

<b>Annexure No.</b>	<b>19 C</b>
<b>SCAA Dated</b>	<b>29.02.2008</b>

**BHARATHIAR UNIVERSITY : COIMBATORE-641 046**  
**SUBJECTS OFFERED FOR BRANCH-II A :: M. Sc. STATISTICS (CBCS)**  
**with Compulsory Diploma in Actuarial Science**  
**(with effect from 2008-09 onwards)**

**List of Core/Elective/Supportive Subjects to be offered**

**CORE Subjects**

1. Real Analysis and Linear Algebra
2. Probability and Distributions
3. Sampling Theory and Methods
4. Statistical Inference - I
5. Multivariate Analysis
6. Statistics Practical – I
7. Statistical Inference - II
8. Statistical Quality Control
9. Linear Models and Design of Experiments
10. Time Series and Stochastic Processes
11. Application of Statistical Software Packages
12. Statistics Practical – II
13. Project & VIVA-VOCE

**ELECTIVE Subjects (for students of Statistics)**

1. Object Oriented Programming with C++
2. Programming in JAVA
3. Operations Research

**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

**Diploma Course ( Diploma in Actuarial Science)**

1. Principles of Insurance
2. Financial Mathematics
3. Practice of Life Assurance
4. Insurance Business Environment

**CONTINUOUS INTERNAL ASSESSMENT**

Theory Papers: Maximum 40%

The sessional Assessments may be in the form of Combination of Periodical tests, Assignments and Seminar. The Assessment Procedure to be followed for each Course shall be approved by the Programme Committee.

**BHARATHIAR UNIVERSITY :: COIMBATORE - 641 046**  
**BRANCH II – STATISTICS -Course Title: M.Sc. (Statistics) :: Course Code: (08STAA)**  
**Course Structure and Scheme of Examinations**

<b>Semester – I</b>					
<b>Subject Code</b>	<b>Title of the papers</b>	<b>Credit Point</b>	<b>Int Mark</b>	<b>Ext Mark</b>	<b>Total Marks</b>
08S13A	Real Analysis and Linear Algebra	4	40	60	<b>100</b>
08S13B	Probability and Distributions	4	40	60	<b>100</b>
08S13C	Sampling Theory and Methods	4	40	60	<b>100</b>
08S1EA (Elective)	Object Oriented Programming with C++	4	40	60	<b>100</b>
Supportive	Offered by other Departments	2	20	30	<b>50</b>
08S1LA	Diploma: Paper I-Principles of Insurance	4	40	60	<b>100</b>
<b>Total</b>		<b>18+4</b>			<b>550</b>
<b>Semester – II</b>					
<b>Subject Code</b>	<b>Title of the papers</b>	<b>Credit Point</b>	<b>Int Mark</b>	<b>Ext Mark</b>	<b>Total Marks</b>
08S23A	Statistical Inference – I	4	40	60	<b>100</b>
08S23B	Multivariate Analysis	4	40	60	<b>100</b>
08S2EA (Elective)	Programming in JAVA	4	40	60	<b>100</b>
08S23P	Statistics Practical – I	4	40	60	<b>100</b>
Supportive	Offered by other Departments	2	20	30	<b>50</b>
08S2LA	Diploma: Paper II-Financial Mathematics	4	40	60	<b>100</b>
<b>Total</b>		<b>18+4</b>			<b>550</b>
<b>Semester – III</b>					
<b>Subject Code</b>	<b>Title of the papers</b>	<b>Credit Points</b>	<b>Int Mark</b>	<b>Ext Mark</b>	<b>Total Marks</b>
08S33A	Statistical Inference – II	4	40	60	<b>100</b>
08S33B	Statistical Quality Control	4	40	60	<b>100</b>
08S33C	Linear Models and Design of Experiments	4	40	60	<b>100</b>
08S3EA (Elective)	Operations Research	4	40	60	<b>100</b>
Supportive	Offered by other Departments	2	20	30	<b>50</b>
08S3LA	Diploma: Paper III-Practice of Life Assurance	4	40	60	<b>100</b>
<b>Total</b>		<b>18+4</b>			<b>550</b>
<b>Semester – IV</b>					
<b>Subject Code</b>	<b>Title of the papers</b>	<b>Credit Points</b>	<b>Int Mark</b>	<b>Ext Mark</b>	<b>Total Marks</b>
08S43A	Time Series and Stochastic Processes	4	40	60	<b>100</b>
08S43B	Application of Statistical Software Packages	4	40	60	<b>100</b>
08S43P	Statistical Practical – II	4	40	60	<b>100</b>
08S4PV	* Project and viva-voce	6			<b>150</b>
08S4LA	Diploma: Paper IV- Insurance Business Environment	4	40	60	<b>100</b>
<b>Total</b>		<b>18+4</b>			<b>550</b>

