



St. Xavier's College – Autonomous Mumbai

T.Y.B.Sc

Syllabus For 5th Semester Courses in STATISTICS (June 2016 onwards)

Contents:

Theory Syllabus for Courses:

- S.STA.5.01 – Probability Theory
- S.STA.5.02 – Statistical Estimation
- S.STA.5.03 – Applied Statistics (IA)
- S.STA.5.04 - Applied Statistics (IIA)

Practical Course Syllabus for: S.STA.5. PR

Title: Probability Theory

Learning Objectives :

- 1) To strengthen their concepts in mathematical statistics.
- 2) To prepare students to develop their own models.

Number of lectures: 60

Unit 1

(15L)

Probability(A)

Theorems on Probability of realization of (i) at least one. (ii) exactly m (iii) atleast m events out of N events $A_1, A_2, A_3, \dots, A_N$.
Maxwell Boltzmann, Bose Einstein and Fermi Dirac statistics
Ordered samples and Runs.
Matching and guessing problems.

Unit 2

(15L)

Probability (B)

Conditional probability and application of Bayes' theorem
Urn Model probability
Chebychev's theorem, Chebychev's inequality.

Unit 3

(15L)

Generating Functions

Definitions of generating function and probability generating function. Expression for mean and variance in terms of generating functions. Definition of a convolution of two or more sequences. Generating function of a convolution. Generating functions of the standard discrete distributions. Relation between.
i) Bernoulli and Binomial distributions.
ii) Geometric and Negative Binomial distributions in terms of convolutions.
Generating function of compound distribution

Unit 4

(15L)

Order Statistics

Definition of the order statistics for a random sample of size n from a continuous distribution. Derivation of the distribution function and hence the probability density function of the n^{th} order statistic.
Joint p.d.f. of the i^{th} and j^{th} order statistics. Joint p.d.f. of all n order statistics. Correlations coefficient between the i^{th} and j^{th} order statistics of the uniform distribution.
Distribution of range and median (n odd) for the Uniform and Exponential distribution.

List Of Recommended Reference Books

1. Feller W. An Introduction to Probability Theory and its Applications. Vol I. Third edition.
2. Alexander M Mood , Franklin A Graybill , Duane C. Boes : Introduction to theory of statistics , Third edition , Mcgraw-Hill Series
3. Hogg R.V. and Craig A.T. : Introduction to Mathematical Statistics.
4. Hogg R.V. and Tanis E.A : Probability and Statistical Inference.
5. S. C Gupta & V K Kapoor : Fundamentals of mathematical statistics, Eleventh edition , Sultan Chand & Sons

Topics For Practicals

1. Probability.
2. Generating Function.
3. Order statistics.

Title: Statistical Estimation

Learning Objective :

To empower students with methods of estimation and inference in order to predict future trends on the basis of current data, with enhanced precision.

Number of lectures: 60

Unit 1. (15L)

Point Estimation

General problem of estimation. Definition of a statistic, estimator & estimate. Properties of a good estimator. Unbiasedness, Consistency, Efficient estimator. Minimum variance unbiased Estimator (MVUE). Relative efficiency, Uniqueness of MVUE if it exists.. Cramer-Rao inequality. Definition of an efficient estimator using CRLB. Definition of a sufficient statistic, Statement of Neyman's factorization theorem.

Unit 2. (15L)

Methods Of Estimation

Method of maximum likelihood estimation Properties of maximum likelihoods estimators
Method of moments.
Method of minimum chi-square. Method of modified minimum chi-square.

Unit 3 (15L)

Bayesian Estimation

Prior distribution. Posterior distribution. Loss function Risk function. Bayes' solution under squared error and Absolute error loss function.

Unit 4. (15L)

Interval Estimation

Concept of confidence interval and confidence limits. Definition of pivotal quantity and its uses in obtaining confidence intervals

Derivation of $100(1-\alpha)\%$ equal tailed confidence intervals for

- (i) single population mean & proportion
- (ii) difference of two population means and proportions
- (iii) population variance
- (iv) ratio of population variances of normal distribution
(based on large and small samples)

Confidence intervals based on asymptotic properties of maximum likelihood estimators for Poisson and Exponential distribution

List Of Recommended Reference Books

1. Hogg R.V. and Craig A.T. : Introduction to Mathematical Statistics. (Macmillan Publishing Co.)
2. Hogg R.V. and Tanis E.A : Probability and Statistical Inference. (Macmillan Publishing Co)
3. Rohatgi V.K. : Statistical Inference. John Wiley
4. S C Gupta & V K Kapoor : Fundamentals of mathematical statistics, Eleventh edition , Sultan Chand & Sons
5. Alexander M Mood , Franklin A Graybill , Duane C. Boes : Introduction to theory of statistics , Third edition , Mcgraw-Hill Series
6. Parimal Mukhopadhyay : Mathematical Statistics, Second edition, Books and Allied (P) Ltd.

Topics For Practicals

1. Method of maximum likelihood estimation.
2. Method of Moments.
3. Method of modified minimum Chi-square.
4. Bayesian estimation.
5. Interval estimation.

Title: Applied Statistics (I A)

Learning Objective :
To apply Statistics to the Biological Sciences.

Number of lectures: 60

Unit 1. (15L)

Epidemic Methods

The features of an epidemic.
Definitions of various terms.
Definition of deterministic and stochastic models.
Deterministic models without removals (for 'a' introductions).
Carrier model. Chain binomial models. Reed-Frost and Greenwood models.
Distribution of individual chains and total number of cases. Maximum likelihood estimator of p and its asymptotic variance for the households of size upto 4.

