UNIVERSIDADE DO ESTADO DE SANTA CATARINA – UDESC
CENTER OF TECHNOLOGICAL SCIENCES
POSTGRADUATE PROGRAM ON ELECTRICAL ENGINEERING

DEPARTAMENT: ELECTRICAL ENGINEERING		
SUBJECT: Introduction of Biomedical Engineering	**INICIALS**: IBME	
TOTAL HOURS: 60	**THEORY**: 50 h	**PRACTICE**: 10 h

COURSES: Doctorate and Master on Electrical Engineering

PROFESSOR/LECTURER: PhD. Pedro Bertemes-Filho (pedro.bertemes@udesc.br)

REQUIREMENTS: Not applicable

OBJECTIVES: Development of basic theoretical skills about biomedical engineering; Guide the students on the specifications of basic requirements for developing biomedical systems towards theirs doctoral and master degree projects.

COURSE SYLLABUS: Historical perspective; Ethic issues; Basic knowledge of Anatomy&Physiology, Rehabilitation and Tissue Engineering, Bioinstrumentation, Biomedical Sensors, Biosignal Processing, Bioelectric Phenomena, Physiological Modelling, Bioinformatics, Medical Imaging and Biomedical Optics and Lasers.

COURSE PROGRAM CONTENT:

1.0 Biomedical Engineering: state of the art
- 1.1 Historical perspective
- 1.2 Moral and ethical issues
- 1.3 Regulation of medical device

2.0 Anatomy and Physiology
- 2.1 introduction
- 2.2 Cellular Organization
- 2.3 Tissues
- 2.4 Major Organ Systems

3.0 Rehabilitation Engineering
- 3.1 Introduction
- 3.2 The Human Component
- 3.3 Principles of Assistive Technology Assessment
- 3.4 Principles of Rehabilitation Engineering
- 3.5 Practice of Rehabilitation Engineering and Assistive Technology

4.0 Biomaterial and Tissue Engineering
- 4.1 Materials in Medicine
- 4.2 Biomaterials: Properties, Types, and Applications
- 4.3 Tissue–Biomaterial Interactions
- 4.4 What Is Tissue Engineering
- 4.5 Biological Considerations
- 4.6 Physical Considerations

5.0 Bioinstrumentation: part I
- 5.1 Introduction

- 5.2 Basic Bioinstrumentation System
- 5.3 Charge, Current, Voltage, Power, and Energy
- 5.4 Resistance
- 5.5 Linear Network Analysis
- 5.6 Linearity and Superposition
- 5.7 Thevenin's Theorem
- 5.8 Inductors
- 5.9 Capacitors

6.0 Bioinstrumentation: part II
- 6.1 Circuits involving resistors, capacitors and inductors: solving approaches
- 6.2 Operational Amplifiers
- 6.3 Time-Varying Signals
- 6.4 Active Analog Filters
- 6.5 Bioinstrumentation Design

7.0 Biomedical Sensors: part I
- 7.1 Introduction
- 7.2 Biopotential Measurements
- 7.3 Physical Measurements

8.0 Biomedical Sensors: part II
- 8.1 Blood Gases and pH Sensors
- 8.2 Bioanalytical Sensors
- 8.3 Optical Biosensors
- 8.4 Other sensors

9.0 Biosignal processing: part I
- 9.1 Introduction
- 9.2 Physiological Origins of Biosignals
- 9.3 Characteristics of Biosignals
- 9.4 Signal Acquisition

10.0 Biosignal processing: part II
- 10.1 Frequency Domain Representation of Biological Signals
- 10.2 Linear Systems
- 10.3 Signal Averaging
- 10.4 Wavelet Transform and Short-Time Fourier Transform
- 10.5 Artificial Intelligence Techniques

11.0 Bioelectric Phenomena
- 11.1 Introduction
- 11.2 History
- 11.3 Neurons
- 11.4 Basic Biophysics Tools and Relationships
- 11.5 Equivalent Circuit Model for the Cell Membrane
- 11.6 Hodgkin–Huxley Model of the Action Potential
- 11.7 Model of the Whole Neuron

12.0 Physiological Modelling
- 12.1 Introduction
- 12.2 Compartmental Modeling
- 12.3 An Overview of the Fast Eye Movement System
- 12.4 Westheimer Saccadic Eye Movement Model
- 12.5 The Saccade Controller
- 12.6 Development of an Oculomotor Muscle Model
- 12.7 A Linear Muscle Model
- 12.8 A Linear Homeomorphic Saccadic Eye Movement Model
- 12.9 A Truer Linear Homeomorphic Saccadic Eye Movement Model

12.10 System Identification

13.0 Bioinformatics

13.1 Introduction
13.2 Core Laboratory Technologies
13.3 Core Bioinformatics Technologies
13.4 Computational Biology
13.5 The Modelling Process
13.6 Bionetworks

14.0 Medical Imaging

14.1 Introduction
14.2 Emission Imaging Systems
14.3 Instrumentation and Imaging Devices
14.4 Radiographic Imaging Systems
14.5 Diagnostic Ultrasound Imaging
14.6 Magnetic Resonance Imaging (MRI)
14.7 Comparison of Imaging Mode

15.0 Biomedical Optics and Lasers

15.1 Introduction to Essential Optical Principles
15.2 Fundamentals of Light Propagation in Biological Tissue
15.3 Physical Interaction of Light and Physical Sensing
15.4 Biochemical Measurement Techniques Using Light
15.5 Fundamentals of Photothermal Therapeutic Effects of Lasers
15.6 Fiber Optics and Waveguides in Medicine
15.7 Biomedical Optical Imaging

METHODOLOGY: Expositive theoretical classes by using slides electronically projected and the white board; Oral presentations related to this subject; Practical projects in a workbench and computer simulations, when applicable.

PERFORMANCE ASSESSMENT: The student may decide between two methods: (1) and (2):

(1) Make 2 tests with weight 40% e 60%, respectively,

OR

(2.1) Present a pre-project to be written in an article format. In order to be accepted as a performance assessment, it has to be orally presented after 4 weeks the class has started (10% of the final score). The expected results should be clearly defined. If the 2 students will be working in the article, then the activities of each one should be clearly described in the pre-project;

(2.2) Develop a practical/theoretical article to solve a problem in the engineering area by using the tools which will be learnt in this discipline (SET). The article should be original and it can be either proposed by the professor or by the students, once it is previously approved. The deadline of the article is the last day of the academic semester, according to the UDESC calendar, and it should be formatted according to the IEEE template (30% of the final score);

(2.3) Present the results of the article (30% of the final score).

In the case of the pre-project is not approved or the deadline was lost, the student(s) will make 2 tests, weighting 40% e 60%, respectively.

If the method (2) is chosen, a final oral presentation of the article must be done (20% of the final score) and the project/article will be 70% of the final score (10%+30%+30%).

R E F E R E N C E S

JOHN D. ENDERLE, JOSEPH D. BRONZINO. Introduction to Biomedical Engineering. Editora Elsevier, 3a edição, 2012.

BRONZINO, J.D. The Biomedical Engineering Handbook, 2 Bände cplt, 2000.

WEBSTER, J.G. Medical Instrumentation: Application and Design. 2nd ed. Boston: Houghton Mifflin Co., 1992.

SPERELAKIS, N.; BANKS, R.O. (ed.) "Physiology", Little Brown & Co., Boston, USA, 1993.

BRONZINO, J. D. "Management of Medical Technology: A Primer for Clinical Engineers", Buttorworth-Heinemann, 1992.