Department Of Statistics (UG)

Semester	Category	Code	Title	Hours	Credits
I	MC	ST 1502	STATISTICAL METHODS	6	6
I	MC	ST 1503	PROBABILITY AND RANDOM VARIABLES	3	3
II	AR	ST 2103	STATISTICAL METHODS FOR ECONOMICS	6	4
II	AR	ST 2104	BUSINESS STATISTICS	6	4
II	AR	ST 2105	FUNDAMENTALS OF STATISTICS	6	4
II	MC	ST 2503	CONTINUOUS DISTRIBUTIONS	6	6
II	MC	ST 2504	DISCRETE DISTRIBUTIONS	3	3
III	EG	ST 3301	BASIC STATISTICAL TECHNIQUES	3	1
III	AO	ST 3204	BIOSTATISTICS	6	4
III	AO	ST 3205	ADVANCED STATISTICAL METHODS	6	4
III	MC	ST 3505	SAMPLING THEORY	6	6
III	MC	ST 3506	MATRIX AND LINEAR ALGEBRA	3	3
IV	AO	ST 4208	STATISTICS FOR MANAGEMENT	6	4
IV	AO	ST 4209	MATHEMATICAL STATISTICS	6	4
IV	AO	ST4210	ECONOMETRICS	6	4
IV	EG	ST 4301	PROGRAMMING IN C	3	1
IV	MC	ST 4503	ESTIMATION THEORY	6	6
IV	MC	ST 4504	SPREADSHEET APPLICATIONS	3	3
V	ES	ST 5407	SQL and PL SQL	3	2
V	ES	ST 5409	RELIABILITY THEORY	3	2
V	ES	ST 5406	ACTUARIAL STATISTICS	3	2
V	ES	ST5408	APPLIED STOCHASTIC PROCESSES	3	2
V	MC	ST 5508	APPLIED STATISTICS	6	6
V	MC	ST 5509	REGRESSION ANALYSIS	6	6
V	MC	ST 5510	TESTING OF HYPOTHESES	6	6
V	MC	ST 5511	STATISTICAL DATA ANALYSIS USING SPSS	6	6

VI	MS	ST 6606	DESIGN AND ANALYSIS OF EXPERIMENTS	5	7
VI	MS	ST 6607	OPERATIONS RESEARCH	5	7
VI	MS	ST 6608	STATISTICAL QUALITY CONTROL	5	6
VI	SK	ST 6652	R LANGUAGE	9	9
VI	SK	ST 6652	SURVEY PRACTICE & REPORTING	6	6

ST 1502 - STATISTICAL METHODS

Semester : I	**Category** : MC
Hours/Week : 6	**Credits** : 6

Objectives: 1) To introduce the basic concepts in Statistics

   2) To develop data reduction techniques

Unit - 1 Definition - Scope and limitations of Statistics - Collection of data - Census.Sampling surveys - Classification and tabulation - diagrammatic and graphical representation of data - Nominal, ordinal and interval scaling.

Unit - 2 Measures of central tendency - Measures of dispersion and Coefficient of variation - Problems based on raw data and grouped data - Moments - raw and central - Measures of skewness - Measures of Kurtosis and their applications.

Unit - 3 Curve fitting - Principle of least squares - linear, nonlinear, exponential and growth curves.

Unit - 4 Correlation - Rank Correlation - Regression analysis - Problems based on raw data and grouped data.

Unit - 5 Association of attributes - Notations - Classes and class frequencies - Consistency of data - Independence of attributes - Yule's coefficient of association - coefficient of colligation.

Books for Study:

1. Bansilal andArora (1989). New Mathematical Statistics, SatyaPrakashan, New Delhi.
2. Gupta. S.C. &Kapoor,V.K. (2002) . Fundamentals of Mathematical Statistics , Sultan Chand & Sons Pvt. Ltd. New Delhi.

Books for Reference:

1. Goon A.M. Gupta. A.K. & Das Gupta, B (1987) . Fundamentals of Statistics, Vol.2, World Press Pvt. Ltd., Calcutta.
2. Kapoor, J.N. &Saxena, H.C. (1976) . Mathematical Statistics , Sultan Chand and Sons Pvt. Ltd, New Delhi.

ST 1503 - PROBABILITY AND RANDOM VARIABLES

Semester I   **Category: MC**

Hours/Week : 3   **Credits : 3**

Objectives: 1) To introduce probability theory as a foundation for Statistics.

2) To help students understand the basic notions about random variables.

Unit 1 Introductory Notions of Probability- Random Experiments – Sample Space and Events. Axiomatic Approach to Probability – Addition Law – Problems in Axiomatic Approach.

Unit 2 Combinatorics and Classical ProbabilityElements of Combinatorics. Classical Definition of Probability. Problems in Classical approach.

Unit 3 Conditional Probability – Occupancy Problems.Stochastic Independence and related concepts - Independence of events – Pairwise and Mutual Independence.

Unit 4.Multiplication Law, Law of Total Probability, Baye's Theorem.Bernoulli Trials – Problems.

Unit 5 Introductory notions on Random Variables - Random Variables – Discrete and Continuous Random Variables – p.g.f, p.m.f. and p.d.f. – c.d.f. Mathematical Expectation and Variance of a random variables. Chebyshev's Inequality.

Books for Study :

1. Gupta, S.C. and Kapoor, V.K. (2002). Fundamentals of Mathematical Statistics. Sultanchand and Sons. New Delhi
2. Parzen, E.(1960). Modern Probability Theory. John Wiley & Sons, New York

Books for Reference:

1. Hogg, R.V. and Craig, A.T. (2002). Introduction to Mathematical Statistics. Pearson Education India

ST 2103 - STATISTICAL METHODS FOR ECONOMICS

(for Economics Students)

Semester II   **Category: AR**

Hours/Week : 6   **Credits : 4**

Objectives: 1) To introduce the basic concepts in Statistics and their applicability in Economics.

2) To develop problem solving skills using statistical tools and techniques.

Unit 1: Introduction to Statistics: Functions – Importance – Uses and Limitations of Statistics. Statistical data – Classification, Tabulation, Diagrammatic & Graphic representation of data.

Unit 2: Data Collection & Sampling Methods: Primary & Secondary data, Sources of data, Methods of collecting data. Sampling – Census & Sample methods – Methods of sampling, Probability Sampling and Non-Probability Sampling.

Unit 3: Averages and Dispersion: Measures of central tendency – Mean, Median, Mode, Geometric Mean, Harmonic Mean. Measures of Dispersion – Range,Quartile deviation, Mean deviation, Standard deviation, Coefficient of variation.Skewness& Kurtosis.

Unit 4: Correlation & Regression: Simple Correlation – Scatter diagram, Rank Correlation, Karl Pearson's Correlation Coefficient. Simple Regression, OLS Technique, Standard Error.

Unit 5: Time Series & Index numbers: Index numbers – Price & Quantity index numbers of Fisher, Laspeyre, Paasche, Kelly& Marshal-Edgeworth. Cost of living Index. Uses & Limitations of index numbers. Analysis of Time series – (Linear Relationship only)

Books for study:

1. Agarwal, B.L. (2006):- **Basic Statistics**. Wiley Eastern Ltd., New Delhi
2. Gupta, S. P. (2011):- **Statistical Methods**. Sultanchand& Sons, New Delhi
3. Sivathanupillai, M &Rajagopal, K. R. (1979):- **Statistics for Economics Students**.

Books for Reference:

1. Arora, P.N., SumeetArora, S. Arora (2007):- **Comprehensive Statistical Methods**. Sultan Chand, New Delhi
2. Fox, James Allen (1991):- **Elementary Statistics in Social Research** – Ed 5.
3. Goon, A.M., Gupta, M.K., and Dasgupta, B. (1998):- **An Introduction to Statistical Theory**.
4. McClave, James, T and George Benson (1990):- **Statistics and Economics**. Collier Macmillan Publishers, London
5. Mood, A. M. and Graybill, F.A. (1974):- **Introduction to the Theory of Statistics**

ST 2104 - BUSINESS STATISTICS
(for Commerce Students)

Semester II   **Category: AR**

Hours/Week : 6   **Credits : 4**

Objectives: 1) To introduce basic concepts of Statistics
                        2)To provide statistical techniques for business data analysis.