**TOTAL MARKS: 2200**

<b>Core</b>	<b>1350</b>
<b>Elective</b>	<b>300</b>
<b>Supportive</b>	<b>150</b>
<b>Diploma</b>	<b>400</b>

**TOTAL CREDITS: 88**

<b>Core</b>	<b>54</b>
<b>Elective</b>	<b>12</b>
<b>Supportive</b>	<b>6</b>
<b>Diploma</b>	<b>16</b>

\*Internal Assessment (30%)+Evaluation of Project (40%)+Project viva-voce (30%)

**45+ 60+ 45= 150**

**SEMESTER – I****AIMS:**

1. To provide a broad based high quality education with combination of the subjects like Real Analysis, Linear Algebra, Probability, Distributions, Sampling Theory, 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.

**08S13A****REAL ANALYSIS AND LINEAR ALGEBRA****Core - 1****UNIT I**

Infinite series: Cauchy's criterion for convergence – alternating series – absolute and conditional convergence – tests for convergence – comparison test, limit comparison test – geometric series – integral test – ratio and root test – Dirichelet and Abel's test.

**UNIT II**

Limit and continuity: limit of a function – algebra of limits – continuity and discontinuity of function – monotonic function – Bolzano – Weirstrass theorem on continuous functions – intermediate value theorem – uniform continuity. Derivability of a function – Rolle's theorem – mean value theorems (Lagrange's, Cauchy's and generalized).

**UNIT III**

Riemann integral: Riemann integrability of a function. Algebraic properties – integration by parts – first and second fundamental theorem of integral calculus – first and second mean value theorems – differentiation under integral sign.

**UNIT IV**

Finite dimensional vector space – sub-spaces – linear independence – basis and dimension – inner product space – orthogonality and orthonormal basis – Gram – Schmidt orthogonalization process. Linear transformations – algebra of matrices, row and column spaces of a matrix, elementary matrices, determinants, rank and inverse of a matrix, null space and nullity of a matrix.

**UNIT V**

Eigen values and eigen vectors of a matrix – characteristic polynomial – Cayley-Hamilton theorem – minimal polynomial. Quadratic forms – classifications of real quadratic forms – rank and signature – reduction of a real quadratic form to diagonal form – Sylvester's law of inertia – some characterizations of positive definite and non-negative definite quadratic forms.

**Books for Study:**

1. Apostol, T.M. (1985), Mathematical Analysis, Naraso Publishing House, New Delhi.
2. Ramachandra Rao, A. and Bhimasankaram, P. (1992), Linear Algebra, Tata McGraw Hill.
3. Rudin, W. (1976), Principles of Mathematical Analysis, McGraw Hill, New York.
4. Sanjay Arora and Bansilal (1988), Real Analysis, Satya Prakasan Mandir, New Delhi.
5. Vasistha, A.R., Matrices, Krishna Prakashan Mandhir, New Delhi.

**Books for Reference:**

1. Hadley, G. (1998), Linear Algebra, Naraso Publishing House, New Delhi.
2. Mallik, S.C Arora, S., Mathematical Analysis, Wiley Eastern Limited, New Delhi.
3. Rao, C.R.(1973), Linear Statistical Inference and its Applications (2<sup>nd</sup> Edition) Wiley Eastern Limited, New Delhi.
4. Rudin, W. (1986) Real and Complex Analysis, McGraw Hill (3<sup>rd</sup> edition), New York.

**08S13B****Core - 2****PROBABILITY AND DISTRIBUTIONS****UNIT-I**

Probability Spaces and Distribution in  $R^n$ , Expectations and Moments, Basic, Markov, Chebyshev's, Holders, Minkowski and Jensen's Inequalities. Independence of events and random Variables, Multiplication Property.

**UNIT-II**

Convergence of random variables, Convergence in Probability, Almost sure in the  $r^{\text{th}}$  mean and in distribution, their relationships, convergence of moments, Helly-Bray theorem.

Convergence of series of random variables, Kolmogorov's three series theorem, Glivenko-Cantelli theorem.

