Syllabus
For B.Sc. 5th Semester Courses in Statistics
(June 2021 onwards)

Contents:
- Theory Syllabus for Courses:
  o SSTA0501 – Probability Theory
  o SSTA0502 – Statistical Estimation
  o SSTA0503 – Applied Statistics (IA)
  o SSTA0504 - Applied Statistics (IIA)
  o SSTA05AC - Statistical Computing using R

- Practical Course Syllabus for: SSTA05PR & SSTA05ACPR

- Evaluation and Assessment guidelines.

T.Y. B.Sc.   Course Code: SSTA0501
Title: Probability Theory

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

Number of lectures: 60

Course Outcomes (COs):
   1) Have a more in-depth understanding of the concept of probability and its applications.
   2) Understand the concept of 'generating functions' in general, and its uses.
   3) Obtain the 'generating functions' of the standard discrete distributions.
   4) Know the concept of order statistics and its use in distribution theory.

Unit 1   (15L)
Probability
Theorems on Probability of realization of (i) at least one. (ii) exactly m
(iii) at least m events out of N events $A_1, A_2, A_3 \ldots A_N$.
 Maxwell Boltzmann, Bose Einstein and Fermi Dirac statistics
 Ordered samples and runs.
 Occupancy problems, Matching and guessing problems.
Conditional probability and application of Bayes'theorem
Urn Model probability

Unit 2   (15L)
Inequalities and Law of Large Numbers
(i)   Markov Inequality
(ii)   Chebychev's inequality.
(iii)   Boole's Inequality
(iv)   Cauchy Schwartz's Inequality
(v)   Weak Law of Large Numbers

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 nth order statistic.
Joint p.d.f. of the ith and j^{th} order statistics. Joint p.d.f. of all n order statistics. Correlations coefficient between the ith 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

Evaluation (Theory): Total marks per course - 100.
    CIA- 40 marks
    CIA 1: Written test -20 marks
    CIA 2: Written test -20 marks
    End Semester Examination – 60 marks
    One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 25.

Evaluation of SSTA05PR (0501)
Total marks - 50.
Group Project – 15 marks
Journal – 5 marks.
End Semester Practical Examination – 30 marks.
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Grid Template - End Semester Examination (Theory)

Q. No	Knowledge (Definition, Descriptive Notes, Theoretical Proofs)	Understanding & Application (Illustration/Numerical Problems)	Marks
1.	15	05	20
2.	15	05	20
3.	15	05	20
Total	45	15	60
Weightage (%)	75%	25%	100%

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T.Y. B.Sc.   Course Code: SSTA0502
Title: Statistical Estimation

Course Objectives:
1) 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

Course Outcomes (COs):
1) Know various types of estimation (point and interval).
2) Know various methods of estimation (MLE, method of moments, method of minimum/modified minimum Chi-square, Bayesian estimation).
3) Utilize of the technique of Bayesian estimation.

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.

List Of Recommended Reference Books (15L)

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. Rohatgi V.K & Ehsanes Saleh A.K. Md. (2008): An Introduction to Probability Theory and Mathematical Statistics, Second Edition: Wiley series in Probability and Statistics.
6. S C Gupta & V K Kapoor : Fundamentals of mathematical statistics, Eleventh edition , Sultan Chand & Sons
7. Alexander M Mood , Franklin A Graybill , Duane C. Boes : Introduction to theory of statistics , Third edition , Mcgraw-Hill Series
8. 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.

Evaluation (Theory): Total marks per course - 100.
CIA- 40 marks
CIA 1: Written test -20 marks
CIA 2: Written test -20 marks
End Semester Examination – 60 marks
One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 25.

Evaluation of SSTA05PR (0502)
Total marks - 50.
Group Project – 15 marks
Journal – 5 marks.
End Semester Practical Examination – 30 marks

Grid Template - End Semester Examination (Theory)

Q. No	Knowledge (Definition, Descriptive Notes, Theoretical Proofs)	Understanding & Application (Illustration/Numerical Problems)	Marks
1.	15	05	20
2.	15	05	20
3.	15	05	20
Total	45	15	60
Weightage (%)	75%	25%	100%

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T.Y. B.Sc.   Course Code: SSTA0503
Title: Applied Statistics (I A)

Course Objectives:
To apply Statistics to the Biological Sciences.

Number of lectures: 60

Course Outcomes (COs):
1) Comprehend deterministic and stochastic models used in the study of an epidemic.
2) Understand the meaning, scope and types of bioassays commonly used in analysis of health data.
3) Understand of the concept of clinical trials and issues pertaining to it.

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).

Introduction to ICH E9 guidelines,

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. Multi centric trial.

Inclusion/exclusion criteria.

Estimation of sample size (for specified power) for the following cases

i)   Single population means
ii)   Single population proportion
iii)   Difference of two population means
iv)   Difference of two population proportions

Unit 4. (15L)

Clinical Trials - II and Bioequivalence

Statistical tools : Analysis of parallel design using Analysis of Variance.

Concept of Odd's Ratio, Concept of Repeated Measures ANOVA, Survival analysis for estimating Median survival time, Kaplan- Miere approach for survival analysis.

Statistics in Bioequivalence Studies: Introduction to Bioequivalence studies

Commonly used designs in BE studies.

Estimation of Pharmacokinetic Parameters:

Cmax, Tmax and Area Under Curve (AUC)

Analysis of Variance for parallel design and concept of 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. Glenwalke : 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.
11. Charles. S.Davis: Statistical Methods for the analysis of repeated measurements, Springer Publications.