Unit 1 Measures of Central tendency: Simple averages – mean, median and mode –Geometric mean and Harmonic mean – weighted arithmetic mean.
 Measures of Dispersion: Range – Quartile deviation – mean deviation – Standard deviation – coefficient of variation – Combined mean and standard deviation.
Skewness: Karl Pearson and Bowley's Coefficient of skewness – Moments – Kurtosis.

Unit 2 Curve fitting: Fitting a straight line and second degree parabola.
Correlation: Scatter diagram – Limits of correlation coefficient – Spearman's Rank correlation coefficient – Simple problems. Regression: Properties of regression coefficients and regression lines.

Unit 3 Time Series: Components of time series-Additive and multiplicative models –
 Measurement of trend – Graphical method-Semi-average method-moving average method-least squares method. Measurement of Seasonal Variation –Method of Simple averages – ratio-to trend method – ratio to moving average method-method of link relatives.

Unit 4 Elements of Operation Research: Linear Programming – Solving L.P.P. by Graphical method – Transportation problems – North-West corner rule – Least cost method - Vogel's Approximation Method.

Unit 5 Game Theory : Introduction – Two-Person Zero-Sum Games – Pure Strategies – Mixed Strategies.

Books for study:

1. Vittal, P.R.(2010) Business Statistics. Margham Publications, Madras
2. Gupta, S.P. (2011), Statistical Methods-Sultan Chand and Sons Publishers. New Delhi.
3. Yule and Kendall (1993).Introduction totheory of Statistics. Universal Book Stall, New Delhi.

Books for reference:

1. Croxton and Cowden (1956).Applied General Statistics.Sir Isaac Pitman and Sons. Ltd., London.
2. Gupta,S.C. and Kapoor,V.K. (2002). Fundamentals of Mathematical Statistics.Sultanchand and Sons. New Delhi
3. Taha,H.A. (1997). Operations Research. Macmillan Publishing Housing Co., New Delhi.
4. KantiSwarup, Gupta, P.K. and Man Mohan (1996), Sultan Chand and Sons (P) Ltd., New Delhi.

ST 2105 – FUNDAMENTALS OF STATISTICS

Semester III   **Category:AR(for B.B.A / B.Com (CS))**

Hours/Week : 6   **Credits : 6**

Objective: 1) To introduce basic concepts of Statistics

                 2) To provide statistical techniques for business data analysis

Unit 1 : Introduction: Origin and development of statistics – Definition of statistics – Importance and scope of statistics – Limitations of statistics – Misuse of statistics – Collection of data: Census method – Sampling method – Simple, Stratified, Systematic random sampling – Judgement, Convenient, Quota sampling – sampling error.

Unit 2: Presentation of Data: Diagrammatic representation of data – Bar diagram – pie diagram – Histogram – Frequency polygon and frequency curve – Pictogram- and cartogram – Measures of central tendency: Simple average, Mean, Median and Mode – Geo-metric mean and Harmonic Mean – Weighted arithmetic mean

Unit 3: Measures of Dispersion: Range – Quartile deviation – Mean deviation – Standard deviation – Coefficient of variation - combined mean and standard deviation - Skewness : Karl Pearson and Bowley's coefficient of Skewness

Unit 4: Correlation and Regression : Scatter diagram – Karl Pearson Coefficient of Correlation – rank correlation – Regression: Importance if regression analysis – regression equations.

Unit 5: Time Series: component of time series – Measurements of trend – graphical method , semi-average method, moving-average method and method of least squares – measurements of seasonal variation – method of simple averages, ratio-to-trend method, ratio-to-moving average method and Link relative method

Books for study:

1. Gupta, S.P. (2011), Statistical Methods-Sultan Chand and Sons Publishers. New Delhi.

Books for reference:

1. Gupta,S.C. and Kapoor, V.K.(2002), Fundamentals of Applied Statistics, Sultan Chand and sons publishers, New Delhi**.**
2. Vittal, P.R.(2010) Business Statistics. Margham Publications, Madras

ST 2503 - CONTINUOUS DISTRIBUTIONS

Semester II   **Category: MC**

Hours/Week : 6   **Credits : 6**

Objective: 1) To impart essential knowledge in continuous distributions

 2) To expose the real-life applications of continuous distribution

Unit 1: Joint - Marginal and Conditional distributions – Conditional Expectation – Conditional Variance – Stochastic Independence, Uniform Distribution – Mean – Variance – M.G.F - Distribution Function

Unit 2: Normal Distribution – Properties – M.G.F – Linear Combinations of Normal Variate – Reproductive Property, Bivariate Normal – Mean – Variance

Unit 3: Beta, Gamma, Cauchy, Exponential – Properties – M.G.F – Distribution Function – Properties

Unit 4: Functions of Random Variable – Transformation of Variables – Chi-square, t and F distribution – Properties

Unit 5: Order Statistics and their distributions. Limiting Distribution – Stochastic Convergence – Lindberg – Levy Central Limit Theorem

Books for Study

1. Hogg, R.V. & Craig, A.T. (2002):- Introduction to Mathematical Statistics. Pearson Education India
2. Rohatgi, V.K. and Saleh, A. K. Md. E (2002) :- An Introduction to Probability and Statistics. John Wiley & Sons, New York.

Books for Reference

1. Goon, A.M., Gupta, M.K., &DasGupta, B. (1988):- An Introduction to Statistical Theory.
2. Gupta, S.C. &Kapoor, V.K. (2002): Fundamentals of Mathematical Statistics, Sultanchand& Sons, New Delhi
3. Sanjay Arora&Bansilal (1989):- New Mathematical Statistics.

ST 2504 - DISCRETE DISTRIBUTIONS

Semester II   **Category: MC**

Hours/Week : 3   **Credits : 3**

Objective: 1**)** To impart essential knowledge in Discrete distributions

                    2) To expose the real-life applications of Discrete distribution

Unit 1: Joint - Marginal and Conditional distributions – Conditional Expectation – Conditional Variance – Stochastic Independence – Correlation Coefficient ,Generating functions.

Unit 2: Uniform Distribution –Properties– M.G.F – P.G.F , Bernoulli distribution – Properties – M.G.F – P.G.F - Binomial distributions – Properties – Recurrence Formula – Additive Property – Limiting Property

Unit 3: Poisson Distribution – Properties – Mode – M.G.F – P.G.F – Characteristic Function – Recurrence formula – Additive Property – Poisson Approximation to Binomial.

Unit 4: Geometric Distribution – Properties – Recurrence Formula – Memory less property- M.G.F – P.G.F, Negative Binomial Distribution – Properties – M.G.F – Recurrence Formula – P.G.F – Reproductive Property

Unit 5: Hyper geometric distribution – Properties – M.G.F – Characteristic function, Multinomial Distribution – Mean – Variance – Marginal and Conditional distribution – Additive Property

Books for Study :

1. Hogg, R.V. & Craig, A.T. (2002):- Introduction to Mathematical Statistics. Pearson Education India
2. Rohatgi, V.K. (1975):- An Introduction to the Theory of Probability and Mathematical Statistics.

Books for Reference:

1. Goon, A.M., Gupta, M.K., &DasGupta, B. (1988):- An Introduction to Statistical Theory.
2. Gupta, S.C. &Kapoor, V.K. (2002): Fundamentals of Mathematical Statistics, Sultanchand& Sons, New Delhi
3. Sanjay Arora&Bansilal (1989):- New Mathematical Statistics.

ST 3204 - BIOSTATISTICS

(for Adv. Zoology and Plant Biology & Biotechnology Students)

Semester III   **Category: AO**

Hours/Week : 6   **Credits : 4**

Objectives : 1) To imbibe statistical techniques applicable in biological sciences.

