CVM UNIVERSITY
(Established under Gujarat Private Universities (Second Amendment) Act : 2019 Gujarat Act No. 20 of 2019)

FACULTY OF ENGINEERING & TECHNOLOGY

First Year Master of Engineering

Semester II

Course Code: 102430204

Course Title: Biomedical Signal Processing

Type of Course: Program Elective III

Course Objectives: To provide knowledge and methodology for extracting useful information from a biomedical signal and to learn basic and advanced signal processing and pattern classification techniques on different biomedical signals like ECG, EEG, and EMG etc.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Internal		External		Total
Lecture	Tutorial	Practical		Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	30 / 15	20 / 10	70 / 35	30 /15	150 / 75

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction To Biomedical Signals: Nature and types of Biomedical Signals- action potential, electrocardiogram (ECG), electroencephalogram (EEG), electromyogram (EMG), electrogastrogram (EGG), electrooculogram (EOG), electroretinogram (ERG); Objectives of Biomedical Signal Analysis.	05
2	Filtering Techniques For Biomedical Signals: Types of digital filters, The z-plane and pole-zero plots, The rubber membrane concept; FIR filters- Smoothing filters, derivative filters, Notch filters, Window design; IIR filters, Integer filters, Adaptive filters, Signal averaging.	07
3	The Cardiovascular System And Ecg Signal Processing: Electrical activity of heart, ECG leads and recording system, Heart rhythms, Heartbeat morphologies, Noise and artifacts in ECG; ECG Signal Processing- baseline wander removal, powerline interference removal, QRS detection- differentiation and template matching techniques, Pan-Tompkins algorithm; P and T wave detection	09
4	The Nervous System And Eeg Signal Processing: The nervous system, EEG rhythms and waveforms, EEG recording techniques, EEG applications- epilepsy, sleep disorders, brain-computer interface (BCI); EEG Signal Processing- artifacts in EEG, artifact cancellation using reference signals, The auto-regressive (AR) and auto-regressive moving average (ARMA) models.	09
5	Advanced Biomedical Signal Processing Techniques: Multi-resolution analysis (MRA) and Wavelets, Pattern classification- Supervised and Unsupervised classification, Neural networks, Support vector machines.	09

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						**R**: Remembering; **U**: Understanding; **A**: Application, **N**: Analyze; **E**: Evaluate; **C**: Create
R	**U**	**A**	**N**	**E**	**C**	
15%	15%	15%	10%	10%	05%	

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 above table.

Reference Books:

1	Lesli Cromwell, F J Weibell, Erich Pfeiffer , "Biomedical Instrumentation and Measurements", PHI
2	Willis J Tompkins, "Biomedical Digital Signal Processing", PHI
3	Rangraj M. Rangayyan , "Biomedical Signal Analysis", John Wiley & Sons
4	Sornmo and Pablo Laguna , "Bioelectrical Signal Processing in Cardiac and Neurological Applications", Leif Elsevier Academic Press

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	To understand human physiological system and generation and acquisition of various biomedical signals.	**25**
CO-2	To understand basic and advanced digital filtering and signal processing techniques for biomedical signals	**25**
CO-3	The student will be able to model biomedical systems.	**20**
CO-4	To implement advanced signal processing and pattern classification techniques for biomedical signals	**30**

List of Practical / Tutorials:

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	Develop an algorithm to remove power line interference from ECG signal
5	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
6	Design an adaptive/ Wiener filter to remove the artifacts in the ECG signal
7	Implement machine learning algorithm on ECG signal
8	Compute the PSD, kurtosis, skewness of the EEG signal
9	Implement algorithm on EEG signal to identify various EEG rhythms
10	Implement Support Vector Machine for biomedical data analysis

Supplementary learning Material:	
1	NPTEL website

Curriculum Revision:	
Version:	**1**
Drafted on (Month-Year):	Apr-20
Last Reviewed on (Month-Year):	Jul-20
Next Review on (Month-Year):	Apr-22