

BHARATHIAR UNIVERSITY :: COIMBATORE - 641 046
BRANCH II B - STATISTICS
Course Title: M.Sc. (Statistics)

List of Core/Elective/Supportive Subjects to be offered

CORE Subjects

1. Probability Theory
2. Distribution Theory
3. Sampling Theory and Methods
4. Object Oriented Programming with C++
5. Principles and Practice of Insurance
6. Statistical Inference – I
7. Multivariate Analysis
8. Statistical Quality Control
9. Statistical Practical - I
10. Statistical Software Practical-I (Using SPSS, MINITAB & STATISTICA)
11. Statistical Inference - II
12. Data Mining
13. Linear Models and Design of Experiments
14. Operations Research
15. Financial Mathematics
16. Stochastic Processes
17. Econometrics
18. Biostatistics and Survival Analysis
19. Statistical Practical - II
20. Statistical Software Practical - II (Using R)
21. Project & VIVA-VOCE

ELECTIVE Subjects (for students of M.Sc., Statistics)

1. Insurance Business Environment
2. Demographic Methods
3. Applied Regression Analysis

ELECTIVE Subjects (for students of other departments)

1. Bio-Statistics
2. Probability and Statistics
3. Statistics for Management
4. Operations Research Methods
5. Actuarial Statistics

SUPPORTIVE Subjects (for students of other departments)

1. Descriptive Statistics
2. Data Analysis
3. Statistical Methods for Industries
4. Statistical Methods for Researchers
5. Statistical Methods for Biologists
6. Elements of Operations Research

BHARATHIAR UNIVERSITY :: COIMBATORE - 641 046
BRANCH II - STATISTICS
Course Title: M.Sc. (Statistics) :: Course Code: (15STAA)
(For Candidates admitted during 2015-2016 and onwards)
Course Structure and Scheme of Examinations

Semester – I					
Subject Code	Title of the papers	Credit Point	Int Mark	Ext Mark	Total Marks
15S13A	Probability Theory	4	25	75	100
15S13B	Distribution Theory	4	25	75	100
15S13C	Sampling Theory and Methods	4	25	75	100
15S13D	Object Oriented Programming with C++	4	25	75	100
15S13E	Principles and Practice of Insurance	4	25	75	100
Supportive	Offered by other Departments	2	12	38	50
	Total	22			550
Semester – II					
Subject Code	Title of the papers	Credit Point	Int Mark	Ext Mark	Total Marks
15S23A	Statistical Inference – I	4	25	75	100
15S23B	Multivariate Analysis	4	25	75	100
15S23C	Statistical Quality Control	4	25	75	100
15S2P1	Statistical Practical - I	4	40	60	100
15S2P2	Statistical Software Practical – I (Using SPSS, MINITAB & STATISTICA)	4	40	60	100
Supportive	Offered by other Departments	2	12	38	50
	Total	22			550
Semester – III					
Subject Code	Title of the papers	Credit Points	Int Mark	Ext Mark	Total Marks
15S33A	Statistical Inference – II	4	25	75	100
15S33B	Data Mining	4	25	75	100
15S33C	Linear Models and Design of Experiments	4	25	75	100
15S33D	Operations Research	4	25	75	100
15S33E	Financial Mathematics	4	25	75	100
Supportive	Offered by other Departments	2	12	38	50
	Total	22			550
Semester – IV					
Subject Code	Title of the papers	Credit Points	Int Mark	Ext Mark	Total Marks
15S43A	Stochastic Processes	4	25	75	100
15S43B	Econometrics	4	25	75	100
15S43C	Biostatistics and Survival Analysis	4	25	75	100
15S4P3	Statistical Practical – II	4	40	60	100
15S4P4	Statistical Software Practical -II (Using R)	4	40	60	100
15S4PV	Project and viva-voce*	4	25	75	100
	Total	24			600

TOTAL MARKS: 2250
Core **2100**
Supportive **150**

TOTAL CREDITS: 90
Core **84**
Supportive **6**

*Internal Assessment (25%)+Evaluation of Project (50%)+Project viva-voce (25%) : **25+50+25= 100**

SEMESTER – I

AIMS:

1. To provide a broad based high quality education with combination of the subjects like Probability Theory, Distribution Theory, Sampling Theory and Methods, Object oriented Programming with C++ and Principles of Insurance to Post-Graduate Degree level for students who have to demonstrate their ability and potential towards Statistical Theory and Applications.
2. To develop knowledge, understanding and experience of the theory, practice and application of selected areas of statistical computing and to produce graduates needed by public and private sector to help and solve practical problems using the skills and techniques of these areas and to develop analytical skills for Insurance Sector.
3. To develop enterprise competences emphasizing the key skills of learning and communication for Statistical theory.

OBJECTIVES:

1. An understanding of the Statistical principles, techniques and applications of selected areas of Statistics and computing.
2. The ability to evaluate, select, write and use of computer software packages for Statistical theory, which takes into account the needs of the user and constraints towards computing environment.
3. The ability and confidence to analyze and solve problems both of a routine and of obvious nature towards applications of Statistical theory.
4. To gain deeper understanding, problem solving skills and greater knowledge of selected topics in statistical computation.

15S13A	Probability Theory	Core - 1
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Unit –I

Functions and Inverse Functions- Random Variables – Limits of Random Variables – Definition of Probability – Simple Properties – Discrete Probability Space – General Probability Space – Induced Probability Space.

Unit –II

Distribution Function of a Random Variable – Decomposition of Distribution functions – Jordan Decomposition Theorem – Distribution Functions of Vector Random Variables. Expectation – Properties of Expectation – Moments – MGF – Holder’s Inequality – Minkowski Inequality- Basic Inequality-Markov Inequality.

Unit –III

Convergence of Random Variables : Convergence in Probability, Convergence Almost Surely, Convergence in Distribution, Convergence in rth Mean, Monotone Convergence Theorem - Fubini Theorem (Statement only)

Unit –IV

Definition and Properties of Characteristic Functions – Inversion Formula – Problems - Kolmogorov 0-1 Law- Borel 0-1 Law- Bochner’s Theorem (Statement only)

Unit –V

Law of Large Numbers- Weak and Strong Law of Large Numbers – Bernoulli’s Weak Law of Large Numbers- Khintchine’s WLLN – Kolmogorov’s SLLN – Central Limit Theorem – Lindeberg – Levy’s CLT - Liapounov’s form of Central Limit Theorem- Lindberg – Feller Central Limit Theorem (Statement only)

Books for Study:

1. Rohatgi V.K. (2002) : **Introduction to Mathematical Statistics**, Wiley.
2. Bhat, B. R. (2005) : **Modern Probability Theory – An Introductory Text Book**, Third Edition, New Age International

Books for Reference :

1. Feller, W. (1972) : **Introduction to Probability Theory and its Applications**, Vol. II, Second Edition, Wiley Eastern.
2. Rao, C.R. (1973): **Linear Statistical Inference**, Second Edition, Wiley Eastern.
3. Johnson and Kotz (1972): **Distributions in Statistics**, Princeton University Press.

15S13B	Distribution Theory	Core - 2
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Unit –I

Probability Distributions : Cauchy distribution– Laplace distribution - Pareto distribution – Log Normal distribution –Power Series distribution – Logarithmic Series distribution – Distribution of functions of random variables

Unit –II

Concept of truncated distribution- compound distribution-mixture distribution and their properties

Unit –III

Non Central t, f and chi-square distributions and their properties

Unit –IV

Order Statistics- distribution of order statistics – Joint distribution of order statistics – Asymptotic distribution of rth order statistics- Joint distribution of Range & Mid range.