**UNIT-III**

Characteristic functions, its properties, Inversion theorem, Continuity theorem and its applications.

**UNIT-IV**

Kinchine's Weak Law of Large Numbers, Strong Law of Large Numbers. Central Limit Theorem - Statement of CLT, Lindeberg and Levy and Liapounov forms with proof and Lindeberg-Feller's form without proof and examples.

**UNIT-V**

Review of Sampling Distributions, Non-central t, F and Chi-Square Distributions and their properties. Order Statistics, their distributions and properties.

**Books for Study:**

1. Rohatgi V.K. (2002) : **Introduction to Mathematical Statistics**, Wiley.
2. Bhat, B. R. (1984) : **Modern Probability Theory – An Introductory Text Book**, Second Edition, Wiley Eastern.

**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.

**08S13C****Core - 3****SAMPLING THEORY AND METHODS****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 bias 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.

**08S1EA OBJECT ORIENTED PROGRAMMING WITH C++ Elective 1****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.

**08S1LA**

**Diploma - 1**

**PRINCIPLES OF INSURANCE**

**UNIT-I**

Concepts of risk, concept of Insurance, Classification of Insurance, Type of Life Insurance, pure and terms, Types of general Insurance, Insurance Act, Fire, Marine, Motor, Engineering, Aviation and Agricultural, Alternative Classification, Insurance Property, Pecuniary interest, liability and person, Distribution between Life and General Insurance.

**UNIT-II**

History of Insurance in General in India, Economic Principles of Insurance, Legal principles of Insurance, The Indian contract Act 1872, Insurable interest, Nomination and assignment, Utmost Good faith, Indemnity, Subrogation, contribution, Proximate cause.

**UNIT-III**

Representations, Warranties, Conditions

**UNIT-IV**

Financial Principles, Premium income and outgo investments, Reserves, Surplus, Profit, Valuation of surplus.

**UNIT-V**

Theory of rating, Actuarial principles, Mortality tables, Physical and Moral Hazard, Risk appraisal, Risk selection, Under writing, Reinsurance, concepts and methods.

**Books for Study and Reference:**

1. Neill, Aistair, Heinemann (1977): **Life Contingencies**.
2. Gerber, Hans, U (1997): **Life Insurance Mathematics**, Springer, Swiss association of actuaries.
3. Booth, Philip N. et al (1999): **Modern Actuarial Theory and Practice**, Chapman and Hall.
4. Dayken, Chris.D et al (1994): **Practical Risk Theory for Actuaries**, Chapman and Hall.

**SEMESTER – II**

**AIMS:**

1. To provide a broad based high quality education with combination of the subjects like Statistical Inference, Multivariate Analysis, Programming in JAVA, Statistical Practical and



Financial Mathematics 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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4. To gain deeper understanding, problem solving skills and greater knowledge of selected topics in statistical computation.

**08S23A**

**STATISTICAL INFERENCE – I**

**Core 4**

#### **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

**08S23B****Core - 5****MULTIVARIATE ANALYSIS****UNIT-I**

Reviews of Multivariate Distributions, Multiple and Partial Correlation and Regression, Multivariate Normal Distribution, Marginal and Conditional Distributions.

**UNIT-II**

Maximum likelihood Estimators of Parameters, Distribution of Sample Mean Vector, and Sample Dispersion Matrix, James-Stein Estimator for the Mean Vector, Wishart Distribution and its Properties (without derivation), Maximum Correlations and their Null Distributions. Tests based on total, partial and multiple Correlations.

**UNIT-III**

Tests on Mean Vectors for one and two Multivariate Normal Distributions, Hotelling's  $T^2$  and Mahalanobis  $D^2$  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, Principal Factor Analysis, Estimating Factor/Score, Testing goodness of fit, Rotation of Factors.

**UNIT-V**

Classification Analysis using Discriminant Function Hierarchical Clustering: (a) Agglomerative techniques, Single Linkage Method, Complete Linkage Method, Incremental Sum of Squares Method, Median Method, Group Average Methods, Comparison of Methods, Divisive techniques - Monothetic Methods, Polythetic Methods.

**Books for Study:**

1. Anderson, T.W. (1980): **An Introduction to Multivariate Statistical Analysis**, Second Edition, Wiley Eastern.
2. 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.

**08S2EA****PROGRAMMING IN JAVA****Elective 2****UNIT I**

Java – data types, variables and arrays – Operators – Control statements – Classes – Methods – Inheritance – Program using these concepts – Package and interfaces.

