St. Xavier's College – Autonomous Mumbai

T.Y.B.A.

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

Contents:
Theory Syllabus for Courses:

     ASTA0501 – Probability & Sampling Distributions (A).
     ASTA0502 – Sampling Techniques.
     ASTA0503 – Applied Statistics (A)

Practical Course Syllabus for: ASTA05PR

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

T.Y.B.A STATISTICS   **Course: ASTA0501**
Title: Probability & Sampling Distributions (A)

Learning Objectives:
1) **To understand the patterns in the data of large populations.**
2) **To obtain data summarizing methods.**
3) **To know the relationship between various distributions.**

No. of lectures: 45

Unit 1   (15L)
Univariate and Bivariate random variables (Discrete and Continuous)

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   (15 L)
Standard Univariate Discrete Probability Distributions:

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)

 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 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

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

T.Y.B.A   STATISTICS   **Course: ASTA0502**
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.**

No. of lectures: 45

Unit 1   **(15L)**
Simple Random Sampling (with and without replacement):
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 2   **(20L)**
Ratio and Regression Estimators under SRSWOR:
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)

Unit 3
Systematic Random Sampling.   **(10L)**
Sampling procedure. Estimation of population mean and total.
(Assuming N = nk)
Expectation and variance of estimators.
Expression for variance in terms of (i) S^2 and S^2_{WSY} (ii) intra class correlation
coefficient.

Topics for Practicals.

1. SRS for variables.
2. SRS for attributes.
3. Estimation of samples size in case of SRS.
4. Confidence Limits in case of SRS.
5. Stratified random sampling.
6. Ratio and Regression methods of estimations.
7. Systematic sampling.

List Of Recommended Reference 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.

T.Y.B.A STATISTICS   **Course: ASTA0503**
Title: Applied Statistics (A)

Learning Objectives:
To apply Statistics to the Insurance industry.

No. of lectures: 45

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 Table:
Various mortality functions. Probabilities of living and dying. The force of
mortality. Estimation of μ_x from the mortality table.
Mortality table as a population model. Stationary population.
Expectation of life and Average life at death. Central death rate.

Unit 2.   **(15 L)**
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.
Redemption of Loan.

Unit 3.   **(15 L)**
Assurance Benefits:
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)
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.

TOPICS FOR PRACTICALS

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

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.

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T.Y.B.A

Syllabus
For 6th Semester Courses in Statistics
(June 2016 onwards)

Contents:
Theory Syllabus for Courses:

     ASTA0601 – Probability & Sampling Distributions (B).
     ASTA0602 – Analysis of Variance & Design of Experiments.
     ASTA0603 – Applied Statistics (B)

Practical Course Syllabus for: ASTA06PR

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

T.Y.B.A
(STATISTICS)

SEMESTER 6   **COURSE: ASTA0601**

PROBABILITY & SAMPLING DISTRIBUTIONS (B)   **[45 Lectures]**

LEARNING OBJECTIVES:
1) **To understand the patterns in the data of large populations.**
2) **To obtain data summarizing methods.**
3) To know the relationship between various distributions.

Unit 1   **(15 lectures)**

Standard Univariate Continuous Probability 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)

Transformation of random variables
One-dimensional and two-dimensional continuous random variables. Jacobian of Transformation, Simple illustrations related to standard distributions

Unit 2
Chi-Square Distribution: **(15 lectures)**
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 Goodness of Fit.

Unit 3
t-distribution: **(15 lectures)**
Definition of Student's t-statistic. Derivation of its density function. Moment. Asymptotic property.

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.
iii) Correlation coefficient (without proof).

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

Topics for practicals:

1. Rectangular and Exponential distribution.
2. Chi-square distribution
3. t – distribution
4. F distribution.

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 6   **COURSE: ASTA0602**
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
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 6   **COURSE: ASTA0603**

LEARNING OBJECTIVES:
1) **To learn techniques of mathematical modelling**
2) **To study methods to solve the formulated problems.**
3) **To learn the applications of operations research in industry.**

APPLIED STATISTICS (B)   **[45 LECTURES]**

Unit 1.   **DECISION THEORY**:
Decision making under uncertainty 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, EPPI, EVPI Decision tree analysis.
GAME THEORY:
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.

Unit 2.   **SIMULATION:**
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.

Unit 3.   **MULTIPLE LINEAR 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 R^2 and adjusted R^2. 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. Concept of Autocorrelation, Heteroscedasticity, Multicollinearity.

Topics for practicals:
1. Deceision Theory.
2. Game theory.
3. Simulation.
4. Multiple Linear regression.

References
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.
5. Damodar Gujrathi: Basic Econometrics, Second edition McGraw-Hill Companies.
6. Vohra N.D. Quantitative Techniques in Management Third edition McGraw Hill Co.

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