Unit –V

Distribution of Quadratic forms – Properties –Cochran’s Theorem – Empirical Distributions - Properties

Books for Study:

1. Rohatgi V.K. (2002) : **Introduction to Mathematical Statistics**, Wiley.
2. Johnson, N, Kotz,S and Balakrishnan,N(1995): **Continuous Univariate Distributions**, Vol.1 & 2, Second Edition, Wiley

Books for Reference :

1. Feller, W. (1972) : **Introduction to Probability Theory and its Applications**, Vol. II, Second Edition, Wiley Eastern.
2. Hogg, R.V, Craig, A and Mckean W.J (2005): **Introduction to Mathematics Statistics**, Sixth Edition, Pearson,
3. Johnson and Kotz (1972): **Distributions in Statistics**, Princeton University Press.

15S13C	Sampling Theory and Methods	Core - 3
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UNIT-I

Concept of Sampling Design, Sampling Scheme and Sampling Strategy, Estimator of Population mean in SRS with replacement. Systematic sampling - Variance of Estimated mean, Populations in Random order, population with Linear and Period Trend, Auto-Correlated Populations.

UNIT-II

Des Raj method of Estimation, Murthy's Unordering Principle, Sampling Strategy due to Rao-Hartley and Cochran, Hartley-Ross Estimator, Midzuno Scheme of Sampling, PPS Sampling Procedures.

Cluster Sampling-Single Cluster Sampling-Cluster of Equal and Unequal sizes, Two Stage Cluster Sampling; Mean, Variance, Variance of the Estimated Mean.

UNIT-III

Ratio Estimates-Methods of Estimation, Approximate Variance of Ratio Estimates, Bias of the Ratio Estimates, Conditions under which the Ratio Estimate is Optimum, Unbiased Ratio-Type Estimates.

Regression Estimates-Linear Regression Estimates, Regression estimated when computed from sample, Accuracy of the Variance of Regression Estimates.

UNIT-IV

Double sampling Procedures and repeated surveys, Double Sampling for Stratification and Optimum Allocation, Regression Estimates-Estimated Variance for Stratification and Regression Ratio Estimates-Repeated Samplings-Sampling on two occasions, Sampling on more than two occasions.

UNIT-V

Errors in Surveys-Non Response, types of Non-Response, Call -Backs, a mathematical model of the effects of Call-Backs adjustment for basis without Call-backs, Mathematical Model for Errors of Measurement, Interpenetrating sub sample.

Books for Study:

1. Cochran, W.G.(1972): **Sampling Techniques**, Wiley Eastern Private Limited.
2. Sukhatme, P.V. and Sukhatme, B.V.(1977): **Sampling Theory of Survey with Applications**, Asia publishing House.

Books for Reference:

1. Des Raj (1976): **Sampling Theory**, Tata-Mcgraw Hill.
2. Sampath.S (2000) : **Sampling Theory and Methods**, Narosa publishing company, New Delhi.
3. Murthy, M.N. (1967): **Sampling theory and Methods**, Statistical Publishing Society, Calcutta.

15S13D	Object Oriented Programming with C++	Core – 4
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UNIT-I

Principles of Object – Oriented Programming – Software Evolution Procedure and Object Oriented Paradigm – Basic concepts of Object – Oriented Programming – Benefits of OOP – Object Oriented Languages – Application of OOP - Beginning with C++ - What is C++?. - Application of C++ - C++ statements – Structure of C++ Program – Tokens , Expressions and Control Structures – Tokens – Identifiers – Basic and User – Defined Data Types – Operators in C++ - Operator Overloading – Operator precedence – Control Structures.

UNIT-II

Functions in C++:- The Main Function – Function Prototyping – Call by Reference – Return by Reference – Inline functions – Function Overloading – Friend and Virtual Functions – Classes and Objects – Introduction – Specifying a Class – Defining Member function – Nesting of Member Function – Private member Functions – Arrays within a Class – Static Data Members- Static Member Function – Array of Objects – Objects as Function Arguments, Friendly Functions – Pointers to Members.

UNIT-III

Constructors and Destructors:- Constructors – Copy Constructor Dynamic Constructor- Constructing Two – Dimensional Arrays – Destructors – Operators Overloading –Type Conversions.

UNIT-IV

Inheritance, Extending Classes:- Defining Derived classes – Single, Multilevel, Multiple, Hierarchical and Hybrid inheritance – Virtual Base Classes – Abstract Classes-Pointers, Virtual Functions and Polymorphism – Pointers to Derived Classes – Virtual Functions.

UNIT-V

Managing Console I/O Operations:-C++ streams – C++ stream Classes – Unformatted I/O Operations - Formatted Console I/O Operations – Managing output with Manipulators- Working with Files:- Classes for File Stream Operations- Opening and Closing a File - File Pointers and their manipulators – sequential I/O Operations. Simple Statistical Problems.

Books for Study and Reference:

1. E.Balagurusamy (1998) : **Object Oriented Programming with C++**. Tata McGraw Hill Publishing Company Limited.
2. K.R.Venugopal, Rajkumar, T.Ravi shankar (1998): **Mastering C++**, Tai.

15S13E	Principles and Practice of Insurance	Core – 5
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PRINCIPLES OF INSURANCE

UNIT I: Concept of risk and Insurance - Classification and its types of Insurance – Physical and Moral hazard - risk appraisal and risk underwriting. Life and general Insurance – the distribution system – Appointment continuation of Agents – Remuneration of Agents.

UNIT II: Marine fire motor - Engineering, Agriculture Insurance, life term Insurance - Pure endowment - whole life and whole life limited payment, endowment, fixed term marriage endowment, Educational annuity and group Insurance various policies.

PRACTICE OF INSURANCE

UNIT III: Insurance Act 1938 - IRDA Act 1999 - the Indian contract Act 1872 - Economic principle and legal principles of Insurance - Insurable interest utmost good faith, Indemnity, subrogation, contribution, proximate cause, representation and warranty - Life Insurance - covers the risk of early death and living too long.

UNIT IV: Application and acceptance - proposal and other related documents, age proof, special reports, policy document, need for format, premium calculation, days of grace. Non-forfeiture regulation lapse and revival - premium income and outgo, investment, reserves, valuation surplus, mortality table.

UNIT V: Policy Conditions and Privileges - Nomination, Assignment, Calculation Of Age, Loan Value, Surrender Value, Maturity Claim, Death Claim, Early Death, Evidence Of Title, Claim Concession, Presumption Of Death, Accident Benefit, Disability Benefit, Settlement Option.

Books for Study:

1. IC.01.Principles of Insurance–Insurance Institute of India- by P.D. Mujumdar & M.G. Diwan.
2. IC.02.Practice of life Insurance - Insurance Institute of India by S. Balachandran.

Books for Reference:

1. Neill, Aistair, Heinemann(1977): LIFE CONTIGENCIES.
2. Gerber, Hans, U(1997): LIFE INSURANCE MATHEMATICS, Springer, swiss association of actuarial.
3. Booth, Philip, M et.al.(1999): MODERN ACTUARIAL THEORY AND PRACTICE, Chapman Hall.
4. Panjer, Harry H et.al.(1998): FINANCIAL ECONIMICS WITH APPLICATIONS TO INVESTEMENTS INSURANCE AND PENSIONS, The Actuarial Foundations.

SEMESTER – II

AIMS:

1. To provide a broad based high quality education with combination of the subjects like Statistical Inference, Multivariate Analysis, Data Mining, Financial Mathematics and Statistical Practical to Post-Graduate Degree level for students who have to demonstrate their ability and potential towards Statistical Theory and Applications.
2. To develop knowledge, understanding and experience of the theory, practice and application of selected areas of statistical computing and to produce graduates needed by public and private sector to help and solve practical problems using the skills and techniques of these areas and to develop analytical skills for Insurance Sector.
3. To develop enterprise competences emphasizing the key skills of learning and communication for Statistical theory.

OBJECTIVES:

1. An understanding of the Statistical principles, techniques and applications of selected areas of Statistics and computing.
2. The ability to evaluate, select, write and use of computer software packages for Statistical theory which takes into account the needs of the user and constraints towards computing environment.
3. The ability and confidence to analyze and solve problems both of a routine and of obvious nature towards applications of Statistical theory.
4. To gain deeper understanding, problem solving skills and greater knowledge of selected topics in statistical computation.

