St. Xavier's College (Autonomous), Mumbai

Syllabus of the courses offered by the Department of Statistics
(2019-20)

St. Xavier's College – Autonomous Mumbai

STATISTICS

F.Y.B.Sc

Syllabus
For 1ˢᵗ Semester Courses in Statistics
(June 2019 onwards)

Contents:
Theory Syllabus for Courses:
S.STA.1.01 – Descriptive Statistics (A)
S.STA.1.02 – Statistical Methods (A)

Practical Course Syllabus for: S.STA.1.PR

Title: Descriptive Statistics (A)

Learning Objectives:
1. **To introduce the technique of data collection and its presentation.**
2. **To emphasize the need for numerical summary measures for data analysis.**

Number of lectures: 45

Unit – 1
Data: Types , Collection and Management.   **(15 L)**
Types of data from a population :
Qualitative and Quantitative data; Geographical, Time series data; Discrete and Continuous data, Panel and Cross Section data.
Different types of scales: Nominal, Ordinal, Ratio and Interval.
Collection of Data :
Concepts of statistical population and sample.
Primary data- designing a questionnaire / schedule, distinction between them, Problems when collecting data through the questionnaire.
Secondary data– its major sources including some government publications.
Elementary Categorical Data Analysis
Preparation of tables with two or three factors (variable /attributes) of classification. Requisites of a good table. Independence and Association for 2 attributes in a 2 x 2 table using Yule's coefficient of colligation and coefficient of association. Relationship between the two coefficients.

Unit 2
Presentation of Data.   **(15 L)**
Univariate : Frequency distribution of discrete and continuous variables. Cumulative frequency distribution.
Graphical representation of frequency distribution by Histogram, Frequency polygon, Frequency curve and Ogives.
Diagrammatic representation using Bar diagrams and Pie chart.
Exploratory data analysis: Stem and Leaf diagram, Dot plot.
Bivariate : Frequency distribution, Marginal and Conditional frequency distributions.

Unit 3
Measures of Central Tendency or Location.   **(15 L)**
Arithmetic mean and its properties (simple and weighted), Combined mean. Geometric mean and Harmonic mean. Quantiles (Median, Quartiles, Deciles, Percentiles.) Mode. (Grouping Method not expected). Empirical relationship between mean, median and mode. Merits, Demerits and Uses of Mean, Median, Mode, G.M. and H.M.
 Requisites of a good average.
Choice of scale of measurement for each measure of central tendency.

List Of Recommended Reference Books

1. Goon A.M., Gupta M.K., Dasgupta B. Fundamentals of Statistics, Volume I, The World Press Private Limited, Calcutta. Fifth edition.
2. Kothari, C.R.: Research Methodology, Methods and Techniques , Wiley Eastern Limited. First Edition.
3. Shah R.J.:Descriptive Statistics, Seth Puplications. Eighth edition.
4. Spiegel, M.R.: Theory and Problems of Statistics, Schaum's Publishing Series. Tata McGraw-Hill. First edition.
5. Welling, Khandeparkar, Pawar, Naralkar : Descriptive Statistics : Manan Prakashan
6. S.P. Gupta : Statistical Methods, Sultan Chand & Sons. First edition.
7. Richard. I. Levin, David .S. Rubin: Statistics for Management   . Fifth edition
8. Prem . S. Mann (2007) . Introductory Statistics (6th edition) John Wiley & Sons.
9. Allan Bluman (2009) Introductory Statistics. A step by step approach (7th edition). McGraw-Hill
10. www.actuaries.org.uk
11. www.actuariesindia.org
12. www.soa.org

List of Practicals:
1. Collection of Data from Secondary source (including Internet sites) / Primary source
2. Tabulation of data (Quantitative and Categorical)
3. Classification of data.
4. Graphs and Diagrams
5. Measures of Central Tendency.

Title: Statistical Methods (A)

Learning Objectives:
To study
1. Concept of probability
2. Probability distribution
3. Testing of hypotheses.

Number of lectures: 45

Unit 1   **(15 L)**
Elementary probability theory.
Random Experiment,   Sample Point & Sample Space.
Discrete Sample Space, Definition of Event, Elementary Event, Algebra of Events.
Mutually exclusive events, Exhaustive events. Subjective Probability.
Classical, Empirical and Axiomatic definitions of probability.
Conditional Probability, Independence of n Events.(n = 2, 3).
Theorems on Addition & Multiplication of Probabilities,
Bayes' Theorem (All theorems with proofs).

Unit 2
Discrete Random variable: **(15 L)**
Univariate :
Random variable. Definition, Properties of Probability Mass Function & Cumulative
Distribution Function. Expectation and variance of a random variable. Theorems on
Expectation and Variance .
Raw & Central Moments and their relationship (without proof). Concept of Skewness
and Kurtosis.
Bivariate :
Joint Probability Mass Function of two Discrete Random Variables, Marginal and
Conditional Probability Distributions, Independence of Two Random Variables.
Theorems on Expectation, Variance.
Covariance, Correlation coefficient between two random variables

Unit 3
Standard Discrete Probability Distributions: **(15 L)**
Degenerate distribution, Bernoulli distribution, Binomial Distribution, Poisson
Distribution,   Hypergeometric Distribution. Uniform Distribution Derivation of mean, &
variance, Calculation of Expected frequencies.
Binomial approximation to Poisson and Hypergeometric approximation to Binomial
Distribution (statement only).

List Of Recommended Reference Books

1. Statistical Methods : Welling, Khandeparkar, Pawar, Naralkar Manan Publications. First edition.
2. Statistical Methods : R.J. Shah – Seth Publications. Tenth edition.
3. Basic Statistics : B.L. Agarwal – New Age International Ltd. Fifth edition
4. Theory and Problems of Statistics : Spiegel M.R. – Schaums Publishing Series, Tata Mcgraw - Hill. First edition
5. Probability and Statistical Inference : Hogg R.V, Tanis E.P. – Macmillan Publishing Co. Inc.
6. Fundamentals of Mathematical Statistics : S. C. Gupta, V.K.Kapoor – Sultan Chand & Sons. Eleventh edition.
7. Statistical Methods : S.P. Gupta – Sultan Chand & Sons. Thirty third edition.
8. Fundamentals of Statistics , Volume II, - Goon A.M., Gupta M.K., Dasgupta B. – The World Press Pvt. Ltd, Calcutta. Fifth edition.
9. Richard. I. Levin, David .S. Rubin: Statistics for Management Fifth edition
10. Prem . S. Mann (2007) . Introductory Statistics (6th edition) John Wiley & Sons.
11. Allan Bluman (2009) Introductory Statistics. A step by step approach (7th edition). McGraw-Hill
12. www.actuaries.org.uk
13. www.actuariesindia.org
14. www.soa.org

List of Practicals:

1. Probability
2. Discrete Random Variable
3. Bivariate Probability Distributions.
4. Binomial, Poisson and Hypergeometric Distributions.
5. Calculation of Expected frequency from a conducted experiment

St. Xavier's College – Autonomous Mumbai

F.Y.B.Sc

Syllabus
For 2nd Semester Courses in Statistics
(November 2019 onwards)

Contents:
Theory Syllabus for Courses:
      S.STA.2.01 – Descriptive Statistics (B).
      S.STA.2.02 – Statistical Methods (B).