2) To demonstrate the applications of statistical methods in real-life situations.

Unit 1 Organizing and summarizing Biological Data – Measures of Central tendency – Measures of Dispersion – Correlation and Regression.

Unit 2 Probability – Addition, Multiplication and Baye's theorems, Distributions – Binomial, Poisson and Normal distributions – Sampling distributions χ^2, t and F

Unit 3 Tests of Significance-Single population mean and the difference between two population means – Paired comparisons-Single proportion and the difference between two population proportions – Confidence Interval – mean, difference of means, proportion, difference of proportions.

Unit 4 Chi-square distribution and the analysis of frequencies – Test of Goodness of fit – Test of Independence of attributes – Analysis of Variance-Completely Randomized Design-Randomized

Block Design – Factorial experiments – 2^2, 2^3 experiments.

Unit 5 Non parametric tests – Sign test, Median test, Mann-Whitney test.

Books for study:

1. Daniel, W.W. (2008): Biostatistics – A Foundation for analysis in the Health Sciences, John Wiley & Sons, New York.
2. Altman, D.G.(1991): Practical Statistics for Medical Research, Chapman – Hall, London.
3. Bailey, N.T.J.(1994): Statistical Methods in Biology, Cambridge University Press, London.

Books for reference:

1. Gurumani, N. (2004): Introduction to Biostatistics, MJP Publishers, Chennai.
2. Bland, M. (1995): An Introduction to Medical Statistics, Oxford University Press, London.
3. Jasra, P.K. and Raj, G. (2000): Biostatistics, Krishna PrakeshamMandir, India.
4. Lewis, A.E.(1971): Biostatistics, Thomson-Wordsworth.
5. Negi, K.S. (2002): Biostatistics, AITBS Publishers.
6. Sokal, R.R. and Rohlf, F.J. (1973): Intrroduction to Biostatistics, Thomson-Wordsworth.

ST 3205 - ADVANCED STATISTICAL METHODS

Semester III   **Category: AO**

Hours/Week : 6   **Credits : 4**

Objective: 1) To impart knowledge and methodology behind the various statistical techniques

2) To equip students with statistical techniques useful in business and economic analysis

Unit 1 Association of attributes: Consistency of data - Methods of studying association: Proportion method, Yule's coefficient of association, Coefficient of colligation, Coefficient of contingency. Partial association.

Unit 2 Probability and Random variables: Probability - Theorem of probability: Addition theorem - Multiplication theorem. Conditional probability: Baye's theorem. Mathematical expectation.Random variable.Probability distributions and concept of Normal distribution.

Unit 3 Tests of significance: Procedure of testing a hypothesis - Standard error and sampling distributions. Tests for assigned mean, assigned proportion, equality of means and equality of proportions(small and large sample tests) - Chi-square test for independence.

Unit 4 Analysis of variance: Assumptions in Analysis of variance - Techniques of Analysis of variance - One-way and Two-way classification models.

Unit 5 Statistical Quality Control: Control charts - Control limits - Types of control charts - X bar chart, R chart, p chart and c chart, Advantages and disadvantages of SQC.

Books for study :

1. Gupta, S.P.(2011), Statistical methods, Sultan Chand and sons publishers, New Delhi.
2. Gupta,S.C. and Kapoor, V.K.(2002), Fundamentals of Applied Statistics, Sultan Chand and sons publishers, New Delhi.
3. Gupta, S.C. and Kapoor, V.K.(2002), Fundamentals of Mathematical Statistics, Sultan Chand and sons publishers, New Delhi.

Books for reference:

1. Grant, E.L(1988), Statistical quality control, Mc-Grawhill publishers, USA.
2. Mood AM, Graybill FA, and Boes, D.C. (1985), Introduction to the theory of statistics, Mc-Grawhill Book Company, New Delhi.

ST 3301: BASIC STATISTICAL TECHNIQUES

Semester: II   **Category: EG**

Hours/Week : 3   **Credits : 1**

Objective: 1) To introduce the basic concepts of statistical methods

                    2) To demonstrate the applications via MS-Excel

Unit 1 Definition and scope of statistics - Construction of frequency table - Diagrammatic representation - Illustrations.

Unit 2 Measures of central tendency - Mean, Median, Mode and Quartiles. Illustrations.

Unit 3 Measures of Dispersion - Mean deviation, Standard deviation, Quartile deviation and Co-efficient of variation. Illustrations.

Unit 4 Correlation and regression - Karl Pearson's correlation co-efficient - Spearman's rank correlation - Regression lines. Applications.

Unit 5 Simple ideas in probability theory - Sample space - Events - Probability of an event. Simple problems.

Books for study:

1. Gupta, S.P.(2011), Statistical methods, Sultan Chand and sons.
2. Kapoor, J.N. and Saxena,H.C(2002), Mathematical Statistics, Sultan Chand and Sons. Pillai.

Books for Reference :

1. R.S.N and Bagavathi,(1984), Practical statistics, Sultan Chand and sons.

ST 3505 - SAMPLING THEORY

Semester III   **Category: MC**

Hours/Week : 6   **Credits : 6**

Objectives: 1) To equip students with Sampling Techniques used in conducting sample surveys.

2) To compare the efficiency of various estimation strategies resulting from

different sampling techniques.

Unit 1 Preliminaries: Sampling Vs Census - Basic concepts of sampling - Population - Parameter - Statistic - Unbiasedness - Mean square error - simple problems.

Unit 2 Simple Random Sampling: Simple random sampling with and without replacement - Estimation of population mean - Variance of estimators - Simple problems.

Unit 3 Stratified Sampling: Estimation of total ,mean - Its variance - Allocation problems - Simple problems.

Unit 4 Systematic Sampling: Linear, Circular. Comparisons for populations with one-dimensional linear trend.

Unit 5 Use of Auxiliary Information.Ratio Estimation.Regression Estimation.

Book for study:

1.   Cochran, W.G.(2009), Sampling Techniques, Wiley Eastern Company Ltd.

Books for Reference:

1.   Murthy,M.N.(1983), Sampling theory and methods, Statistical publishing society,Calcutta.
2.   Sampath,S.(2000), Sampling theory and methods, Narosa publishing house.

ST 3506 - MATRIX AND LINEAR ALGEBRA

Semester III   **Category: MC**

Hours/Week : 3   **Credits : 3**

Objective: 1) To expose students acquaintance with some fundamental notions and techniques of

matrices and vectors

2) To impart mathematical techniques which are required for pursuing core areas of

statistics.

Unit 1 (**Matrix Algebra):** Matrices – Operations on matrices. Various types of matrices. Trace of a square matrix. Determinants,Cofactors,Minors.Properties of Determinants (without proof).Evaluation of Determinants.

Unit 2 (Inversion & Rank): Singular & Non-Singular matrices. Inverse of a matrix – Properties. Rank of a matrix – Properties. Methods of matrix inversion.

Unit 3 (Vectors): Vector space. Linear dependence & Independence.Basis & Dimension.Linear equations – Cramer's rule.

Unit 4 (Linear Transformations) : Linear Transformations & Properties. Matrix of a LT. Orthogonal Transformations.

Unit 5 (Eigen values & Vectors): Characteristic equation, eigen roots & vectors – Properties. Cayley-Hamilton Theorem.Matrix inversion by CH Theorem.