Topics For Practicals

1. Epidemics
2. Bio Assays.
3. Clinical Trials

Evaluation (Theory): Total marks per course - 100.
    CIA- 40 marks
    CIA 1: Written test -20 marks
    CIA 2: Written test -20 marks
    End Semester Examination – 60 marks
    One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 25.

Evaluation of SSTA05PR (0503)
Total marks - 50.
Group Project – 15 marks
Journal – 5 marks.
End Semester Practical Examination – 30 marks

Grid Template - End Semester Examination (Theory)

Q. No	Knowledge (Definition, Descriptive Notes, Theoretical Proofs)	Understanding & Application (Illustration/Numerical Problems)	Marks
1.	15	05	20
2.	15	05	20
3.	15	05	20
Total	45	15	60
Weightage (%)	75%	25%	100%

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T.Y. B.Sc.   Course Code: SSTA0504
Title: Applied Statistics (II A)

Course Objectives:
To apply Statistics to the Insurance industry.

Number of lectures: 60

Course Outcomes (COs):
1) Understand the concept of vital statistics and mortality tables.
2) Understand and calculate several quantities pertaining to the field of actuarial science (compound interest and annuities certain, life annuities, assurance benefits).

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.   (15L)
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   (15L)
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).
                                                                                                  (15L)
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.
4. Ajay Kumar Srivastava & Gorakhnath Agarwal: Mathematical Basis of Life Assurance, First edition Insurance Institute of India

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

Evaluation (Theory): Total marks per course - 100.

  CIA- 40 marks
  CIA 1: Written test -20 marks
  CIA 2: Written test -20 marks
  End Semester Examination – 60 marks
  One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 25.

Evaluation of SSTA05PR (0504)

Total marks - 50.
Group Project – 15 marks
Journal – 5 marks.
End Semester Practical Examination – 30 marks

Grid Template - End Semester Examination (Theory)

Q. No	Knowledge (Definition, Descriptive Notes, Theoretical Proofs)	Understanding & Application (Illustration/Numerical Problems)	Marks
1.	15	05	20
2.	15	05	20
3.	15	05	20
Total	45	15	60
Weightage (%)	75%	25%	100%

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T.Y.B.Sc. Statistics (Applied Component)   Course: SSTA05AC
Title: Statistical computing using R
**THIS COURSE IS OFFERED TO STUDENTS WHO HAVE TAKEN
STATISTICS UPTO THE 4 TH SEMESTER**

Course Objectives:
To enable students to:
1. Install, update & learn the preliminaries of R - software
2. Input, Access & Index data.
3. Save, Store & Retrieve files.
4. Import, Review, Manipulate & Summarize a variety of data formats into R using RStudio
5. Use R-programming for statistical analysis.
6. Explore different ways of Data Visualization.

Number of lectures: 60 Lectures

Course Outcomes (COs):

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

1. Be confident of using R and R-Studio.
2. Develop their own simple programs in R.
3. Create and edit visualizations with R.
4. Appreciate and apply R programming from a statistical perspective.

Unit 1   (15 Lectures)

Introduction to R Programming and Data Management

R Programming- History, programming rules, packages in R and using RStudio as IDE

Importing data in R, checking data features using functions - dim, str, head, tail etc.

Sorting of data, merging two data sets, data aggregation, creating subsets.

Numeric and String Functions

Data Cleaning- Removing duplicate records, making data consistent and treating missing values using simple methods

Unit 2   (15 Lectures)

Descriptive Statistics and Data Visualization

Measures of Central Tendency & Dispersion

Measures of Skewness & Kurtosis

Impact of missing data on R functions to calculate above measures

Box-Whisker Plot and Histogram

Bar Charts and Pie chart

Heat Map

Unit 3   (15 Lectures)

Standard Distributions and Statistical Inference using R

Probability calculations for Binomial, Poisson, Normal and Lognormal distributions

Generating random observations from specific distribution

Independent samples t test and paired t test

F test for two variances

Analysis of Variance-One way and two way

Unit 4   (15 Lectures)

Bivariate Data Analysis in R

Scatter Plot

Analysis of Correlation, Simple Linear Regression-Estimation of parameters, hypothesis testing, R squared, Residual Analysis and predictions for out of sample data.

Fitting of Curves

Cross Table for two categorical variables

Chi Square test for independence of attributes

List Of Recommended Reference Books:
1. Maria. L. Rizzo: Statistical Computing with R (2007), (Chapman & Hall/CRC), 2nd edition.
2. S.G. Purohit, S.D. Gore, S.R. Deshmukh: Statistics using R (Narosa Publishing), 2nd edition.
3. Garrett Grolemund, Hadley Wickham: R for Data Science, 1st edition
4. Hadley Wickham: Advanced R, 2nd edition
5. College Statistics in R: http://www.r-tutor.com/elementary-statistics
6. Google R Style Guide: https://google.github.io/styleguide/Rguide.xml

Topics for practicals:
1. Importing data in R & Data pre-processing
2. Descriptive Statistics
3. Graphs & Diagrams
4. Standard probability distributions
5. Testing of Hypothesis
6. Bivariate data analysis

Evaluation (Theory): Total marks per course - 100.

    CIA- 40 marks

    CIA 1: Written test -20 marks

    CIA 2: Written test -20 marks

    End Semester Examination – 60 marks

    One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 25.

Evaluation of SSTA05AC

Practical: 50 Marks

Practical Examination - 45 marks

Journal: 05 marks

Grid Template - End Semester Examination (Theory)

Q. No	Knowledge (Definition, Descriptive Notes, Theoretical Proofs)	Understanding & Application (Illustration/Numerical Problems)	Marks
1.	15	05	20
2.	15	05	20
3.	15	05	20
Total	45	15	60
Weightage (%)	75%	25%	100%

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