Practical Course Syllabus for: S.STA.2. PR

F.Y.B.Sc
(STATISTICS)

SEMESTER 2

DESCRIPTIVE STATISTICS (B)   [45 LECTURES]

LEARNING OBJECTIVE : To orient students on techniques of data analysis.

Unit –4 : Absolute and Relative Measures of Dispersion.   (15 Lectures)
Range, Interquartile Range, Quartile Deviation, Mean Absolute Deviation, Standard Deviation (Variance) and their relative measures. Combined variance. Raw and Central moments up to fourth order and the relationship between them (with proof). Measures of Skewness and Kurtosis
Box-Whisker Plot.

Unit-5 : Analysis of Bivariate Data.   (15 Lectures)
Scatter diagram. Product Moment correlation coefficient and its properties. Rank correlation- Spearman's measure. Concept of linear regression. Principle of least squares. Fitting of straight line by method of least squares. Relation between regression coefficients and correlation coefficient. Coefficient of determination. Fitting of curves reducible to linear form by transformation. Fitting of quadratic curve using least squares.

Unit-6 : Index Numbers.   (15 Lectures)
Index number as a comparative tool. Stages in the construction of Index Numbers. Simple and Composite Index Numbers.
Fixed base Index Numbers. Chain Base Index Numbers, Base shifting, Splicing and Deflating. Price and Quantity Index Numbers - Laspeyres', Paasche's , Marshal-Edgeworth's, Dorbisch-Bowley's and Fisher's Index Numbers. Value Index Number. Time reversal test. Factor reversal test, Circular test. Cost of Living Index Number. Concept of Real Income based on the Consumer Price Index Number.
Problems in the construction of Consumer Price Index Number.

List of Practicals:

6. Measures of Dispersion.
7. Skewness and Kurtosis.
8. Correlation Analysis
9. Regression Analysis.
10. Curve fitting by the Method of Least Squares.
11. Index Numbers.

REFRENCES:

1. Goon A.M., Gupta M.K., Dasgupta B. Fundamentals of Statistics, Volume I, The World Press Private Limited, Calcutta. Fifth edition.
2. Kothari, C.R.: Research Methodology, Methods and Techniques , Wiley Eastern Limited. First Edition.
3. Shah R.J.:Descriptive Statistics, Seth Puplications. Eighth edition.
4. Spiegel, M.R.: Theory and Problems of Statistics, Schaum's Publishing Series. Tata McGraw-Hill. First edition.
5. Welling, Khandeparkar, Pawar, Naralkar : Descriptive Statistics : Manan Prakashan
6. S.P. Gupta : Statistical Methods, Sultan Chand & Sons. First edition.
7. Richard. I. Levin, David .S. Rubin: Statistics for Management   . Fifth edition
8. Prem . S. Mann (2007) . Introductory Statistics (6th edition) John Wiley & Sons.
9. Allan Bluman (2009) Introductory Statistics. A step by step approach (7th edition). McGraw-Hill
10. www.actuaries.org.uk
11. www.actuariesindia.org
12. www.soa.org

****

COURSE :   S.STA.2.02

STATISTICAL   METHODS (B)   **[45 LECTURES]**

LEARNING OBJECTIVES :
To study : 1) Continuous probability distributions
**   2) Testing of hypotheses.**

Unit 1 :   Continuous Random variable   **(15 L)**
   Concept and properties of Probability Density Function and Cumulative Probability distribution Function. Expecation and variance of a random variable and its properties. Measures of location, dispersion, skewness and kurtosis. Raw and Central Moments. (Simple illustrations.),

Unit 2: Some Standard Continuous Probability Distributions.   **(15 L)**
   Rectangular Distribution, Exponential Distribution and Normal Distribution. Derivation of mean, median and variance for Rectangular and Exponential distribution. Properties of Normal Distribution and Normal Curve (without proof). Normal Approximation to Binomial and Poisson Distributions (without proof). and using graph / probability histogram

9

Unit 3 : Sampling Distribution.   (15L)

Concept of Parameter, Statistic, Estimator and bias. Sampling distribution.of estimator. Standard error and M.S.E. of an estimator.

Central Limit Theorem (Statement only).

Sampling distribution of sample mean and sample proportion for large samples.

Point and interval estimation of single mean and single proportion, for large sample only.

Statistical tests - Concept of Hypotheses. (Null and Alternative Hypotheses.).

Types of Errors, Critical Region, Level of Significance, p-value,

Large Sample Tests using Central Limit Theorem, if necessary.

- For testing specified value of population mean
- For testing specified value in difference of two population means
- For testing specified value of population proportion
- For testing specified value in difference of two population proportions.

TOPICS FOR PRACTICALS.
6. Continuous Random Variables.
7. Uniform, Exponential Distributions.
8. Normal Distribution
9. Testing of Hypotheses
10. Estimation
11. Large Sample Tests.

REFERENCES:
15. Statistical Methods : Welling, Khandeparkar, Pawar, Naralkar Manan Publications. First edition.
16. Statistical Methods : R.J. Shah – Seth Publications. Tenth edition.
17. Basic Statistics : B.L. Agarwal – New Age International Ltd. Fifth edition
18. Theory and Problems of Statistics : Spiegel M.R. – Schaums Publishing Series, Tata Mcgraw - Hill. First edition
19. Probability and Statistical Inference : Hogg R.V, Tanis E.P. – Macmillan Publishing Co. Inc.
20. Fundamentals of Mathematical Statistics : S. C. Gupta, V.K.Kapoor – Sultan Chand & Sons. Eleventh edition.
21. Statistical Methods : S.P. Gupta – Sultan Chand & Sons. Thirty third edition.
22. Fundamentals of Statistics , Volume II, - Goon A.M., Gupta M.K., Dasgupta B. – The World Press Pvt. Ltd, Calcutta. Fifth edition.
23. Richard. I. Levin, David .S. Rubin: Statistics for Management Fifth edition
24. Prem . S. Mann (2007) . Introductory Statistics (6th edition) John Wiley & Sons.
25. Allan Bluman (2009) Introductory Statistics. A step by step approach (7th edition). McGraw-Hill
26. www.actuaries.org.uk
27. www.actuariesindia.org
28. www.soa.org

St. Xavier's College – Autonomous Mumbai

S.Y.B.Sc Syllabus For 3rd Semester Courses in STATISTICS (June 2019 onwards)

Contents:
Theory Syllabus for Courses:
    S.STA.3.01 - Probability and Sampling Distributions (A)
    S.STA.3.02 - Sampling Techniques
    S.STA.3.03 - Operations Research.