Book for Study:

1. Datta, K. B. (2004): Matrix and Linear Algebra. Prentice Hall of India.
[Chapters & Sections to be covered]

   For Unit 1:   Chapter 1 (Sections 1.1 to 1.4 – Relevant Portions)

   Chapter 2 (Sections 2.2 to 2.4 – Relevant Portions)

   For Unit 2:   Chapter 3 (Sections 3.1 to 3.3 – Relevant Portions) ;

   Chapter 4 (Sections 4.1, 4.2, 4.4, 4.5, 4.7 – Relevant Portions)

   For Unit 3:   Chapter 5 (Sections 5.1, 5.2, 5.6 – Relevant Portions)

For Unit 4:   Chapter 6 (Sections 6.1 – 6.3, 6.5 – Relevant Portions)

For Unit 5:   Chapter 7 (Sections 7.1, 7.2, 7.4 – Relevant Portions)

Books for Reference:

1. Hohn, F.E. (1964): Elementary Matrix Algebra. Amerind Publishing Co. Pvt. Ltd.
2. Shantinarayan (1964): A Textbook of Matrices. Sultanchand& Co, New Delhi

ST 4208 - STATISTICS FOR MANAGEMENT

Semester: IV   **Category:AO**

Hour/Week: 6   **Credits: 4**

Objectives: 1) To expose students to concepts in Business Statistics

2) To teach the applications of Statistics in Management

UNIT - 1: Probability: Definition - Theorems of probability: Addition and multiplication theorem - Conditional probability - Baye's theorem - Probability distributions: Binomial, Poisson and Normal distributions - fitting of Binomial and Poisson distributions.

UNIT - 2: Tests of Significance: Procedure for testing hypothesis - standard error - tests for assigned mean, assigned proportion, equality of means and equality of proportions - small and large sample tests - Chi-square test for independence - Analysis of Variance - one and two way ANOVA only.

UNIT - 3: Index Numbers: Construction of Index numbers - unweighted index numbers - weighted index numbers - Laspeyre's method, Paasche's method, Dorbish&Bowley method, Marshal Edgeworth method, Fisher's method, Kelly's method - quantity index numbers - chain index numbers - base shifting - Splicing and deflating the index numbers - consumer price index numbers - aggregate expenditure method and family budget method.

UNIT - 4: Statistical Quality Control: Control charts - control limits - types of control charts - $\overline{X}$ Chart, R chart, p Chart and c chart - merits and demerits of SQC.

UNIT - 5: Operations Research: Elements of Operations Research - Linear Programming - formulation - solving L.P.P. by graphical method only - transportation problem (North West Corner Rule, Least Cost Method, Vogel's Approximation Method only) - assignment problem - game theory.

Books for study:

1. S. P. Gupta (2011): Statistical Methods, Sultan Chand & Sons Publishers, New Delhi.
2. KantiSwarup, Gupta P. K. and Man Mohan (1996), Operations Research for Management Sultan Chand & Sons (P) Ltd., New Delhi.

Books for reference:

1. Vittal, P. R. (2008): Business Statistics, Margham Publishers, Madras.

2. Grant E .L. (1988): Statistical Quality Control, McGraw Hill Publlilshers, USA.

3. Taha, Hamdy A. (2008): Operations Research, Macmillan Publishing Housing Co.,

New York.

ST 4209 - MATHEMATICAL STATISTICS

Semester IV   Category: AO

Hours/Week : 6   Credits : 4

Objective: 1) To impart statistical concepts and results with rigorous mathematical treatment.

2) To enable the real-life applications of Statistics

Unit 1 Probability: Definition of probability, finite sample space, conditional probability and independence of events. Basic problems.

Unit 2 Random variables: Definition of random variable, distribution function, and expectation. Discrete, continuous and concept of mixture of distributions. Expectation and moments: Moment generating function, Chebyshev's inequality.

Unit 3 Special univariate distributions: Discrete distributions - uniform, binomial and Poisson distributions. Their properties. Continuous distributions - uniform, normal, exponential, beta and gamma distributions.

Unit 4 Joint, marginal and conditional distributions: Trinomial and bivariate normal distribution. Their properties. Correlation and regression. Transformation of random variables. Chi-square, t, and F distributions.

Unit 5 Statistical inference: Random sample - Parametric point estimation unbiasedness and consistence - method of moments and method of maximum likelihood. Tests of hypotheses - Null and Alternative hypotheses. Types of errors. Neyman-Pearson lemma - MP and UMP tests. Illustrations.

Books for study:

1. Hogg ,R.V. and Craig, A.T.(2006), An introduction to mathematical statistics, Amerind publications.
2. Hogg, R.V and Tanis, E.(1989), Probability and statistical inference, Macmillan publishing house, New york.
3. Kapur, J.N. and Saxena,H.C.(1970), Mathematical statistics, Sultan Chand & company, New Delhi.

Books for reference:

1. Mood AM, Graybill FA, and Boes, D.C.(1985), Introduction to the theory of statistics, Mc-Grawhill Book Company, New Delhi.
2. Rao, C.R.(1989), Linear statistical inference and its applications, Wiley eastern company, New Delhi.
3. Rohatgi, V.K.(1976), An introduction to probability theory and mathematical statistics, John Wiley and sons, New York.

ST4210 - ECONOMETRICS

Semester IV   **Category: AO**

Hours/Week : 6   **Credits : 4**

Objective: 1) To equip the students with concepts and techniques of analysing economic

phenomenausing statistical tools.

2) To expose the students to econometrical modelling.

Unit 1 Statistical inference (basic concepts only), random variables, probability distribution, expectation and variance, random sample, sampling distributions, point and interval estimation, hypothesis testing, illustrations.

Unit 2 Role of econometrics, General linear model - matrix representation,

Least - squares estimation, properties of OLSE , two and three variable regression models, illustrations.

Unit 3 Linear hypothesis - hypothesis testing, coefficient of determination. Tests of structural change. Dummy variables. Prediction. Illustrations.

Unit 4 Problems in regression analysis - Multicollinearity, heteroscedasticity,

Auto - correlation, specification error. Tests for heteroscedasticity and auto - correlation. Illustrations.

Unit 5 Generalized least squares, GLS estimator and its properties, Auto - regressive models, lagged variables.

Books for study

1. Gujarati,D.(2007).Basic Econometrics.Mc-Graw Hill, New Delhi.
2. Johnson,A.C,Johnson,M.B and Buse,R.C(1993)., Econometrics- Basic and Applied. Macmillan Publishing Company.
3. Johnston,J(2007).Econometric Methods.Mc-Graw Hill. New Delhi.

Book for reference:

1. Kelejian,H.H and Oates,W.E(1989).Introduction to Econometrics - Principles and applications.Harper and Rower Publishers . Singapore.

ST 4301: PROGRAMMING IN "C"

Semester III   **Category: EG**

Hours/week: 3   **Credit: 1**

Objective: 1) To equip the students with basic principles of "C" language.

2) To expose the students to their real-life applications.

Unit 1 "C" –Character set, constants, variables and arithmetic expressions. Basic structure of a C program. Operators: Arithmetic operators, assignment operator, relational operators, conditional operators, logical operators and special operators.

Unit 2 Pre-processor directives: #define and #include directives. Library functions: mathematical library functions, string-handling functions. Input and output functions: scanf, printf, gets, puts, getchar and putchar functions.

Unit 3 Control statements: decision making statements – if, if … elseif, goto, switch case, break and continue statements.

Unit 4 Loop statement: while, do and for statements.

Unit 5 Arrays: one-dimensional and two – dimensional arrays. User defined functions – examples.

Books for study :

    1.Balagurusamy, E. (2011), ANSI "C" programming, Tata-McGrawhill publishers ltd.

Books for Reference:

    1. Byron Gottfried, (2006). Programming with ""C". Tata- McGrawhill. New York

ST 4503 - ESTIMATION THEORY

Semester IV   **Category: MC**

Hours/Week : 6   **Credits : 6**

Objective: 1) To equip the students with the theory essential for estimation of unknown   parameters.

2) To expose the students to its real-life applications.

Unit 1   Unbiasedness, Consistency - Efficiency - Cramer - Rao inequality - Chapman - Robbin's inequality. Example.

Unit 2 Sufficiency - Factorization theorem - UMVUE - Properties- Completeness.Rao-Blackwell theorem, Lehmann - Scheffe theorem - Examples.

Unit 3   Methods of estimation: Method of moments - Method of maximum likelihood - Method of minimum chi-square, Method of modified minimum chi-square, Properties of MLE(without proof) - Method of least squares - Examples.

Unit 4   Elements of Baye's estimation - Prior and Posterior distributions - Examples.