15S23A	Statistical Inference - I	Core - 6
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UNIT-I

Estimation and point estimation - Sufficiency – Factorization Theorem – minimal sufficiency, likelihood equivalence – completeness – Uniformly minimum variance unbiased estimator – Rao-Blackwell and Lehmann-Scheffe's theorems.

UNIT-II

Mean-squared error, Fisher's information measure. Cramer-Rao inequality, Bhattacharya inequality, Chapman-Robbins inequality - Fisher's information matrix-simultaneous of parameters in normal (univariate and bivariate) distribution.

UNIT -III

Methods of point estimation-maximum likelihood method (the asymptotic properties of ML estimators are not included), method of moments, method of minimum chi-square and modified minimum chi-square.

UNIT-IV

Consistency and CAN estimators. Asymptotic properties of maximum likelihood estimators. Example of consistent but not asymptotic normal estimators from Pitman family. Information lower bound for asymptotic variance. Asymptotic relative efficiency. Method of least squares.

UNIT-V

Interval estimation: Confidence level and confidence coefficient. Duality between acceptance region of a test and a confidence interval. Pivotal quantity method. Shortest length confidence intervals.

Construction of confidence intervals for population proportion (small and large samples) and between two population proportions (large samples)-confidence intervals for mean, variance of a normal population-difference between mean and ratio of two normal populations.

BOOKS FOR STUDY:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (1989). An Outline of Statistical Theory-Vol.II.
2. Kale, B.K. (1999). A First Course on Parametric Inference, Narosa Publishing House, NY
3. Rohatgi, V.K. (1992). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd, New Delhi.

BOOKS FOR REFERENCE:

1. Dudewicz, E.J., and S.N. Mishra (1988). Modern Mathematical statistics, John Wiley, NY.
2. Lehman, E.L., and G. Cassella (1998). Theory of point estimation (II Edition), Springer, NY.

15S23B	Multivariate Analysis	Core - 7
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UNIT-I

Reviews of Multivariate Distributions, Multiple and Partial Correlation and Regression, Multivariate Normal Distribution, Marginal and Conditional Distributions - Maximum likelihood Estimators of sample Mean and dispersion Matrix.

UNIT-II

Distribution of mean vector and Sample Dispersion Matrix - James-Stein Estimator for the Mean Vector, Wishart Distribution and its Properties (without derivation)- Distribution of Total, Partial and Multiple correlation under null case – Maximum likelihood estimators of total, partial and multiple correlation – Test based on total, partial and multiple correlations.

UNIT-III

Tests based on Mean Vectors for one and two Multivariate Normal Distributions - Hotelling's T^2 and Mahalanobis D^2 test statistics with their null and non-null distributions - Related Confidence Regions - Testing and Illustration using likelihood Ratio Criterion.

UNIT-IV

Principal Component Analysis, Factor Analysis Underlying Models and Illustrations- Identification Problem, Estimation - Maximum likelihood Method, Centroid Method, Canonical Correlation – Extraction - Properties.

UNIT-V

Classification Analysis using Discriminant functions - Clustering techniques- Hierarchical Clustering - Agglomerative techniques, Single Linkage Method, Complete average linkage method – Non-hierarchical method – K-Mean concept of multidimensional scaling and correspondence analysis.

Books for Study:

1. Anderson, T.W. (1980): **An Introduction to Multivariate Statistical Analysis**, Second Edition, Wiley Eastern.
2. Applied Multivariate Statistical, 5th Edition, Richard A.Johnson Dean.W.Wichern.
3. M.Jambu and Lebeaux, M.O.(1983): **Cluster Analysis and Data Analysis**, North-Holland Publishing Company.

Books for Reference:

1. Kshirsagar, A.M. (1972): **Multivariate Analysis**, Marcel Decker.
2. Morrison, D.F.(1976): **Multivariate Statistical Methods**, Second Edition, McGraw Hill.
3. Afifi,A.A.and Azen, S.P. (1979): **Statistical Analysis - A Computer Oriented Approach**, Academic Press.
4. N.Giri, Multivariate Statistical Inference, Academic Press.
5. Reucher, Multivariate Analysis, Academic Press.

15S23C	Statistical Quality Control	Core – 8
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UNIT-I

Shewhart Control Charts for \bar{X} , \bar{R} , np, p, c etc., and their uses, OC and ARL of Control Charts, Control Charts based on C.V., Modified Control Charts, CUSUM procedures, use of V-mask, Derivation of ARL.

UNIT-II

Decision Interval Schemes for CUSUM charts. Economic Designs of Control Charts, Pre-control, Relative Precision and Process Capability analysis and Gauge capability analysis, Multivariate Control charts χ^2 and Hotelling T^2 .

UNIT-III

Basic Concepts of Acceptance Sampling, Single, Double, Multiple and Sequential Sampling Plans for Attributes, Curtailed and Semi Curtailed Sampling. Dodge-Romig Tables-LTPD and AOQL protection (Single Sampling Plan only). MIL-STD-105D.

UNIT-IV

Variable Sampling: Assumptions, Single and Double Variable Sampling Plans. Application of Normal and Non-central t-Distributions in Variable Sampling. Continuous Sampling Plans: CSP-1, CSP-2 and CSP-3. Special Purpose Plans: Chain Sampling Plans, Skip-lot Plans.

UNIT-V

Concept : Hazard Function and Reliability Function. Exponential, Gamma and Weibull Failure Models. Models for wearout failures. System Reliability-Serial, parallel and mixed systems.

Books for Study:

1. Montgomery, D.C., (1985): **Introduction to Quality Control** John Wiley.
2. Schilling, E.G. (1982): **Acceptance Sampling in Quality Control**, Marcel Dekker.
3. Burr, I.W., (1976): **Statistical Quality Control Methods**, Marcel Dekker.
4. H.J. Mittag and H. Rinne (1993): **Statistical Methods of Quality Assurance**, Germany Chapman & Hall India (UK) – Chapter 3 and 4.

Books for Reference:

1. Whetherill, G.B., (1977): **Sampling Inspection and Quality Control**, Halsted Press, New York.
2. Freeman, H.A., Friedman, M. and Others (1948). **Sampling Inspection Principles- Procedures and Tables for Single, Double and sequential Plans in Acceptance Quality Control**, McGraw Hill.
3. Hald, A. (1981): **Statistical theory of Sampling by Attributes**, Academic Press.
4. Ott, E.R., (1975): **Process Quality Control**, McGraw Hill.
5. Halpern, S (1979): **An Introduction to Quality Control and Reliability**, Prentice Hall of India.
6. Lawless J.R. (1982) : **Statistical Methods for Lifetime Data**, John Wiley & Sons.

15S2P1	Statistical Practical - I	Core – 9
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The Maximum Mark is 100 with 40 Marks for Internal involving Test and Record work. 60 Marks for End Examination. The candidate should attend 3 questions out of 4 questions each with 20 Marks with Internal choice. Problem relating to the areas listed below covered under Semester I and Semester II. The Core Practical-I examination is to be conducted at the end of the II Semester. The list of topics included for practical are given below,

1. SAMPLING THEORY AND METHODS:

Simple Random Sampling – Stratified Random Sampling – Systematic Sampling – Cluster Sampling for Single stage and Two stage – Ratio and Regression estimates – Double Sampling methods.

2. MULTIVARIATE ANALYSIS:

Test based on Discriminant function – Hotelling T^2 Statistic – Mahalanobis D^2 Statistic - Principal component analysis – Factor analysis - Single linkage method – complete linkage method – classification analysis – Divisive techniques.

3. STATISTICAL INFERENCE:

Point Estimation - Maximum Likelihood method – Method of Moments – Minimum Chi-Square method - Interval estimation.

