



**SARVAJANIK UNIVERSITY**  
**Sarvajanik College of Engineering and Technology**  
**Bachelor of Technology**



**B. Tech. Semester VIII**

**Subject Name:** Biomedical Signal and Image Processing      **Subject Code:** BTEC13805

**Type of course:** PEC

**Prerequisite:** Fundamentals of signal and Image processing, Fourier transform

**Rationale:** The biomedical parameters like ECG, EEG, EMG, etc. are vital signs considered for preliminary diagnostic tools for patient health conditions. This course describes the principles, applications, and design process of the medical instruments used for such measurement. The course covers the topics from the origin of bio-potential, through electrodes, to the special amplifier design requirement and electric safety in hospitals. This course aims at understanding the process and techniques of digital signal processing to make captured biomedical signals understandable and applicable for healthcare sectors.

**Teaching and Examination Scheme**

Teaching Scheme				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	0	3	60	25	15	--	--	100

**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

**Content:**

Sr. no.	Topics	Teaching Hrs.	Module % Weightage
1.	<b>Fundamentals of Signal Processing:</b> Physiological origin of some biomedical signals, such as ECG, EEG, EMG, blood pressure and blood flow. Recording techniques, characteristic features and sources of artefact and noise in these signals Sampling and aliasing, simple signal conversion systems, spectral analysis, Different types of bioelectric signals and its basic characteristics.	4	5
2.	<b>Signal processing and analysis tools:</b> Digital filtering, Coherent averaging, Spectral estimation, Cross correlation, Coherence, Linear models of systems, Noise reduction in biomedical signals.	4	5
3.	<b>Basics of Electrocardiogram (ECG) and its analysis :</b> Fundamental of ECG, waveforms and their characteristics, electrocardiograph, P-wave detection, QRS complex detection-derivative based method, Pan Tompkins algorithm, Template	5	10



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	matching method, Signal averaged ECG , Analysis of heart rate variability-time domain method and frequency domain method.		
<b>4.</b>	<b>Basics of Electroencephalogram (EEG) Signals and its analysis:</b> Fundamentals of EEG, waveforms and their characteristics, 10-20 electrode placement system, Electroencephalogram, EEG rhythms, EEG measurement electrode system, sleep EEG analysis, Elimination of Artifacts, Analysis of EEG in epilepsy, Seizure detection and prediction, EEG monitoring during anesthesia.	6	15
<b>5.</b>	<b>Basic concepts of medical imaging and its properties and various medical image modalities:</b> Pixel vs voxel, spatial resolution, orientation, data type , File formats: DICOM, NIFTI, MINC , Signal-to-noise (SNR) vs Contrast-to-noise (CNR) ratio,- Noise, blurring and modality-specific artefacts, Signal representation: frequency domain, spherical harmonics, sparse bases, Radiography, X-rays projection, fluoroscopy and computed tomography (CT), Nuclear medicine: SPECT and PET,- Ultrasound imaging (US),- Magnetic Resonance Imaging (MRI).	7	20
<b>6</b>	<b>Biomedical Image Analysis Techniques:</b> Image representations and transforms, Image filtering, enhancement, Contrast adjustment, de-noising methods using convolution and Fourier transform techniques, solving an ill-conditioned sparse linear system using de-blurring method, Image restoration, Edge detection, segmentation and registration.	5	10
<b>7.</b>	<b>Segmentation:</b> Various segmentation methods such as thresholding, region growing and watershed. More advanced methods like snakes (adaptive mesh), level set method and clustering method .	5	15
<b>8.</b>	<b>Registration:</b> Intensity-based methods with a variety of cost functions like correlation, least squares, mutual information, robust estimators, optimization techniques like fixed-point iteration, gradient descent, Nelder-Mead simplex method, etc.	4	10
<b>9</b>	<b>Technologies in healthcare:</b> Fundamental of ethical and legal frameworks in biomedical engineering. Introduction to the technology lifecycle and technology assessment for biomedical technologies.	5	10

**Suggested Specification table with Marks (Theory/Practical):**

% Distribution of Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	20	20	20	15

**Legends: R:** Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create



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**Note:** This specification table shall be treated as a general guideline for students and teachers

**Reference Text Books:**

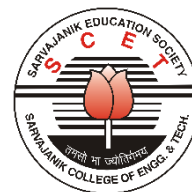
Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	Biomedical signal analysis-A Case-Study Approach	Rangaraj M Rangayan	Wiley Inter science, John Wiley & Sons	2011	Latest
2.	Medical Image Processing: Concepts And Applications	Sinha G. R, Patel B. C	Prentice Hall	2014	Latest
3.	Introduction to biomedical imaging	Andrew Webb	Wiley-IEEE Press	2003	Latest
4.	The Essential Physics of Medical Imaging	Jerrold T. Bushberg	Lippincott Williams	2011	3 <sup>rd</sup>
5.	Biomedical Signal and Image Processing	Kayvan Najarian	CRC Press	2012	2nd
6.	Practical Biomedical Signal Analysis using Matlab	Katarzyna J. Blinowska	CRC Press	2012	4 <sup>th</sup>
7.	Handbook of Biomedical instrumentation	R.S.Khandpur	Tata McGraw	2014	3rd
8.	Medical Instrumentation application and design	John G.Webster	Wiley India	2015	4th
9.	Introduction to biomedical equipment technology	Joseph J Carr John M Brown	Pearson Education	2004	4th

**Course Outcome:**

Sr. No.	CO Statement After learning this subject students will be able to,	Marks % weightage
CO-1	Describe various sources, types and characteristics of Different artifacts present in biomedical signals	20
CO-2	Apply filters for noise and artifacts removal from biomedical signals	25
CO-3	Apply various methods for analysis of biomedical signal characteristics.	20
CO-4	Explain workings of the main medical imaging modalities, including Xray, CT, MRI, Ultrasound and video	15
CO-5	Perform biomedical image analysis including segmentation, registration , visualization and 3D medical image reconstruction	20



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**Mapping with POs:**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
<b>CO-1</b>	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2</b>	3	-	-	-	2	-	-	-	-	-	-	2	2	2	2
<b>CO-3</b>	3	-	-	-	2	-	-	-	-	-	-	2	2	2	2
<b>CO-4</b>	2	-	-	-	2	-	1	1	--	-	-	2	-	2	-
<b>CO-5</b>	3	2	3	2	2	2	1	1	2	2	2	2	1	2	2

**List of Open Source/learning website:**

- [https://nptel.ac.in/courses/108105101-Biomedical Signal Processing](https://nptel.ac.in/courses/108105101-Biomedical%20Signal%20Processing)
- [https://nptel.ac.in/courses/108105091-Medical Image Analysis](https://nptel.ac.in/courses/108105091-Medical%20Image%20Analysis)
- [https://nptel.ac.in/courses/102105090-Introduction to Biomedical Imaging Systems](https://nptel.ac.in/courses/102105090-Introduction%20to%20Biomedical%20Imaging%20Systems)

**List of Open Source Software:**

- python, keras and pandas, opencv