Unit 5   Confidence intervals for mean when S.D is known and S.D is unknown when the sample is drawn from Normal Population , Confidence interval for Proportion, Confidence interval for difference in means, difference in proportions, Confidence interval of variance and ratio of variances.

Books for study:

1. Hogg, R.V. and Craig, A.T.(2002), Introduction to Mathematical Statistics, Pearson Education(P.Ltd, Singapore).
2. Mood, A.M. Graybill, F.A. and Boes, D.C.(1988), Introduction to the Theory of Statistics, New York; McGraw Hill.
3. Rohatgi.V.K.andSaleh, A.K.Md.E. (2002), An Introduction to Probability and Statistics, John Wiley and Sons, New York.

Books for Reference:

1. Casella, G and Berger,R.L. (1990), Statistical Inference, Wadworth, Inc., Belmont, California.
2. Goon,A.M., Gupta, M.K. amdGupta,B.D.(1987) An outline of Statistical Thoery, Vol.II, The World Press Pvt. Ltd., Calcutta.
3. Kale, B.K.1999, A First Course on Parametric Inference, Narosa Publishing House.
4. Silvey, S.D.(1970), Statistical Inference, Chapmans Hall, London.

ST 4504 – SPREADSHEET APPLICATIONS

Semester IV   **Category: MC**

Hours/Week : 3   **Credits : 3**

Objective: 1) To impart knowledge in Excel Functions and Data Handling

                      2)To train students in Applied Statistics through MS Excel

Unit 1: Overview of MS Excel – Numeric, String and Date Formats – Entering formula in cell, Inbuilt mathematical and Statistical functions and its use

Unit 2: Construction of Bar, Pie, Histogram, Line Chart, Scatter Plot, Usage of Secondary axis in charts, Chi-square test of independence

Unit 3: Sorting - Filtering – Removing duplicates – Conditional formatting – Relative and Absolute Cell reference – Vlookup – Hlookup – Pivot tables – Integration with Data base MS access and Oracle.

Unit 4: Simple Correlation, Simple Regression - Constructing Model - Predicting New Observation - Curve Fitting – Fitting of Binomial, Poisson, Normal

Unit 5: Matrix Operations – Inverse – Solutions of linear of equations – Eigen roots and Vectors

Book for Reference:

1. John Walkenbach. Excel for Windows 95 Bible.

ST 5407 - SQL and PL SQL

Semester : V   **Category: ES**

Hours/Week : 3   **Credits : 2**

Objectives: 1) To create an awareness to database concepts

2) To manage database effectively through SQL and PL/SQL

Unit - 1   Introduction to Database Systems **–** Basic concepts of relational database systems – Database administrator- Data models - Storage management - Entity Relationship model

Unit – 2 Delimiters-   Identifiers-Reserved Words-Predefined Identifiers-Quoted Identifiers-Literals-Numeric   Literals-Character   Literals-String   Literals-BOOLEAN   Literals-Comments-Restrictions   on Comments-Declarations-Constants - Restrictions on Declarations and properties.

Unit - 3 Data Definition Language (DDL) - Data Manipulation Language (DML) - Data Control Language (DCL).

Unit - 4 Programming Languages through SQL. PL / SQL - PL / SQL syntax and constructs - SQL within PL / SQL - DML in PL / SQL - Cursors – Procedures.

Unit- 5: Functions - Packages and Triggers – Merges – Inner joint - Outer joint.

Books for study :

1. Abraham Silberschatz , Henry F.Korth, and S.Sudharshan(2010). Database systems and concepts. Tata McGrawhill Companies Inc., New Delhi.

Book for Reference:

1. Scott Urman, (2002). Oracle PL/SQL programming (The authorized Oracle Press Edition): Osborne McGrawHill, New Delhi.

ST 5409: RELIABILITY THEORY

Semester: V   **Category: ES**

Hours/week: 3   **Credits   : 2**

Objective: 1) To Impart the Statistical concepts underlying Reliability theory
                        2) To discuss several performance measures of systems in industries and related
                            inference problems.

Unit 1 Basic concepts in reliability theory – failure time distribution, reliability, MTBF, hazard rate function, examples, IFR and DFR distributions. Reliability importance of exponential distribution.

Unit 2 types of systems – series, parallel and standby systems of order2.(k, n) systems.Measures of system performance.

Unit 3 Systems with repair, parallel and standby systems of order 2 with a repair facility. Transient solution and measures of performance. Availability and Steady state availability.

Unit 4 Coherent systems – structure function, examples of coherent systems, properties – representation of coherent systems in terms of paths and cuts – reliability of systems of independent components.

Unit 5 Life testing – exponential distribution in life testing. Inference based on Type II censored sample.

Books for Study:

1. Barlow, R.E and Proschan, F. (1981). Statistical Theory of reliability and life testing. Holt, Rienhart and Winston Inc. New York.
2. Rau, J.G. (1970). Optimization and probability in systerms engineering. Van Nostrand.
3. Ross, S.M. (1987). Introduction to probability and statistics for engineers and scientists .John Wiley and sons. New York.

Books for reference:

1. Sinha, S.K (1986). Reliability and life testing. Wiley Eastern Ltd. New Delhi.
2. Zacks, S. (1993). Introduction to reliability anasysis. Springer-Verlag. Germany.

ST 5406 - ACTUARIAL STATISTICS

Semester V   **Category: ES**
Hours/Week : 3   **Credits : 2**

Objectives: 1) To impart basic concepts in actuarial studies

       2) To prepare students to take up a career in Actuarial Practice

Unit –1 Effective Rate of Interest i - Nominal Rate of Interest $i^{(m)}$ - Force of Interest δ - Relationships between different rates of interest - Expression for δ by use of calculus - Present values - Effective rate of discount d - Nominal rate of discount $d^{(m)}$.

Unit - 2 Annuities - Immediate Annuity - Annuity-due - Perpetuity - Accumulation and Present values of Annuities - Increasing and Decreasing annuities - Annuities and interest rates with different frequencies - Continuous Annuities.

Unit - 3 Analysis of Annuity payments - Capital and Interest elements included in the Annuity payments - Loan outstanding after t payments - Purchase price of Annuities - Annuities involving income tax - Purchase price of an annuity net of tax.

Unit - 4 Stochastic Interest rates - Independent annual interest rates - The definition of S_n - Mean and variance of S_n - Definition of A_n - Mean and variance of A_n - Simple problems.

Unit - 5 Probabilities of living and dying - The force of mortality μ_x - Estimation of μ_x - Uniform Distribution of deaths - Select and Ultimate rates.

Books for study :

1. Dixit, S.P., Modi, C.S. & Joshi, R.V. (2002) Mathematical Basics of Life Assurance. Insurance Institute of India, Mumbai.
2. Donald, D.W.A.(1975). Compound Interest and Annuities certain .Heinemann, London.
3. Frank Ayres, J.R. (1983). Theory and problems of mathematics of finance. Schaum's outline series, McGrawHill, Singapore.

Books for reference:

1. McCutcheon J.J. and Scott.(1989). Mathematics of Finance. Heinemann, London. Neill, A (1977). Life Contingencies. Heinemann, London.

ST 5408: APPLIED STOCHASTIC PROCESSES

Semester V   **Category: ES**

Hours/Week : 3   **Credits : 2**

Objective:1) To imbibe Statistical knowledge in Stochastic Process

2) To equip students with elements of stochastic processes with applications in

other disciplines.

Unit – 1 Elements of stochastic processes - definition and examples. Classification of general Stochastic processes.

Unit – 2 Markov Chains - definition and examples. Recurrent and transient states, periodicity. Examples. One-dimensional random walk.

Unit – 3 Basic limit theorem and its applications - Irreducible Markov Chain, Basic limit theorem - examples.

Unit – 4 Stationary distribution of a Markov Chain - existence of a stationary distribution. Illustrations.

Unit – 5 Continuous time Markov Chains - Poisson process - marginal distribution of a Poisson process - Pure Birth process - marginal distribution of a Pure Birth process.