15S2P2	Statistical Software Practical - I (Using SPSS, MINITAB & STATISTICA)	Core – 10
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The Maximum Mark for this paper shall be 100 with 40 Marks for Internal Assessment and 60 Marks for End Examination, Internal assessment marks were carried out by Internal Test, Model test and Record work etc., The End examinations will be conducted at the end of the first year (II semester) of this programme. The candidate should attend 3 questions out of 5 each carries 20 Marks with an internal choice. The contents for this paper are given below which are to be taught with statistical problems relating to this programme using statistical software's like **SPSS**, **STATISTICA** and **MINITAB**. The contents for Statistical Software Practical-I are restricted to the following topics, the students has inculcate the statistical knowledge into computer based skills using these three software's.

Problems relating to:

1. Functions of Statistics (Classification, Diagrams and Graphical representation of Data)
2. Descriptive Statistics
3. Calculation of Probabilities under various distributions
4. Correlation & Regression-Partial and Multiple Correlations, Multiple Regression
5. Curve Fitting, Time series and Forecasting models
6. Confidence Intervals for mean, variance, proportions
7. Inferential Statistics for Single through multiple samples. (Chi-square, t, f, and z test)
8. Non-parametric tests
9. Experimental Design: One way ANOVA-two way ANOVA-factorial designs– Multiple comparison tests
10. Multivariate :Principal component and discriminant analysis - Factor Analysis
11. Statistical Quality Control charts – Determination of parameters for constructing basic control charts, such as \bar{X} , R, S, p and c charts.
12. Generating random samples.

SEMESTER – III

AIMS:

1. To provide a broad based high quality education with combination of the subjects like Statistical Inference, Statistical Quality Control, Linear Models, Design of Experiments, Operations Research, and Practice of Life Assurance to Post-Graduate Degree level for students who have to demonstrate their ability and potential towards Statistical Theory and Applications.
2. To develop knowledge, understanding and experience of the theory, practice and application of selected areas of statistical computing and to produce graduates needed by public and private sector to help and solve practical problems using the skills and techniques of these areas and to develop analytical skills for Insurance Sector.
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OBJECTIVES:

1. An understanding of the Statistical principles, techniques and applications of selected areas of Statistics and computing.
2. The ability to evaluate, select, write and use of computer software packages for Statistical theory which takes into account the needs of the user and constraints towards computing environment.
3. The ability and confidence to analyze and solve problems both of a routine and of obvious nature towards applications of Statistical theory.
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15S33A	Statistical Inference - II	Core – 11
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UNIT-I

Testing of hypotheses: simple and composite hypothesis, two types of errors, level of significance, randomized and non-randomized tests, power and size of a test. Most powerful test-Neyman-Pearson lemma. Monotone likelihood ratio property-uniformly most powerful tests. Applications to standard statistical distributions.

UNIT-II

Generalization of Neyman-Pearson fundamental lemma (statement only). Unbiased tests-Construction of uniformly most powerful unbiased tests for one-parameter and multi-parameter exponential families-applications to standard statistical distribution-similar regions. Locally most powerful (LMP) test-LMP unbiased test.

UNIT-III

Invariance-maximal invariant statistic-invariant test. Likelihood ratio (LR) test-asymptotic distribution of LR test statistic-consistency of LR test-Construction of LR tests for standard statistical distributions. Analysis of variance (one-way). Bartlett's test for homogeneity of variances.

UNIT-IV

U statistic and its property as an estimator of its expected value. Tests for goodness of fit-Chi-square and Kolmogorov-Smirnov tests. Test for randomness. Wilcoxon's signed-rank test. Kolmogorov-Smirnov two sample test. Mann-Whitney U test. Kruskal-Wallis test.

UNIT-V

Introduction to sequential procedures - Stopping times - Wald's equation. SPRT: termination property, approximation to stopping bounds and applications to standard distributions. Statement of Wald's fundamental identity. OC and ASN functions and their plotting

BOOKS FOR STUDY

1. Conover, W.J. (1980). Practical Non-parametric Statistics, (Second Edition), John Wiley and sons, New York.
2. Gibbons, J.D. and Chakrabarti, S. (1992) Non-parametric Statistical Inference (Third Edition)
3. Goon, A.M., Gupta, M.K., Das Gupta, B. (1973). An outline of Statistical Theory, Vol. II, The World Press, Calcutta.
4. Kale, B.K. (1999). A First course on parametric Inference, Narosa Publishing House, New Delhi/
5. Lehmann, E.L. (1986). Testing Statistical hypothesis (Second Edition), John Wiley, New York.
6. Rohatgi, V.K. (1988). An Introduction to probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi.
7. Wald, A. (1982) Sequential Analysis. John Wiley, New York.

15S33B	Data Mining	Core - 12
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Unit – I

Introduction – An expanding universe of data – production factor – data mining – data mining verses query tools – data mining in marketing – practical applications. Learning: Introduction – self learning – machine learning and methodology of science – concept learning.

Unit – II

Data mining and the data warehouses: Introduction – need – decision support system – integration with data mining – client / server data warehousing – multi processing machine – cost justification.

Unit – III

Knowledge discovery process: Introduction – data selection – cleaning – enrichment – coding – data mining and its techniques – reporting.

Unit –IV

KDD environment: Introduction – different forms of knowledge – getting started – data selection – cleaning – enrichment – coding – reporting - ten golden rules.

Unit – V

Customer profiling – predicting bid behavior of pilots – learning of compression of data sets – noise and redundancy – fuzzy database – the traditional theory – relation to tables – statistical dependencies – data mining primitives.

Books for study and references:

1. Pieter Adriaans and Dolf Zantinge – Data Mining, Addison Wesley publications.
2. K.P. Soman, Shyam Diwakar, V. Ajay - Data Mining theory and Practice PHI.
3. Rhonda Delmater and Monte hancock – Data Mining explained, Digital press.
4. David Hand, Heikki Mannila and Padhraic Smyth - Principles of Data Mining, PHP

15S33C	Linear Models and Design of Experiments	Core – 13
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UNIT-I

Linear Models and Linear Model Assumptions on Error Components-Fixed/Mixed and Random Component Models-Gauss-Markov set up and its generalization-Linear estimation-Gauss-Markov theorem-BLUE-Test for Linear Hypothesis - Review of Basic Designs and Principles of Experimentation CRD-RBD-LSD.

UNIT-II

Multiple Comparisons - Multiple Range Tests- Analysis of Covariance-Construction of Orthogonal - Analysis of Graeco Latin Squares, Cross Over Designs, Split Plot and Strip Plot Designs.

UNIT-III

Construction and Analysis of Factorial Experiments Symmetrical and Asymmetrical Factorial- 2^n , 3^n , S^n and $n \times p$ Experiments - Concept and Principle of total, partial and balanced Confounding in Symmetrical Factorial experiments.

UNIT-IV

Concept of Fractional Replication in Symmetrical Factorial $1/2$ and $1/4$ in replicate of 2^n , $1/3$ replicate of S^n Construction and Analysis – Concept of Orthogonal Arrays - Response Surface experiments - first and second order Rotatable Designs.

UNIT-V

Incomplete Block Designs, Incidence matrix and its properties, Concept of Connectedness and Orthogonality, Analysis of Non-Orthogonal Two way data-Simple and Balanced Lattice Designs-Balanced Incomplete Block Designs- Youden Square Design, Partially Balanced Incomplete Block Design and its analysis.

Books for Study:

1. Montgomery, D.C. (1976): **Design and Analysis of Experiments**, John Wiley and Sons.
2. Graybill, F.A. (1968): **An Introduction to Linear Statistical Models**, McGraw Hill.
3. Alope Dey (1986): **Theory of Block Designs**, Wiley Eastern.

Books for Reference:

1. Fisher, R.A. (1947): **The Design of Experiment**, Fourth Edition, Oliver and Boyd.
2. Federar, W.T. (1963): **Experimental Design Theory and application**, Mcmillian and Co., New York Oxford IBM.
3. Kempthorne, O (1965): **Design and Analysis**
4. Cochran, W.G. and Cox,G.M.: **Experimental Designs**, John Wiley.
5. Nigam,A.K., Puri, P.D and Gupta,V.K. (1988): **Character- isations and Analysis of Block Design**, Wiley Eastern.
6. Kshirsagar,A.M: **A Course in Linear Models** - Marcel Dekkar.

