SEMESTER S5

BIOMEDICAL SIGNAL PROCESSING

Course Code	PCBMT501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	PC

Course Objectives:

1. To enable the students to learn about widely used signal processing techniques, emphasizing biomedical applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Signals and Signal Processing-** Characterization and Classification of Signals- Elementary Signals , Typical signal Processing Operations, Examples of Biomedical Signals , Analog-to-Digital Conversion (block diagram only) **Discrete-Time Signals** –Typical Sequences and Sequence-Representation, Discrete-Time Systems-Classification of Discrete-Time Systems	11
2	**Discrete-Time Fourier Transform (DTFT)**-Definition, Properties **Discrete Fourier Transform (DFT)-**Definition, Properties **Fast Fourier Transform (FFT)**-Decimation-in-Time, Decimation-in-Frequency. **z Transform**- Properties of the z-Transform, Poles and Zeros, Inversion of the z-Transform Using partial fraction expansion, Analysis of Linear Time-Invariant Systems in the z-Domain, Transfer function, Frequency response	11
3	**LTI systems as frequency selective filters**- Ideal filter characteristics, Simple Digital Filter Design-Preliminary Considerations, Design of linear-phase FIR Filter using windows (Bartlett) and frequency sampling method **IIR Filter Design**- Approximation of Derivatives, Impulse invariance, Bilinear Transform Method, Analog filter approximation -Butterworth approximation, Frequency Transformations (Analog and Digital domain)	11

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4	**Periodogram**- Averaged periodogram, QRS detection in ECG, Analysis of Heart Rate Variability using periodogram **Adaptive Filters-** Principle of Wiener Filters, Principle of adaptive filtering, Principle of adaptive noise cancellation, Cancellation of 50-Hz interference in ECG	**11**

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

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End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate the fundamentals of discrete-time signals and systems.	**K2**
CO2	Apply domain transformation techniques in discrete-time signals.	**K4**
CO3	Design digital filters and apply the concepts in biomedical scenarios.	**K4**
CO4	Apply different power spectrum estimation and noise cancellation techniques for biomedical applications.	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3							2		2
CO2	3	3	3	3	3					2		2
CO3	3	3	3	3	3					2		3
CO4	3	3	3	3	3					2		3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

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Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Biomedical signal processing: principles and techniques	Reddy, D. C.	McGraw-Hill	2005
2	Digital Signal Processing Principles, Algorithms and Applications	John G Proakis& Dimitris G Manolakis	Prentice Hall of India	2005
3	Biomedical signal processing	Akay Metin.	Academic press	2012
4	Biomedical digital signal processing	Tompkins Willis J.	Editorial Prentice Hall	1993
5	"Digital signal processing (Book, 598 p)." Research supported by the Massachusetts Institute of Technology, Bell Telephone Laboratories, and Guggenheim Foundation	Oppenheim Alan V Ronald W. Schafer.	Englewood Cliffs, N. J., Prentice-Hall, Inc	1975
6	Biomedical signal processing: principles and techniques	Reddy, D. C.	McGraw-Hill	2005
7	Digital Signal Processing Principles, Algorithms and Applications	John G Proakis& Dimitris G Manolakis	Prentice Hall of India	2005

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital signal processing: a computer-based approach. Vol. 2	Mitra, Sanjit Kumar YonghongKuo	New York: McGraw-Hill	2006
2	Signals and systems for bioengineers: a MATLAB-based introduction	John Semmlow	Academic Press	2011
3	Biomedical Signal Analysis	Rangaraj M Rangayyan	John Wiley	2002

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/104/108104100/
2	https://nptel.ac.in/courses/117102060
3	https://nptel.ac.in/courses/117102060

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