Books for study:

1. Karlin, S. and Taylor, H. M. (1975): A First Course in Stochastic Processes, Academic Press, New York.
2. Feller, W. (1957): An Introduction to Probability Theory and its Applications, Vol. 1 2nd ed., John Wiley & Sons, New York.

Books for reference:

1. Medhi, J. (1994): Stochastic Processes, Wiley Eastern Ltd., New Delhi.
2. Ross, S. M. (1983): Stochastic Processes, John Wiley & Sons, New York.

ST 5508 APPLIED STATISTICS

Semester V   **Category: MC**

Hours/Week : 6   **Credits : 6**

Objective: 1) To expose statistics students to wide genre of study

                  2) To bring out its significant role in various areas of study

Unit 1: Index Numbers :-Basic problems in construction of index numbers.Methods – Simple and WeghtedAggeregate methods, Average of Price Realtives, Chain Base method

Criteria of goodness – Unit test, Time Reversal, Factor Reversal & Circular tests.

Base shifting, Splicing & Deflating index numbers.Wholesale Price index & Consumer price index numbers. Index of industrial production.

Unit 2: Educational & Psychological Statistics

Scaling procedures – Scaling of individual test items, of scores, of rankings & of ratings.

Reliability of test scores – Index of reliability, Parallel tests, Methods for determining test reliability, Effect of test length & ranges on reliability.

Unit 3: Vital Statistics

Uses and Methods of obtaining vital statistics. Rates & Ratios. Measurement of Mortality – Crude, Specific & Standardised death rates.Life Table – Stationary & Stable population, Construction of life tables.Fertitlity – Crude, General, Specific & total fertility rates

Unit 4: Time Series – Trend Component :-

Components of Time Series, Mathematical models of time series. Measurement of Trend Component : Graphic, Semi-Averages, Moving Averages. Least-squares – Straight Line, Second Degree Parabola, Exponential Curve, Modified Exponential Curve, Gompertz Curve, Logistic Curve.

Unit 5: Time Series – Other Components:

Measurement of Seasonal Variations – Simple averages, Ratio-to-trend, Ratio-to Moving average, Link Relative. Deseasonalisation of data.Measurement of Cyclic variations.

Book for Study:

1. Gupta, S.C. &Kapoor, V.K (2007). Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.

Book for Reference:

1. Gupta, S.P. (2011), Statistical Methods. Sultan Chand and Sons Publishers. New Delhi.

ST 5509 REGRESSION ANALYSIS

Semester V   **Category: MC**
Hours/Week : 6   **Credits : 6**

Objective: 1) To introduce the vital area of regression models applicable in a wide variety of situations.

2)To expose the students to the wide areas of its applications.

Unit 1: Introduction to Regression – Mathematical and Statistical Equation – Meaning of Intercept and Slope – Error term – Measure for Model Fit –R^2 – MAE – MAPE – Testing Significance of Model Coefficients, Confidence interval for model coefficients.

Unit 2: Model diagnostics - Mean predicted value, Testing normality of error term, QQ-plot, PP-plot, Anderson Darling, Kolmogrov Smirnov

Unit 3: Introduction to Multiple Linear Regression Model, Partial Regression Coefficients, Testing Significance overall significance of Overall fit of the model, Testing for Individual Regression Coefficients, Estimating R^2, MAE and MAPE

Unit 4: Dummy Variable trap, Study of Interaction Effects, Varying Intercept and Slope using dummy variable, Detection and Removal of Outliers

Unit 5: Study of Normality of Error Term using graphical and testing procedures, Testing for Multicollinearity using VIF, Testing for assumption of Homoscedasticity

Books for Study:

1. Gujarati, D.(2004): Introduction to Econometrics. McGraw Hill, New Delhi.

Books for Reference:

1. Montgomery,D.C. ,Peck E.A, & Vining G.G.(2003). Introduction to Linear Regression Analysis. John Wiley and Sons,Inc.NY

ST 5510 TESTING OF HYPOTHESES

Semester V   **Category: MC**

Hours/Week : 6   **Credits : 6**

Objective: (i)To introduce the concepts of hypothesis testing
                     (ii) To illustrate the concepts with various numerical examples.

Unit – 1 Statistical hypotheses- simple null hypothesis against simple alternative - Best Critical Region. Neyman -Pearson Lemma - Most powerful randomized tests - examples.

Unit - 2 One parameter exponential family - Families with monotone likelihood ratio property - UMP tests for one-sided hypotheses (without proof) - examples.

Unit - 3 Elements of SPRT - Likelihood ratio tests - examples.

Unit - 4 Tests of significance - tests based on normal, t, chi - square and F distributions

Unit - 5 Non-parametric methods - Run test for randomness - sign test for location - Median test - Mann-Whitney - Wilcoxon test - Kolmogorov-Smirnov test - one and two sample problems.

Books for Study:

1. Hogg, R.V. and Craig, A.T.(2002), Introduction to Mathematical Statistics, Pearson Education(P.Ltd, Singapore).
2. Beaumont, G. P. (1980). Intermediate Mathematical Statistics, Chapman and Hall, New York.

3. Gibbons, J. D. (1971). Non-parametric Statistical Inference, McGraw-Hill Kogakusha Ltd., New Delhi.

Books forReference:

1. Rohatgi.V.K.andSaleh, A.K.Md.E. (2002), An Introduction to Probability and Statistics, John Wiley and Sons, New York.
2. Hogg, R. V. and Tanis, E. A. (1983). Probability and Statistical Inference, Maxwell Macmillan international edition, New York.
3. Mood, A. M., Graybill, F. A. and Boes, D. C. (1983). Introduction to the Theory of Statistics, McGraw-Hill, New Delhi.

ST 5511 - STATISTICAL DATA ANALYSIS USING SPSS

Semester V   **Category: MC**

Hours/Week : 6   **Credits : 6**

Objective: 1) To train students in SPSS Software

2) To expose the students to the analysis of statistical data

Unit 1: Data handling: open SPSS data file – save – import from other data source – data entry – labeling for dummy numbers - recode in to same variable – recode in to different variable – transpose of data – insert variables and cases – merge variables and cases.

Unit 2: Data handling: Split – select cases – compute total scores – table looks – Changing column - font style and sizes

Unit 3: Diagrammatic representation: Simple Bar diagram – Multiple bar diagram – Sub-divided Bar diagram - Percentage diagram - Pie Diagram – Frequency Table – Histogram – Scatter diagram – Box plot.

Unit 4: Descriptive Statistics - Mean, Median, Mode, SD- Skewness- Kurtosis. Correlation – Karl Pearson's and Spearman's Rank Correlation

Regression analysis: Simple and Multiple Regression Analysis

[Enter and stepwise methods]

Unit 5: Testing of Hypothesis: Parametric – One sample – Two sample Independent t – test – Paired t – test. Non – parametric: One sample Mann-Whitney u – test – Wilcoxon Signed Rank test - Kruskal Wallis test – Chi- square test. Analysis of variance: One way and Two way ANOVA.

Books for Study:

1. Clifford E.Lunneborg (2000). Data analysis by resampling: concepts and applications. Dusbury Thomson learning. Australia.
2. Everitt, B.S and Dunn, G (2001). Applied multivariate data analysis. Arnold London.

Books for reference:

1. Jeremy J. Foster (2001). Data analysis using SPSS for windows. New edition. Versions 8-10. Sage publications. London.
2. Michael S. Louis – Beck (1995). Data analysis an introduction, Series: quantitative applications in the social sciences. Sage. Publications. London.

ST 6606 - DESIGN AND ANALYSIS OF EXPERIMENTS

Semester VI   **Category: MS**

Hours/Week : 5   **Credits : 7**

Objective: 1) To provide basic principles of experimentation

                      2) To discuss the analysis of data relating to agriculture, biological sciences and industry.

Unit 1 Contrasts - linear constraints - orthogonal contrasts - linear models - fixed effect model - random effect model - mixed effect model.

