GUJARAT TECHNOLOGICAL UNIVERSITY

BIO MEDICAL ENGINEERING (31)
BIOMEDICAL SIGNAL PROCESSING
SUBJECT CODE: 2713109
SEMESTER: I

Type of course: Core Subject

Prerequisite: Signal & systems

Rationale: The course aims at providing the students with the knowledge and methodology for extracting useful information from a biomedical signal, interpret the results and validate the descriptors obtained in the light of knowledge of the biological system involved, produce innovation within the scope of the improvement of physiological knowledge, the design of novel, smart medical equipment, the definition of new clinical protocols for prevention, diagnosis, and treatment.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Introduction to Biomedical Signals**	2	8
2	**Analysis of Concurrent, coupled and correlated processes**	2	8
3	**Filtering for removal of artifacts:** Random noise, structured noise, and physiological interference, Stationary versus non-stationary processes, Time-domain filters, Frequency-domain filters, Optimal filtering- the wiener filter, Adaptive filters for removal of interference and applications.	5	15
4	**Event detection**: Detection of Events and Waves: Derivative-based methods for QRS detection, The Pan-Tompkins algorithm for QRS detection, Detection of the dicrotic notch, Detection of the P wave and Applications	6	14
5	**Analysis of Wave shape and waveform complexity** Illustration of case-studies, Analysis of Event-related potentials, Morphological Analysis of ECG waves, Envelope Extraction and Analysis, Analysis of Activity: The root mean-squared value, Zero-crossing rate, Turns count and Form factor	6	15
6	**Frequency-domain characterization of signals and systems:** **Estimation of the Power Spectral Density Function**: The periodogram, The need for averaging, The use of windows: Spectral resolution and leakage, Estimation of the autocorrelation function, Synchronized averaging of PCG spectra, **Measures Derived from PSDs**: Moments of PSD functions, Spectral power ratios, Estimation of the autocorrelation function	7	15

7	**Modeling biomedical systems:** Parametric system modeling, Autoregressive or all pole modeling, Applications of Modeling biomedical systems, Concept of curve fitting	6	10
8	**Pattern Classification and Diagnostic Decision** Introduction & case studies**,** Pattern Classification, Supervised Pattern Classification, Unsupervised Pattern Classification, Probabilistic Models and Statistical Decision, Logistic Regression Analysis, The training and Test Steps, Neural Networks, its applications	8	15

Reference Books:

1. Biomedical Signal Analysis, A Case Study Approach by Rangaraj M. Rangayyan, IEEE Press Series on Biomedical Engineering, John Wiley & Sons,INC.
2. Biomedical Digital signal processing, Willis J. Tompkins, PHI publication.
3. Practical Biomedical signal analysis Using MATLAB , K J Blinowska, J Zygierewicz, CRC press, 2012 by Taylor & Francis Group, LLC

Course Outcome:

After learning the course the students should be able to:

1. The student will be able to understand the applications of biomedical signal processing.
2. The student will apply knowledge of biomedical signal processing to medical diagnostic field.
3. The student will be able to model biomedical systems.
4. The student will be able to analyze and detection of events of various biomedical signals

Suggested List of Experiments:

1 Filter the noisy ECG signal using different filters realized through MATLAB or suitable software
2. Develop a MATLAB program to perform synchronized averaging.
3. Develop different methods for selecting QRS complex from the ECG signal.
4. Select QRS complex from the ECG signal for use as the template and use a suitable threshold on the cross-correlation function for beat detection
5. Design a Wiener filter to remove the artifacts in the ECG signal
6. Develop a program to derive the envelogram
7. Develop a program to compute the RMS value at each instant for the EMG signal
8. Compute the PSDs of a few channels of the EEG

Suggested Open Ended Problems:

- Design an algorithm to detect event in EEG due to various physiological activities.
- Design an algorithm to measure muscles strength by using firing capacity of EMG.
- Establish mathematical relationship between physiological parameters.

Major Equipments:

- A PC/LAPTOP of high specifications
- DSP kit

List of Open Source Software/learning website:

LABVIEW/ MATLAB