Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ET911	Advanced Digital Signal Processing	4	--	--	4	--	--	4
		Examination Scheme						
		Theory Marks						
		ISE			MSE		ESE	
		10			30		100 (60% Weightage)	

Pre-requisite Course Codes		Signals and Systems, Discrete Time Signal Processing
Course Outcomes	CO1	To design multirate DSP systems.
	CO2	Implement adaptive filters for a given application
	CO3	Study and apply the techniques of power spectrum estimation and wavelet theory for various applications.
	CO4	Apply Signal processing tools to bio-medical signal processing.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Discrete Random Signal Processing**	1	08
	1.1	Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem, special types of random process – Signal modeling-Least Squares method, Pade approximation, Prony's method, iterative Prefiltering, Finite Data records,Stochastic Models.		
2		**Spectrum Estimation**	5	08
		Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation - Model based approach - AR, MA, ARMA Signal modeling -Parameter estimation using Yule-Walker method.		
3		**Linear Estimation and Prediction**	5,8	08
	3.1	Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion -Wiener filter - Discrete Wiener Hoff equations - Recursive estimators - Kalman filter - Linear prediction, Prediction error - Whitening filter, Inverse filter -Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.		
4		**Adaptive Filters**	6	08
	4.1	FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization -		

		Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS - Sliding window RLS - Simplified IIR LMS Adaptive filter.		
5	**5.1**	**Multirate Digital Signal Processing**	5	08
		Mathematical description of change of sampling rate - Interpolation and Decimation -Continuous time model - Direct digital domain approach - Decimation by integer factor -Interpolation by an integer factor - Single and multistage realization - Poly phase realization - Applications to sub band coding - Wavelet transform and filter bank implementation of wavelet expansion of signals.		
6		Application of Digital Signal Processing to Biomedical Signal Processing	12	08
	6.1	ECG preprocessing, QRS template, QRS detection methods, performance measure for QRS detection.		
	6.2	Adaptive removal of ocular artifacts from human EEGs- Methods for removal and control of ocular artifacts, online Ocular Artifacts Removal (OAR) algorithm and system, hardware for online OAR system, system testing and experimental results.		
			Total	48

References:

[1] John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing", PHI, 2005.

[2] Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, 2006.

[3] Sophoncles J. Orfanidis, "Optimum Signal Processing ", McGraw-Hill, 2000.

[4] Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ1986.

[5] S. Kay," Modern Spectrum Estimation Theory And Application", Prentice Hall, Englehood Cliffs, Nj1988.

[6] P. P. Vaidyanathan, "Multirate Systems And Filter Banks", Prentice Hall, 1992.

[7] S. M. Kay, Modern Spectrum Estimation Theory and Application", PHI.

[8] K. P. Soman, K.I. Ramchandran and N. G. Reshmi, "Insight into Wavelets: From theory to practice, Third Edition PHI, 2010.

[9] Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach", Wiley 2002.

[10] Willis J. Tompkins, Biomedical Digital Signal Processing, PHI, 1999.

[11] Sen M Kuo, Bob H Lee and W Tian, "Real Time Signal processing: Fundamentals, Implementations and Applications" Springer, Wiley Publishers, Third Edition 2013.

[12] S. K. Mitra, "Digital Signal Processing", TMH, 2001

[13] Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing, A Practical Approach", Pearson Education, 2008.

[14] D. C. Reddy, Biomedical Signal Processing Principles and Techniques, Tata Mc Graw-Hill, 2005.

[15] A. H. Sayed, "Adaptive filters", Wiley Student Edition, 2010.

[16] S. Thomas Alexander, Adaptive signal processing-Theory and Applications, Springer – Verlag.

[17] Torrence, Christopher, and Gilbert P. Compo, "A practical guide to wavelet analysis." Bulletin of the American Meteorological society Jan. 1998.

[18] Burrus, C. Sidney, Ramesh A. Gopinath, and Haitao Guo. "Introduction to wavelets and wavelet transforms." Prentice Hall Inc. 1997.

[19] Paul S. Addison, "The illustrated wavelet transform handbook: introductory theory and applications in science, engineering, medicine and finance." CRC press, 2002.