PCL 105: Statistical Methods and Algorithms (for M.tech CSE, Mech., Civil)

L	T	P	Cr
3	0	2	4

Course Objective: The course aims to introduce to the students, fundamental principles as well as advanced topics in statistics and sampling techniques. This course underscores the importance of statistical methods to perform scientific and engineering research.

Review of basic probability and statistical principles: Axioms of probability, conditional probability, Bayes' rule, Conditional probability distributions, conditional expectations, law of total probability and law of total expectation, introduction to Bernoulli, binomial, Poisson, geometric, Normal, exponential, distributions, joint and marginal distributions, central limit theorem, probability distribution of functions of random variables.

Hypothesis tests: Introduction to sampling distributions (standard Normal, chi-square, F and t distributions) and their properties, introduction to hypothesis tests (difference between one tailed and two tailed tests), level of significance of test and power of test, two sample test for means using t-distribution.

Analysis of variance: One Way ANOVA, two-way ANOVA with examples.

Time Series Analysis: Autoregressive models: AR(1), AR(p), moving average models: MA(1), MA(q), autoregressive moving average models: ARMA(p,q).

Multivariate Data Analysis and regression: Introduction to linear regression with trends and least squares estimate, definition of Covariance matrix and its application in engineering problems using Principal Component Analysis.

Markov Chains: Introduction to discrete Markov chains in finite state space, multi-step state transition probabilities, stationary (limiting distributions), Chapman-Kolmogorov equations, hitting probabilities, return and exit time distributions for discrete Markov chains, classification of states, detailed balance.

Laboratory Work: Each laboratory experiment will consist of numerical exercises on one of the above topics. Laboratory experiments will be performed using Matlab/SPSS.

Course Learning Outcomes (CLO): Upon the completion of this course, the students will able to:

1. compute probabilities of composite events, apply concepts of random variables and distributions.
2. obtain foundational understanding of discrete Markov processes.
3. make statistical inferences using principles of hypothesis tests and ANOVA.
4. perform analysis of time series data with different time series models.
5. perform multivariate data analysis using Principal Component Analysis and linear regression.

Recommended Books:

1. Durrett, R., Essentials of Stochastic Processes, Springer (2016).
2. Ross, Sheldon, Stochastic Processes, John Wiley and Sons (1996).
3. Hogg, R., McKean, J. and Craig, A. Introduction to Mathematical Statistics, Pearson (2013).
4. Hamilton, James, Time Series Analysis, Princeton University Press (2012).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	Mid-Term Examination	25
2	End-Term Examination	45
3	Assignment/Lab Evaluation/Projects	30