St. Xavier's College – Autonomous Mumbai

S.Y.B.Sc
Syllabus
For 3rd Semester Courses in STATISTICS
(June 2018 onwards)

Contents:
Theory Syllabus for Courses:

      SSTA0301 - Probability and Sampling Distributions (A)
      SSTA0302- Sampling Techniques
      SSTA0303- Operations Research.

Practical Course Syllabus for: SSTA03PR

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   **COURSE:** SSTA0301
Title: Probability and Sampling distributions (A)

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

Topics for Practicals
1. Distribution of random variables: 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.

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.

S. Y. B. Sc. STATISTICS   Course: SSTA0302
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 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.

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.

S.Y.B.Sc. STATISTICS   **COURSE:** SSTA0303
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 Practicals.
1. L.P.P.
2. Transportation Problem.
3. Assignment Problem.
4. Decision Theory.

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.

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S.Y.B.Sc
Syllabus
For 4th Semester Courses in
STATISTICS
(June 2018 onwards)

Contents:
Theory Syllabus for Courses:

      SSTA0401- Probability and Sampling Distributions (B)
      SSTA0402– Analysis of variance & Design of Experiment
      SSTA0403 – Industrial Statistics

Practical Course Syllabus for: SSTA04PR

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)

Probability & Sampling distributions (B)   [45 lectures]

LEARNING OBJECTIVE:
    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.

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

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.

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SEMESTER 4   **COURSE:** SSTA0401

<u>Analysis of Variance & Design of Experiments</u>   [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 Significant 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
               1. One Way ANOVA / CRD.
               2. Two Way ANOVA / RBD.
               3. LSD.
               4. Missing Plot Technique.
               5. 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.

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SEMESTER 4   **COURSE:** SSTA0403

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

Topics for Practicals.

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

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.