Unit 2 Principles of experimentation - analysis of variance - one-way classification - two-way classification - two-way classification with more than one observation per cell efficiency of two way over one way.

Unit 3 Completely Randomised Design (CRD) - Randomised Block Design (RBD) - Latin Square Design (LSD) - missing plot techniques.

Unit 4 Factorial designs: 2^2, 2^3 and 3^2 factorial designs; confounding and partial confounding.

Unit 5 BIBD: Intra block analysis of BIBD. Construction of BIBD (Simple construction).

Books for study:

1. Gupta S.C and Kapoor V.K.(2008), Fundamentals of Applied Statistics
2. Montgomery, D.C. (2010), Design and Analysis of Experiments, John Wiley & sons.

Books forreference:

1. Das M.N. and Giri N. (1986), Design and Analysis of Experiments, Wiley Eastern.
2. Kempthorne, O. (1987), Design and Analysis of Experiments, Wiley Eastern.

ST 6607 - OPERATIONS RESEARCH

Semester VI   **Category: MS**

Hours/Week : 5   **Credits : 7**

Objective: 1) To train the students with Optimization techniques towards solving decision

making problems based on deterministic and probabilistic models.

2) To impart an insight of the applications of Operations Research in Management

Unit 1 Introduction to OR - Linear programming problem - Formulation - Graphical method - Basic solution - Optimum solution - Simplex method - Various cases - Unbounded solution - Unrestricted variables, alternative optimum.

Unit 2 Need for artificial variables - Two phase method - Big M method - Primal, Dual relationship - Dual simplex method.

Unit 3 Transportation problem- North-west corner rule – least cost method- Vogel's Approximation Method – Modified Method, Assignment problem.

Unit 4 Networks - CPM and PERT - problems.

Unit 5 Decision under uncertainty - Laplace criterion - Minimax criterion - Savage criterion - Hurvitz theorem - Games - Two person zero sum games - Saddle point - Solving by graphical method - solving by LPP.

Books for study

1. Don T. Philips, Ravindran, A, James J. Solberg (2007), Operations Research: Principles and Practices, John Wiley & sons.
2. Hadley (2006), Linear Programming, Addison - Wesley publishers.
3. Hamdy A. Taha (2008) Operations Research - An Introduction (fourth edition), Macmillan publishers.

Books for reference:

1. Hillier, F.S. and Lieberman, G.J. (1974), Introduction to Operations Research, Holden Day Publishing, San Francisco.
2. KantiSwarup, Gupta, P.K., Manmohan (1993), Operations Research, Sultan Chand Publishers.
3. Mittal, K.V. (1976), Optimization Methods in Operations Research, Wiley Eastern.

ST 6608 - STATISTICAL QUALITY CONTROL

Semester VI   **Category: MS**

Hours/Week : 5   **Credits : 6**

Objective: 1) To provide an insight into quality assessment techniques.

                          2) To provide an insight into the real-life and varied application of the subject.

Unit 1 Quality improvement in the modern business environment: Philosophy and basic concepts of quality improvement - Statistical methods for quality improvement - Total Quality Management (TQM).

Unit 2 Modeling process quality: Describing variation - Histogram, Stem and Leaf plot, Box plot, Frequency distributions, Quantile plot (qq-plot) applications.

Unit 3 Statistical Process Control (SPC): Methods and philosophy of SPC - Control charts for attributes data - p chart, np chart, c and u charts and D chart - Control charts for variables - X and R charts, X and S charts - Applications.

Unit 4 Basic principles of CUSUM and slant control charts - process capability analysis - Applications.

Unit 5 Acceptance sampling: The acceptance sampling problem - Single sampling plan for attributes with applications - Basic concepts of double, multiple and sequential sampling plans - Concept of CSP.

Books for study:

1. Montgomery, D.C. (2007), Introduction to Statistical Quality Control (Third Edition), John Wiley and sons Inc.
2. Duncan, A.J. (2010), Quality Control and Industrial Statistics (Fourth Edition), Irwin, Homewood, Ill.
3. Forrest W. Breyfogle III(1999)- implementing six sigma: smarter solutions using statistical methods, john Wiley and Sons, Inc.

Books for reference:

1. Schilling, E.G. (1982), Acceptance Sampling in Quality Control, Marcel Dekker Inc., N.Y.
2. Grant, E.L. and Leavenworth, R.S. (1980), Statistical Quality Control (Fifth Edition), McGraw Hill, New York.

<u>**SKILL BASED MODULE**</u>

Component 1

ST 6652 - R Language

Semester VI   **Category: SK**

Hours/Week : 9   **Credits : 9**

Objective: 1)To impart efficient Data Handling Techniques

2) To equip students to Statistical Programming Skills based on real life

examples and datasets

Unit 1: Overview of R Environment – R editor – Workspace – Data type – Importing and Exporting Data – Basic Computational Ideas – Merges in R

Unit 2: Matrix Determinant – Inverse – Transpose – Trace – Eigen Values and Eigen Vectors – Construction of Bar, Pie, Histogram, Line Chart, Box Plot, Scatter Plot

Unit 3: Parametric and Non Parametric testing of Statistical Hypothesis – One Sample t test – two group t test – paired t test – one way ANOVA- two way ANOVA – Latin Square Design – Sign Test – Wilcoxon – Mann Witney – Kruskal Wallis

Unit 4: Simple Correlation - Linear Regression – Multiple Linear Regression – Testing for overall significance of Model Coefficients – Testing for Individual Regression Coefficients – Outliers Detection – Dealing with Multicollinearity

Unit 5: Control Charts – Variable Control Chart - $\bar{x}$, R, S. Attribute Control Chart- p, np, c, u. CUSUM Control Chart, EWMA Control Chart, Process Capability Analysis

ST 6652 - SURVEY PRACTICE & REPORTING

COMPONENT 2

Semester VI   **Category: SK**

Hours/Week : 6   **Credits : 6**

Objective: 1) To motivate the students to understand the fundamentals to Sampling Survey

                         2) To enable and motivate the students to perform Statistical Analysis in Sampling Survey

Groups of students are expected to collect Primary Data through Design of Sample Surveys and Secondary Data from various sources, carry out statistical analysis and present a report on their findings. The surveys shall address some of the contemporary issues.

The data analysis needs to be carried out using any statistical package of the students' choice.

Department of Statistics (PG)

Sem	Cate	Code	Title	Hrs	Crs
I	MC	ST 1820	ADVANCED DISTRIBUTION THEORY	5	5
I	MC	ST 1821	APPLIED REGRESSION ANALYSIS	6	6
I	MC	ST 1822	STATISTICAL MATHEMATICS	6	3
I	MC	ST 1823	FUNDAMENTALS OF DATA BASE ADMINISTRATION	6	4
I	MC	ST 1824	STATISTICS LAB – I	6	3
II	MC	ST 2814	ESTIMATION THEORY	5	5
II	MC	ST 2815	TESTING STATISTICAL HYPOTHESES	5	5
II	MC	ST 2816	SAMPLING THEORY	5	5
II	MC	ST 2817	CATEGORICAL DATA ANALYSIS	5	4
II	MC	ST 2818	STATISTICS LAB – II	4	2
II	ES	ST2959	MODERN PROBABILITY THEORY	4	3
II	ES	ST 2960	ACTUARIAL STATISTICS	4	3
III	MC	ST 3815	MULTIVARIATE ANALYSIS	6	5
III	MC	ST 3816	STOCHASTIC PROCESSES	6	5
III	MC	ST 3817	STATISTICAL QUALITY CONTROL	4	3
III	MC	ST 3818	STATISTICS LAB – III	4	2
III	ES	ST 3957	DATA WAREHOUSING AND DATA MINING	4	3
III	ES	ST 3958	NON-PARAMETRIC METHODS	4	3
III	ID	ST 3875	MATHEMATICAL FINANCE MODELS	6	5
IV	MC	ST 4813	APPLIED EXPERIMENTAL DESIGNS	6	5
IV	MC	ST 4814	ADVANCED OPERATIONS RESEARCH	6	5
IV	MC	ST 4815	BIOSTATISTICS AND SURVIVAL ANALYSIS	6	5
IV	MC	ST 4816	STATISTICS LAB – IV	4	2
IV	MC	ST 4817	PROJECTS	8	7

ST 1820 ADVANCED DISTRIBUTION THEORY

Semester I   Category: MC

Hours/Week : 6   Credits : 5

Objectives: 1) To impart knowledge on the construction of statistical models

2) To apply statistical models which are relevant to real life problems

Unit 1: Discrete distributions : Uniform. Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Power series.   Continuous distributions : Uniform, Normal, Exponential, Gamma, Chi-square, t, F, Lognormal, Weibull, Cauchy, Beta, Inverse Gaussian. Characterisations of distributions : Geometric, Normal, Exponential.   Truncated distributions : Binomial, Poisson, Normal.