15S33D	Operations Research	Core – 14
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UNIT-I

Review of LP problems -Methods using Artificial Variables- Two Phase Method - Principle of Duality-Dual Simplex Method- Transportation and Assignment Problems- Travelling Salesman Problem- Degeneracy and cycling.

UNIT-II

Games in Normal and Extended Forms, Fundamental Theorem of Matrix Games(without proof), Solution of 2×2 , $2 \times m$ and $m \times n$, Zero Sum Games by Dominance Principle, LP Representation and Graphical Methods. Sequencing and Scheduling Models, 2 Machine n-job problem (no passing), 3 Machine n-job problems.

UNIT-III

Introduction to Networks, Determination of Flows and of Critical Path, PERT, Multi-stage Decision Processes and Dynamic Programming, Delman's Principle.

UNIT-IV

Analytic Structure of Inventory Problems, EOQ formula, its Sensitivity Analysis and Extensions allowing Quantity Discounts and Shortages. Multi-Item Inventory subject to Constraints, Models with Random Demand, The Static Risk Model P and Q Systems with constant and Random Lead Times.

UNIT-V

Queueing Models-Specifications and Effectiveness Measures. The M/M/1, M/M/C and M/C/1 Queues and their steady state Solutions, Machine Interference Problems, Waiting Time Distributions for M/M/1 and M/M/C Models.

Books for Study:

1. Hadley, G. (1969): **Linear Programming**, Addison-Wesley.
2. Hillier, F. S. and Lieberman, G. J. (1962): **Introduction to Operations Research**, Holden Day.
3. Kanti Swarup, Gupta P.K., and Man Mohan. (1977): **Operations Research**, Sultan Chand and Sons.

Books for Reference:

1. Taha, H. A. (1982): **Operations Research**, Third Edition, Collier- McMillan.
2. Saaty, T. L. (1961): **Elements of Queueing Theory with Applications**, McGraw Hill.
3. Wagner, H. M. (1973): **Principles of Operations Research with Application to Managerial Decisions**, Prentice Hall of India.

15S33E	Financial Mathematics	Core - 15
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UNIT-I

Generalized cash flow model for financial transaction, making allowance for the probability of payment, Time value of money using the concepts of compound interest and discounting, Interest rates or discount rates in terms of different time periods.

UNIT-II

Calculation of the present value and the accumulated value of a stream of equal or unequal payments using specified rates of interest and the net present value at a real rate of interest, assuming a constant rate of inflation.

UNIT-III

Use of compound interest function, Equation of value, Repayment by regular installments of interest and capital, Discounted cash flow techniques.

UNIT-IV

The investments and risk characteristics of the following types. Simple compound interest problems, The delivery price and the value of the forward contract using arbitrage free pricing methods.

UNIT V

Structure of interest rates, Simple Stochastic interest rate models

Books for Study and Reference:

1. Bowers, Newton.L. et al (1997): **Actuarial Mathematics**, Society of Actuaries, 2nd Edition.
2. Meculcheon, John, J. Scott William F (1986): **An Introduction to Mathematics of Finance**, London, Heinemanr.
3. Study Material of Actuarial Education company – London (1988) for subject 1 **Fundamentals of Actuarial Mathematics.**

SEMESTER – IV

AIMS:

1. To provide a broad based high quality education with combination of the subjects like Stochastic Processes, Econometrics, Insurance Business Environment, Statistical Practical, Statistical Software Practical and Project Viva-voce to Post-Graduate Degree level for students who have to demonstrate their ability and potential towards Statistical Theory and Applications.
2. To develop knowledge, understanding and experience of the theory, practice and application of selected areas of statistical computing and to produce graduates needed by public and private sector to help and solve practical problems using the skills and techniques of these areas and to develop analytical skills for Insurance Sector.
3. To develop enterprise competences emphasizing the key skills of learning and communication for Statistical theory.

OBJECTIVES:

1. An understanding of the Statistical principles, techniques and applications of selected areas of Statistics and computing.
2. The ability to evaluate, select, write and use of computer software packages for Statistical theory which takes into account the needs of the user and constraints towards computing environment.
3. The ability and confidence to analyze and solve problems both of a routine and of obvious nature towards applications of Statistical theory.
4. To gain deeper understanding, problem solving skills and greater knowledge of selected topics in statistical computation.

15S43A	Stochastic Processes	Core – 16
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UNIT-I

Introduction to Stochastic Processes - Classification of Stochastic Processes, Markov Processes – Markov Chain - Countable State Markov Chain. Transition Probabilities, Transition Probability Matrix. Chapman - Kolmogorov's Equations, Calculation of n - step Transition Probability and its limit.

UNIT-II

Classification of States, Recurrent and Transient States - Transient Markov Chain, Random Walk and Gambler's Ruin Problem. Continuous Time Markov Process:, Poisson Processes, Birth and Death Processes, Kolmogorov's Differential Equations, Applications.

UNIT-III

Branching Processes – Galton – Watson Branching Process - Properties of Generating Functions – Extinction Probabilities – Distribution of Total Number of Progeny. Concept of Weiner Process.

UNIT-IV

Renewal Processes – Renewal Process in Discrete and Continuous Time – Renewal Interval – Renewal Function and Renewal Density – Renewal Equation – Renewal theorems: Elementary Renewal Theorem. Probability Generating Function of Renewal Processes.

UNIT V

Stationary Processes: Discrete Parameter Stochastic Process – Application to Time Series. Auto-covariance and Auto-correlation functions and their properties. Moving Average, Autoregressive, Autoregressive Moving Average, Autoregressive Integrated Moving Average Processes. Basic ideas of residual analysis, diagnostic checking, forecasting.

Books for Study:

1. Karlin,S. and Taylor,H.M. (1975): **A First Course in Stochastic Process**, vol.I, Academic Press.
2. Medhi, J. (1982): **Stochastic Process**, Wiley Eastern.
3. Box, G.E.P., and Jenkins, G.M., (1976): **Time Series Analysis- Forecasting and Control**. Holden-Day San Francisco.

Books for Reference:

1. Granger, C.W.J. and Newbold, (1984): **Forecasting Econometric Time Series**, Third Edition, Academic.
2. Anderson, T.W., (1971): **The Statistical Analysis of Time Series**, Wiley, NY.
3. Kendall, M.G., and Stuart, A.(1966): **The advanced Theory of Statistics**, Vol.3, Charles Griffin, London.
4. Adke, S.R. and Manjunath, S.A. (1984): **An Introduction to Finite Markov Processes**, Wiley Eastern.
5. Parzen, E. (1962): **Stochastic Processes**, Holland-Day.

15S43B	Econometrics	Core – 17
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Unit –I

Introduction to Econometrics- Meaning and Scope – Methodology of Econometrics – Nature and Sources of Data for Econometric analysis – Types of Econometrics

Unit –II

Aitken's Generalised Least Squares(GLS) Estimator, Heteroscedasticity, Auto-Correlation, Multicollinearity, Auto-Correlation, Test of Auto-correlation, Multicollinearity, Tools for Handling Multicollinearity

Unit –III

Linear Regression with Stochastic Regressors, Errors in Variable Models and Instrumental Variable Estimation, Independent Stochastic linear Regression, Auto regression, Linear regression, Lag Models

Unit –IV

Simultaneous Linear Equations Model : Structure of Linear Equations Model, Identification Problem, Rank and Order Conditions, Single Equation and Simultaneous Equations, Methods of Estimation- Indirect Least squares, Least Variance Ratio and Two-Stage Least Square

Unit –V

Statistical Inference in Simultaneous Equations Models : Conditions for Identification, Asymptotic properties of Two-Stage Least Squares Estimator, Limited Information Maximum Likelihood and K-Class Estimators, Methods of Three- Stage Least Squares.

