M5.3	1		Final Presentation
There is a total of 28 Hours. The other two hours are scheduled to organize a Seminar with an expert of an specific area.			

**Laboratory Project**

The laboratory project is an important part of the course. The student will design a complete medical system combining different type of sensors, electronic hardware and graphical software in order to monitor continuously different variables of an hypothetical patient.

The laboratory project is guided during all the curs and it is defined to mandatory deliverables to control a proper realization. The final medical system will control a temperature sensor, a humidity sensor and basic ECG preamplifier. The electronic hardware interface (Back-End) will be implemented and assembled by the students, as well as the PC control system based on LabView.

**Grades:**

Homework and class discussions 50%, Laboratory Project: 50%

**Bibliography**

Introduction to Biomedical Equipment Technology, by Joseph Carr and John Brown. 4th edition. ISBN: 0-13-010492-2 (Available in the PNC bookstore)

Principles of Medical Electronics and Biomedical Instrumentation, by CR Rao and SK Guha, Universities Press ISBN: 978 81 7371 257 9

Introduction to Biomedical Engineering, by J. Enderle, S.M. Blanchard and J. D. Bronzino, Academic Press, 2nd edition, ISBN-10\_ 0122386620

Medical Instrumentation, by J.G. Webster, editor, Wiley, ISBN-13 978-0471-67600-3

Design of Biomedical Devices and Systems, by Paul H. King and Richard C. Fries, CRC Press, ISBN 978-1-4200-6179-6

Fault Diagnosis of Analog Integrated Circuits, by Prithviraj Kabisatpaty, Alok Barua and Styabroto Sinya, Springer, ISBN 0-387-2574-X