Central University of Punjab, Bathinda

Course Scheme & Syllabus

for

M.Sc. Statistics

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
### Scheme of Programme M.Sc. Statistics

#### SEMESTER I

<table>
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<th>S.No</th>
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| C_A  | Continuous Assessment: Based on Objective Type Tests/ Assignments |
| M_1  | Mid-Term Test-1: Based on Objective Type & Subjective Type Test  |
| M_2  | Mid-Term Test-2: Based on Objective Type & Subjective Type Test  |
| E_T  | End-Term Exam (Final): Based on Objective Type Tests             |
| T_M  | Total Marks                                                     |

C: Core; I_E: Interdisciplinary elective; F: Foundation; L: Lectures; T: Tutorial; P: Practical; Cr: Credits.

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**Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016**
# Scheme of Programme M.Sc. Statistics

## SEMESTER II

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- **C_A**: Continuous Assessment: Based on Objective Type Tests/ Assignments
- **M_1**: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
- **M_2**: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
- **E_T**: End-Term Exam (Final): Based on Objective Type Tests
- **T_M**: Total Marks
- **C**: Core; **I_E**: Interdisciplinary elective; **F**: Foundation; **L**: Lectures; **T**: Tutorial; **P**: Practical; **Cr**: Credits.

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**Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016**
### Scheme of Programme M.Sc. Statistics

#### SEMESTER III

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*CA*: Continuous Assessment: Based on Objective Type Tests/ Assignments  
*M₁*: Mid-Term Test-1: Based on Objective Type & Subjective Type Test  
*M₂*: Mid-Term Test-2: Based on Objective Type & Subjective Type Test  
*Eₚ*: End-Term Exam (Final): Based on Objective Type Tests  
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**Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016**
### Scheme of Programme M.Sc. Statistics
#### SEMESTER IV

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Semester I

Course Title: Research Methodology-I
Course Code: STA.401
Total Hours: 32

Objectives:
The course Research Methodology -I has been framed to introduce basic concepts of research methods and statistics.

Unit I (8 Lecture Hours)
Introduction: Meaning and importance of research, Different types and styles of research, Role of serendipity, Critical thinking, Creativity and innovation, Hypothesis formulation and development of research plan, Art of reading, understanding and writing scientific papers, Literature survey, Interpretation of results and discussion, Poster preparation and presentation.

Unit II (8 Lecture Hours)
Library: Classification systems, e-library, Reference management, Web-based literature search engines, Intellectual property rights (IPRs).
Entrepreneurship and business development: Importance of entrepreneurship and its relevance in career growth, Types of enterprises and ownership.

Unit III (8 Lecture Hours)
Statistical analysis and fitting of data: Meaning, Characteristics, Measure of central tendency, Arithmetic mean, median, mode, geometric mean, harmonic mean.

Unit IV (8 Lecture Hours)
Skewness, Moments and Kurtosis: Skewness, Test of skewness, objectives of skewness, distinction between skewness and dispersion, measure of skewness, kurtosis, meaning and importance, measures of moments and kurtosis
Correlation and regression analysis: Positive and negative correlation, Causation and correlation, Methods of studying correlation, Regression coefficient and the coefficient of correlation, the point of intersection of two regression lines.

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Probability and Distribution Theory
Course Code: STA.501
Total Hours: 56

Objectives:
The course is designed to equip the students with knowledge of various probability distributions and to develop greater skills and understanding of various inequalities for further studies.

Unit I (13 Lecture Hours)
Random experiments, sample spaces (finite and infinite), events, algebra of events, three basic approaches for defining probability, combinatorial problems. Product sample spaces, conditional probability, Bayes’ formula.

Unit II (14 Lecture Hours)

Unit III (15 Lecture Hours)
Bivariate random variable and their joint, marginal and conditional p.m.fs. and p.d.fs, correlation coefficient, conditional expectation. Bivariate normal and multinomial distributions. Moment generating and probability generating functions. Functions of random variables and their distributions using Jacobian of transformation and other tools. Probability Integral transformation, order statistics and their distributions (continuous case only), truncated distributions, compound distributions.

Unit IV (14 Lecture Hours)

Recommended Books:

Suggested Readings:
Course Title: Real Analysis  
Course Code: STA.502
Total Hours: 56

Objectives:
The aim of this course is to make the students learn fundamental concepts of metric spaces, Riemann-Stieltjes integral as a generalization of Riemann Integral, Sequence and series of functions, the calculus of several variables and some basic theorems.

