GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160313
Semester – VI
Biomedical Signal Analysis

Type of course: Professional Elective Course -II

Prerequisite: Fundamentals of Signals & Systems, Basics of Human Anatomy and Physiology, Linear Constant Co-Efficient Differential Equation, Z-Transform, Fourier Transform, Laplace – Z domain Co-relation, Structure of Digital Time Systems

Rationale: To prepare the student with advanced understanding of signal processing techniques such as Digital Filter Design, Concepts of Adaptive Filtering & Wavelets for Biomedical data processing, Event Detection and Wave Shape Analysis of Biomedical Signals

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	Weightage %
1	**IIR & FIR Filter Design Techniques** **Design of IIR Filter:** IIR filter design using Bi-linear Z-Transform, IIR filter design using Bi-linear Z-Transform with pre warping, IIR filter design using Impulse Invariance Method, Realization of IIR Filters **Design of FIR Filter:** Design of Linear Phase FIR filters, FIR filter design using windowing method (Rectangular, Triangular or Bartlett, Hanning, Hamming, Blackman, Kaiser), Realization of FIR filters Basic Concepts of Moving Average Filters and its Implementation, Comparison between FIR & IIR filters **Filtering for removal of artifacts**: Random noise, structured noise, and physiological interference, Stationary versus non-stationary processes, Various Time-domain filters and Frequency-domain filters for removal of noise	12	25%
2	**Adaptive Signal Processing:** Introduction, Least Square System Design - Introduction, Design Example and Applications, Mean Squared Error Performance, Performance surface search, Steepest Descent and LMS Algorithm and their Examples, Direct Descent and	09	15%

	RLS Algorithm and their examples, Measurement of Adaptive System performance, Other adaptive systems and their examples and structures		
3	**Introduction to Wavelets in Signal Analysis:** Introduction and Overview to Wavelets, From ST to STFT, 1-D Continuous Wavelet Transform, 1-D Discrete Wavelet Transform (DWT), 1-D DWT on Discrete Signals, 2-D Discrete Wavelet Transform (DWT), 2 -D DWT on Discrete Signals, Applications of DWT in Signal processing	08	20%
4	**Application of various algorithm for cardiovascular signal Analysis** ECG Heart Sound, Identification of Heart Sounds, Cardiovascular Diseases and ECG changes, Detection of Events & Waves - Derivative based method for QRS Detection, Pan Tompkins Algorithm, Detection of P wave in ECG, Processing and Extracting feature from ECG, ECG Rhythm Analysis, Arrhythmias Detection, Event Related Potentials analysis, Morphological analysis of ECG, Envelope extraction and Analysis.	08	20%
5	**Application of various algorithm for Brain signal Analysis** EEG Rhythm, Diseases of Central Nervous System and EEG, Processing and Feature Extraction of EEG, Detection of Dicrotic Notch, Correlation analysis of EEG Rhythm, Detection of EEG Rhythm, Template matching for EEG Spike and wave detection, Coherence analysis of EEG channels, EEG for assessment of Anaesthesia, Analysis of Event Related Potentials from EEG	08	20%
	Total	**45**	**100%**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	25%	30%	25%	10%	0%

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from the above table.

Reference Books:

1. Digital Signal Processing N. G. Palan, 2011, Tech-Max Publication
2. Essentials of Digital Signal Processing, B. P. Lathi, 2014, Cambridge University Press
3. Digital Signal Processing with Examples in MATLAB, 2nd Edition, Samuel D.Stearns, CRC Press
4. Biomedical Signal & Image Processing, 2nd Edition, Kayvan Najarian & Robert Splinter, CRC Press
5. Biomedical Signal Analysis - Case Study Approach, Rangaraj M. Rangayyan, IEEE Press

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Course Outcomes:

At the end of this course students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Implement structure of digital filters for noise removal	25%
CO-2	Apply adaptive filtering techniques	15%
CO-3	Summarize different types of Wavelets and its application	20%
CO-4	Understand concepts of Event Detection and Wave Shape analysis	20%
CO-5	Study different algorithms for Biomedical application or diagnosis	20%

Suggested List of Experiments (Outline)

1. To implement structure of IIR and FIR systems in MATLAB
2. To realize and Implement IIR Filters in MATLAB
3. To design and implement various windowing filters in MATLAB
4. To design and implement digital filters for Biomedical Signal Acquisition
5. To implement LMS algorithm in MATLAB
6. To study various descent algorithms for Signal Analysis
7. To study and implement various wavelets for Signal Analysis
8. To detect QRS complex wave from ECG signal using different approaches
9. To measure or extract various ECG features using signal processing approach
10. To measure or extract various ECG features using signal processing approach

Design based Problems (DP)/Open Ended Problem:
To design digital filters systems for analysis of Biomedical Signal.

Major Equipment:
MATLAB/SCILAB, NI LABVIEW software

Online Learning Resources:
https://nptel.ac.in/courses/108/105/108105101/
https://nptel.ac.in/courses/117/102/117102060/
https://nptel.ac.in/courses/108/106/108106151/
https://nptel.ac.in/courses/117/105/117105075/