**UNIT – II**

Exception handling – Multithreaded programming – Input/Output Basics – Programs using these concepts.

**UNIT – III**

String handling – Exploring Java language – utility classes – Exploring Java 1.0 programming using lang and 1.0 package.

**UNIT – IV**

Networks – sockets – reserved sockets – proxy server, internet addressing, Java and Net, InetAddress – TCP/IP client sockets, URL, TCP/IP server and client applet basics – class and architecture – applet skeleton – display methods – handling events – understanding the HTML – APPLET tag – passing parameters to Applets – AudioClip, Applet stub interface – Outputting to the console – simple programming examples.

**UNIT –V**

Introduction to Abstract Window Toolkit (AWT) – working with Windows, Graphics and Text, AWT controls, Layout managers, menus, images – simple programming examples.

**Books for Study:**

1. Patrick Naughton and Herbert Schildt, The Complete Reference Java (Osborne series), Tata McGraw Hill Publishing Company Limited, New Delhi, 1997
2. Thomas, M.D., Patel, P.R., Hudson, A.D., and Ball, D.A., Java Programming for the Internet – A Guide to Creating Dynamic Interactive Internet Applications, Ventana Communications Group, Inc, 1996.

**Books for Reference:**

1. ABC of the Internet, Tech Media, BPB Publications, New Delhi.
2. ABC of MS Internet, Tech Media, BPB Publications, New Delhi.

**08S23P****Core – 6****STATISTICAL PRACTICAL – I**

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

**08S2LA****Diploma - 2****FINANCIAL MATHEMATICS****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.

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**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, 2<sup>nd</sup> 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 – 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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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.
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**08S33A****STATISTICAL INFERENCE-II****Core - 7****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.

**08S33B****Core - 8****STATISTICAL QUALITY CONTROL****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  $\chi^2$  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.

**08S33C****Core - 9****LINEAR MODELS AND DESIGN OF EXPERIMENTS****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- Analysis of Covariance-Multiple Comparisons - Multiple Range Tests.

**UNIT-II**

Review of Basic Designs and Principles of Experimentation CRD-RBD-LSD. 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  $p \times p$  Experiments - Concept and Principle of total, partial and balanced Confounding in Symmetrical Factorial.

**UNIT-IV**

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

**UNIT-V**

Analysis of Block Designs, C-matrix and its properties, Concept of Connectedness and Orthogonality Simple and Balanced Lattice Designs-Balanced Incomplete Block Designs- Youden Square Design, Partially Balanced Incomplete Block Designs and its Classification, Group Divisible Designs.

**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. Aloke 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.



**08S3EA****Elective - 3****OPERATIONS RESEARCH****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  $2 \times 2$ ,  $2 \times m$  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.

**08S3LA****Diploma - 3****PRACTICE OF LIFE ASSURANCE****UNIT-I**

Life insurance organization, The Indian context, The Distribution system, function of appointment and continuance of agency, remuneration of agents, trends in life insurance distribution channels.

**UNIT-II**

Plans of Life insurance, need levels, term life increasing, decreasing term policy, whole life insurance endowment insurance, money back endowment plan, marriage endowment plan, education annuity plan, children deferred assurance plans annuities.

**UNIT-III**

Group insurance, nature of group insurance types of group insurance, gratuity liability, group superannuating scheme, other group schemes, social security schemes, other special need plan, industrial life insurance salary saving scheme, disability plans.

**UNIT-IV**

Application and acceptance, prospectus, proposal forms and other related documents, age proof, special reports, policy documents, need and format, preamble operative conditions clauses, proviso, schedule, attestation conditions and privileges, alteration duplicate policy, premium, premium calculation, days of grace, non-forfeiture options, lapse and revival schemes.

**UNIT-V**

Assignment nomination loans, surrenders, foreclosures, Married women's property act policy, calculations, policy claims, maturity claims, survival benefit payments, death claims, waiver of evidence of title, early claims, claim concession, presumption of death accident benefit and disability benefit settlements options valuations and bonus, distribution of surplus, Types of reinsurance, exchange control regulations payment of premia payment claims etc., assignment in favor of non-residents deposit export of policies

**Books for Study and Reference:**

1. Booth, Philip, M et. al. (1999): **Modern Actuarial Theory and Practice**, Chapman Hall
2. Panjer, Harry H et. al. (1998): **Financial Economics with Applications to Investments Insurance and Pensions**, The Actuarial Foundations

**SEMESTER – IV****AIMS:**

1. To provide a broad based high quality education with combination of the subjects like Time Series, Stochastic Process, Application of Statistical Software Packages, Statistical Practical, Project-Viva voce and Insurance Business Environment 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.

