

Branch Name:	Signal Processing and Communication
Program Code:	ET214
Course Name:	Biomedical Signal Processing
Course Code:	2ET2140204T
Pre-requisite Course:	Basic Knowledge of Signals and Systems, Digital Signal Processing

Course Objectives:

1. 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
2. The Course also covers to produce innovation within the scope of the improvement of physiological knowledge; implement basic and advanced signal processing and pattern classification techniques on different biomedical signals like ECG, EEG, and EMG.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								Total (Marks)
					Theory (Marks)				Practical (Marks)				
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40		-	-	-	100

Subject Contents				
Sr. No	Topic	Total Hours	Weight (%)	
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.	04	12	
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.	06	14	
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, first and second heart sound detection.	10	23	

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, Non-parametric spectral analysis; The auto-regressive (AR) and auto- regressive moving average (ARMA) models.	09	23
5	Advanced Biomedical Signal Processing Techniques: Multi-resolution analysis (MRA) and Wavelets, Principal component analysis (PCA), Independent component analysis (ICA), Pattern classification-Supervised and Unsupervised classification, Neural networks, Hidden-Markov models.	10	28
Total		39	100

List of Text Book:

- 1.“Biomedical Instrumentation and Measurements”, Lesli Cromwell, F J Weibell, Erich Pfeiffer, PHI.

List of Reference Books:

1. “Biomedical Digital Signal Processing”, Willis J Tompkins, PHI.
2. “Biomedical Signal Analysis”, Rangraj M. Rangayyan, John Wiley & Sons.
3. “Bioelectrical Signal Processing in Cardiac and Neurological Applications”, Leif Sornmo and Pablo Laguna, Elsevier Academic Press.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand human physiological system and generation and acquisition of various biomedical signals.	1 Remembering 2 Understanding
CLO2	understand basic and advanced digital filtering and signal processing techniques for biomedical signals	2 Understanding 5. Evaluate
CLO3	Design Model biomedical systems	4 Analyze
CLO4	Implement advanced signal processing and pattern classification techniques for biomedical signals.	3 Applying

Mapping of CLOs with POs & PSOs

Course	Program Outcomes (POs)	Program Specific Outcomes(PSOs)
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Learning Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1	H				L	M							H	M	L	
CLO2	H		M	M	L					L		H		M	L	
CLO3		M	H		L									H		L
CLO4		M	H		L			L					L		M	H

H: High, M: Medium, L: Low