Practical Course Syllabus for: S.STA.3.PR

Academic/field/industrial visits and seminars may be organized by the Department, at other venues, as part of the curriculum.

S.Y.B.Sc. STATISTICS   <mark>COURSE :   S.STA.3.01</mark>
<mark>Title: Probability and Sampling distributions (A)</mark>

Learning Objectives :

1) **To understand the patterns in the data of large populations.**
2) **To obtain the central location and dispersion of the data.**
3) **To know the relationship between various distributions.**

Number of lectures : 45

Unit 1
Univariate and Bivariate random variables (Discrete and Continuous)   **(15 L)**
    Probability generating functions ,Moment Generating Functon, Cumulant generating Function. Their properties. Relationship between moments and cumulants and their uses.
Discrete joint probability mass function,, Continuous joint probability density function.
Marginal densities, covariance, correlation coefficient.
Independence of random variables.
Conditional Distribution, conditional expectation and conditional variance..

Unit 2
 Standard Univariate Discrete Probability Distributions: **(15 L)**
Uniform Distribution, Bernoulli's Distribution, Binomial Distribution, Poisson
Distribution Geometric Distribution, Negative Binomial Distribution :
The following aspects to be discussed wherever applicable to the above stated distributions:
Mode, Median, Derivation of m.g.f., c.g.f., Moments , Additive property, Recurrence
Relationship for central moments. Skewness and Kurtosis.
Limiting distribution (without proof)
Truncated Binomial and Truncated Poisson distributions.: p.m.f. Mean and variance.
(with simple illustrations)

Unit 3
Normal Distribution: **(15 L)**
Normal Distribution: Definition. Derivation of its M.G.F., C.G.F., Mean, Median, Mode,
S.D., M.D. Recurrence Relationship for moments. Distribution of linear function of Normal
variables. Fitting of Normal Distribution. Central Limit Theorem with proof for i.i.d. r.v.s.
Log Normal Distribution : Determination of Mean and Variance and its properties

 List of Recommended Reference Books.
1. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor : 8th edition, Sultan Chand & Sons.
2. Outline of Statistical Theory – Volume I, A.M. Goon, M. K. Gupta,   B. Dasgupta : 3rd edition, The World Press Pvt Ltd.

3. Introduction to Theory of Statistics, Mood, Graybill and Boes: 3rd edition, Mc Graw-Hill Publishers.
4. Introduction to Mathematical Statistics, R. V. Hogg & A. T. Craig : 4th edition, Collier Mc Millan Publishers.
5. Probability and Statistical Inference, R. V. Hogg & E. A. Tanis :   3rd edition, Mc Millan Publishing Co.
6. Mathematical Statistics, John E. Freund : 5th edition, Prentice-Hall of India Pvt Ltd.

Topics for Practicals
1. Distribution of random varianbles : M.g.f , C.g.f.
2. Bivariate Probability Distribution and Joint m.g.f.
3. Binomial Distribution
4. Poisson Distribution
5. Geometric and Negative Binomial distribution.
6. Normal Distribution.

S. Y. B. Sc. STATISTICS   Course : S. STA. 3.02
Title: Sampling Techniques

Learning Objectives :

1. **To understand various sampling techniques.**
2. **To apply these techniques in real life situation.**
3. **Comparison of sampling techniques**.

Number of lectures: 45

Unit 1
Concepts of sample survey   **(15 L)**
Concepts of population, population unit, sample, sample size, parameter, statistic estimator, biased and unbiased estimator, mean square error (M.S.E), standard error.
Census and Sample Surveys
Sampling and Non sampling errors.
Concepts of Probability and non-probability sampling.
Introduction to Simple Random Sampling(Use of Lottery Method, Random numbers and Pseudo random numbers), Stratified Random Sampling, Systematic Sampling, Cluster Sampling, Two Stage Sampling
NSSO, CSO and their functions

Unit 2
Simple Random Sampling (with and without replacement): (15L)

SRS for Variables :

Estimation of population Mean and Total .Expectation and Variance of these Estimators. Unbiased estimators of the variance of these estimators

SRS for Attributes :

Estimation of Population proportion and Variance of these estimators.

Estimation of sample size based on desired accuracy , in case of variables and attributes.

Confidence interval for Population Mean and Proportion.

Unit 3
Ratio and Regression Estimators under SRSWOR: (15L)

Ratio estimators for population mean, ratio and total. Expectation and M.S.E. of Estimators. Unbiased Estimators of M.S.E.

Regression estimation of population mean and total.

Expectation. Variance and Minimum variance.

Comparison of ratio estimator, regression estimator and mean per unit estimator

Stratified Random Sampling

Concepts of Stratified population and stratified sample.

Estimation of population mean and Total based on stratified sample. Expectation and variance of estimator of population mean and Total assuming SRSWOR within strata. Unbiased estimator of the variances of these estimators.

Proportional allocation,   Optimum allocation with and without varying costs.

Comparison of simple random sampling and stratified random sampling with proportional and optimum allocations (Neyman. Allocation)

List of Recommended References books:

1. Sampling Techniques : W.G. Cochran, 3rd edition, Wiley Eastern Ltd.
2. Sampling Theory and Methods : M.N.Murthy, 1st edition, Statistical Publishing Society.
3. Sampling Theory : Des Raj, 1st edition, McGraw-Hill Publishing Co.
4. Sampling Theory of Surveys with Applications : P.V.Sukhatme and B.V.Sukhatme, 3rd edition, Iowa State University Press.
5. Fundamentals of Applied Statistics: S.C.Gupta and V.K.Kapoor, 3rd edition, Sultan Chand & Sons.

List of Practicals:

1. Simple Random Sampling for variables.
2. Simple Random Sampling for attributes.
3. Estimation of sample size in SRS.
4. Confidence limits in SRS.
5. Ratio and Regression methods of Estimation.
6. Stratified Random Sampling.

S.Y.B.Sc. STATISTICS   **COURSE :   S.STA.3.03**
Title: Operations Research

LEARNING OBJECTIVES :
1) **To learn mathematical formulation of real life situations.**
2) **To study methods to solve the formulated problems.**
3) **To learn the applications of Operations Research in industry.**

Number of lectures: 45

Unit 1
Linear Programming Problem (L.P.P.) :   **(15 L)**
Definition, Mathematical Formulation. Concepts of Solution, Feasible Solution, Basic Feasible Solution, Optimal solution, Slack, Surplus & Artificial variable, Standard form, Canonical form
Graphical Method & Simplex Algorithm to obtain the solution to an L.P.P. Problems involving Unique Solution, Multiple Solution, Unbounded Solution
 and Infeasible Solution
Concept of Duality & its economic interpretation

Unit 2
Transportation Model   **(15 L)**
Definition, Mathematical Formulation Concepts of Feasible solution, Basic feasible solution Optimal and multiple solutions.
Initial Basic Feasible Solution using

(i) North-West Corner rule.
(ii) Matrix Minima Method.
(iii)Vogel's Approximation Method.
 MODI Method for optimality.
Problems involving unique solution, multiple solutions, degeneracy, maximization,
prohibited route(s) and production costs.
Unbalanced Transportation problem.