Books for Study :

1. Johnston,J (1997) : **Econometric Methods**, 4th Edition, McGraw Hill
2. Gujarathi, D and Dawn Porter (2008) : **Basic Econometrics**, 5th Edition, McGraw-Hill

Books for References:

1. Intriligator, M.D (1980) : **Econometric Models-Techniques and Applications**, Prentice Hall.
2. Theil,H(1971) : **Principles of Econometrics**, John Wiley.
3. Walters, A.(1970) : **An Introduction to Econometrics**, McMillan and Co.

15S43C	Bio-Statistics and Survival Analysis	Core – 18
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Unit I

Introduction - Clinical Trials- Goals of Clinical Trials - Phases of Clinical Trials - Classification of Clinical Trials - Randomization: Fixed Allocation, Simple, Blocked, Stratified, Baseline Adaptive and Response Adaptive - Blinding: Single, Double and Triple - Designs for Clinical Trials : Parallel Groups Design, Cluster Randomization Designs, Crossover Designs.

Unit II

Biological Assays: Introduction, Parallel-line assay, Slope- ratio assays and Quantal- Response assay, Feller's theorem. Dose-response relationships-qualitative and quantitative response, dose response relation- Estimation of median effective dose.

UNIT III

Introduction to Survival analysis - terminology and functions of survival analysis- goals - Basic data layout - Censoring-different types of censoring - Parametric survival models - Basic life time distributions - Exponential, Weibull, Gamma and Log- logistic.

UNIT IV

Kaplan-Meier's method- general features - the log rank test for two groups, several groups - alternatives to the log rank test - Cox PH model and its features - ML estimation of the Cox PH model-Hazard Ratio-adjusted survival curves-Cox likelihood.

UNIT V

Evaluating the proportional Hazards Assumptions - overview - graphical approach - log-log plots - Observed versus expected plots- time - dependent covariates - The Stratified Cox Procedure-hazard function- Extension of the Cox PH Model- hazard ratio formula- extended Cox likelihood.

References:

1. Shein-Chung Chow, Jen-Pei Liu (2004): "Design and Analysis of Clinical Trials: Concepts and Methodologies", Second edition, Wiley Series
2. Lawrence M.Friedman,Curt D.Furberg (2010), "Fundamentals of Clinical Research", 4th edition, Springer Science
3. M.N. Das, N.C. Giri(2011): "Design and Analysis of Experiment", Second edition, New Age.
4. Elisa T. Lee & John Wenyu (2003): "Statistical methods for Survival Data Analysis", 3rd Edition, John Wiley
5. Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty, Thomas lumley(2004): "Bio Statistics- A Methodology for the Health Science", Second edition, John Wiley
6. Wayne W. Dainel (2011): "Bio Statistics - Basic Concepts and Methodology for the Health Science", 9th edition, John Wiley
7. David G. Kleinbaum, Mitchel Klein (2008): "Survival analysis- A Self-Learning Text", second edition, Springer
8. John P. Kelin, Melvin L. Moeschberger(2005): "Survival analysis - Techniques for Censored and Truncated data", Second edition, Springer

15S4P3	Statistical Practical - II	Core – 19
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The Maximum Mark is 100 with 40 Marks for Internal involving Test and Record work. 60 Marks for End Examination. The candidate should attend 3 questions out of 4 questions each with 20 Marks with Internal choice. Problem relating to the areas listed below covered under Semester III and Semester IV. The Core Practical II examination is to be conducted at the end of the IV Semester. The list of topics included for practical are given below,

1. STATISTICAL INFERENCE:

Most powerful test – Uniformly Most Powerful test – Likelihood Ratio test – Chi-Square goodness of fit test – Non-parametric Tests

2. STATISTICAL QUALITY CONTROL:

Control Charts for X, R, \bar{p} , np, c and u charts – Single Sampling plan – Double Sampling Plan – Sequential Sampling Plan – Reliability on type I censoring, type II censoring and complete censoring.

3. LINEAR MODELS AND DESIGN OF EXPERIMENTS:

Linear Models and Estimation of BLUE – Analysis of Covariance – Greco Latin Square Design – Split plot and Strip plot techniques – 2^n and 3^n factorial experiments with and without total and partial confounding - BIBD – PBIBD - Youden Square Design – Lattice Design.

4. OPERATIONS RESEARCH:

Artificial Variable – Dual Simplex methods – Game with and without saddle point – Dominance principle and job sequencing problems – PERT and CPM techniques – Inventory problems – Queueing problems.

15S4P4	Statistical Software Practical - II (Using R)	Core –20
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The Maximum Mark for this paper shall be 100 with 40 Marks for Internal Assessment and 60 Marks for End Examination, Internal assessment marks were carried out by Internal Test, Model test and Record work etc., The End examinations will be conducted at the end of programme. The candidate should attend 3 out of 5 questions each carries 20 Marks. This paper covers problems relating to the following area studied during this programme which are listed below. The aim of Statistical Software Practical-II is to utilize theoretical knowledge gained in this programme and to develop skills in the real time applications. Further it emphasize the importance of R software to develop computational and technical skills.

Problems relating to:

1. Using R command-Operations on vectors, logical vector, index vector and matrices.
2. Graphical procedures - Bar chart, Box plots, Histograms using single & multiple groups.
3. Creating and Manipulation of data frames, using various user defined functions.
4. Calculations of probability functions and generation of random samples for various discrete and continuous distributions.
5. Writing R functions for Descriptive statistics, Correlations and Regression co-efficient.
6. Statistical Inference: Parametric and Non-Parametric test.
7. Experimental design for One way and Two way ANOVA
8. Execution of control charts and Acceptance sampling plans
9. Using R functions writing program for Linear models and least square techniques.
10. Multivariate techniques.

15S4PV	Project and Viva-voce	Core – 21
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Project work shall be carried out under the supervisor of a Faculty member on the recommendation of the Head of the Department. **Three copies** of the Project report should be submitted atleast two weeks before the last working day of the fourth semester. The Project work with components are:

Internal Assessments : **25%**

Evaluation of Project report by External

Examiner and Guide : **50 %**

**Supervisor and External Examiner
by Viva-Voce** : **25 %**

The Evaluation of the Project will be based on Project Report and a VIVA-VOCE examination to be conducted by the Supervisor and an External Examiner.

DEPARTMENT OF STATISTICS

List of Elective & Supportive Papers offered for Other Department Students

Details of the Subjects offered and Scheme of Examinations

Elective Papers					
Subject Code	Title of the papers	Credit Point	Internal	End Exam	Total Marks
15STAGE13	Bio-Statistics	4	40	60	100
15STAGE14	Probability and Statistics	4	40	60	100
15STAGE15	Statistics for Management	4	40	60	100
15STAGE16	Operations Research Methods	4	40	60	100
15STAGE24	Actuarial Statistics	4	40	60	100

Supportive Papers					
Subject Code	Title of the papers	Credit Point	Internal	End Exam	Total Marks
15STAGS17	Descriptive Statistics	2	20	30	50
15STAGS18	Data Analysis	2	20	30	50
15STAGS19	Statistical Methods for Industries	2	20	30	50
15STAGS20	Statistical Methods for Researchers	2	20	30	50
15STAGS21	Statistical Methods for Biologists	2	20	30	50
15STAGS22	Elements of Operations Research	2	20	30	50

15STAGE13

Elective-I

BIO-STATISTICS

UNIT-I

Nature of biological and Clinical experiments and data - Classification of data -Need and nature of tabulation - Charts and Diagrams for data - Bar diagrams, pie diagrams, pictograms, histograms-frequency curves and their use.

UNIT-II

Measures of Central tendency - Mean, Median, Mode, Geometric mean, Use of these averages in biological Studies.

Measures of deviation and Standard deviation – Co-efficient of variation -Measure of Skewness and Kurtosis.

UNIT-III

Correlation and regression theory - Correlation coefficient - rank correlation -Regression equations (only problems) - Multiple and Partial correlation and regression.