Unit I (15 Lecture Hours)
Metric spaces: Definition and examples, Open and closed sets, Compact sets, Elementary properties of compact sets, k-cells, Compactness of k-cells, Compact subsets of Euclidean space \(\mathbb{R}^k\), Perfect sets, Cantor set, Separated sets, Connected sets in a metric space, Connected subsets of real line. Convergent sequences (in Metric spaces), Subsequences, Cauchy sequences, Complete metric space, Cantor’s intersection theorem, Category of a set and Baire’s category theorem. Examples of complete metric space, Banach contraction principle.

Unit II (15 Lecture Hours)
Limits of functions (in Metric spaces), Continuous functions, Continuity and compactness, Continuity and connectedness, Discontinuities, Monotonic functions, Uniform continuity. Riemann Stieltje’s Integral: Definition and existence of Integral, Properties of integral, Integration and differentiation, Riemann sums and Riemann integral. Fundamental theorem of Calculus, Integration of vector valued functions, Rectifiable curves.

Unit III (13 Lecture Hours)

Unit IV (13 Lecture Hours)
Functions of several variables, Linear transformation, Derivative is an open subject, Chain rule, Partial derivatives, Jacobian, Interchange of the order of differentiation, Derivation of higher order, Inverse function theorem, Implicit function theorem.

Recommended Books:

Suggested Readings:
Course Title: Statistical Methods with Packages in R
Course Code: STA.503
Total Hours: 45

Objectives:
The course is designed to equip the students with various techniques used in summarization and analysis of data and also to give understanding of testing of hypotheses, some important distributions and also non-parametric tests for practical knowledge.

Unit I (12 Lecture Hours)
Descriptive Statistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart. Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Data on two attributes, independence and association of attributes in 2x2 tables. Linear regression and correlation (Karl Pearson’s and Spearman’s) and residual plots.

Unit II (12 Lecture Hours)
Normal, Chi-square, t and F distributions and their relations. Population, random sample, parameter, statistic and sampling distribution. Sample mean and sample variance associated with a random sample from a normal distribution: their independence, sampling distributions, expectations and standard errors.

Unit III (11 Lecture Hours)
Statistical hypotheses, Type I and II errors, level of significance, test of significance, concept of p-value. Tests of significance for the parameters of normal distribution (one sample and two sample problems) and the relevant confidence intervals. Chi-square test of goodness of fit and independence of attributes. Test of significance for correlation coefficient ($\rho = 0, \rho = \rho_0$) (one and two sample problem).

Unit IV (10 Lecture Hours)

Recommended Books:

Suggested Readings:
Course Title: Statistical Methods with Packages in R (LAB)
Course Code: STA.504
Total Hours: 30

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Topics should include graphic representation of data, descriptive statistics, correlation, linear regression and non-parametric tests.
Course Title: Linear Algebra

Course Code: STA.505

Total Hours: 56

Objectives:
The concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines. The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences. The emphasis will be to combine the abstract concepts with examples in order to intensify the understanding of the subject.

Unit I (14 Lecture Hours)
Vector Space: Vector spaces, Subspaces, Direct sum of subspaces, Linear dependence and independence, Basis and dimensions, Linear transformations, Algebra of linear transformations, Dual spaces, Matrix representation of a linear transformation, Rank and nullity of a linear transformation, Invariant subspaces.

Unit II (15 Lecture Hours)
Characteristic polynomial and minimal polynomial of a linear transformation, Cayley Hamilton theorem, Eigenvalues and eigenvectors of a linear transformation, Diagonalization and triangularization of a matrix, Characteristic polynomial and minimal polynomial of block matrices. Canonical forms, Diagonal forms, Triangular forms, Jordan canonical forms, rational canonical forms, Quotient spaces.

Unit III (14 Lecture Hours)
Linear functional, Dual space, Dual basis, Annihilators, Bilinear forms, Symmetric bilinear forms, Sylvester’s theorem, quadratic forms, Hermitian forms. Reduction and classification of quadratic forms.

Unit IV (13 Lecture Hours)

Recommended Books:
2. V. Bist and V. Sahai, Linear Algebra, Narosa, Delhi, 2002.

Suggested Readings:
Course Title: Operational Research
Course Code: STA.506
Total Hours: 56

Objectives:
The objective of this course is to acquaint the students with the concept of convex sets, their properties, Linear and nonlinear programming problems. The results, methods and techniques contained in this paper are very well suited to the realistic problems in almost every area.

Unit I (14 Lecture Hours)

Unit II (14 Lecture Hours)

Unit III (14 Lecture Hours)

Unit IV (14 Lecture Hours)
Replacement problem, replacement of items that Deteriorate, replacement of items that fail completely. Job Sequencing Problems: Introduction and assumption, Processing of n jobs through two machines, Processing of n jobs through three machines and m machines, Processing two jobs through n machines.