Assignment model
Definition, Mathematical formulation. Solution by Hungarian Method.
Unbalanced Assignment problems.
Problems involving Maximization & prohibited assignments.

Unit 3
 Decision Theory.   **(15 L)**
Decision making under uncertainity Laplace criterion, Maximax (Minimin) criterion,
Maximin (Minimax) criterion, Hurwicz α criterion, Minimax Regret criterion.
   Decision making under risk: Expected Monetary value criterion, Expected Opportunity
   Loss Criterion, EPPL, EVPI. Decision trees (with posterior probabilities).

List of Recommended Reference books:
1. Operations Research : Kantiswaroop, P.K. Gupta and Manmohan, 4th edition, Sultan
    Chand & Sons.
2.   Operations Research : S. D. Sharma, 11th edition, Kedarnath, Ramnath & Co.   .
3. Operations Research : H.A. Taha, 6th edition, Prentice Hall of India.
4. Operations Research: V.K. Kapoor, 7th edition, Sultan Chand & Sons.
.

List of Practicals.
1. L.P.P..
2. Transportation Problem.
3. Assignment Problem.
4. Decision Theory.

St. Xavier's College – Autonomous Mumbai

S.Y.B.Sc
Syllabus
For 4th Semester Courses in STATISTICS
(June 2019 onwards)

Contents:
Theory Syllabus for Courses:
        S.STA.4.01 - Probability and Sampling Distributions (B)
        S.STA.4.02 – Analysis of variance & Design of Experiment
        S.STA.4.03 – Industrial Statistics

Practical Course Syllabus for: S.STA.4.PR

Academic/field/industrial visits and seminars may be organized by the Department, at other venues, as part of the curriculum.

S.Y.B.Sc
(STATISTICS)

SEMESTER 4   <mark>COURSE : S.STA.4.01</mark>
<mark>**Probability & Sampling distributions (B)**</mark>   **[45 lectures]**

LEARNING OBJECTIVE :
   4) **To understand the patterns in the data of large populations.**
   5) **To obtain the central location and dispersion of the data.**
   6) **To know the relationship between various distributions.**

Unit 1   **(15 L)**
Transformation of random variables & Standard Univariate Continuous Probability Distributions.
One-dimensional and two-dimensional continuous random variables.
Jacobian of Transformation, Simple illustrations related to standard distributions
Rectangular and Exponential distributions, Laplace distribution, Gamma distribution (with single and double parameter). Beta distribution (Type I and Type II)
The following aspects to be discussed wherever applicable to the above stated distributions:
Mode, Median, Derivation of M.g.f., C.g.f., Moments, Skewness and Kurtosis. Additive property. Limiting distribution (without proof)

Unit 2
. **Chi-Square Distribution**:   **(15 L)**
Definition, its M.G.F., C.G.F, Moments, Mode, Derivation of distribution of Sum of Squares of standard normal variates, Additive property. Distributions of Sample Mean, Sample Variance and their independence for a sample drawn from Normal population. Asymptotic Property (without proof)
Applications of Chi-Square Distribution:
Test of significance for specified variance of Normal population.
Test for independence of attributes (2x2 and r x c contingency tables without derivation of the test statistic), Yate's correction. Test for Goodness of Fit.

Unit 3
t-distribution :   **(15L)**
Definition of Student's t-statistic. Derivation of its density function. Moments . Asymptotic property (without proof).
Applications of t-distribution:
Tests of significance for:
i) Single population mean
ii) Difference between two population means

a) with equal variances based on independent samples.
b) based on paired observations.

F-distribution :

Definition., Derivation of density function Derivation of distribution of reciprocal of F-variate. Moments ,mode .Test for equality for two variances of two normal populations. Relationship between F, Chi-Square and t-distributions.

List of Recommended Reference books

1. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor : 8th edition, Sultan Chand & Sons.
2. Outline of Statistical Theory – Volume I, A.M. Goon, M. K. Gupta,   B. Dasgupta : 3rd edition, The World Press Pvt Ltd.
3. Introduction to Theory of Statistics, Mood, Graybill and Boes: 3rd edition, Mc Graw-Hill Publishers.
4. Introduction to Mathematical Statistics, R. V. Hogg & A. T. Craig : 4th edition, Collier Mc Millan Publishers.
5. Probability and Statistical Inference, R. V. Hogg & E. A. Tanis : 3rd edition, Mc Millan Publishing Co.
6. Mathematical Statistics, John E. Freund : 5th edition, Prentice-Hall of India Pvt Ltd.

List of Practicals
1. Rectangular and Exponential distribution.
2. Chi-Square Distribution.
3. t-Distribution.
4. F-Distribution.

S.Y.B.Sc
(STATISTICS)
SEMESTER 4   *COURSE : S.STA.4.02.*
Analysis of Variance & Design of Experiments   **[45 LECTURES]**

LEARNING OBJECTIVES :
   1) To introduce and apply the techniques and methodology available for designing and analysis of experiments.
   2) To emphasize the need for sound and unambiguous interpretation of experimentation.

 Unit 1.   Analysis of Variance (Fixed effect models) :   **(15 lectures)**
             One way classification (With equal and unequal observations per class)

Mathematical model and its assumptions. Estimation of parameters by Least Squares Method. Expectation and variance of the estimators. Expectation of various sums of squares, ANOVA table

Multiple comparisons of treatments

(i) Least Signficant difference test.. (ii) Tukey's test. (iii) Dunnet's test.

Two way classification (with one observation per cell)

Mathematical model and its assumptions. Estimation of parameters by Least Squares Method. Expectation and variance of the estimators. . Expectation of various sums of squares. ANOVA table

Unit 2. Design of Experiments: (**15 lectures)**

Experiment, experimental unit, treatment, replicate, block, experimental error and precision.

Principles of design of experiment: Replication, Randomization and Local Control.

Choice of size, shape of plots and block in different agriculture and non-agriculture experiments.

Completely randomized design.(CRD) & Randomized block design (RBD).

Mathematical model and its assumptions. Expectation of various sums of squares Estimation of parameters by Least Squares Method. ANOVA table Standard errors of treatment differences.

Efficiency of RBD over CRD.

Missing plot technique for one observation in RBD.

Unit 3. Latin square design (LSD)   (**15 lectures)**

Mathematical model and its assumptions. Expectation of various sums of squares Estimation of parameters by Least Squares Method. Standard errors of treatment differences, ANOVA table.

Efficiency of CRD over RBD.

Missing plot technique for one observation in LSD.

Symmetrical Factorial Experiments:

Purpose and advantages.

$2^2, 2^3$ experiments. Calculation of main and interactions effects.

Yates method.

Analysis of $2^2, 2^3$ experiments

Concepts of Confounding in 2^3 experiments.

