Course Module for Biomedical and Image Processing
(B.Tech 8th Sem ECE)
Biomedical and Image Processing

Subject Code: ECE-109E   **L T P: 3 1 0**   **Credits: 03**

Syllabus

Unit I
Fundamentals of Signal Processing: Sampling and aliasing, Signal reconstruction, Signal conversion systems, Circular convolution Correlation- Autocorrelation – Cross correlation, FFT-decimation in time algorithm, Decimation in Frequency algorithm

Unit II
Digital Filter Design: Basics of filter, Design of IR filter-impulse invariant method – Bilinear Transformation Method Warping and pre-warping effect, Frequency transformation, Characteristics of FIR filter, FIR filter design using windowing techniques- Rectangular window – Hamming window – Hanning window

Unit III
Wavelet and Speech Processing: Introduction to wavelets, Time frequency representation, Discrete wavelet transform, pyramid algorithm, Comparison of Fourier transform and wavelet transform, Speech analysis – Cepstrum – Homomorphic filtering of speech signals, ECG signal characteristics – EEG analysis..

Unit IV:
Analysis of Bio-signals: Automatic analysis and classification of ECG, P-wave detection, QRS complex detection, Correlation analysis of ECG signals, Signal averaged ECG, Analysis of Heart Rate variability, Synchronized averaging of PCG envelopes, Analysis of PCG signal, Analysis of EMG signal

Unit V:
Introduction to Human vision and perception: Image enhancement, feature detection

TEXT BOOKS:

R1.   Digital Signal Processing, Principles Algorithms and Applications, Third edition; **John G, Proakis and Dimitris G Manolakis** (Prentice Hall)

R2.   Biomedical signal analysis-A Case-Study Approach, **Rangaraj M Rangayan** (Wiley-Interscience, John Wiley & Sons, Inc)

R3.   Biomedical Digital Signal Processing ,**Willis J. Tompkins** (Prentice Hall)

R4.   Introduction to Wavelets and Wavelet Transforms- A Primer, **C. Sidney Burrus, Ramesh A. Gopinath and Haitao Guo** (Prentice Hall)

R5.   Digital Image Processing, Second edition **Rafael C. Gonzalez, Richard E. Woods**, (Prentice Hall)

Download Link for Text Books:
https://drive.google.com/open?id=1hsqXSlxCr5DE5IlJsrOmX39bQbL0Wpx-

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Course Module/Plan

Unit	Unit Name	Topics	Reference	NPTEL Videos Link
I	Fundamentals of Signal Processing	• Sampling of analog signals and Sampling -Theorem • Reconstruction of analog signal from its samples • DFT and circular Convolution • Fast Fourier Transform (FFT)- Divide and Rule Approach • Radix-2FFT Algorithms	R1 (Chapter 1) R1 (Chapter 5) R1 (Chapter 6)	https://nptel.ac.in/courses/108/105/108105055/ Digital Signal Processing Prof. T.K. Basu IIT Kharagpur
II	Digital Filter Design	• General Consideration- Causality and its implications • Design of liner phase FIR filters using windows • IIR filter design by impulse invariance methods • IIR filter design by the Bilinear transformation • Frequency Transformations	R1 (Chapter 8)	https://nptel.ac.in/courses/108/105/108105055/ Digital Signal Processing Prof. T.K. Basu IIT Kharagpur
III	Wavelets	Introduction to Wavelets: • Wavelets and wavelet expansion systems • The discrete time and continuous wavelet transform	R4 (Chapter 1)	https://nptel.ac.in/courses/108/101/108101093/ Fundamentals of Wavelets, Filter Banks and Time Frequency Analysis Prof. V.M. Gadre, IIT Bombay
		A Multiresolution formulation of wavelet systems : • The scaling function • The wavelet functions • Examples of wavelet expansions	R4 (Chapter 2)	
		Filters banks and discrete wavelet transform • Analysis- From fine scale to coarse scale ;filtering and down sampling • Synthesis- From coarse scale to fine scale ; filtering and up sampling • Time frequency analysis	R4 (Chapter 3)	
		Wavelet based signal processing and applications	R4 (Chapter 10)	
IV	Analysis of Bio-medical signals	Introduction to Biomedical Signals • The Nature and Examples of Biomedical Signals The electrocardiogram (ECG), The electroencephalogram (EEG), The phonocardiograrn (PCG) • Basic electrocardiography: ECG lead systems :ECG signal characteristics • Objectives of Biomedical Signal Analysis • Difficulties in Biomedical Signal Analysis	R2 (Chapter 1) R3 (Chapter1, Chapter 2)	https://nptel.ac.in/courses/108/105/108105101/ Biomedical Signal Processing Prof. Sudipta Mukhopadhyay IIT Kharagpur
		Filtering for Removal of Artifacts: • Random noise, structured noise, and physiological interference	R2 (Chapter 3)	

		• High-frequency noise in the ECG; Motion artifact in the ECG Power-line interference in ECG signals; Maternal interference in fetal ECG Potential solutions to the problem • Time-domain Filters • Frequency-domain Filters • Optimal Filtering: The Wiener Filter • Adaptive Filters for Removal of Interfere Application: Removal of Artifacts in the ECG Application: Maternal - Fetal ECG		
		Event Detection: • The P, QRS, and T waves in the ECG • The first and second heart sounds • The dicrotic notch in the carotid pulse • EEG rhythms, waves, and transients • The Pan-Tompkins algorithm for QRS detection • Detection of the dicrotic notch	R2 (Chapter 4)	
IV	Introduction to Human vision and perception	Digital Image Fundamentals	R5 (Chapter2)	https://nptel.ac.in/courses/117/105/117105079/ Digital Image Processing Prof. P.K. Biswas, IIT Kharagpur
		Image enhancement in the spatial domain • Basic Gray level transformations • Histogram processing • Smoothing spatial filters • Sharpening spatial filters	R5 (Chapter3)	
		Image enhancement in the frequency domain	R5 (Chapter 4)	