Recommended books:

Suggested Readings:
Course Title: Basic Statistics
Course Code: STA.402
Total Hours: 32

Objectives:
To provide the understanding and use of Statistical techniques for students of other departments.

Unit I (8 Lecture Hours)

Unit II (8 Lecture Hours)
Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Data on two attributes, independence and association of attributes in 2x2 tables. Linear regression and correlation (Karl Pearson’s and Spearman’s) and residual plots.

Unit III (8 Lecture Hours)
Random experiments, sample spaces (finite and infinite), events, algebra of events, three basic approaches to probability, combinatorial problems. Axiomatic approach to probability. Product sample spaces, conditional probability, Bayes’ formula.

Unit IV (8 Lecture Hours)

Recommended Books:

Suggested Readings:
Semester II

Course Title: Computer Fundamentals and C-programming
Course Code: STA.403
Total Hours: 45

Objectives:
The aim of this course is to provide adequate knowledge of fundamentals of computer along with problem solving techniques using C programming. This course provides the knowledge of writing modular, efficient and readable C programs. Students also learn the utilization of arrays, structures, functions, pointers, file handling and their applications.

Unit I (10 Lecture Hours)
Computer Hardware: Definitions, Historical overview, Technological advancement in computers, Shape of today’s computer, Computer as a system. CPU, Primary memory, Secondary storage devices, Input and Output devices.

Unit II (11 Lecture Hours)
Computer Software: Significance of software in computer system, Categories of software – System software, Application software, Compiler, Interpreter, Utility program, Binary arithmetic for integer and fractional numbers, Operating System and its significance. Introduction to algorithm, Flow charts, Problem solving methods, Need of programming languages.

Unit III (12 Lecture Hours)
C Programming: Historical development of C, C character set, Identifiers and keywords, Data types, Declarations, Statement and symbolic constants, Input-output statements, Preprocessor commands, Operators, Expressions, Library functions, Decision making and loop control statements.

Unit IV (12 Lecture Hours)
C Programming: Functions, Storage Classes, Arrays, Strings, Pointers, Structure and Union, File handling.

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Computer Fundamentals and C-programming (LAB)

Course Code: STA.404

Total Hours: 30

Laboratory experiments will be set in context with the materials covered in theory.
Course Title: Estimation and Testing of Hypotheses
Course Code: STA.507
Total Hours: 45

Objectives:
The concepts and techniques of estimation and testing of hypotheses are of great importance in statistics. The main objective is to introduce estimation as well as introduction to hypothesis testing in practical life.

Unit I
(10 Lecture Hours)


Unit II
(11 Lecture Hours)


Tests of Hypotheses: Concepts of critical regions, test functions, two kinds of errors, size function, power function, level of significance. Most Powerful (MP) and Uniformly Most Powerful (UMP) tests in a class of size $\alpha$ tests.

Unit III
(12 Lecture Hours)

Neyman-Pearson Lemma, MP test for simple null against simple alternative hypothesis. UMP tests for simple null hypothesis against one-sided alternatives and for one-sided null against one-sided alternatives in one parameter exponential family. Extension of these results to Pitman family when only upper or lower end depends on the parameter and to distributions with MLR property. Non-existence of UMP test for simple null against two-sided alternatives in one parameter exponential family. Likelihood Ratio Tests. Wald’s SPRT with prescribed errors of two types.

Unit IV
(12 Lecture Hours)

Interval estimation: Confidence interval, confidence level, construction of confidence intervals using pivots, shortest expected length confidence interval, uniformly most accurate one sided confidence interval and its relation to UMP test for one sided null against one sided alternative hypotheses. Tests of hypotheses and interval estimation viewed as decision problems with given loss functions.

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Estimation and Testing of Hypotheses (LAB)
Course Code: STA.508
Total Hours: 30

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Laboratory experiments will be set in context with the materials covered in theory.
Course Title: Measure Theory
Course Code: STA.509
Total Hours: 56

Objectives:
The objective of this course is to introduce student’s measure theory in an abstract setting after having studied Lebesgue measure on real line. Some important theorems are also studied.

Unit I (13 Lecture Hours)
Semi-algebras, Algebras, Monotone class, \(\sigma\) -algebras, Measure and outer measures, Caratheödory extension process of extending a measure on a semi-algebra to generated \(\sigma\) -algebra, Completion of a measure space.

Unit II (14 Lecture Hours)

Unit III (14 Lecture Hours)
Measurable functions on a measure space and their properties, Borel and Lebesgue measurable functions, Simple functions and their integrals, Littlewood’s three principle (statement only), Lebesgue integral on R and its properties.

