GUJARAT TECHNOLOGICAL UNIVERSITY
BIOMEDICAL ENGINEERING (03)

Bioelectric Potential and Measurement Techniques

SUBJECT CODE: 2130303

B.E. 3RD SEMESTER

Type of course: Core

Prerequisite: Fundamentals of Human Anatomy and Physiology

Rationale: The students need to learn fundamental concepts of generation & measurement techniques of various bioelectric potentials.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**INTRODUCTION TO BIOELECTRIC POTENTIALS** Introduction to Physiological systems of the body, Sources of Bioelectric potentials, Propagation of action potential, Bioelectric potentials ECG, EEG and EMG responses, Development of Bioelectric potential measurement, Problems encountered in measuring a living system.	5	10
2	**TRANSPORT PROCESSES** Basic concepts of transport processes, Propagation of electrical impulse through ion exchange, Chemical balances, force balances, general bioelectrical potential balances, Kirchhoff's laws, Conservation of mass & energy.	5	10
3	**ELECTRODES AND TRANSDUCERS** Introduction to electrode theory, Half-cell Potential, Skin-Electrode Interface, Types of electrodes, Basic transduction principles, Classification of transducer, Types of Transducers: Active & Passive transducers, Analog and Digital transducers, Transducers for biomedical Applications.	5	15
4	**CARDIOVASCULAR SYSTEM AND MEASUREMENTS** The heart and cardiovascular system, Cardiac Cycle, Generation of ECG, Electrocardiography, Measurement of heart rate and cardiac output, Cardiac Abnormality Diagnosis by ECG.	6	15
5	**NERVOUS SYSTEM AND MEASUREMENTS** Structure and Function of Brain and Neurons, Nerve impulse transmission through Spinal cord, Characteristics of Electroencephalogram (EEG), Techniques of Measurement of EEG.	6	15
6	**MUSCULAR SYSTEM AND MEASUREMENTS** Structure of Muscle, Generation of Muscle Action Potential, Motor movement analysis, Physiology of Electromyogram (EMG), Measurement Techniques of Electromyography.	6	15
7	**PATIENT CARE AND MONITORING** Requirement of Continuous Monitoring of Bioelectrical Signals, Elements of intensive care monitoring, Patient monitoring displays, Multi-parameter Monitoring Device, Automated Diagnosis of Bioelectrical Signals.	6	10
8	**THERAPEUTIC AND PROSTHETIC DEVICES**	6	10

	Fundamentals of Bioelectrical Therapeutic Devices: Cardiac Pacemaker, Defibrillators, Audio and hearing aids, Myoelectric arm, Diathermy, Nerve and Muscle Stimulators, Functional Electrical Stimulation.		
	Total -	45	100

Reference Books:

Sr. No.	Title of Books	Author	Publication
1	Bio-Medical instrumentation	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer	Prentice-Hall
2	Biomedical Instrumentation and Measurements	R. Anandanatarajan	PHI Learning Pvt. Ltd.
3	Hand book of bio-medical instrumentation	R. S. Khandpur	McGrawHill
4	Introduction to biomedical equipment technology, 4th edition	Joseph J. Carr, John M.Brown	Pearson publications
5	Biopotential Readout Circuits for Portable Acquisition Systems	Refet Firat Yazicioğlu, Chris van Hoof, Robert Puers	Springer
6	Bio-Medical Electronics & Instrumentation	Onkar N.Pandey, Rakesh Kumar	S. K. Kataria & Sons

Course Outcome:

After completion of the course the student will be able to:

1. Know the generation of various bioelectrical potentials and propagation through human body.
2. Understand the transport phenomenon of signal through electrical channels.
3. Learn the origins of bioelectrical potentials and their characteristics in time and frequency domain.
4. Describe the routine clinical electro-diagnosis and monitoring procedures.
5. Learn basic sensors for collection of physiological signals from living systems.
6. Learn the characteristics and electrical models of skin-electrode interface.
7. Work in groups on lab exercises and develop written communication skills.

List of Experiments:

Sr. No.	Name of Practical	Planned Hours
1	To understand the generation and measurement technique of Electrocardiogram.	2
2	To understand the generation and measurement of Electroencephalogram.	2
3	To understand the generation and measurement of Electromyogram.	2
4	To understand the generation and measurement of Electrooculogram.	2
5	To understand the TENS and muscle stimulator.	2
6	To understand the measurement of Galvanic Skin Resistance.	2
7	To understand the measurement of pH.	2
8	To study the fundamentals of Functional Electrical Stimulation.	2
9	To study the fundamentals of diathermy.	2
10	To study the fundamentals of pacemaker.	2
	Total Lab Hours	20

Major Equipments:

1. Portable ECG Machine
2. Multipara Monitor System
3. pH measurement system
4. Electrooculogram system
5. Galvanic Skin Resistance machine
6. EEG with 10-20 lead system

7. EMG Acquisition System /simulator
8. Transcutaneous Electrical Nerve Stimulator (TENS)
9. Digital muscle stimulator

Design based Problems (DP)/Open Ended Problem:

1. Prepare charts of classification of sensors
2. Prepare charts of classification of noises and errors
3. Prepare catalogue of various types of electrodes
4. Design measurement system charts for various biopotentials

A student and faculty may choose any other such problem which includes the concept used in the course.

Active learning Assignments (AL) : Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The Power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.