

B. Tech. III Semester VI
Program: Minor- Medical Equipment Technology

Subject Name: Biomedical Signal Processing

Subject Code: BTIC13403

Type of course: Minor

Prerequisite (if any): Signals and Systems , Digital Signal Processing, Physiological Measurement System, Familiarity with MATLAB

List of Courses where this course will be prerequisite:

Rationale:

Real world biomedical signals usually include stochastic components. Therefore the biomedical engineering students must first recognize the range of possible signal types and be able to determine the most appropriate type of analysis and processing for the signal of interest. This course includes sources of various physiological students

Teaching and Examination Scheme:

Teaching Scheme				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
4	0	2	5	60	25	15	30	20	150

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests CA2: Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems TEE: Term End Examination TEP: Term End Practical Exam (Performance and viva on practical skills learned in course) CA3: Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

BSC: basic science course /ESC: Engineering Science Course /HSM: Humanities and management /PCC: Professional Core course /PEC: professional Elective course /OEC: Open Elective course/ MD: mandatory noncredit course

Content:

Sr. No.	Content	Total Hrs	Module Weight age
1	Signal Processing Review of Discrete time signals and systems – LTI systems – Response of LTI systems – Convolution – Difference equation representation of discrete systems Z transform – Transform analysis of LTI system – DFT. STFT – Introduction to wavelets – CWT and DWT with Haar wavelet.	10	16%
2	Introduction to Biosignals Computers in medicine. Human anatomy and physiology – Cell structure – Origin of bioelectric potentials – Biomedical signals – The Brain and its potentials. Electrophysiological origin of brain waves. EEG signal and its characteristic- ECG signal origin and characteristics.PPG signal and its characteristic and origin.	12	20%
3	Filtering for Removal of Artifacts for different Biosignals Types of noise in biosignals; Digital filters,IR and FIR, Notch filters – Optimal and adaptive filters. Weiner filters, steepest descent algorithm – LMS adaptive algorithm – Adaptive noise canceller – cancellation of 50 Hz signal in ECG ,Mean Square Error Minimization, Time Series analysis	14	24%
4	Cardiological Signal Processing and analysis Example events (viz. P, QRS and T wave in ECG), Derivative based Approaches for QRS Detection Pan Tompkins Algorithm for QRS Detection, Dicrotic Notch Detection Correlation Analysis of EEG /PPG Signal. Frequency domain characterization.	12	20%
5	Neurological signal processing and analysis The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and	12	20%

	transients), Correlation. Detection of EEG rhythms, Template matching for EEG, spike and wave detection.		
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Suggested Specification table with Marks (Theory): (For B Tech only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20%	30%	20%	10%	10%	10%

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 above table.

Reference Books:

Sr no	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Biomedical signal analysis	Rangayyan, R.M.	John Wiley & Sons. ISBN:978-81-265-2219-4	2013	
2	Signals and Systems in Biomedical Engineering	Suresh R Devasahayam	Kluwer Academic/Plenum publishers ISBN:0-306-46391-1	2000	
3	Biomedical signal processing: principles and techniques.	Reddy, D.C	McGraw-Hill ISBN:9780070583887	2005	

4	Biomedical Digital Signal Processing:C-language Examples and Laboratory Experiments for the IBM PC	Willis J. Tompkins	Prentice Hall of India. ISBN:8120314786, 9788120314788	2006	2 nd Edition
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Course Outcomes:

After studying the subject, Student will be able to

Sr. No.	CO statement	Marks weightage	%
CO-1	To introduce the students to the Sources, Types & Characteristics of Different Noises and Artifacts present in Biomedical Signals.	30%	
CO-2	To Design Time Domain and Frequency Domain Filters for Noise and Artifact Removal from Biomedical signals.	25%	
CO-3	To explore various techniques for cardiological signal processing and analysis.	25%	
CO-4	To explore various techniques for Neurological signal processing and analysis.	25%	

How strongly Pos are addressed by each CO of a subject is indicated by level 1: Slight (Low)2: Moderate (Medium)3: Substantial (High)

Mapping CO-POs

	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				3									3		

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CO2					3								3		
CO3					3								2	3	1
CO4					3								1	3	1

List of Open learning website:

NPTEL lectures on Biomedical Signal Processing

https://onlinecourses.nptel.ac.in/noc20_ee41/preview

List of Open Source Software:

FOR LAB SESSIONS:

1. Laboratory Exercise: Acquisition of ECG and EMG Signals.
2. Matlab Practice to plot ECG, EEG, PPG etc
3. Convolution of two different signals.
4. Fourier transform ,STFT and DWT analysis of ECG signals
5. Laboratory Exercise: Moving Averaging for Noise Reduction
6. Frequency-domain Analysis of Biomedical Signals
7. Filtering of the ECG for the Removal of the 60 Hz Powerline Artifact
8. Filtering of the ECG for the Removal of Noise
9. Detection of the QRS and Parameterization of the ECG.
10. Use of ECG and EEG from open source data lab and processing of them.