# Biomedical Signal Processing(404191)

**Teaching Scheme:**
Lectures:3Hrs/ Week

**Examination Scheme:**
In Semester Assessment:
Phase I : 30
End Semester Examination:
Phase II: 70

## Course Objectives:

1. To understand the basic signals in the field of biomedical.
2. To study origins and characteristics of some of the most commonly used biomedical signals, including ECG, EEG, evoked potentials, and EMG.
3. To understand Sources and characteristics of noise and artifacts in bio signals.
4. To understand use of bio signals in diagnosis, patient monitoring and physiological investigation
5. To explore research domain in biomedical signal processing.
6. To explore application of established engineering methods to complex biomedical signals problems.

## Course Outcomes:

Aftersuccessfully completing the course students will be able to:

- The student will be able to model a biomedical system.
- The student will be able to understand various methods of acquiring bio signals.
- The student will be able to understand various sources of bio signal distortions and its remedial techniques.
- The students will be able to analyze ECG and EEG signal with characteristic feature points.
- The student will have a basic understanding of diagnosing bio-signals and classifying them.

### Unit I : Biomedical Signals 6L

Bioelectric Signals and Electrodes: Bio-potentials and their origin: ECG, EEG, EMG, ENG, ERG, EOG, MEG. Biomedical Instrumentation System, biomedical transducers, electrodes and their characteristics. Origin of bio potentials. Sources and contamination of Noise in bio signals.Motion artifacts and skin Impedance. Classification of biomedical signals.

### Unit II : Cardio Vascular and Nervous System 6L

Cardio Vascular System: Cardiovascular system, Coronary and Peripheral Circulation, Electrical

Activity of the heart, Lead configurations , ECG data acquisition, ECG recorder, Concept of Blood Pressure Measurement, Cardiac output, Heart Sounds.
Nervous System: Nervous System, Structure and functions of Neurons, Electrical activity of nerve cell, Synapse, Reflex action and Receptors.

## Unit III :Analysis of Electrical Activity of Heart 6L

ECG signal parameters & their estimation - Use of multiscale analysis for ECG parameters estimation, Noise & Artifacts, ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection, Highlight the Feature points of ECG and its classification for Normal and Abnormal state using Multilayer Perceptron.

## Unit IV : Analysis of Electrical Activity of Brain 6L

Electroencephalogram – Structure of brain, EEG signal acquisition,10-20 electrode placement, EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Use of Fourier Transform in EEG Signal Analysis.

## Unit V : Analog Signal Processing 6L

Basics of Instrumentation Amplifier, Isolation amplifier, Grounding and shielding techniques.
Integer Filters: Basic design Concept, Low Pass and High Pass Filters, Band Pass, Band Stop and Band Reject Filters. Its application in Biomedical field.
Adaptive Filters: Basic Concept, Principle noise cancellation model, removal of periodic events using adaptive cancellation, adaptive cancellation of maternal ECG from fetal ECG of Interest.

## Unit VI : Digital signal Processing 6L

Characteristics, frequency domain representation; Stationary and non-stationary bio-signals, waveform detection, Sampling Theory, Finite data considerations (Edge effects), Z Transform, FIR and IIR filters specific to event detection of ECG.Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis like PCA and ICA.

**TEXT BOOKS**


1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Prentice Hall, 2000.
2. R. Rangayan, "Biomedical Signal Analysis", Wiley 2002.
3. John L Semmlow, "Bio-signal and Biomedical Image Processing", Marcel Dekker.


**REFERENCES BOOKS**

1. R.S.Khandpur, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2003, Edition-II.
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, 4th Edition, Prentice Hall, 2000.
3. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley, 2001
4. Sörnmo, “Bioelectrical Signal Processing in Cardiac & Neurological Applications”, Elsevier.
5. C.Reddy “Biomedical Signal Processing: Principles and techniques”, Tata McGraw Hill, New Delhi, 2005.
6. Willis J Tompkins, “Biomedical Signal Processing”, ED, Prentice – Hall, 1993.