Unit IV (15 Lecture Hours)
Bounded convergence theorem, Fatou’s lemma, Lebesgue monotone convergence theorem, Lebesgue dominated convergence theorem, Minkowski’s and Hölder’s inequalities, Riesz-Fischer theorem (statement only).

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Stochastic Processes  
Course Code: STA.510  
Total Hours: 56  

Objectives:
This course is framed to equip the students of M.Sc. Statistics with knowledge of different processes, stationarity as well as basic knowledge of this course.

Unit I  
(14 Lecture Hours)

Unit II  
(16 Lecture Hours)

Unit III  
(13 Lecture Hours)
Renewal theory: Renewal process, elementary renewal theorem and applications. Statement and uses of key renewal theorem, study of residual lifetime process. 

Unit IV  
(13 Lecture Hours)

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Complex Analysis
Course Code: STA.511
Total Hours: 56

Objectives:
This course is aimed to provide an introduction to the theories for functions of a complex variable. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field. The concepts of analyticity, Cauchy-Riemann equations and harmonic functions are then introduced. Students will be equipped with the understanding of the fundamental concepts of complex variable theory.

Unit I (14 Lecture Hours)

Unit II (14 Lecture Hours)
Complex line integral, Cauchy’s theorem, Cauchy-Goursat theorem, Cauchy’s integral formula and its generalized form, Index of a point with respect to a closed curve, Cauchy’s inequality. Poisson’s integral formula, Morera’s theorem. Liouville’s theorem, Contour integral, Power series, Taylor’s series, Higher order derivatives, Laurent’s series.

Unit III (14 Lecture Hours)
Singularities of analytic functions, Casorati-Weierstrass theorem, Fundamental theorem of algebra, Zeroes of analytic function, Poles, Residues, Residue theorem and its applications to contour integrals, Branches of many valued functions with arg z, log z, and \( z^a \). Maximum modulus principle, Schwarz lemma, Open mapping theorem.

Unit IV (14 Lecture Hours)
Meromorphic functions, The argument principle, Rouche’s theorem, Mobius transformations and their properties and classification, Definition and examples of conformal mappings.

Recommended Books:

Suggested Readings:
Course Title: Linear Models and Regression
Course Code: STA.512
Total Hours: 32

Objectives:
The concepts and techniques from linear models are of fundamental importance in statistics. The main objective is to introduce estimator in linear models. The emphasis will also be upon the testing of linear hypothesis, linear and non-linear models to intensify the understanding of the subject.

Unit I (8 Lecture Hours)
Point and interval estimates, best linear unbiased estimates, construction of confidence intervals of the parameters of linear model.

Unit II (8 Lecture Hours)
Gauss-Markoff set-up, normal equations, least squares estimates and their precision, use of g-inverse, statements and applications of fundamental theorems of least squares.

Unit III (8 Lecture Hours)
Introduction to fixed, mixed and random effect models. Tests of significance and interval estimates based on least squares theory in one-way and two-way classified data.

Unit IV (8 Lecture Hours)
Bivariate, Multiple and polynomials regression and use of orthogonal polynomials. Residuals and their plots as tests for departure from assumptions of fitness of the model normality, homogeneity of variances.

Recommended Books:

Suggested Readings:
Course Title: Basics of Inferential Statistics
Course Code: STA.405
Total Hours: 32

Objectives:
The course will help students from other streams like Microbiological Sciences, Plant Sciences, Animal Sciences etc. to understand testing of hypotheses concept in an easy manner. The main objective is to give basic understanding of testing of hypotheses to science students so that they can frame correct Hypothesis in their research work and both parametric and non-parametric tests help them to draw conclusions from the sample.

Unit I (8 Lecture Hours)

Unit II (8 Lecture Hours)
Meaning of parameters, test statistic and their sampling distributions. Need of Inferential Statistics. Estimation: Point Estimation and Confidence Interval. Testing of Hypothesis: Simple and Composite Hypothesis, Type I error, Type II error, power, level of significance, acceptance region, rejection region, confidence interval.

Unit III (8 Lecture Hours)
Parametric tests: Test for parameters of Normal population (one sample and two sample problems) z-test, student’s t-test, F and chi-square test and Analysis of Variance (ANOVA).

Unit IV (8 Lecture Hours)

Recommended Books:

Suggested Readings:
Semester III

Course Title: Research Methodology-II
Course Code: STA.406
Total Hours: 32

Objectives:
The objective of this course is to equip the students with knowledge of some basic as well as advanced concepts related to research. The course covers preparation of research plan, reading and understanding of scientific papers, scientific writing, research proposal writing, ethics, plagiarism etc.

