CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **BACHELOR OF TECHNOLOGY (Electronics and Communication)**

Semester: **VI**

Course Code: **202060606**

Course Title: **Biomedical Signal Processing**

Course Group: **Professional Elective Course**

Course Objectives: To study origins and characteristics of some of the most commonly used biomedical signals including ECG, EEG, evoked potentials, and EMG. To understand Sources and characteristics of noise and artifacts in bio signals. To understand the use of bio signals in diagnosis, patient monitoring and physiological investigation. To explore application of established engineering methods to complex biomedical signals problems.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50/18	50/17	25/9	25/9	150/53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Introduction to Biomedical Signals:** Bio-potentials and their origin: ECG, EEG, EMG, ENG, ERG, EOG, MEG. Biomedical Instrumentation System, biomedical transducers, electrodes and their characteristics. Sources and contamination of Noise in bio signals. Motion artifacts.	8
2	**Filtering for removal of artifacts:** Statistical Preliminaries, Time domain filtering (Synchronized Averaging, Moving Average), Time domain filtering (Moving Average Filter to Integration, Derivative-based operator), Frequency Domain Filtering (Notch Filter), Optimal Filtering: The Weiner Filter.	8

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3	**Event Detection:** Detection of Events and Waves: Derivative-based methods for QRS detection, The Pan-Tompkins algorithm for QRS detection, Detection of the dicrotic notch, Detection of the P wave and Applications.	**8**
4	**Waveform Analysis:** Illustrations of problem with case studies, Morphological Analysis of ECG, Envelop Extraction and Envelogram, Analysis of activity, Root Mean Square value, Zero-crossing rate, Turns Count, Form factor.	**7**
5	**Frequency-domain Analysis:** Periodogram, Averaged Periodogram, Blackman-Tukey Spectral Estimator, Daniell's Spectral Estimator, Measures derived from PSD.	**7**
6	**Modelling of Biomedical Systems:** Parametric system modeling, Autoregressive or all pole modeling, Applications of Modeling biomedical systems, Concept of curve fitting	**7**
		45

List of Practicals / Tutorials:

1	Designing High Pass and Low Pass filter using FDA (Filter Design & Analysis) tool. Also observe Power spectra using SPTOOL (Signal Processing GUI Suite).
2	Consider an ECG signal affected with 100 Hz noise signal. Perform Low pass filter operation on noise affected ECG signal and observe the filtered signal.
3	Design a notch filter to remove a 50 Hz noise signal added with an ECG signal.
4	Design different FIR filters to remove noise from ECG signal.
5	To study mean, variance, standard deviation and heart rate of an ECG signal.
6	Determine the heart rate variability (HRV) of an ECG signal
7	Develop an algorithm for QRS-detection of an ECG signal, Estimate the heart rate
8	Removal of Baseline Wander from given ECG signal using Wavelet (DWT).
9	Autoregressive (AR) modeling of EEG signal by linear filtering of AWGN noise
10	Design an adaptive filter for noise (100Hz) cancellation from ECG/EEG signals.
11	Principal Component Analysis (PCA) with ECG Signal

Reference Books:

1	Rangaraj M. Rangayyan, **Biomedical Signal Analysis: A Case Study Approach**, John Wiley & Sons.
2	Willis J. Tompkins, **Biomedical Digital signal processing**, PHI publication.
3	K J Blinowska, and J Zygierewicz, **Practical Biomedical signal analysis Using MATLAB**, Taylor & Francis, 2012.
4	R. Rangayan, **Biomedical Signal Analysis**, Wiley, 2002.

Supplementary learning Material:	
1	https://onlinecourses.nptel.ac.in/noc20_ee41/preview(Swayam NPTEL Portal)
2	Coursera Video Lectures

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Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

Internal Evaluation:

The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
10	25	20	15	15	15	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	The student will be able to explore the signal processing techniques in analyzing biological signals.	**20**
CO-2	Analyze the behavior of biomedical signal in spatial and frequency domain.	**25**
CO-3	To detect anomalous events in various biomedical signals.	**30**
CO-4	Further they able to model biomedical systems.	**25**

Curriculum Revision:	
Version:	2.0
Drafted on (Month-Year):	June -2022
Last Reviewed on (Month-Year):	-
Next Review on (Month-Year):	June-2025

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