**08S43A**

**Core - 10**

### **TIME SERIES AND STOCHASTIC PROCESSES**

#### **UNIT-I**

Introduction to Stochastic Process, Classification of Stochastic Process. Countable State Markov Chain. Chapman-Kolmogorov's Equations, Calculation of n-step Transition Probability and its limit. Stationary Distribution, Classification of States, Transient Markov chain, Random Walk and Gambler's Ruin Problem.

#### **UNIT-II**

Continuous Time Markov Process: Kolmogorov Differential Equations, Poisson Process, Birth and Death Process, Applications to queues and Storage problems.

#### **UNIT-III**

Discrete Parameter Stochastic Process/time series. Auto- Covariance and Auto-correlation and their properties.

#### **UNIT-IV**

Detailed study of the stationary process like (a) Moving Average, (b) Autoregressive, (c) Autoregressive moving average. (d) Autoregressive Integrated Moving Average, Box Jenkins Models, Brief discussion of Estimation and Related Large Sample theory of the mean.

#### **UNIT-V**

Choice of AR and MA terms. Brief discussion of techniques of the ARIMA model parameters and forecasting. Study of Residuals and Diagnostic Checking.

#### **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. Fuller, W.A. (1976): **Introduction to Statistical Time Series**, John Wiley, NY.

**Books for Reference:**

1. Granger, C.W.J. and Newbold, (1984): **Forecasting Econometric Time Series**, Third Edition, Academic.
2. Box, G.E.P., and Jenkins, G.M., (1976): **Time series Analysis- Forecasting and Control**. Holden-Day San Francisco.
3. Anderson, T.W., (1971): **The Statistical Analysis of time Series**, Wiley, NY.
4. Kendall, M.G., and Stuart, A. (1966): **The advanced Theory of Statistics**, Vol.3, Charles Griffin, London.
5. Adke, S.R. and Manjunath, S.A. (1984): **An Introduction to Finite Markov Processes**, Wiley Eastern.
6. Parzen, E. (1962): **Stochastic Processes**, Holland-Day.

**08S43B****Core – 11****APPLICATION OF STATISTICAL SOFTWARE PACKAGES****UNIT-I**

Introduction to Excel – Various Distributions - Descriptive Statistics - Data analysis tools – ANOVA – Covariance - Regression – Correlation – Non parametric tests — Time series analysis - Using Macros

**UNIT-II**

Introduction to SPSS 10.0 Icons - Opening files - File extension - Working with Data - Summarizing Data and Printing - Hypothesis Testing - Descriptive statistics for qualitative and quantitative data – Graphs and Charts - Regression and Correlation Analysis - Simple Correlation – scatter diagram, Simple Regression – scatter diagram, Simple Regression – Estimation and Interpretation of results, Multiple Regression Scatter plot Matrix - Multiple Regression - Estimation and Testing of Hypothesis - Time Series Analysis and Forecasting – Linear Trend – Non – Linear Trend – Seasonality –Forecasting with Linear Trend and regression Models - Index Numbers.

**UNIT-III**

Introduction to MINITAB 14.2 – Preliminary data analysis – Descriptive statistics – Probability theory – Inferential Statistics for single through multiple samples.

**UNIT-IV**

Introduction to STATISTICA 7- Basic Statistical Analysis Methods – ANOVA – Nonparametric – Distribution Fitting – Multiple Regression – General Linear / Nonlinear models – General Regression Models – Time Series and Forecasting models – Cluster, Factor, Principal Component and Discriminant Analysis – Quality Control Charts – Experimental Design (DOE) – Process Analysis

**UNIT-V**

Case studies – Problem Solving and Applications of SPSS, Statistical Process Control, MINITAB, STATISTICA and MS Excel

**Websites:**

[www.spss.com/Help](http://www.spss.com/Help)

[www.stata.com](http://www.stata.com)

[www.spss.org](http://www.spss.org)

**Help manuals of SPSS version 10**

**Manual of MINITAB**

**Books for Study and Reference:**

1. **SPSS for Windows Step by Step: A simple Guide and Reference**, 10.0 update (3<sup>rd</sup> edition) by Darren George and Paul Mallery
2. **An Introductory Guide to SPSS for Windows** by Eric L. Einpruch
3. Borovikov, I.P. and Borovikov, V.P. **STATISTICA: Data Preparation and Analysis**. Moscow: Filini, (1998)
4. Borovikov, V.P. **A Quick Introduction to STATISTICA**. Moscow: Computer, (1998)
5. **The Complete Idiot's Guide to Microsoft Excel** (2000) By Sherry Kinkoph
6. **How to Do Everything with Microsoft Office Excel** (2003) By Guy Hart - Davis

**08S43P**

**Core - 12**

### **STATISTICAL PRACTICAL – II**

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<sup>n</sup> and 3<sup>n</sup> 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.