Unit 2. (15L)

Bioassays

Meaning and scope of bioassays. Basic terms. Direct assays. Fieller's theorem. Indirect assays. Conditions of similarity monotony and linearity. Linearizing transformation for Parallel line and slope ratio assays.
Definitions – Symmetric and unsymmetric parallel line assays.
Symmetrical 2K-point parallel line assays ($k=2,3$), using orthogonal contrasts.
Quantal assays, ED50 and LD 50. Probit analysis.

Unit 3. (15L)

Clinical Trials – I

Introduction to clinical trials : The need and ethics of clinical trials.
Overview of phases (I – IV). Common terminology used in clinical trials.
Study protocol, case record/report form/blinding (single/double).
Randomized control (placebo/active control).
Study designs (parallel, cross over).
Type of trials : inferiority, superiority and equivalence. Multicentric trial.
Inclusion/exclusion criteria.
Estimation of sample size (for specified power) for the following cases
i) Single population mean
ii) Single population proportion
iii) Difference of two population means
iv) Difference of two population proportions

Unit 4.

(15L)

Clinical Trials - II

Statistical tools : Analysis of parallel design using analysis of variance.

Concepts of Odd's Ratio.

Statistics in Bioequivalence Studies: Introduction to Bioequivalence studies

Commonly used designs in BE studies.

Estimation of Pharmacokinetic Parametres :

Cmax, Tmax and Area Under Curve (AUC)

Analysis of Variance for parallel and non replicated cross over design.

Ratio Analysis.

90% Confidence Interval and Bioequivalence Criteria

List Of Recommended Reference Books

1. Bailey N.T.J. : The mathematical theory of Infectious Diseases, Second edition, Charles Griffin and Co. Ltd. London.
2. Das M.N. and Giri N.C. : Design and Analysis of Experiments. Second edition, Wiley Eastern .
3. Finney D.J. : Statistical methods in Biological Assays. First edition, Charles Griffin and Co. Ltd. London.
4. Stanford Boltan and Charles Bon : Pharmaceutical statistics, Fourth edition, Marcel Dekker Inc.
5. Zar Jerrold H. : Biostatistical Analysis , Fourth edition, Pearson's education.
6. Friedman L. M., Furburg. C., Demets D. L. : Fundamentals of clinical trials, First edition (1998) . Springer Verlag.
7. Fleiss J.L. : Design and Analysis of Clinical experiments, Second edition (1989), Wiley and Sons.
8. Glenwalker : Common Statistical Methods.
9. Shein-Chung-Chow : Design and analysis of Bioavailability and Bioequivalence studies, 3rd edition, Chapman & Hall / CRC BioStatistics series.
10. Daniel Wayne W : Biostatistics- A foundation for analysis in the health sciences 7th edition, Wiley Series in Probability and Statistics.

TOPICS FOR PRACTICALS

1. Epidemics
2. Bio Assays
3. Clinical Trials

Title: Applied Statistics (IIA)

Learning Objective :

To apply Statistics to the Insurance industry.

Number of lectures: 60

Unit 1

(15L)

Concepts of Vital Statistics & Mortality Tables :

Vital Statistics:

Crude death rate, Age specific death rate & Standardized death rate.

Crude birth rate, General fertility rate, Age specific fertility rate & Total fertility rate. Gross & Net Reproduction rates.

Mortality Tables:

Various mortality functions. Probabilities of living and dying. The force of mortality.

Estimation of μ_x from the mortality table. Select and ultimate mortality table. Mortality table as a population model. Stationary population. Stable population

Expectation of life and Average life at death. Central death rate.

Unit 2.

(20L)

Compound Interest and Annuities Certain:

Accumulated value and present value, nominal and effective rates of interest. Discount and discounted value, Varying rates of interest. Equation of value. Equated time of payment.

Present and accumulated values of annuity certain , perpetuity (immediate and due) with and without deferment period.

Present and accumulated values of

i) increasing annuity

ii) increasing annuity when successive installments form

a) arithmetic progression

b) geometric progression. (iii) annuity with frequency different from that with which interest is convertible.

Redemption of Loan.

Unit 3

(10L)

Life Annuities:

Present value in terms of commutation functions of Life annuities and Temporary life annuities (immediate and due) with and without deferment period. Present values of variable and increasing life annuities (immediate and due).

Unit 4

Assurance Benefits:

Present value of assurance benefits in terms of commutation functions of i) pure endowment assurance ii) temporary assurance iii) endowment assurance iv) whole life assurance v) double endowment assurance vi) increasing temporary assurance vii) increasing whole life assurance viii) special endowment assurance ix) deferred temporary assurance x) deferred whole life assurance.
Net premiums and Level annual premiums for the various assurance plans.
Natural and Office premiums.

List Of Recommended Reference Books

1. Neill A. : Life Contingencies, First edition, Heineman educational books London
2. Dixit S.P., Modi C.S., Joshi R.V. : Mathematical Basis of Life Assurance, First edition Insurance Institute of India
3. Gupta S. C. & Kapoor V. K. : Fundamentals of Applied Statistics, Fourth edition, Sultan Chand & Sons.

TOPICS FOR PRACTICALS

1. Mortality tables & Vital Statistics
2. Annuities
3. Life annuities
4. Assurance benefits