# MEDTEC SCHOOL

## Course: Biomedical Electronics and instrumentation

## Year: 3rd

## Period: 1st semester

## Credits: 10

## Objectives

The course will allow students to:

- be familiar with the basic components of medical instrumentation
- be familiar with the basic principles of the biomedical sensors
- analyze and understand the basic principles and techniques of biomedical instrumentation
- know the main uses and applications of biomedical instrumentation in the clinical settings
- understand the main limits of validity of biomedical instrumentation
- compare different possible available instruments for clinical measurements
- have a sense of the state of the art in the field of biomedical technology
- develop a critical appraisal and understand the limits of measurements

## Prerequisites

Student are required to have acquired the content of the following Courses:

- Fundamentals of Experimental Physics
- Chemistry and Organic Chemistry
- Computer science
- Basics of Circuit theory
- Physiology, Anatomy and Biochemistry

## Contents

| Topic | Hours | Teacher/s |
|---|---|---|
| **Introduction** | 1 | AA, RD, MS, AC, RR |
| **Basic Concepts of Medical Instrumentation -** Classifications of Biomedical Instruments, Static and Dynamic Characteristics, Amplifiers, | 10 | AA, RD |

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| Comparators, Noise and Active Filters, Frequency Response, Impedance measurements | | |
| **Basic Sensors and Principles of detection-** Displacement Measurements, Resistive Sensors, Bridge Circuits, Inductive Sensors, Phase-Sensitive, Capacitive Sensors, Piezoelectric Sensors, Accelerometer, Temperature Measurements, Thermocouples, Thermistors, Radiation Thermometry | 18 | AA, RR |
| **Digital electronics and Microcontrollers in Medical Instrumentation –** A/D convertion. Basics of digital electronics, Microcontrollers, Embedded Medical Systems, Selection of a Microcontroller, IoT-Based Medical Devices, examples. | 20 | RD |
| **Biopotential Electrodes and amplifiers-** The Electrode–Electrolyte Interface, Polarization, Polarizable and Nonpolarizable Electrodes, Electrode Behavior and Circuit Models, The Electrode–Skin Interface and Motion Artifact, Body-Surface Recording Electrodes. Specific applications: ECG, EMG and EEG.<br><br>Basic Requirements, The Electrocardiograph, Problems Frequently Encountered, Transient Protection, Common-Mode and Other Interference-Reduction Circuits, Amplifiers for Other Biopotential Signals, Example of a Biopotential Preamplifier, Other Biopotential Signal Processors, Cardiac Monitors, Biotelemetry | 10 | MS, RR |
| **Non-electrical Measurements of the Cardiovascular System –**<br><br>Pulse-Oximeter<br><br>Blood Pressure and Sound: – Direct Blood Pressure Measurements. honocardiography. Indirect Measurements of Blood Pressure, Tonometry<br><br>Measurement of Flow and Volume of Blood: - Indicator-Dilution Method Ultrasonic Flowmeters, Thermal-Convection Velocity Sensors, Chamber Plethysmography, Electrical-Impedance Plethysmography, Photoplethysmography | 8 | AA, RD |
| **Respiratory System: measurement and therapeutic devices -** Measurement of Pressure, Gas Flow, Lung Volume, Respiratory | 15 | AA, RD |

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|---|---|---|
| Plethysmography, Gas Concentration<br>ICU monitoring<br>Mechanical Ventilators | | |
| **Biosensors -** Electrochemical Sensors, Chemical Fibrosensors, Ion-Sensitive Field-Effect Transistor (ISFET), Immunologically Sensitive Field-Effect Transistor (IMFET), Noninvasive Blood-Gas Monitoring, Blood-Glucose Sensors, Electronic Noses, Lab-on-chip, Impedance-based biosensors, Fabrication technology of biochips, Surface functionalization, Antibodies detection, Limit Of Detection (LOD), Point-of-care instrumentation | 12 | MS, RR |
| **Clinical Laboratory Instrumentation -** Spectrophotometry, Automated Chemical Analyzers, Chromatology, Electrophoresis, Hematology | 4 | RR |
| **Medical Imaging Systems –**<br>a. Basic principles of interaction between EM waves/radiation and tissues<br>b. transduction methods. Optical Measurements, Radiation Sources, Radiation Sensors<br>c. Medical Imaging systems. Radiography, Computed Tomography, Magnetic Resonance Imaging, Ultrasonography, Single-Photon Imaging, Single-Photon Emission Computed Tomography, Positron Emission Tomography, Optical Imaging<br>Multimodality | 20 | AC, RD, RR |
| **Medical devices.** Design Criteria, Commercial Medical Instrumentation Development Process, Regulation of Medical Devices | 2 | RD |
| **TOTAL** | 120 | |

## Teaching Methods

The course will be offered through:

- Frontal lectures

- Numerical and circuit exercises
- Watching demonstrations of biomedical instruments (also in collaboration with biomedical companies)
- Practice- based demos

## Verification of learning

The final exam is constituted by a written test (made of numerical exercise, open-ended questions, multiple choice questions) and a final oral exam.

## Texts

John G. Webster (Editor), Amit J. Nimunkar (Editor). Medical Instrumentation: Application and Design, 5th Edition. Wiley