BIOMEDICAL SIGNAL PROCESSING

B.E., VII Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) Scheme]

Course Code	**17EC742**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (8 Hours / Module)**	**Exam Hours**	**03**

CREDITS – 03

Course Objectives: The objectives of this course are to:

- Describe the origin, properties and suitable models of important biological signals such as ECG and EEG.
- Introduce students to basic signal processing techniques in analysing biological signals.
- Develop the students mathematical and computational skills relevant to the field of biomedical signal processing.
- Develop a thorough understanding on basics of ECG signal compression algorithms.
- Increase the student's awareness of the complexity of various biological phenomena and cultivate an understanding of the promises, challenges of the biomedical engineering.

Module-1

Introduction to Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis.
Electrocardiography: Basic electrocardiography, ECG lead systems, ECG signal characteristics.
Signal Conversion :Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits (Text-1) **L1, L2**

Module-2

Signal Averaging: Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging.
Adaptive Noise Cancelling: Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model, other applications of adaptive filtering (Text-1) **L1, L2, L3**

Module-3

Data Compression Techniques: Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms The Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG (Text-1) **L1, L2, L3**

Module-4

Cardiological signal processing:
Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Realtime ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor. (Text -2) **L1, L2, L3**

Module-5

Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation.

Analysis of EEG channels: Detection of EEG rhythms, Template matching for EEG, spike and wave detection (Text-2). **L1, L2, L3**

Course outcomes: At the end of the course, students will be able to:

- Possess the basic mathematical, scientific and computational skills necessary to analyse ECG and EEG signals.
- Apply classical and modern filtering and compression techniques for ECG and EEG signals
- Develop a thorough understanding on basics of ECG and EEG feature extraction.

Text Books:

1. **Biomedical Digital Signal Processing-** Willis J. Tompkins, PHI 2001.
2. **Biomedical Signal Processing Principles and Techniques-** D C Reddy, McGraw-Hill publications 2005

Reference Book:

Biomedical Signal Analysis-Rangaraj M. Rangayyan, John Wiley & Sons 2002

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