Basic concepts of sampling - Simple random sample - Stratified sample -Systematic samples.

UNIT-IV

Test of significance based on large sample test: for mean - Variance and proportions-test for means, Variance and attributes using t, F and Chi-Square distribution. Test for correlation regression coefficients, Chi-Square test for goodness of fit.

UNIT-V

Analysis of variance: One way and two way Classifications - Completely Randomized blocks - Randomized Block Design and Latin Square Design (Simple problems based on biological and biochemical data).

Books for Study and Reference:

1. Sundar Rao, Jesudian, Richard - **An Introduction to Biostatistics**, Wiley.
2. Alvi E-Lewis-**Biostatistics**-Eastwest Press.
3. Daniel. Wayne : **Bio-Statistics**, Wiley.
4. Campell-**Statistical for Biologist**, Wiley.
5. Zar.S **Bio-Statistics**, Prentice Hall India.

15STAGE14

Elective-II

PROBABILITY AND STATISTICS

UNIT-I

Sample spaces – events – Probability axioms – Conditional Probability – Independent events – Baye's formula- Random Variables - Distribution functions – Marginal distributions, Conditional distribution – Stochastic Independence. Expectation – Conditional expectation and Conditional Variance. Moment generating functions – Cumulant generating functions.

UNIT-II

Probabilty distributions – Binomial,Poisson,geometric, Uniform, exponential, normal, gamma, beta (generating function, Mean, variance & Simple problems). Correlation – Regression – Multiple & Partial Correlation & regression(Only Problems). Probability density function & Properties to t,f, Chi-square distributions.

UNIT-III

Test for means, Variances & attributes using the above distributions large sample tests – tests for means, Variances & Proportions.

Analysis of Variance: One way and two way classifications – Complete Randomized blocks – Randomized Block Design and Latin Square Design (Only Problems).

UNIT-IV

Estimation: Point estimation – Characteristics of estimation – Interval estimation – Interval estimates of Mean, Standard deviation, proportion, difference in Means & ratios of Standard deviations.

Time series analysis: Trend & Seasonal variations – Box – Components of time Series – Measurement of trend – linear & Second degree Parabola.

UNIT-V

Statistical quality control – Statistical basis for control charts – Control limits – Control Charts for variables – X,R Charts, Charts for defective – P, nP Charts – charts for defects – C Charts..

Books for Study:

1. K.S.Trived, (1982): **Probability & Statistics with reliability, queueing & Computer applications**, Prentice Hall.
2. S.C.Gupta & V.Kapoor, (1977) : **Fundamentals of Mathematical Statistics**, Sultan Chand & Sons.

Books for Reference:

1. Montgomery.DC, and Johnson.A, (1976): **Forecasting & time Series analysis**, McGraw Hill.
2. Dajeh Bester field, (1986): **Quality Control**, Prentice Hall.

15STAGE15

Elective-III

STATISTICS FOR MANAGEMENT

UNIT-I

Nature of quantitative analysis in Management, purpose of Statistics, Measurements, attributes, Units, Variables, discrete and Continuous.

Need and nature of tabulation-Charts and diagrams for data-Bar diagrams, pie diagrams, pictograms-frequency curves.

UNIT-II

Measure of Central tendency-Mean, Median, Mode-Measure of dispersion - Quartile deviation, Mean deviation and Standard deviation-Coefficient of variation-Measure of Skewness and Kurtosis.

UNIT-III

Concepts of events-probability of events-joint, conditional, Marginal probabilities-Probability distribution of a Random variable-Expected value and variance.

UNIT-IV

Theoretical probability distribution-Binomial, Normal and students t distributions.

UNIT-V

Estimation-population and sample-population parameters-Central Limit and theorem-point estimate and interval estimates of population mean and population proportion.

Concept and Construction of Index numbers. Understanding Index numbers applicable in the context of economics, business and Management.

Books for Study and Reference:

1. Richard Levin, **Statistics for Management**. Prentice Hall.
2. Paul Marton, **Applied Business Statistics**, Holt and Reinlast.
3. Good and Hatt, **Research Methods on Social Science**.

15STAGE16

Elective-IV

OPERATIONS RESEARCH METHODS

UNIT-I

Linear Programming-Graphical Method for two-dimensional problems-General Problem of Linear programming-Variations definitions-Statements of basic theorems & properties. Phase I and Phase II of the Simplex Method-Sensitivity analysis-transportation Problem and its Solution. Assignment Problem and its Solution Duality and Shadow Price.

UNIT-II

Queueing theory: Characteristics of queueing Systems-Steady State M/M/1, M/M/C and M/M/K queueing Models.

Replacement theory: Replacement of items that deteriorate- Replacement of items that fail – Group replacement.

UNIT-III

Inventory theory: Costs involved in inventory Problems-Single item deterministic Model-Economic lot size Models without shortages & with shortages having production rate infinite & finite.

UNIT-IV

Decision Making: Decision under certainty, uncertainty & under risk. Decision trees-expected value of Project information & imperfect information.

UNIT-V

PERT & CPM: Arrow networks-time estimates-earliest expected time, latest allowable occurrence- critical path- probability of meeting scheduled time of completeness of projects-calculations on CPM networks, various floats for structures- external path-updating project-operation time cost trade of curve.

Books for Study and Reference:

1. Kanti Swarup, Gupta P.K.,and Man Mohan.(1977): **Operations Research**, Sultan Chand and Sons.
2. Taha, H.A (1982): **Operations Research**, Third Edition, Collier- McMillan.
3. Ackoff,R.L. and Sasieni,M.W (1968):**Fundamentals of Operations Research**,John Wiley.

15STAGE24

Elective-V

ACTUARIAL STATISTICS

UNIT-I

Elements of Compound Interest (nominal and effective rates of interests). Annuities certain, Present values, accumulated amounts, deferred annuities – Simple problems.

UNIT-II

Redemption of loans, Sinking funds, The Average yield on the life fund of an insurance office. Simple Problems.

UNIT-III

The mortality table – construction, characteristics and uses of mortality table . The features of Indian assured lives, Orientals 1925-1935 mortality tables. The LIC (1961-64) table and the LIC(1970-7 table – Simple Problems

UNIT-IV

Premiums, general principles, natural premiums, level premiums, office premiums, loading for expenses. With profit and without profit premiums, adequacy of premiums relative consistency.

UNIT-V

Life office valuation, General principles, Policy values, Retrospective and prospective methods of valuation of liabilities. (net premium, gross premium and bounds reserve) Sources of surplus principle method of surplus.

Books for Study :

1.Federation of Insurance Institutes study courses : **Mathematical Basic of the Life Assurance F.I.2.1**

Books for Reference:

1. Donald D.W. : **Compound interest and annuities**
2. Neil. A : **Life Contingencies**
3. Gupta S.P.CH. : **Fundamentals of Applied Statistics**

15STAGS17

Supportive-I

DESCRIPTIVE STATISTICS

UNIT-I

Origin-Scope-Functions, limitations, uses and Misuses of statistics. Classification and Tabulation of data, Diagrammatic and graphic representation of data.

UNIT-II

Measure of Central tendency–Measures of Dispersion-relative measures of dispersion-Skewness and Kurtosis-Lorenz's curve.

UNIT-III

Elementary Probability space-Statistical probability Axiomatic approach to probability-Finitely additive and countable additive probability functions-Addition and multiplication theorems-Conditional probability-Bayes theorem-Simple problems.

UNIT-IV

Random variables-Discrete and continuous random variables-Distribution function and probability density function of a random variable-Expectation of a random variable-Addition and product theorems- Evaluation of standard measures of location, dispersion, Skewness and Kurtosis.

UNIT-V

Simple linear correlation and regression-Regression equations-their properties spearman's Rank correlation Co-efficient.

Books for Study:

1. Goel & Sharma : **Mathematical Statistics**.
2. S.P.Gupta (1969): **Statistical Method**, Sultan Chand and Sons.
3. S.C.Gupta & V.K.Kapoor (1977): **Fundamentals of Mathematical Statistics**, Sultan Chand and Sons.

