BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

Hyderabad Campus AGSRD DIVISION FIRST SEMESTER 2023 - 2024 COURSE HANDOUT

Date: 23 / 07 / 2023

Course No : EEE G613

Course Title : Advanced Digital Signal Processing

Instructor-in-charge : Dr. Rajesh Kumar Tripathy

Instructors: **Practical**: Ms. Shaswati Dash

1. Course Description:

This course deals with introduction to random processes and spectral representation, modeling of AR, ARMA time-series processes, spectrum estimation, spectrum analysis and design of optimum (Wiener and Kalman) filters for estimating signals in noise, adaptive filters for estimating & predicting non-stationary signal and linear prediction. Some applications based on algorithms for adaptive statistical signal processing would be included.

2. Scope and Objective:

To provide a strong background on most important advanced DSP topics. It will include topics, which are used in different fields of signal processing applications, which include linear prediction and optimal filter design using Wiener and Kalman filters. The focus is on adaptive signal processing. It deals with signal modeling, optimal filtering, spectrum estimation and adaptive filtering.

3. Text Book:

- 1. Monson H. Hayes, *Statistical Digital Signal Processing and Modeling*, Wiley-India, 2008. **Reference books:**
- 1. Manolakis, D., Ingle, M., Kogon, S., *Statistical and Adaptive Signal Processing*, McGraw-Hill, 2000.
- 2. Simon Haykin, *Adaptive Filter Theory*, Pearson Education, Fourth Edition, 2002.

4. Course Plan:

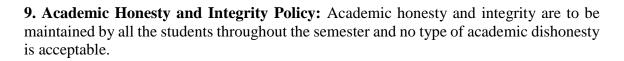
Lecture	Topics to be covered	Learning Objectives	References
No.			
1	Introduction to the course, evaluation system		1
2-4	Background: z-transform, DTFT principles,	Fourier transform	T1: 2
	matrix algebra, complex gradients	orthogonality principle	
5-8	Random variables and random processes and	Difference between	T1: 3.1-3.3
	basic probability theory for statistical signal	Random variables and	
	analysis	random processes	
9-13	Special types of random processes, signal	Model approximation	T1: 4.1-4.4.4, 4.6
	modeling and approximation methods (Pade,	methods least square	
	Prony)	approach	

14-17	Stochastic Models , AR, MA and ARMA	Difference between AR,	T1: 4.7
		ARMA and MA models	
18-21	Levinson-Durbin Recursion Algorithm and	Efficient algorithm to	T1: 5, 5.2.6,
	Lattice Filter Structure, Cholesky	compute filter coefficients	5.2.7
	Decomposition	and their practical	
		implementation	
22-25	Introduction to filtering, Optimal FIR filtering:	Optimum filters for various	T1: 7
	Wiener filter	applications such as noise	
		cancellation, removal of	
		degradation	
26-28	Kalman filters	Optimum filters for various	T1: 7.4
		applications such as noise	
		cancellation, removal of	
		degradation	
29-30	Non parametric spectrum estimation	Power spectrum estimation	T1: 8.2
		for non-stationary signals	
31-33	Minimum variance spectrum estimation,	Different algorithms to	T1: 8.3,8.5,8.6
	Parametric spectrum estimation, Frequency	perform spectrum	
	estimation: Pisarenko, MUSIC	estimation	
34-38	Steepest descent algorithm and convergence	Different types of	T1: 9.2.1, 9.2.2,
	analysis LMS, NLMS, Adaptive filters, Least	algorithms for estimating	9.2.3, 9.2.4, :
	Square methods and The RLS algorithm,	filter coefficients in an	9.3, 9.4
	Acoustic Echo Cancellation	optimal manner	
39- 42	Term Project presentations		

5. Evaluation Scheme:

Component	Duration	Weightage	Marks	Date & Time	Evaluation type
Midsem	2 hours	20%	60	14/10 4.00 - 5.30PM	Closed book
Take-home Assignments		20%	60	To be announced	Open book
Compre. Exam.	3 hours	40%	120	21/12	Closed Book
Lab	Regular	20%	60	-	Open Book
Total			300		

- **6. Chamber Consultation Hours:** To be announced in the class.
- **7. Make-up Policy:** Make-up for the tests will be granted as per ID rules. In all cases prior intimation must be given to IC. **There will be no make-up for the term paper/project presentations.**
- **8. Notices:** Notices regarding the course will be displayed in CMS/Google Classroom



Instructor - in - charge