Topics for Practicals
- One Way ANOVA / CRD.
- Two Way ANOVA / RBD.
- LSD..
- Missing Plot Technique.
- Factorial Experiment.

References
1. Fundamentals of Applied Statistics: S.C.Gupta and V.K.Kapoor, 3rd edition, Sultan Chand & Sons.
2. Designs and Analysis of Experiments : M. N. Das and N.C. Giri 2nd edition, Wiley Eastern Ltd.
3. Designs and Analysis of Experiments : D.C. Montgomery, 6th

edition, Wiley Eastern Ltd.

4. Applied Multivariate Analysis and Experimental Designs: N. Krishnan Namboodiri, Lewis F. Carter. Hubert M. Blalock. JR., 1st edition, McGraw –Hill, Inc.
5. Experimental Designs : William G. Cochran, Gertrude M. Cox, 2nd edition, Bombay, Asia Publishing House.
6. The Design of Experiments : Sir Ronald A. Fisher, 9th edition, Collier Macmillan Publishers.

S.Y.B.Sc
(STATISTICS)

SEMESTER 4   **COURSE : S.STA.4.03**

INDUSTRIAL STATISTICS.   **[45 LECTURES]**

LEARNING OBJECTIVES :
1) **To learn the applications of operations research in industry.**
2) **To plan and schedule projects.**
3) **To study quality control methods in industrie**

Unit 1.
Statistical Quality Control   **(15L)**
Introduction, Assignable causes, Chance causes, Process control, Product control, Shewhart's control charts, 3σ Limits.
X and R, p, c, np charts, their uses, p-chart with variable sample size,
Problems involving setting up standards for future use. Process capability.

Unit 2
Acceptance Sampling   **(15L)**
Introduction to Lot Acceptance Sampling Plans by Attributes. Consumers Risk, Producers Risk. Single and Double Sampling Plans : OC function and OC curves, AQL, LTPD, ASN, ATI, AOQ. Concept of 6σ limits.

Unit 3.
CPM and PERT: **(15L)**
Introduction, Basic concepts of network analysis
Definitions : Activity, Event, Dummy activity, Predecessor and successor activities and events.
Rules for drawing network, Fulkerson's Rule.
Bar Diagram (Gnatt Chart) and Network Diagram. Slack time and Float times. Critical path Method (CPM), Project evaluation review technique (PERT).
Project cost analysis, Updating, Resource Leveling, Resource Allocation

References

1. Statistical Quality Control : E.L.Grant., 2nd edition, McGraw-Hill Publishers.
2. Quality Control and Industrial Statistics : Duncan D.B. , 3rd edition, Taraporwala Sons & Co.
3. PERT and CPM Principles and Applications : Srinath, 2nd edition, East West Press Pvt Ltd.
4. Operations Research : Kantiswaroop, P.K. Gupta and Manmohan, 4th edition, Sultan Chand & Sons.
5. Operations Research : S. D. Sharma, 11th edition, Kedarnath, Ramnath & Co. .
6. Operations Research : H.A. Taha, 6th edition, Prentice Hall of India.
7. Operations Research: V.K. Kapoor, 7th edition, Sultan Chand & Sons.

Topics for Practicals.

1. **Statistical Quality Control.**
2. **Acceptance Sampling.**
3. **Network Analysis.**

St. Xavier's College – Autonomous Mumbai

SYBSc

Syllabus for Scientific Communication Skills (Statistics)

3rd Semester

(June 2011 onwards)

Contents:

Syllabus for Courses: SSTA03SCS

Learning Objectives:

The course enables students to:
1. Be knowledgeable of various aspects of scientific communication.
2. Convey the importance of scientific communication and its various modes like precis, journal paper and scientific presentation.
3. Introduce students to the historical and philosophical aspects of science so that they can critically reflect on the topic to be communicated, and overcome objections, tackle reviews etc.

Number of lectures: 12 Lectures

	Sessions	Plan	Tutor
1.	**Introduction**	Relevance of Communication Skills (CS), Overview of course Emphasize various aspects of CS Listening, Reading, Comprehension, Summarization, Group Discussion, Speaking	SXC dept faculty/ invitee
2	**Listening, Reading and Comprehension** **Aim: To teach students to write without reproducing all that was said ad-verbatim**	a] Talk for 10-15 minutes by teacher on any topic. Students don't take notes. At the end of 10 minutes, students given time to write what they recall and understand. b] Students should read the photocopies of 2-3 pages of matter provided for 10 minutes. Then through memory write what they recall and understand. c] Show a 10-15 min film clip. Students to be asked to write what they recalled and understood after the clip. d] Random selections of student writings to be read out in class and discussed	SXC dept faculty / invitee Matter used for the exercise could be decided by each dept Chiefly Memory-based
3	**Comprehension & Writing a summary**	a] Staff member to give input for 10 -15 minutes on how to write a summary/précis. b] Groups of 3-4 students to be given a chapter from a book/science article/science magazine/journal. c] Convert the given material into a small report.	SXC dept Faculty / invitee Shift from memory – based

		d] Groups of 3-4 students with each individual of a group having a different type of material. Individual student completes his summary and then exchanges his material with next person in the group. All in one group separately write 3 different summaries. Then they compare each summary with group members and finalize a new consensus summary. Whole class – All groups could be given the same set of 3 articles **OR** 2 different sets of 3 articles could be prepared and distributed randomly.	to understanding –dependent writing
4	**Reading a simple research paper**	a] Why and How to read a paper? b] Explain the general format of a paper i.e. Introduction, Method, Results & Discussion, Conclusion. c] What to look for while summarizing a paper / How to select salient features in a paper. d] Students given a Paper / Article to read and understand. e] Students to summarize/ pointwise listing of key features.	SXC dept faculty/invitee
5	**Writing an Abstract**	a] Staff to explain the structure of an abstract and the points to remember while writing an abstract b] Recognize good and bad abstracts based on the above information- students to be provided with good & bad abstract samples in sets of 3. Groups + Individual work in group + Sharing of conclusions in group + Teacher conducting general discussion on the positives and negatives of each abstract c] Make a summary of the paper read in the previous session and it could be converted into an abstract. d] Compare and understand the difference between summary and abstract	SXC dept faculty/invitee

| 6 | Evaluation & Feedback | **Evaluation Options:**
a] Provide a scientific paper and ask for an abstract to be written

b] Give article and let the salient features be written in abstract format

c] Provide a 3 - 4 page article from a Research journal/ Science magazine and students will write a 1-page summary of it.

d] Any other approach could be suggested for example: Recognize good and bad abstracts and write a report/news article/abstract

Feedback :
A questionnaire will have to be prepared and circulated before the start of the evaluation / after they complete the evaluation | SXC Dept faculty

A questionnaire to be created by coordinators of the course. |

References:

Selected Reads from the following:

1. Laudan: From theory to research traditions.
2. Thomas Kuhn on Scientific Revolutions.
3. Rationalism vs Empiricism, Realism, Idealism and other topics using the Stanford Encyclopaedia of Philosophy.
4. Positivism and Pauperian logic vs Logical Positivism vs Hermeneutics.
5. Rosenberg on Explanation, Causation and Laws.
6. Review of select scientific papers and manual of style for citations.