Unit I
Formulation of Research Problem and Hypothesis:
Hypothesis: The meaning, Importance, Type of sources, Characteristics of a usable hypothesis, The use of hypothesis in different types of research, Different forms of hypothesis in different types of research, Different forms of hypothesis, Difficulties in formulation of hypothesis, Testing the hypothesis.

Unit II
Literature Survey: References, Abstraction of a research paper, Possible ways of getting oneself abreast of current literature.

Unit III
Documentation and Scientific Writing: Result and conclusions; Preparation of manuscript for publication of research paper, Presenting a paper in scientific seminar, thesis writing.
Structure and components of research report, Types of reports, Thesis, Research project reports, Pictures and graphs, Citation styles, Writing a review of paper, Bibliography.

Unit IV
Computer Applications: Use of word processing, Spreadsheet and database software. Plotting of graphs. Internet and its applications: Email, WWW., Web browsing, acquiring technical skills, drawing inferences from data.

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Numerical Analysis
Course Code: STA.601
Total Hours: 45

Objectives:
The aim of this course is to teach the applications of various numerical techniques for a variety of problems occurring in daily life. At the end of the course, the students will be able to do programming in C/C++/MATLAB and understand the basic concepts in Numerical Analysis of differential equations.

Unit I  (11 Lecture Hours)


Unit II  (11 Lecture Hours)

Eigen Value Problems: Power method and Jacobi method.
Polynomial Interpolation: Interpolating polynomial, Lagrange and Newton divided difference interpolation, Error in interpolation, Finite difference formulas, Hermite Interpolation.

Unit III  (12 Lecture Hours)

Spline and Approximation: Cubic Spline, B-Spline, Least square method, Pâte approximation, Chebyshev Approximation.
Numerical Differentiation: Numerical differentiation with finite differences, Errors in numerical differentiation.
Numerical Integration: Trapezoidal rule, Simpson's 1/3 - rule, Simpson's 3/8 rule, Error estimates for Trapezoidal rule and Simpson's rule, Gauss quadrature formulas.

Unit IV  (11 Lecture Hours)


Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Numerical Analysis (LAB)
Course Code: STA.602
Total Hours: 30

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Objective: Laboratory experiments will be set in context with the materials covered in theory in C/C++/MATLAB.

Laboratory Work: Programming exercises on numerical methods using C/C++/MATLAB languages.

1. To detect the interval(s) which contain(s) root of equation $f(x)=0$ and implement bisection method to find root of $f(x)=0$ in the detected interval.
2. To find the root of $f(x)=0$ using Newton-Raphson and fixed point iteration methods.
3. To compute the intermediate value using the Newton’s forward difference interpolation formula.
4. To compute Lagrange and divided difference interpolating polynomials.
5. To solve linear system of equations using Gauss elimination (without pivoting) method.
6. To solve linear system of equations using Gauss-seidel method.
7. To find the dominant eigen-value and associated eigen-vector by Rayleigh power method.
8. To integrate a function numerically using trapezoidal and Simpson’s rule.
9. To solve the initial value problem using Euler and modified Euler’s methods.
10. To solve the initial value problem using Runge-Kutta methods.
11. To solve the initial value problem using predictor corrector methods.
Course Title: Sampling Theory
Course Code: STA.603
Total Hours: 45

Objectives:
The course is designed to equip the students with basic knowledge of different sampling schemes, their mean and variance estimations and also give understanding of non-sampling errors.

Unit I (11 Lecture Hours)
Introduction to usual notations used in sampling. Basic finite population sampling techniques: SRSWOR, SRSWR, stratified, systematic and related results on estimation of population mean/total. Relative precision of different sampling techniques. Allocation problem in stratified sampling.

Unit II (12 Lecture Hours)
Ratio and regression estimators based on SRSWOR method of sampling. Two-stage sampling with equal size of first stage units. Double sampling for ratio and regression methods of estimation. Cluster sampling - equal clusters.

Unit III (12 Lecture Hours)
PPS WR/WOR methods [cumulative total, Lahiri’s schemes] and related estimators of a finite population mean : [Thompson-Horwitz, Yates and Grundy estimator, Desraj estimators for a general sample size and Murthy’s estimator for a sample of size 2].

Unit IV (10 Lecture Hours)
Sampling and Non-sampling errors with special reference to non-response problems. National sample surveys office (NSSO) and role of various statistical organizations in national development.

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Sampling Theory (LAB)
Course Code: STA.604
Total Hours:30

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Experiments based on various sampling techniques and comparison in appropriate practical situations.
Objective:
This course is framed to equip the students of M.Sc. Statistics with knowledge of industrial statistics as well as application of Time series in our practical life.

