2BM504: Biological Digital Signal Processing **[3 2 0 3 1]**

Learning Outcomes:

After successful completion of the course, student will be able to

- Understand signals and systems.
- Various Transform techniques for Digital Signal Processing.
- Digital Filter design concepts and their application for biological signal processing.
- Digital data compression.

SYLLABUS

Unit No.	Topics	Lectures (Hours)
	Introduction to the overview and importance of the course.	
1	**INTRODUCTION:** Basic of DSP, Block Diagram of Digital System, Comparison between Digital Signal Processing and Analog Signal Processing, Applications and Advantages of Digital Signal Processing	**2**
2	**DISCRETE TIME SIGNALS AND SYSTEMS:** **Basic Concepts of Signal:** continuous and discrete time signals, periodic and aperiodic signals, even and odd signals, energy and power signals, operations on sequences. Representation of Discrete Time Signal and standard test signals. Basic Operation on Discrete Time Signals: Time Shifting Operations. **Discrete Time System:** Definition and notation, Symbol to represent DTS, Interconnection of DTS, linear vs. nonlinear ,time variant vs. time invariant, causal vs. non-causal , stable vs. unstable system, **Linear Time Invariant System:** impulse response, convolution, correlation-autocorrelation, cross correlation with computation and example of each.	**12**
3	**TRANSFORM DOMAIN TECHNIQUES:** **Discrete Time Fourier Transform and its properties.** **Discrete Fourier Transform (DFT):** Definition and mathematical equation, relationship between DTFT and DFT, Twiddle factor and cyclic property. DFT computation using various techniques. DFT properties. **Inverse DFT and its calculation.** **Fast Fourier Transform (FFT):** Need of FFT, Radix-2 FFT algorithm, Radix-2 Decimation In Time algorithm, Butterfly diagram, construction of Butterfly diagram using Radix-2 Decimation In Time algorithm for 4 and 8 point DFT.**Z-transform**: Region of convergence (ROC), Z-transform properties	**10**
4	**FILTER DESIGN:** Basics of Digital Filters, Digital Filter system Transfer Function **Infinite Impulse Response (IIR) Filters:** TF of FIR system, Impulse Response of Ideal Low Pass Filter, Design of IIR filters, Analog filters to design digital filters, Frequency transformations.	**10**

	Finite Impulse Response (FIR) Filters: TF of FIR system, Design of linear phase FIR filters, **Design of FIR filters using window techniques**: Rectangular, Hamming, Hanning, Blackman, Kaiser, Gibb's phenomenon**,** Advantages and disadvantages of Window method, Comparison between IIR and FIR filters. Removal of noise, motion artifacts from ECG signal, removal of baseline drift in ECG using different FIR filters. **Adaptive Filters:** Basic concept, principal noise cancellation model, removal of periodic events using adaptive cancellation, adaptive cancellation of maternal ECG from Fetal ECG of interest	
5	**DATA COMPRESSION TECHNIQUES:** Lossy and Lossless data reduction algorithms, ECG data compression using Turning point, AZTEC, CORTES and Hoffman coding.	**4**
6	**BIOLOGICAL SIGNAL PROCESSING::** **Cardio logical Signal Processing:** pre-processing, QRS detection methods, Rhythm analysis, Arrhythmia detection algorithms, Heart rate variability analysis. **Neurological Signal Processing:** Modeling EEG signals, Detection of spikes and spindles, Detection of Alpha, Beta and Gamma waves, Sleep stage analysis, Inverse filtering.	**4**
7	Finite word length effects, Commercial DSP processors, Comparison of microprocessor and DSP processor.	**2**

Term Work and Practical shall be based on the above syllabus.

Text Books:

1. Digital Signal Processing by N.G.Palan
   Tech-Max publication, Pune.
2. Biomedical Signal Processing- Principles and techniques By D.C.Reddy
   Pub.: TMH, 2005
3.

Reference Books:

1. Biomedical Digital Signal Processing By Wills J.Tompkins.
   Pub.: Prentice Hall of India Pvt. Ltd. New Delhi.
2. Digital signal processing By oppenheim & schafer
   Pub.: Prentice Hall
3. Digital signal processing By Sanjit K Mitra.
   Pub.: Tata Mcgraw-hill Publishing company ltd.
4. Biomedical Signal analysis By Rangaraj M. Rangayyan
   IEEE Press, 2001.
5. Digital Signal Processing by John G. Proakis, Dimitris G. Manolakis.
   Pearson Prentice Hall, 2007
6. Analog and Digital Signal Processing by Ashok Ambardar, 2e