St. Xavier's College – Autonomous

Mumbai

SYBSc

Syllabus for Scientific Communication Skills (Statistics)

4th Semester

(June 2011 onwards)

Contents:

Syllabus for Courses: SSTA04SCS

Learning objectives:

The course enables students to understand:
1. The development and communication of science as a team activity.

2. Scientific communication as a vehicle of dissemination of rational thinking

Number of lectures: 12 Lectures

Sr. No.	Sessions	Plan	Tutor
1.	**Recap of semester 3 & Types and Structure of Scientific Writings**	a) Explain the various types of scientific writings: Papers, Reviews, Short communications, Articles for newspapers, Popular science writing, Chapters in textbook, etc. b) Discuss in detail the structure of science paper using different journals in your subject c) Exercise: Students to be given papers to work on in group and asked to list all points discussed in (b)	Faculty member of the Dept/ an invited expert.
2	**Writing: The 'How to of writing'**	a) Teacher input on the rules for: Text, figures, graphs, tables, etc. Example - Punctuation, Location Legends, Details etc b) How to write a title? How to write an introduction? Example - Give photocopies of a paper (excluding the title and introduction) Ask students to: • Formulate the title of the paper • Prepare an introduction i.e. list the points they would like to cover in the introduction. c) How to write a bibliography? Teacher input regarding different styles of reference writing and the variation for books, journals etc.	Faculty member of the Dept/ an invited expert. The Matter used for the exercise could be decided by the Dept/ expert

		Example - Students to write names of 5 text books/ reference books they normally use as if they were writing for the bibliography of their paper. Get 4 – 5 science magazines, let students pick an article in each and write it as a reference d) How to gather information? • Literature survey from magazines, journals (letters/short communication/ abstracts/ articles/reviews) • What are good journals/authentic sites? • Search engines Example – As Homework - Give a topic (maybe their assignment topic), Student collects information...Number of references in each of the following categories: Books, Papers, Reviews…	
3.	**Writing**	a) 10 – 15 minutes staff input on how to write a paper/article. b) Groups of 3 – 4 students given papers maybe in study pack/asked to get papers in previous session and asked to read them. c) Create a new paper using the reference papers provided/ collected for their project etc: • Start with creating a title. • Write an introduction of 2 pages • Group presentation d) Writing the result. Teacher provides data/student project data. e) Students complete paper and submit to the teacher	
4.	**Writing a simple research paper/article**	a) Teacher discusses all positives and negatives of all submitted papers.	SXC Department faculty/Invitee.

		b) Student revise papers keeping in mind the suggestions of the teacher. c) Teacher explains how to make PPT of the paper, (how many slides/what to write on ppt/what to say verbally, time per slide etc)	Students given 2 weeks to get their revised papers and the corresponding ppt ready.
5.	**PPT Presentation**	Practice presentation by 4 – 5 students, randomly selected; evaluation and discussion of positives and negatives	SXC Department Faculty/Invitee (Could be a short session of 45 minutes)
6.	**Evaluation & Feedback**	Evaluation: • A fifteen minute presentation by each group. • Ten minutes for Q & A. Feedback: A questionnaire will have to be prepared and circulated before the start of the evaluation/after they complete the evaluation.	SXC Department Faculty Presentations will have to be spread over 2 weeks. A questionnaire to be created by coordinators of the course.

Course Outcomes
1. Students are familiarised with scientific method and have gained competence in using online scientific resources. (Relevant papers from research databases like Science Direct and JSTOR)
2. Students have gained competence in using offline scientific resources like Journal of Indian Statistical Association (JISA), Journal of Statistical Theory & Applications (JSTA) etc.
3. Students have developed insights on various analytical techniques that the scientific method relies on, most critically, deductive reasoning and inductive logic.
4. Students have enhanced their skills for developing concept notes and writing research papers using appropriate methods of referencing.

References:
Selected Reads from the following:
1. Thomas Kuhn on Scientific Revolutions,
2. Rationalism vs Empiricism, Realism, Idealism and other topics using the Stanford Encyclopaedia of Philosophy.
3. Positivism and Pauperian logic vs Logical Positivism vs Hermeneutics.
4. Rosenberg on Explanation, Causation and Laws.
5. Review of select scientific papers and manual of style for citations.

St. Xavier's College – Autonomous
Mumbai

T.Y.B.Sc

Syllabus
For 5th Semester Courses in
STATISTICS
(June 2019 onwards)

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

Practical Course Syllabus for: SSTA05PR

Academic/field/industrial visits and seminars may be organized by the Department, at other
venues, as part of the curriculum.

T.Y. B.Sc. Statistics   <mark>**Course: SSTA0501**</mark>

<mark>**Title: Probability Theory**</mark>

<mark>**Learning Objectives :**</mark>

    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
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….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.

T.Y. B.Sc. Statistics

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 CRL. 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)
(v)   population median (Concept of Bootstrapping)

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. 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.

T.Y. B.Sc. Statistics   <mark>Course: SSTA0503</mark>

<mark>Title: Applied Statistics (I A)</mark>

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).
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

<u>Unit 4</u>.   (15L)
<u>Clinical Trials - II and Bioequivalence</u>
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.

<u>List Of Recommended Reference Books</u>

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.

T.Y. B.Sc. Statistics   Course: SSTA0504

 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.   (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

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

St. Xavier's College – Autonomous Mumbai

T.Y.B.Sc

Syllabus
For 6th Semester Courses in STATISTICS
(June 2019 onwards)

Contents:

Theory Syllabus for Courses:

    SSTA0601– Probability Distributions and Stochastic Processes.

    SSTA0602– Statistical Inference.

    SSTA0603– Applied Statistics (I B)

    SSTA0604- Applied Statistics (II B)

Practical Course Syllabus for: SSTA06PR

Academic/field/industrial visits and seminars may be organized by the Department, at other venues, as part of the curriculum.

T.Y.B.Sc
(STATISTICS)

SEMESTER 6   <mark>COURSE: SSTA0601</mark>

<mark>PROBABILITY DISTRIBUTIONS AND STOCHASTIC PROCESSES</mark>

[60 LECTURES]

LEARNING OBJECTIVES:
1) To strengthen their concepts in mathematical statistics.
2) To prepare students to develop stochastic and queueing models.