Books for Reference:

1. A.M.Goon, Gupta & Das Gupta: **Fundamentals of Statistics**, Vol.1 World press Ltd, Calcutta.
2. Rohatgi, V.K.: **An introduction to Probability Theory and Mathematical Statistics**, Wiley Eastern Ltd., New Delhi.

15STAGS18

Supportive-II

DATA ANALYSIS

UNIT-I

Sampling procedure - determination of Sample size and selection of sample formation of questionnaire- Structured and unstructured questionnaire. Field work- Execution of survey-data collection, Scaling techniques -Guttman scale-Likert 5 points scale.

UNIT-II

Summarizing data- tabulation- averages- Dispersions- measurement of risk- relative measures of dispersion-efficiency and consistency- comparison of two or more populations-large samples test, small sample test - ANOVA - Application of Statistical packages.

UNIT-III

Association of attributes: Chisquare test- correlation-rank difference correlation/biserial correlation, point biserial correlation. Significance of correlation, rank correlation and biserial correlation coefficient, partial and multiple correlations. Significance of multiple regression equation-significance of b_0 , b_1 .. b_n the liner regression coefficient- application of statistical packages.

UNIT-IV

Non-parametric tests: Tests for randomness, Run test, Sign test, and Mann Whitney U test. Wilcoxon signed rank test. Median test- Statistical packages

UNIT-V

Curve fitting - Curves of type

$$\begin{array}{ll} Y=a+bx+cx^2 & Y= abx \\ Y =a+bx+cx & Y=a.ebx \end{array}$$

Time series -estimates of trend and seasonal variation -forecasting -statistical packages.

Books for Study and Reference :

1. Siegel, sand Castellan, NJ (1988): **Non-Parametric Statistics for Behavioral Science** McGraw Hill Book Co, New York
2. Srivastava UK, Shenoy GC and Sharma SC (1989): **Quantitative Techniques Managerial Decision** Wiley Eastern ,New Delhi.
3. VK Kapoor and SC Gupta, (1986): **Fundamentals of Mathematical Statistics**, Sultan Chand and sons, New Delhi
4. Garrett H.E, (1973): **Statistics in Psychology and Education**. Vakils, Feffer and Simons Pvt. Ltd.
5. Hoel P.G. (1957): **Introduction to Statistics**, Asia Publishing Housing Pvt Ltd, New Delhi
6. Kothari CR (1984): **Quantitative Techniques**, vikas Publishing House Pvt Ltd, New Delhi
7. Kothari CR (1990): **Research Methodology**, Wiley Eastern Ltd, New Delhi

15STAGS19

Supportive - III

STATISTICAL METHODS FOR INDUSTRIES

UNIT-I

Historical development of Statistical Quality Control - Meaning of Quality - improvement - Quality cost - Total Quality Management - causes of variations - X, R, P and C charts.

UNIT-II

Acceptance sampling plans by Attributes - Single Sampling Plan - Double Sampling Plan - OC curves - AOQ, ATI curves, Dodge Roaming AOQL and LTPD plans, MIL - STD 105D plans.

UNIT-III

Variable Sampling Plan - One sided and Two sided specifications - Taguchi philosophy and contributions to Quality Improvement (Basic concepts only)

UNIT-IV

Test of significance and design of experiments: Tests based on t, F and chi-square distributions - Analysis of variance - One way and Two way classification Complete Randomized Design(CRD), Randomized Block Design(RBD) , Latin Square Design(LSD).

UNIT-V

Basic of reliability theory - Life time distribution - Hazard rate- Survival function- Exponential, Weibull, Gamma and life time distributions

Books for Study and Reference:

1. Montgomery, DC (1991) **Introduction of Statistical Quality Control**, John Wiley and Sons.
2. Sivazlian and Stanfel (1975), **Analysis of Systems in Operations Research**, Prentice Hall

15STAGS20

Supportive - IV

STATISTICAL METHODS FOR RESEARCHERS

UNIT-I

Definition of Statistics and its applications in various disciplines - Collection of Data - Classification, Tabulation and graphical representation of data- Construction of univariate and Bivariate frequency distribution-measures of central tendency-measures of dispersion - coefficient of variation.

UNIT-II

Random experiment-sample space-events-mathematical and statistical definition of probability-conditional probability-Bayes' theorem-random variable-distribution function-moments- Binomial distribution-Poisson distribution-normal distribution and their properties

UNIT-III

Scatter diagram-Karl Pearson's coefficient of correlation - concurrent deviation method-coefficient of determination-Spearman's Rank correlation-Linear regression-regression lines.

UNIT-IV

Tests of significance-types of hypotheses-two types of errors-critical region-level of significance, small sample tests based on t, F distribution, Chi-square test of goodness of fit, contingency table-test of independence of factors-Large sample tests.

UNIT-V

Test of equality of several populations means, one way and two way analysis of variance. Non-parametric tests-sign, Run and Median tests-two sample rank test-sampling and its uses, sampling methods- unrestricted Random sampling (SRS)- Restricted Sampling (Stratified and Systematic).

Books for Study and Reference:

1. Agarwal (1980): **Basic Statistics**, Wiley Eastern
2. Sokal P.R. and Rohlf F.J. (1969): **Bio Statistics**, W.H. Freedom & Co, San Francisco
3. Snedecor G.W. and Cochran W.G. (1967): **Statistical Methods**, Oxford-IBH, Pvt Co.
4. Zar,J.H.(1984): **Bio Statistical Analysis**, Prentice Hall,Inc, London.

15STAGS21

Supportive - V

STATISTICAL METHODS FOR BIOLOGISTS

UNIT-I

Nature of Biological and Clinical experiments of data-Classification and tabulation of data-Diagrammatic representation of data- Histogram and frequency curves

UNIT-II

Measures of Central tendency-Mean, Median, Mode, Geometric mean, Harmonic Mean-Measures of deviation – Range, Mean deviation, Quartile and standard deviation – Measures of Skewness and Kurtosis.

UNIT-III

Correlation : Rank Correlation – Multiple and Partial Correlation – Regression – Regression equations for biological problems.

UNIT-IV

Basic concepts of sampling – Simple random sample – Stratified sample – systematic sample – cluster sample. Test of significance based on large sample – Mean, Variance and Proportions.

UNIT-V

Analysis of variance –One way and Two way classifications – Completely Randomized blocks – Randomized Block design and Latin Square Design (Simple problems based on biological data)

Books for Study and Reference:

1. Alvi E-Lewis-**Biostatistics** – East west Press
- 2.Campell - **Statistical for Biologist**, Wiley
- 3.J.N.Kapur and H.C.Saxena – **Mathematical Statistics**
- 4.Marcello Pagano and Kimberlee Gauvrean – **Principles of Bio- Statistics.**

15STAGS22

Supportive - VI

ELEMENTS OF OPERATIONS RESEARCH

UNIT-I

Linear Programming Problem – Graphical Method – General Problem of Linear Programming – Simplex Method – Phase I and Phase II Problems – Transportation and Assignment Problems.

UNIT-II

Replacement theory : Replacement of Items that deteriorate – Replacement of items that fail completely – Individual and group replacement policy.

UNIT-III

Sequencing Theory – Processing ‘n’ jobs through 2 machines – Processing ‘n’ jobs through 3 machines – Processing ‘n’ jobs through ‘m’ machines.

UNIT-IV

Network Theory – Introduction to Network – Determination and flow for Critical Path Method – Project Evaluation Review Techniques and its differences.

UNIT-V

Inventory Theory – Meaning of Inventory – Factors involved in Inventory – Economic Models with and without shortages.

Book for Study and Reference:

- 1.Kanti Swarup, Gupta P.K. and Man Mohan (1977) – **Operations Research**, Sultan Chand and Sons
2. Taha, H.A. (1982) : **Operations Research,Mc.Millan**