IIT Mandi
Proposal for a New Course

Course number : IK 502
Course Name : **Introduction to Bio-signals**
Credit Distribution : *3-0-2-4*
Intended for : BTech/MTech/MS/MSc/MA/Ph.D.
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

This course is meant for students interested and working in various types of biological signal measurements including neurological signals and images, cardiac signals, muscular signals etc. The course covers various aspects in the study of biosignals including acquisition, basic signal processing, high-level processing, and applications. This would be serve as a basic but detailed course for students and scholars working in the area of medical signal analysis as well as cognitive science.

2. Course Modules with quantitative lecture hours:

Unit 1: Mathematical Preliminaries: **(3 hours)**
Fourier transform, sampling and filtering, Solution to wave equation in spherical co-ordinate system, Introduction of Spherical Harmonics.

Unit 2: Basics of bio-signals: **(2 hours)**
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: **(10 hours)**
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: **(10 hours)**
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: **(8 hours)**
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: **(6 hours)**
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: **(3 hours)**
Pulse signals, blood pressure, blood flow, photoplethysmogram, electrooculogram, electroretinogram, center of pressure, and respiratory signals.

Laboratory/practical/tutorial Modules: The course will involve practical assignments which can be conducted in the lab, and would also involve programming assignments.

3. Textbooks:

1. R.M. Rangayyan, Biomedical Signal Analysis: A case Based Approach, IEEE Press, John Willy & Sons. Inc, 2002.

2. Kayvan Najarian and Robert Splinter, Biomedical Signal and Image Processing, Second Edition, CRC Press, 2005.

4. References:

1. M.A. Jatoi and N. Kamel, *Brain source localization using EEG signal analysis*. CRC Press, 2017

2. Boaz Rafaely, Fundamentals of spherical array processing, Berlin: Springer, 2015

3. HL Van Trees, Optimum Array Processing, New York: Wiley, 2002

4. Scott Heuttel, Allen Song, Gregory McCarthy, Functional Magnetic Resonance Imaging (2nd Edition), Sinauer Associates, 2009

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	NA			

6. Justification of new course proposal if cumulative similarity content is >30%:

NA