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

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

9. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor - in - charge