UNIT 1   BIVARIATE DISTRIBUTIONS: (15 L)

i) Definition and properties of Moment Generating Function of two random variables of
continuous and discrete type. Necessary and sufficient condition for independence of two
random variables.

ii) Trinomial distribution:

Definition of joint probability distribution (X,Y). Joint moment generating function,
moments μ_{rs} where r = 0,1,2 and s = 0,1,2

Marginal & conditional distributions. Their Means & Variances.
Correlation coefficient between the random variables.
Distribution of the Sum X+Y.

iii) Multinomial distribution:
Definition of joint probability distribution with parameters $(n, p_1, p_2, \ldots p_{k-1})$ where
$p_1 + p_2 + \ldots p_{k-1} + p_k = 1$.
Other properties (Concept only)

UNIT 2   BIVARIATE NORMAL DISTRIBUTIONS: (15 L)
Definition of joint probability distribution (X,Y). Joint moment generating function, moments
μ_{rs} where r = 0,1,2 and s = 0,1,2
Marginal & conditional distributions. Their Means & Variances.
Correlation coefficient between the random variables. Condition for the independence of X and
Y. Distribution of aX+bY, where a and b are constants.

SIGNIFICANCE OF CORRELATION COEFFICIENT:
Distribution of sample correlation coefficient when $\rho = 0$. Testing the significance of a
correlation coefficient.
Fisher's z – transformation. tests for
i) $H_0 : \rho = \rho_0$ and ii) $H_0 : \rho_1 = \rho_2$. Confidence interval for ρ.

UNIT 3   STOCHASTIC PROCESSES: (15L)
Definition of stochastic process. Postulates and difference differential equations for the i)
Poisson process ii) Pure birth process iii) Yule's process iv) Pure death process v) Poisson type
of death process vi) Yule's type / Linear Markovian death process vii) Birth and death process
viii) Linear growth model.
Derivation of Pn(t), mean and variance wherever applicable.

UNIT 4   <u>QUEUEING</u> <u>THEORY</u>   (15L)
Basic elements of the Queueing model. Roles of the Poisson and Exponential distributions.
Derivation of Steady state probabilities for the birth and death process.
Steady state probabilities and the various average characteristics for the following models
i) (M/M/1): (GD/ ∞ / ∞)   ii) (M/M/1) : (GD/ N / ∞)
iii) (M/M/c): (GD/ ∞ / ∞) iv) (M/M/c) : (GD/ N / ∞)
v) (M/M/c): (GD/ N / N) c<N   vi) (M/M/ ∞) : (GD/ ∞ / ∞)
Derivation of the waiting time distribution for the(M/M/1):(FCFS/ ∞/∞) model

REFERENCES:
1. Feller W: An introduction to probability theory and it's applications, Volume:1,
    Third edition,Wiley Eastern Limited.

2. Robert V. Hogg & Allen T. Craig: Introduction to Mathematical Statistics, Fifth edition,
    Pearson Education Pvt Ltd.
3. Alexander M Mood, Franklin A Graybill, Duane C. Boes: Introduction to the theory of
    statistics, Third edition, Mcgraw- Hill Series.
4. Hogg R. V. and Tanis E.A. Probability and Statistical Inference Fourth edition McMillan
    Publishing Company
5. S C Gupta & V K Kapoor: Fundamentals of Mathematical statistics, eleventh edition,
    Sultan Chand & Sons.
6. Taha H.A. Operations Research Mcmillan Publishing Co.
7. Kantiswaroop , P.K Gupta and Manmohan, Fourth edition, Sultan Chand & Sons.
8.   Vohra N.D. Quantitative Techniques in Management Third edition McGraw Hill
     Companies
9. J Medhi: Stochastic Processes, Second edition, Wiley Eastern Ltd.
10. Biswas S. Topics in Statistical Methodology Wiley Eastern Ltd.
11. J. N. Kapur, H. C. Saxena Mathematical Statistics Fifteenth edition S. Chand and Company

TOPICS FOR PRACTICALS:

Ser. No.	Topic
1.	Trinomial & Multinomial distributions
2.	Bivariate Normal distribution
3.	Significance of correlation coefficient
4.	Stochastic processes
5.	Queueing theory

T.Y.B.Sc
(STATISTICS)

SEMESTER 6   <mark>COURSE: SSTA0602</mark>

<mark>STATISTICAL INFERENCE</mark>   [60 LECTURES]

LEARNING OBJECTIVE : To empower students to validate assumptions made on population
parameters.

Unit 1   TESTING OF HYPOTHESIS:
Statistical hypothesis. Problem of testing of hypothesis. Definitions and illustrations
of i) Simple hypothesis ii) Composite hypothesis iii) Null Hypothesis iv)
Alternative Hypothesis v)Test of hypothesis vi) Critical region vii) Type I and Type
II errors viii) Level of significance ix) p-value   x) size of the test xi) Power of
the test xii) Power function of a test
xiii) Power curve.
Definition of most powerful test of size α for a simple hypothesis against a simple
alternative hypothesis. Neyman –Pearson fundamental lemma. Definition of
uniformly most powerful (UMP) test. Construction of UMP test for one tailed
alternative hypothesis. Randomized test.   **(15L)**

Unit 2   LIKELIHOOD RATIO TEST: **(15L)**
Likelihood ratio principle. Definition of the test statistic and its asymptotic
distribution (statement only) Derivation of the test procedure for testing a composite
hypothesis against a composite alternative hypothesis for the parameters of
Binomial, Poisson, Discrete & Continuous Uniform and Normal distribution.

Unit 3   NON-PARAMETRIC TESTS: **(15L)**
Need for non-parametric tests. Distinction between a parametric and a non
parametric test. Concept of a distribution free statistic.
Confidence interval for a quantile.
One sample and Two sample non parametric test: (i) Sign test (ii) Wilcoxon Signed
Rank test. (iii) Run test (iv) Kolmogrov Smirnov test.
 (v) Median test (vi) Mann-Whitney-Wilcoxon test. (vii) Kruskal-Wallis test
(viii) Friedman test (ix) Fisher's Exact test
Assumptions, justification of the test procedure, critical regions for one tailed and
two tailed test procedures. Problems with no ties.

Unit4   SEQUENTIAL PROBABILITY RATIO TEST: **(15L)**
Sequential probability ratio test procedures for testing a simple null hypothesis
against a simple alternative hypothesis. Its comparison with fixed sample size. Most
powerful test procedure. Definition of Wald's SPRT of strength (α, β). Problems
based on standard distributions such as Bernoulli , Poisson, Normal, Exponential .
Graphical and tabular procedures for carrying out the tests. O.C function and A.S.N
function and their respective curves.

REFERENCES:

1. Hogg R.V. and Craig A.T: Introduction to Mathematical Statistics Fourth edition London Macmillan Co. Ltd.
2. Hogg R.V. and Tanis E.A.: Probability and Statistical Inference. Third edition Delhi Pearson Education.
3. Daniel W.W.: Applied Non-Parametric Statistics First edition Boston-Houghton Mifflin Company
4. Sidney Siegal, N. John Castelian Jr. Nonparametric Statistics For Behavioral Sciences , Second edition McGraw Hill International editions
5. Wald A.: Sequential Analysis First edition New York John Wiley & Sons
6. Biswas S.: Topics in Statistical Methodology. First edition New Delhi Wiley eastern Ltd.
7. Gupta S.C. and Kapoor V.K.: Fundamentals of Mathematical Statistics Tenth edition New Delhi S. Chand & Company Ltd.
8. F.D. Gibbons: Non Parametric Statistical Inference

TOPICS FOR PRACTICALS:
- Testing of Hypotheses.
- Likelihood Ratio Tests.
- Non-Parametric Tests.
- Sequential Probability Ratio Test.

