



# PROBABILITY AND STATISTICS

## PROF. SOMESH KUMAR

Department of Mathematics  
IIT Kharagpur

**INTENDED AUDIENCE** : Any Interested Learners.

**PRE-REQUISITES:** Must have good knowledge of Differential and Integral Calculus, sequences and series, Basic Linear/ Matrix Algebra (usually students who have completed Mathematics-I and II at first year undergraduate

**INDUSTRY SUPPORT :** Today all industries use statistical methods. So for students desirous to work in any type of industry, this course will be indispensable. In particular, companies dealing with Business Analytics, Banking and finance, Insurance machine learning, data mining etc. this course will be invaluable.

## COURSE OUTLINE :

The use of statistical reasoning and methodology is indispensable in modern world. It is applicable to every discipline, be it physical sciences, engineering and technology, economics or social sciences. Much of the advanced research in electronics, electrical, computer science, industrial engineering, biology, genetics, and information science relies increasingly on use of statistical tools. It is essential for the students to get acquainted with the subject of probability and statistics at an early stage. The present course has been designed to introduce the subject to undergraduate/postgraduate students in science and engineering. The course contains a good introduction to each topic and an advance treatment of theory at a fairly understandable level to the students at this stage. Each concept has been explained through examples and application oriented problems.

## ABOUT INSTRUCTOR :

Prof. Somesh Kumar is a professor in the Department of Mathematics, IIT Kharagpur. He has over 32 years of experience of teaching courses on Probability Statistics, Statistical Inference, Sampling Theory, Stochastic Processes, Multivariate Analysis, Regression Analysis, Time Series, Experimental Designs, Decision Theory to undergraduate, postgraduate and doctorate students. His NPTEL courses (under MHRD) on Probability and Statistics, Statistical Inference and Statistical Methods for Scientists and Engineers (each of 40 hours) are available online and very popular. He has also taught Mathematics-I in QEEE program of MHRD to 130 engineering college students in online mode during Autumn 2014-2015. He offered the course "Probability and Statistics" for certification program in Jan-April 2016, Jan-April 2017, Jan-April 2019. He also offered the course "Statistical Inference" for certification program during Jan-April 2019. His lectures on "Probability" and "Permutation and combinations" for class XII students under IIT-PAL scheme of MHRD are also available through DTH channels of national television. His research interests are Statistical Decision Theory, Estimation Theory, Testing of Hypothesis, Classification Problems, Directional Distributions, Limit Theorems. He has published more than 100 research papers in refereed reputed international journals and book chapters. He has supervised eleven Ph.D. students and more than two hundred fifty Masters (M.Tech./ M.Sc./B.Tech.) dissertations. He has been guest professor in University of Ulm, Germany in July 2017 and June-July 2018 and in University of Dortmund in May-June 2019. He is Principal Investigator for a major research project "Drone for Vaccine Delivery" funded by the Indian Council for Medical Research. He has delivered invited lectures in various universities in India and abroad.

## COURSE PLAN :

### Week 1:

1. Sets, Classes, Collections
2. Sequence of Sets
3. Ring, Field (Algebra)
4. Sigma-Ring, Sigma-Field, Monotone Class
5. Random Experiment, Events
6. Definitions of Probability
7. Properties of Probability Function-I
8. Properties of Probability Function-II

### Week 2:

9. Conditional Probability
10. Independence of Events
11. Problems in Probability-I
12. Problems in Probability-II
13. Random Variables
14. Probability Distribution of a Random Variable-I

**Week 3:**

- 15. Probability Distribution of a Random Variable-II
- 16. Moments
- 17. Characteristics of Distributions-I
- 18. Characteristics of Distributions-II
- 19. Special Discrete Distributions-I
- 20. Special Discrete Distributions-II\

**Week 4:**

- 21. Special Discrete Distributions-III
- 22. Poisson Process-I
- 23. Poisson Process-II
- 24. Special Continuous Distributions-I
- 25. Special Continuous Distributions-II
- 26. Special Continuous Distributions-III

**Week 5:**

- 27. Special Continuous Distributions-IV
- 28. Special Continuous Distributions-V
- 29. Normal Distribution
- 30. Problems on Normal Distribution
- 31. Problems on Special Distributions-I
- 32. Problems on Special Distributions-II

**Week 6:**

- 33. Function of a Random Variable-I
- 34. Function of a Random Variable-II
- 35. Joint Distributions-I
- 36. Joint Distributions-II
- 37. Independence, Product Moments
- 38. Linearity Property of Correlation and Examples

**Week 7:**

- 39. Bivariate Normal Distribution-I
- 40. Bivariate Normal Distribution-II
- 41. Additive Properties of Distributions-I
- 42. Additive Properties of Distributions-II
- 43. Transformation of Random Variables
- 44. Distribution of Order Statistics

**Week 8:**

- 45. Basic Concepts
- 46. Chi-Square Distribution
- 47. Chi-Square Distribution (Cont...), t-Distribution
- 48. F-Distribution
- 49. Descriptive Statistics – I 50. Descriptive Statistics – II

**Week 9:**

- 51. Descriptive Statistics – III
- 52. Descriptive Statistics – IV
- 53. Introduction to Estimation
- 54. Unbiased and Consistent Estimators
- 55. LSE, MME 56. Examples on MME, MLE

**Week 10:**

- 57. Examples on MLE-I
- 58. Examples on MLE-II, MSE
- 59. UMVUE, Sufficiency, Completeness
- 60. Rao-Blackwell Theorem and its Applications
- 61. Confidence Intervals-I
- 62. Confidence Intervals- II 63. Confidence Intervals- III\

**Week 11:**

- 64. Confidence Intervals- IV
- 65. Basic Definitions
- 66. Two Types of Errors
- 67. Neyman-Pearson Fundamental Lemma 68. Applications of N-P Lemma-I
- 69. Applications of N-P Lemma-II

**Week 12:**

- 70. Testing for Normal Mean
- 71. Testing for Normal Variance
- 72. Large Sample Test for Variance and Two Sample Problem
- 73. Paired t-Test
- 74. Examples
- 75. Testing Equality of Proportions