NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B.Tech. Electronics & Communication Engineering
Course Code:	3EC403ME24
Course Title:	Statistical Signal Processing
Course Type:	Departmental Elective
Year of Introduction:	2024-25

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Course Learning Outcomes (CLOs):

At the end of the course, students will be able to

1. solve the problems on random variables and random processes. BL-4
2. apply the concepts of random processes in information theory. BL-3
3. analyse the prediction algorithm using statistics. BL-4
4. evaluate power spectrum estimation using parametric and non-parametric methods. BL-5

Unit No.	Contents	Teaching hours (Total 45)
I	**Probability and random variables:** Overview of probability and random variables, Statistics of random variables, mean, variance, covariance, Random processes, classification of random processes.	05
II	**Functions of random variables:** Function of one random variable, Function of two random variables, joint probability mass function, joint probability density functions, marginal probability distribution, cumulative distribution function, conditional probability distribution, central limit theorem, determination of probability of addition, subtraction, multiplication, division of two random variables, two functions of two random variables, Jacobian, linear transformation	10
III	**Stochastic processes:** Classification of stochastic processes, Continuous and discrete random processes, statistics of random processes, stationary random processes, wide sense stationary processes, strict sense stationary processes, ergodic processes, non-stationary processes, Random walks, bandlimited processes and sampling theory, Entropy, Markov processes, Markov chain with higher transition probabilities, classification of states, branching processes Poisson random processes, statistics of Poisson random processes,	10
IV	**Linear Prediction:** innovation representation of a stationary random process, Forward linear prediction, relationship of an autoregressive process to linear prediction, backward linear prediction, Wiener filters for filtering and prediction, FIR Wiener filter, Orthogonality principle in linear mean square estimation, Wiener Hopf equations, IIR wiener filter, noncausal Wiener filter, autoregressive processes (AR), moving average (MA) processes, auto regressive moving average processes (ARMA) Yule Walker equation	15
V	**Power spectrum estimation:** Estimation of spectra from finite duration observation signals, Estimation of the autocorrelation and power spectrum of random signals, the use of the DFT in power spectrum estimation, Non-parametric methods for power spectrum estimation, Parametric methods for power spectrum estimation.	05

Self-Study:

The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Suggest List of Tutorials (not restricted to the following):
(Only for information)

Sr. No.	Title of the tutorial	Hours
1.	Probability theory	01
2.	Functions of one random variable	01
3.	Functions of two random variables	01
4.	Sequences of random variables	01
5.	Classification of random processes	01
6.	Statistics of random variables and random processes	01
7.	Random walks and other applications	01
8.	Spectral estimation	01
9.	Markov processes	01
10.	Linear prediction	01
11.	Wiener filters	01
12.	Autoregressive processes	01
13.	Yule walker equations	01
14.	Parametric methods for power spectrum estimation	01
15.	Non-parametric methods for power spectrum estimation	01

Suggested Readings:

1. A. Papoulis, S. Unnikrishna Pillai, Probability, random variables and stochastic processes, Tata McGraw-Hill
2. S. Palaniammal, Probability and random processes, PHI Publication
3. M. D. Srinath, P.K. Rajasekaran, R. Viswanathan, Introduction to Statistical Signal Processing with Applications, PHI Publication
4. D. G. Manolakis, V. K. Ingle, S.M. Kogan, statistical and adaptive signal processing: spectral estimation, signal modelling and adaptive filtering and array processing, Artech house.