Unit I  
(11 Lecture Hours)
The meaning of quality, quality assurance, technology and productivity. Statistical methods for quality control and improvement. Chance and assignable causes of quality variation, general theory of control charts, control charts for variables: $\bar{X}$ and $R$ chart, analysis of pattern on control charts, control chart for attributes- $np$, $p$, $c$ and $u$ charts.

Unit II  
(11 Lecture Hours)
Multiple stream processes: Group control charts. Specification limits and tolerance limits, O.C and ARL of control charts, CUSUM charts using V-mask and decision intervals, economic design of (Mean) chart.

Unit III  
(12 Lecture Hours)
Review of sampling inspection techniques, single, double, multiple and sequential sampling plans and their properties, methods for estimating $(n, c)$ using large sample techniques, curtailed and semi-curtailed sampling plans, Dodge’s continuous sampling inspection plans for inspection by variables for one-sided and two-sided specifications.

Unit IV  
(11 Lecture Hours)

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Quality Control and Time Series (LAB)
Course Code: STA.606
Total Hours: 30

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Topics should include problems of Quality Control and Time Series using SPSS.
Course Title: Seminar
Course Code: STA.599
Total Hours: 32

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Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Actuarial Statistics
Course Code: STA.607
Total Hours: 56

Objectives:
This course is framed to equip the students of M.Sc. Statistics with concept of actuarial science and different premium models.

Unit I  (16 Lecture Hours)
Probability Models and Life Tables, Loss distributions: modelling of individual and aggregate losses, moments, fitting distributions to claims data, deductibles and retention limits, proportional and excess-of-loss reinsurance. Risk models: models for individual claims and their sums, Distribution of aggregate claims, Compound distributions and applications, Introduction to credibility theory.

Unit II  (12 Lecture Hours)
Survival function, curtate future lifetime, force of mortality. Multiple life functions, joint life and last survivor status. Multiple decrement model.

Unit III  (12 Lecture Hours)
Life Contingencies: Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor.

Unit IV  (16 Lecture Hours)
Assurance and annuity contracts: definitions of benefits and premiums, various types of assurances and annuities, present value, formulae for mean and variance of various continuous and discrete payments. Calculation of various payments from life tables: principle of equivalence, net premiums, prospective and retrospective provisions/reserves.

Recommended Books:

Suggested Readings:
Course Title: Demography and Vital Statistics
Course Code: STA.608
Total Hours: 56

Objectives:
The course on Demography and Vital Statistics is framed to equip the students of M.Sc. Statistics with knowledge of terms and analysis of data related with vital events.

Unit I (14 Lecture Hours)
Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data, Adjustment of age data use of Myer and UN indices Population composition, dependency ratio.

Unit II (14 Lecture Hours)
Measures of fertility: stochastic models for reproduction, distribution of time to first birth, inter-live birth intervals and of number of births, estimation of parameters, estimation of parity progression ratio from open birth interval data.

Unit III (14 Lecture Hours)

Unit IV (14 Lecture Hours)

Recommended Books:

Suggested Readings:
Course Title: Non-Parametric Inference
Course Code: STA.609
Total Hours: 56

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Objectives:
This course is framed to equip the students of M.Sc. Statistics with non-parametric inference and its various tests. Various measure to measure risk will be studied in this course.

Unit I
(14 Lecture Hours)

Unit II
(14 Lecture Hours)

Unit II I
(14 Lecture Hours)

Unit IV
(14 Lecture Hours)

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Queuing theory and Advanced Stochastic Processes

Objectives:
This course is framed to equip the students of M.Sc. Statistics with concept of Queuing theory and Advanced Stochastic Process.

Unit I
Queuing Theory: Steady state analysis of M/M/1, M/M/C queues. Method of stages for steady state solution of M/E_r/1 and E_r/M/1 queues. Simple design and control problems in queuing theory.

Unit II
Non-Markovian Queuing Systems: Concept of imbedded Markov chain, Steady state solution, Mean number of arrivals, expected queue length and expected waiting time in equilibrium.

Unit III
Inventory Models: Classification of inventory models, Deterministic inventory model (DIM), Basic Economic order Quantity (EOQ) models with no shortages, DIM with Shortages, EOQ with finite replenishment, EOQ with price break, single multi- item deterministic inventory models. Inventory problems with uncertain demand, Probabilistic (Stochastic) inventory models, Determination of Reserve Stock, Q-System/ P System, Uniform Demand & discrete units, instant demand & discrete units.

