Biomedical Signal Processing (404212)

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:

After successfully completing the course students will be able to:

1. Model a biomedical system.
2. Understand various methods of acquiring bio signals.
3. Understand various sources of bio signal distortions and its remedial techniques.
4. Analyze ECG and EEG signal with characteristic feature points.
5. Have a basic understanding of diagnosing bio-signals and classifying them.

Unit I : Biomedical Instrumentation System **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.

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

Cardio Vascular System: Introduction to Heart System, Heart Structure, Functioning of Heart System, ECG Electrodes, Electrocardiograph, Lead Configurations to measure ECG, ECG Machine, Heart sounds.

Nervous System: Nervous System, Structure and functions of Neurons, Electrical activity of nerve cell, Synapse, Reflex action and Receptors.

Unit III: Cardiological Signal Processing **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, Feature points of ECG and its classification for Normal and Abnormal state using Multilayer Perceptron.

Unit IV: Neurological Signal Processing **6L**

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 system and its component, EEG Signal Analysis -Use of Fourier Transform in EEG Signal Analysis.

Unit V: Analog Signal Processing **6L**

Basics of Instrumentation Amplifier, Isolation amplifier, Grounding and shielding techniques.
Design of Filters for Biomedical field. Basic design Concept, Low Pass and High Pass Filters, Band Pass, Band Stop and Band Reject Filters.
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.

Reference 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