BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

Hyderabad Campus

**FIRST SEMESTER 2022 - 2023**

**COURSE HANDOUT (PART II)**

Date: 23 / 07 / 2022

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**

*Course Title* : **Advanced Digital Signal Processing**

*Instructor-in-charge* : Dr. Rajesh Kumar Tripathy

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

**Description :** Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalman-filter, non-linear identification, quasi linearization, numerical identification methods.

**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.

1. **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 |  |  |

1. **Evaluation Scheme:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Component** | **Duration** | **Weightage** | **Marks** | **Date & Time** | **Evaluation type** |
| Midsem | 1.5 hours | 20% | 60 | 31/10 3.30 - 5.00PM | Closed book |
| Take-home Assignments |  | 20% | 60 | To be announced | Open book |
| Compre. Exam. | 3 hours | 40% | 120 | 19/12 AN | 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.**

**8. Notices:** Notices regarding the course will be displayed in **CMS/Google Classroom**

**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