Unit IV

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Reliability Theory
Course Code: STA.611
Total Hours: 56

Objectives:
The course on Reliability Theory is framed to equip the students of M.Sc. Statistics with knowledge of terms involved in reliability theory as well as concepts and measures.

Unit I (14 Lecture Hours)
Reliability concepts and measures: Components and systems, coherent systems, reliability of coherent systems, cuts and paths, modular decomposition, bounds on system reliability, structural and reliability importance of components.

Unit II (14 Lecture Hours)
Life distributions and associated survival, conditional survival and hazard rate functions. Exponential, Weibull, gamma life distributions and estimation of their parameters.

Unit III (14 Lecture Hours)
Notions of ageing. IFR IFRA, NBU, DMRL, NBUE, and HNBUE classes; their duals and relationships between them. Closures of these classes under formation of coherent systems, convolutions and mixtures.

Unit IV (14 Lecture Hours)
Partial orderings: Convex, star, stochastic, failure rate and mean-residual life orderings. Univariate shock models and life distributions arising out of them. Maintenance and replacement policies, availability of repairable systems.

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Survival Analysis

Objectives:
The course gives the application of statistics in handling survival data. The course introduces the concept of censoring and the various distributions used to analyse such data. Various models are also suggested to deal with survival data.

Unit I (14 Lecture hours)
Concepts of Type-I (time), Type-II (order) and random censoring likelihood in these cases. Life distributions, exponential, gamma, Weibull, lognormal, Pareto, linear failure rate.

Unit II (14 Lecture hours)
Inference for exponential, gamma, Weibull distributions under censoring. Failure rate, mean residual life and their elementary properties. Ageing classes and their properties, bathtub failure rate.

Unit III (14 Lecture hours)
Estimation of survival function – Actuarial estimator, Kaplan – Meier estimator, Tests of exponentiality against non-parametric classes: Total time on Test, Deshpande Test.

Unit IV (14 Lecture hours)
Two sample problem: Gehan test, Log rank test, Mantel-Haenszel test, Cox’s proportional hazards model, competing risks model.

Recommended Books:

Suggested Readings:
Semester IV

Course Title: Multivariate Analysis
Course Code: STA.613
Total Hours: 45

Objectives:

This course is framed to equip the students of M.Sc. Statistics with knowledge of multivariate analysis.

Unit I (11 Lecture Hours)

Unit II (12 Lecture Hours)
Null distribution of Hotelling’s $T^2$ Statistic. Application in tests on mean vector for one and more multivariate normal populations and also on equality of the components of a mean vector in a multivariate normal population. Mahalanobis $D^2$ and its sampling distribution.

Unit III (11 Lecture Hours)
Wishart distribution and its properties. Distribution of sample generalized variance. Classification and discriminant procedure for discriminating between two multivariate normal populations, Sample discriminant function and tests associated with discriminant functions, probabilities of misclassification and their estimation.

Unit IV (11 Lecture Hours)

Recommended Books:

Suggested Readings:
Course Title: Multivariate Analysis (LAB)
Course Code: STA.614
Total Hours: 30
Laboratory experiments will be set in context with the materials covered in theory.
Course Title: Design and Analysis of Experiment  
Course Code: STA.615  
Total Hours: 45

Objectives:
The course is designed to equip the students with various types of designs that are used in practical life and to develop greater skills and understanding of analysis of these designs.

Unit I  (12 Lecture Hours)
Three basic principles of design of experiments: Randomization, replication and local control. Design useful for one-way elimination of heterogeneity. Completely randomized, randomized complete block and balanced incomplete block designs. Analysis of Basic Design: Asymptotic relative efficiency, Missing plot technique, Analysis of covariance for CRD and RBD.

Unit II  (11 Lecture Hours)
Concepts of balancing, orthogonality, connectedness and properties of C-matrix. General inter and intra block analysis of incomplete block designs. $2^2$, $2^3$, $3^2$ and $3^3$ factorial designs, fractional replication and split-plot designs. Design useful for two-way elimination of heterogeneity and their general method of analysis by using fixed effect model, Latin squares, Graeco Latin squares and Youden squares designs.

Unit III  (11 Lecture Hours)
Missing plot techniques, illustrations of construction of s x s mutually orthogonal Latin squares and balanced incomplete block designs (by using finite geometries, symmetrically repeated differences and known B.I.B. designs).

Unit IV  (11 Lecture Hours)

Recommended Books:

Suggested Readings:
Course Title: Design and Analysis of Experiment (LAB)
Course Code: STA.616
Total Hours: 30
Laboratory experiments will be set in context with the materials covered in theory.
Course Title: Dissertation Research
Course Code: STA.600
Total Hours: 180

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Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Course Title: Game Theory and Non-Linear Programming
Course Code: STA.617
Total Hours: 56

Objectives:
This course is framed to equip the students of M.Sc. Statistics with concept of game theory as well as Non-linear Programming problem.

