

1. Course Modules:

Unit 1: Mathematical Preliminaries:

Fourier transform, sampling and filtering, Solution to wave equation in spherical co-ordinate system, Introduction of Spherical Harmonics.

Unit 2: Basics of bio-signals:

Definition and models of bio-signals, types of bio-signals, bio-signals monitoring, Pre-processing for bio-signals, bio-signals analysis, and classification of bio-signals.

Unit 3: Brain signals:

Human Brain Anatomy, Electroencephalogram (EEG) and magnetoencephalogram (MEG) signals, recording of EEG and MEG signals, EEG signals characteristics and rhythms, evoke potentials, diagnosis of central nervous systems disorders based on brain-signals, various approaches for analysis, feature extraction, and classification of brain signals, MRI and FMRI basics, BOLD signal acquisition, applications of FMRI

Unit 4: Brain Source Localization and connectivity:

Array Signal Processing Basics - Data model, correlation and subspace based (MUSIC) localization, Brain Source Localization: Forward & Inverse Problem, Introduction of Head harmonics for brain source localization (BSL), Application of BSL in BCI control, Epileptogenic zone detection. Brain connectivity representation, decomposition methods and types of networks, Clinical and cognitive applications of brain connectivity.

Unit 5: Cardiac signals:

Electrocardiogram (ECG) and phonocardiogram (PCG) signals, recording process of ECG and PCG signals, heart rate variability (HRV) signals, diagnosis of heart diseases based on cardiac signals, various methods for analysis, feature extraction, and classification for cardiac signals.

Unit 7: Muscle signals:

Electromyogram (EMG) signal, motor unit action potentials (MUAP), EMG and neuro-muscular diseases, feature extraction of EMG, analysis and classification methods for EMG signals.

Unit 8: Other bio-signals:

Pulse signals, blood pressure, blood flow, photoplethysmogram, electrooculogram, electroretinogram, center of pressure, and respiratory signals.