



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Biomedical Engineering

Subject Code : BE04003041

Subject Name : Biopotential Measurement Techniques

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	PCC-07

Prerequisite:	Human anatomy and physiology, Fundamental of Analog Electronics
Rationale:	The students need to learn fundamental concepts of generation & measurement techniques of various bioelectric potentials.

Course Outcome:

After Completion of the Course, Student will able:

No	Course Outcomes	RBT Level
01	To understand the origin of the biopotential signal and its propagation along with electrical properties of excitable cells.	R,U
02	To evaluate the properties of electrodes used for recording and stimulating purpose.	R,U,A
03	To understand physiological phenomena of ECG and how to acquire and analyze the ECG.	R,U,A,N,E
04	To understand physiological phenomena of EEG and how to acquire and analyze the EEG.	R,U,A,N,E
05	To understand physiological phenomena of EMG and how to acquire and analyze the EMG.	R,U,A,N,E

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours per Semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	PR	TW/SL	TH		C	Theory		Tutorial / Practical		
					ESE (E)		PA (M)	PA (I)	TW/SL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Where L : Lecturo, T: Tutorial, P: Practical, TWSL: Term-Work / Self-Learning, TH: Total Hours, ESE: End-Semester Examination, PA: Progressive Assessment



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	INTRODUCTION TO BIOELECTRIC POTENTIALS: Definition of Bioelectric potentials, Introduction to Physiological systems of the body and related Bioelectric potentials, Electrical activity of excitable cells: Resting Potential, Nernst equation, G-H-K equation, Action Potentials, Propagation of the Action Potential, Medical Instrumentation System, Problems encountered in measuring a living system.	9	20%
2.	ELECTRODES: Electrode as a bioelectric transducer, The electrode-electrolyte interface, Half-cell potential, Polarizable and nonpolarizable electrodes, The electrode-skin interface and Motion artifact, Body-surface recording electrodes, Internal electrodes, Electrode arrays, Microelectrodes.	8	20%
3.	CARDIOVASCULAR SYSTEM AND MEASUREMENTS: Cardiac Cycle, Generation of ECG, Characteristics of ECG waveform, Wigger's diagram, The standard 12-lead ECG system, Artifact in ECG measurement, Block diagram scheme of ECG, Cardiac disorders diagnosed by ECG, Measurement of Heart rate, Generation and Measurement of Blood Pressure.	10	20%
4.	NERVOUS SYSTEM AND MEASUREMENTS: Neuronal Firing Measurements, Generation of EEG, Characteristics of EEG waveform, 10-20 EEG electrode placement system, Artifact in EEG measurement, Block diagram scheme of EEG, Neurological disorders diagnosed by EEG, Introduction to Electroneurogram (ENG).	8	20%
5.	MUSCULAR SYSTEM AND MEASUREMENTS: Generation of EMG, Characteristics of EMG waveform, Measurement Techniques of Electromyography, Artifact in EMG measurement, Block diagram scheme of EMG, Muscular disorders diagnosed by EMG, Introduction to Electrooculogram (EOG) and Electroretinogram (ERG).	10	20%
	Total	45	100

Suggested Specification Table with Marks (Theory):



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Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
25%	25%	25%	15%	10%	0%

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Medical Instrumentation: Application and Design Fourth Edition, John G. Webster, John Wiley & Sons, Inc.
2. Bio-Medical instrumentation, Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer Prentice-Hall
3. Bio-Medical Electronics and Instrumentation, Onkar Pandey, Rakesh Kumar, S. K. Kataria & Sons.
4. Biomedical Instrumentation and Measurements, R. Anandanatarajan PHI Learning Pvt. Ltd.
5. Hand book of Biomedical instrumentation R. S. Khandpur McGrawHill
6. Introduction to biomedical equipment technology, 4th edition Joseph J. Carr, John M. Brown Pearson publications
7. Biopotential Readout Circuits for Portable Acquisition Systems Refet Firat Yazicioğlu, Chris van Hoof, Robert Puers Springer

(b) Open source software and website:

1. <https://archive.nptel.ac.in/courses/107/106/107106081>
2. <https://vlab.amrita.edu/?sub=3&brch=78&sim=219&cnt=2193>
3. <https://bmsp-coep.vlabs.ac.in/exp/biopotential-amplifier/theory.html>

Suggested Course Practical List:

1. Introduction to Physiological systems of the body and related Bioelectric potentials.
2. To understand the Electrical activity of excitable cells and propagation of action potential.
3. To simulate the generation of an Action potential.
4. To understand the different electrodes used in Biopotential measurements.
5. To understand the generation and measurement technique of Electrocardiogram.
6. To understand the generation and measurement technique of Blood Pressure.
7. To understand the generation and measurement of Electroencephalogram.
8. To understand the generation and measurement of Electromyogram.
9. To understand the generation and measurement of Electrooculogram.



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List of Laboratory/Learning Resources Required:

Suggested Project List: Nil

Suggested Activities for Students: If any

Designing of a hardware circuitry to acquire ECG/EEG/EMG.

Term Work /Self Learning Suggested Activities:

Sr. No	Name of the Activity	No. of Hours	Evaluation Criteria
1	Industry/Research laboratory visit	Visit: 5h Report preparation: 5h Total: 10h	Based on the report submitted. Report should contain observations and calculations based on industry/lab data.
2	Technical video-based learning related to the subject	Duration of video: 5h Report preparation: 5h Total: 10h	Report/presentation based on the video learning outcomes.
3	Assignment writing (Numerical-based assignment is preferable)	5 assignments \times 4h each Total: 20h	Based on the assignments submitted.
4	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL, or any other relevant software	5 small coding-based assignments \times 2h each Total: 10h	Based on the coding solutions submitted.
5	Self-learning online course	Minimum duration: 10h	Examination-based assessment at the end of the course. Based on the certificate produced.
6	Complex problem solving	Maximum 2 problems Study and solution finding Total: 10h/problem	Based on the depth of the solution submitted.



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Sr. No	Name of the Activity	No. of Hours	Evaluation Criteria
7	Videos on Industrial Safety/Disaster Management aspects based on subject	Duration of video: 5h Report preparation: 5h Total: 10h	Based on quiz/report submitted.
8	Discussion on research paper based on relevant subject	5 research papers: 20h	Summarize research papers and evaluate critical parameters.
9	Poster/Chart/PowerPoint preparation on technical topics	Duration: 6h	Based on poster/chart preparation and presentation skills.
10	Working/Non-working model on technical topics	Working: 12h Non-working: 8h	Based on inter-department/external evaluation.
11	Industrial exposure (2–3 days) to observe and provide tentative solutions on society/environment/health/other issues	Industrial exposure: 15h Problem identification and tentative solution: 10h Total: 25h	Based on evaluation of critical problems and proposed solutions.
12	Group discussion on emerging/trending technical topics based on subject	Duration: 1h each	Based on performance in group discussion, technical depth, and knowledge.
13	Real world case studies based learning	Data collection/study: 5h Report preparation: 5h Total: 10h	Based on in-depth study, technical depth, data collected, and fact finding.
14	Application/Software development	Duration: 10h	Depending on the complexity of the Application/Software developed.
15	Expert lecture/session	Duration: 2h Attendance: 2h Report writing: 2h Total: 4h	Based on proof of attendance and report submitted.
16	Blog or Technical Article Writing	Research: 6h Writing: 4h Total: 10h	Based on originality, technical content, references cited, and clarity of communication.



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Sr. No	Name of the Activity	No. of Hours	Evaluation Criteria
17	Annotated Video Explanation of Concept/Problem	Preparation + Recording + Submission: 10h	Based on accuracy of explanation, clarity, and presentation style.
18	Online Technical Quizzes/Simulations	Multiple quizzes totaling 10h	Based on quiz scores and reflection report after each quiz.
19	Tech Blog/YouTube Channel Curation	Content curation + Analysis: 10h	Summary report on curated content and learning outcomes.
20	Patent Search and Innovation Gap Identification	Search + Report: 10h	Based on number of relevant patents analyzed and identification of innovation scope.
21	Maintenance or Troubleshooting Logbook	Example: lab instruments, computer hardware — 10h	Based on documented cases, approach, and resolution.

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