Unit I (14 Lecture Hours)

Unit II (14 Lecture Hours)

Unit III (14 Lecture Hours)

Unit IV (14 Lecture Hours)

Recommended Books:

Suggested Readings:
Course Title: Statistical Simulation  
Course Code: STA.618  
Total Hours: 56

Objectives:
This course is framed to equip the students of M.Sc. Statistics with knowledge of random number generation using congruential and Monte Carlo Methods as well as basic knowledge of this course.

Unit I  (16 Lecture Hours)

Unit II  (10 Lecture Hours)
Random Number Generation: Congruential generators, statistical tests for pseudo random numbers.

Unit III  (16 Lecture Hours)

Unit IV  (14 Lecture Hours)
Monte Carlo integration and variance reduction techniques: Hit or miss Monte Carlo method, sample mean Monte Carlo method, importance sampling, correlated sampling control variates, stratified sampling, antithetic variates, partition of region.

Recommended Books:

Suggested Readings:
Course Title: Advanced Numerical Methods
Course Code: STA.619

Total Hours: 56

Objectives:
The objective of the course is to familiarize the students about some advanced numerical techniques e.g. solving systems of nonlinear equations, linear system of equations, Eigen value problems, Interpolation and Approximation techniques and their use in differentiation and integration, differential equations etc.

Unit I  
(15 Lecture Hours)
Non-Linear Equations: Methods for multiple roots, Muller’s, Iteration and Newton-Raphson method for non-linear system of equations, and Newton-Raphson method for complex roots.
Polynomial Equations: Descartes’ rule of signs, Birge-Vieta, Bairstow and Giraffe’s methods.
System of Linear Equations: Triangularization, Cholesky and Partition methods, SOR method with optimal relaxation parameters.

Unit II  
(13 Lecture Hours)
Eigen-Values of Real Symmetric Matrix: Similarity transformations, Gerschgorin’s bound(s) on eigenvalues, Givens, Householder and Rutishauser methods.
Interpolation and Approximation: B - Spline and bivariate interpolation, Gram-Schmidt orthogonalisation process and approximation by orthogonal polynomial, Legendre and Chebyshev polynomials and approximation.

Unit III  
(13 Lecture Hours)
Differentiation and Integration: Differentiation and integration using cubic splines, Romberg integration and multiple integrals.
Ordinary Differential Equations: Shooting and finite difference methods for second order boundary value problems, Applications of cubic spline to ordinary differential equation of boundary value type.

Unit IV  
(15 Lecture Hours)

Recommended Books:

Suggested Readings:

Syllabi Applicable for Admissions in M. Sc. (Statistics), 2016
Objectives:
This course is framed to equip the students of M.Sc. Statistics with concept of econometrics as well as practical usage of this course.

Unit I
Nature of econometrics. The general linear model (GLM) and its assumptions. Ordinary least squares (OLS) estimation and prediction. Significance tests and confidence intervals, linear restrictions. Use of dummy variables and seasonal adjustment. Generalized least squares (GLS) estimation and prediction. Heteroscedastic disturbances.

Unit II

Unit III

Unit IV
Estimation in simultaneous equations model. Recursive systems. 2 SLS estimators, k-class estimators. 3SLS estimation. Full information maximum likelihood method. Prediction and simultaneous confidence intervals. Monte Carlo studies and simulation.

Recommended Books:

Suggested Readings:
Course Title: Investment Risk Analysis  
Course Code: STA.621  
Total Hours: 56

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Objectives:
This course is framed to equip the students of M.Sc. Statistics with concept of risk involved in investment. Various measure to measure risk will be studied in this course.

Unit I (15 Lecture Hours)

Unit II (14 Lecture Hours)

Unit III (14 Lecture Hours)

Unit IV (13 Lecture Hours)

Recommended Books:

Suggested Readings:
Course Title: Economic Statistics
Course Code: STA.622
Total Hours: 56

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Objectives:
This course is framed to equip the students of M.Sc. Statistics with applications of statistics in economics. Various measure to measure risk will be studied in this course.

Unit I (14 Lecture Hours)
The theory of Consumer Behaviour: Utility function, indifference curves and their properties, price and income elasticities, substitution and income effects.

Unit II (14 Lecture Hours)

Unit III (14 Lecture Hours)

Unit IV (14 Lecture Hours)

Recommended Books:

Suggested Readings: