BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
INSTRUCTION DIVISION
FIRST SEMESTER 2021 - 2022
COURSE HANDOUT (PART II)

Date: 07/08/2021

In addition to Part I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No **: EEE G613** **3 2 5**

Course Title **: Advanced Digital Signal Processing**
Instructor-in-charge **: Ramakant Yadav**

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 provides a comprehensive treatment of signal processing algorithms for modeling discrete-time signals, designing optimum filters, estimation of the power spectrum of a random process, and implementing adaptive filters. These are important topics that are frequently encountered in professional engineering, and major applications such as digital communication, array processing, biomedical signal processing and multimedia (speech and audio processing, image processing).

3. Text Book:

1. Monson H. Hayes, *Statistical Digital Signal Processing and Modeling*, Wiley-India, 2008.

4. 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.

5. 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: 5.1-5.2.2, 5.2.7, 6.2
22-25	Introduction to filtering, Optimal FIR filtering: Wiener filter,	Optimum filters for various applications such as noise cancellation, removal of degradation	T1: 7.1, 7.2
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. Lab Experiments:

Practical No	Name of the experiment
1.	Introduction to the lab Introduction to MATLAB
2.	Operations on matrices
3.	Operations on random variable and random processes
4.	Determine the autocorrelation and power spectral density
5.	Signal Modeling using Pade' approximation
6.	Signal Modeling using Prony's approximation Method
7.	Power Spectrum Estimation
8.	Implementation of Levinson-Durbin Recursion Algorithm
9.	Design of Weiner Filter for Filtering Application
10.	Design of Weiner Noise Cancellation Filter

6. Evaluation Scheme:

Component	Duration	Weightage	Marks	Date & Time	Evaluation type
Mid-Sem	90 min	25%	25	As per Timetable	Open Book
Quizzes, No makeup allowed		10%	10	To be announced	Open Book
Lab (weekly Lab)		10%	10	-	Open Book
Lab (Lab exam)		5%	5	-	Open Book
Term Project		10%	10	-	Open Book
Comprehensive	3 hours	40%	40	As per Timetable	Open Book
Total		**100%**	**100**		

7. Chamber Consultation Hours: To be announced in the class.

8. 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 and quizzes.**

9. Notices: Notices regarding the course will be displayed in CMS.

10. 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
EEE G613