T.Y.B.Sc
(STATISTICS)

SEMESTER 6   <mark>**COURSE: SSTA0603**</mark>

<mark>**APPLIED STATISTICS (I B)**</mark>   **[60 LECTURES]**

LEARNING OBJECTIVE: To orient students on various applications of Statistics in industry.

Unit 1   INVENTORY CONTROL: 15L
          Deterministic Models:
          Single item static EOQ models for i) Constant rate of demand with
          instantaneous replenishment, with and without shortages.
          ii) Constant rate of demand with uniform rate of replenishment, with and
          without shortages. iii) Constant rate of demand with instantaneous
          replenishment without shortages, with at most two price breaks.
          Probabilistic models. :
          Single period with
           i) Instantaneous demand (discrete and continuous) without setup cost.
           ii) Uniform demand (discrete and continuous) without set up cost.

Unit 2   REPLACEMENT THEORY: 15L
          Replacement of items that deteriorate with time and the value of money:
           i)   remains constant
           ii)   changes with time (weighted average of costs method).
          Replacement of items that fail completely.
          Individual replacement and Group replacement policies.

Unit 3   GAME THEORY: 15L
          Definitions of Two person Zero Sum Game, Saddle Point, Value of the Game,
          Pure and Mixed strategy.
          Optimal solution of two-person zero sum games: Dominance property,
          Derivation of formulae for (2 x 2) game. Graphical solution of (2 x n) and
          (m x 2) games.
          Reduction of Game Theory to LPP.

Unit 4   SIMULATION: 15L
          Scope of simulation applications. Types of simulation. Monte Carlo Technique
          of Simulation. Elements of discrete event simulation. Generation of random
          numbers. Sampling from probability distribution. Inverse method. Generation of
          random observations from i) Uniform distribution ii) Exponential distribution iii)
          Gamma distribution
          iv) Normal distribution. Simulation techniques applied to inventory and
          Queueing models.

REFERENCES:

1. Sharma J. K.: Operations Research Theory and Application, Third edition, Macmillan India Ltd.

2. Sharma S.D.: Operations Research. Eleventh edition, Kedarnath, Ramnath & Co.

3. Kantiswaroop , P.K Gupta and Manmohan, Fourth edition, Sultan Chand & Sons.

4. V.K. Kapoor. Operations Research. -Techniques for Management. Seventh edition, Sultan Chand & Sons Educational Publishers New Delhi.

5. Taha H.A. Operations Research, Sixth edition, Prentice Hall of India Pvt Ltd.

6. Vohra N.D. Quantitative Techniques in Management Third edition McGraw Hill Companies

7. Bannerjee B. Operation Research Techniques, Second edition, Mumbai Business Books.

8. Bronson R. Operations Research, Shaum's Outline series

9. Smith P.J. Analysis of Failure and Survival Data.

TOPICS FOR PRACTICALS:

- Deterministic inventory models.
- Probabilistic inventory models.
- Replacement Theory.
- Game Theory.
- Simulation.

T.Y.B.Sc
(STATISTICS)

SEMESTER 6

[60 LECTURES]

LEARNING OBJECTIVE : To enable students to develop the technique of model building

Unit 1	MULTIPLE LINEAR REGRESSION – I :	15L

Unit 1 — MULTIPLE LINEAR REGRESSION – I :   **15L**
Concept of General Linear Model.
Introduction to Binary Logistic Regression.
Multiple linear regression model with two independent variables: Assumptions of the model, Derivation of ordinary least square (OLS) estimators of regression coefficients.
Properties of least square estimators (without proof)
Concept of multiple correlation, partial correlation, R^2 and adjusted R^2.
Properties of multiple and partial correlation coefficients.
Testing the significance of multiple and partial correlation coefficients.
Procedure of testing
i)   overall significance of the model
ii)   significance of individual coefficients
iii)   significance of contribution of additional independent variable to a model.
Confidence intervals for the regression coefficients
Residual analysis using graphs.

Unit 2 — MULTIPLE LINEAR REGRESSION – II :   **15L**
Autocorrelation: Concept, Detection using i) Run Test ii) Durbin Watson Test, Consequences of using OLS estimators in presence of autocorrelation, Generalized least square(GLS) method.
Heteroscedasticity: Concept,Detection using i) Spearman's rank correlation test ii) Breusch – Pagan – Godfrey Test.   Consequences of using OLS estimators in presence of heteroscedasticity Weighted least square (WLS) estimators
Multicollinearity: Concept, Detection using R square & t ratios, simple correlation coefficients, Tolerance-Variance Inflation Factor (VIF) Consequences of using OLS estimators in presence of multi collinearity.

Unit 3 — TIME SERIES: **15L**
Definition of Time series. Its components. Models of Time Series.
Estimation of trend by i) Freehand curve method ii) Method of semi averages iii) Method of moving averages iv)   Method of least squares.
v) Exponential smoothing method
Estimation of seasonal component by i) Method of simple averages
ii) Ratio to moving average method iii) Ratio to trend method

RELIABILITY: 15L

Concept of reliability or survival function, Hazard function, Cumulative hazard function

Life time distributions: i) Exponential ii) Gamma iii) Weibull iv) Gumbel.

Definitions of increasing (decreasing) failure rate.

Observation schemes and censoring: left and right censoring, interval censoring, Type I, Type II, random right censoring. Kaplan-Meier estimator of survival function and median survival time.

Reliability: Structure function, coherent system, standard systems: series, parallel, k-out-of-n system of independent components having exponential life distributions.

Mean Time to Failure of a system (MTTF).

TOPICS FOR PRACTICALS:
- Multiple regression model.
- Autocorrelation, Heteroscedasticity, Multicollinearity.
- Time series.
- Reliability.

REFERENCES:
- S.C.Gupta , V.K.Kapoor: Fundamentals of Applied Statistics, Third edition, Sultan Chand & Sons.
- Barlow R.E. and Prochan Frank: Statistical Theory of Reliability and Life Testing, First edition, John Wiley & Sons
- Mann N.R., Schafer R.E., Singapurwalla N.D.: Methods for Statistical Analysis of Reliability and Life Data., First edition, Wiley International
- Damodar Gujrathi: Basic Econometrics, Second edition McGraw-Hill Companies.
- S.M.Ross: Probability Models & Applications.
- A.M.Goon, M.K.Gupta, B.Dasgupta: Fundamentals of Statistics, Vol Two, Fifth Revised edition, The World Press Pvt Ltd.
- Smith P.J: Analysis of Failure and Survival Data
- Daniel W.W: Applied Non-Parametric Statistics First edition Boston-Houghton Mifflin Company