### PROJECT WORK

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 : 30%**

**Evaluation of Project report by External**

**Examiner and Guide : 40 %**

**Supervisor and External Examiner : 30 %  
by Viva-Voce**

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.

**08S4LA**

**Diploma - 4**

## **INSURANCE BUSINESS ENVIRONMENT**

### **UNIT I**

Laws to the regulation of Insurance business in India. The Insurance Act 1938, The IRDA ACT 1999, LIC of India ACT 1956 and General Insurance Business ACT 1972. Motor vehicles ACT 1939, Public Liability Insurance ACT 1991, Marine Insurance ACT 1963, Carriage of goods ACT 1925 etc, including consumer protection ACT 1986.

### **UNIT II**

The economic environment vis-à-vis national Income, Various five year plans, Effect of inflation, recession, fiscal policy, VAT, Information Technology, Indian Agricultural sector, Natural resources, Railways

### **UNIT III**

Social and political environment, constitution of India, social Milien, Population education, Health, industrial environment in the socialistic pattern, economic reforms in India, globalization, Role of public sector, automobile, aviation, pharma, Biotech, International trade, WTO.

### **UNIT IV**

The commercial environment & Financial environment, partnership, Cooperative organizations, companies ACT 1956, Money, Monetary policy, financial institutions, Narasimham committee, Mutual funds, stock exchanges

### **UNIT V**

Office organization, methods of filing, business correspondence, structure of business letters, controls, insurance business ABROAD, pensions.

### **REFERENCES:**

1. Insurance Business Environment, S.Balachandran, published by Insurance Institute of India, Mumbai.
2. Principles of Life Insurance, S.Balachandran published by Insurance Institute of India, Mumbai.
3. Principles of General Insurance by Insurance Institute of India, Mumbai.

**List of Elective & Supportive Papers offered for  
Other Department Students**

**Details of the Subjects offered and Scheme of Examinations**

<b>Elective Papers</b>					
<b>Subject Code</b>	<b>Title of the papers</b>	<b>Credit Point</b>	<b>Internal</b>	<b>End Exam</b>	<b>Total Marks</b>
01STAGE13	Bio-Statistics	4	40	60	<b>100</b>
01STAGE14	Probability and Statistics	4	40	60	<b>100</b>
01STAGE15	Statistics for Management	4	40	60	<b>100</b>
01STAGE16	Operations Research Methods	4	40	60	<b>100</b>
06STAGE24	Actuarial Statistics	4	40	60	<b>100</b>

<b>Supportive Papers</b>					
<b>Subject Code</b>	<b>Title of the papers</b>	<b>Credit Point</b>	<b>Internal</b>	<b>End Exam</b>	<b>Total Marks</b>
01STAGS17	Descriptive Statistics	2	20	30	<b>50</b>
01STAGS18	Data Analysis	2	20	30	<b>50</b>
01STAGS19	Statistical Methods for Industries	2	20	30	<b>50</b>
01STAGS20	Statistical Methods for Researchers	2	20	30	<b>50</b>
06STAGS21	Statistical Methods for Biologists	2	20	30	<b>50</b>
06STAGS22	Elements of Operations Research	2	20	30	<b>50</b>

01STAGE13

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. Campbell-**Statistical for Biologist**, Wiley.
5. Zar.S **Bio-Statistics**, Prentice Hall India.

**01STAGE14****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**

Probability 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.

**01STAGE15****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**.

**01STAGE16****Elective-IV****OPERATIONS RESEARCH METHODS****UNIT-I**

Linear Programming-Graphical Method for two-dimensional problems-General Problem of Linear programming-Variou 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.

**06STAGE24****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**

**01STAGS17****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.

**01STAGS18****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

**01STAGS19****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

**01STAGS20****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. Freeman & 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.

**06STAGS21****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**.

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## **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**