Unit   2: Multivariate discrete distributions : Trinomial and Bivariate Poisson distribution, their properties, Multinomial and   Multivariate Poisson distributions.

Unit 3: Multivariate continuous distributions : Bivariate normal and Bivariate exponential (Marshall and Olkin) distributions, properties, Multivariate extensions.

Unit 4: Non-central distributions : Non-central Chi-square, Non-central t and Non-central F distributions and their properties. Compound distributions and Mixtures of distributions, order statistics, their distributions and properties.

Unit 5: Quadratic forms in Normal variates, properties of idempotent matrices. Quadratic forms, definiteness of a quadratic form. Generalised inverse (elementary ideas only). Necessary and Sufficient condition for a Quadratic form to be distributed as a Chi-square,Cochran's theorem.

Books for study
1. Hogg, R.V.and Craig, A.T.(2002). Introduction to Mathematical Statistics . Pearson Education, Asia.
2. Johnson, N.L. and Kotz, S.(2004). Distributions in Statistics.Vol. 1 – 4. John Wiley and Sons, New York .
3. Johnson,N.L. Kotz,S and Balakrishnan,N(2004). Discrete Multivariate Distributions. John Wiley and Sons, New York.

Books for reference:
1. Johnson, N.L., Kotz, S. and Balakrishnan, N. (2004). Continuous Univariate Distribution. Vol. 1 John Wiley and Sons,(Asia) Pte.Ltd. Singapore.
2. Johnson, N.L., Kotz, S. and Balakrishnan ,N(2004). Continuous Univariate Distributions Vol. 2. John Wiley and Sons,(Asia) Pte.Ltd. Singapore
3. Johnson, N.L., Kotz, S.and Kemp, A.W (1992). Univariate Discrete Distributions . John Wiley and Sons, New York.
4. Rohatgi, V.K. and Saleh, A.K.Md.E (2002). Introduction to Probability and Statistics, Pearson Education, Asia.

ST 1821 APPLIED REGRESSION ANALYSIS

Semester: I   **Category: MC**

Hours/Week : 6   **Credits : 5**

Objectives: 1) To study linear and non linear relationships between variables.

2) To train students in applications of regression models in real life situations.

Unit 1 Multiple Linear Regression.Estimation of model parameters, Hypothesis testing, Confidence intervals, Prediction, Residual analysis, PRESS statistic, Lack of fit.

Unit 2 Correcting Model Inadequacies. Variance stabilizing transformations, Linearizing a model, Selection of transformation, Generalized and weighted least squares, Indicator variables.

Unit 3 Model Building. Model building problem, Variable selection – Stepwise regression methods, Multicollinearity problem, Diagnostic, Methods for dealing with multicollinearity – Lift curve – KS statistic – Cross validation.

Unit 4 Polynomial and Non Linear Regression. Polynomial regression model in one variable – Piecewise polynomial fitting (Splines), Non-parametric regression, IVM-Linear regression models, Non-linear least squares, Transformation to a linear model, Inference problem in non-linear regression.

Unit 5 Auto correlation, Partial Auto Correlation, Stationarity, Unit Root Test, Non Stationarity in Variance, Random Walk, Random Walk with Drift, Auto Regressive Model, Moving Average Process, ARIMA – Determining Model, Estimation and Forecasting.

Books for Study:

1. Montgomery,D.C.,PeckE.A,Vining G.G.(2003).**Introduction to Linear Regression Analysis**.John Wiley and Sons,Inc.NY
2. Ngai Hang Chan(2002), **Time Series Applications to Finance**, Wiley Series

Books for reference:

1. Draper, N. R. & Smith, H(1998) **Applied Regression Analysis**, 3rd Ed. (John Wiley).

ST 1822 STATISTICAL MATHEMATICS

Semester I   **Category: MC**

Hours/Week : 6   **Credits : 4**

Objectives: 1) To train students in the mathematical foundation for post-graduate studies in

 Statistics.

           2) To expose students the mathematical pre-requisites of statistics

Unit 1: Real Sequences – boundedness , monotonicity , convergence. Operations on sequences.

      Infinite series – convergence – tests for convergence

Unit 2: Real functions – Boundedness, monotonicity , continuity. Differentiable functions – Extreme Values.

Unit 3: Riemann Integrals – Properties – Fundamental theorem. Improper integrals – Tests forconvergence.

Unit 4: Euclidean Spaces – Linear Independence / Dependence – Basis – Dimension. Innerproducts – Orthogonality.

Unit 5: Eigen values and vectors – Quadratic forms – Diagonal forms – Matrix square root. Gram-Schmidt Orthogonalization (Notion only)

Books for Study:

1. Somasundaram,D and Choudhry,B (1999): A First Course in Mathematical Analysis –[Narosa Publishing house]

   Unit – I   : Sections 2.1, 2.3 to 2.8, 3.1 to 3.4, 3.6

   Unit – II : Sections 4.2, 4.3, 4.4, 4.5, 7.1, 7.3, 9.2

   Unit – III : Sections 8.1, 8.3, 8.4, 8.5

2. Franz, E. Hohn (1973): Elementary Matrix Algebra – [Amerind Publishing Co. Pvt. Ltd]

   Unit IV : Sections 5.9 to 5.13, 5.17, 5.19, 5.22, 6.4, 7.2, 7.3, 7.4

   Unit V : Sections 8.1 to 8.4

3. Bellman, R (1974): Introduction to Matrix Analysis – [Tata-McGraw-Hill Publishing Co. Ltd]

    Unit – V : Sections 3.4 to 3.7, 6.5

Books for Reference:

 1.   Chakrabarti, A (2006): A First Course in Linear Algebra – [Vijay Nicole Imprints Pvt. Ltd]
 2.   Burkill, J. C. (1962): A First Course in Mathematical Analysis – [Cambridge University Press]
3. Goldberg, R. R. (1970): Methods of Real Analysis – [Oxford& IBH Publishers]

 4. Hadley, G. (1987) : Linear Algebra – [Narosa Publishing House]

ST 1823 FUNDAMENTALS OF DATA BASE ADMINISTRATION

Semester :I   **Category: MC**

Hours/Week : 6   **Credits : 3**

Objectives: 1) To introduce the concepts and practice of data base administration

2) To demonstrate the purpose of analysing large scale statistical data sets

Unit 1: Client Server Architecture – Three Tier Architecture – Application Server Components – SQL Basics that covers creating database objects, stosing, retrieving and manipulating data in a relational database – Advanced SQL – SQL* Loader

Unit 2: PLSQL fundamentals, language structures, flow of execution and interface with SQL – Stored Procedures, Functions, Packages and Triggers.

Unit 3: Oracle Architectural Components, Creating a database & creating data dictionary – Views and Standard Packages.

Unit 4: Managing Table Spaces – Maintaining Data files, Control files, Redo Log Files – Storage structure and relationships – Managing rollback segments, Tables and indexes, Data Integrity.

Unit 5: Managing Password Security and resources – Users, Roles and Privileges.

Books for study :

1.   Christopher Allen.(2004), ORACLE Database 10g PL / SQL 101. Tata McGrawHill Publishers
2.   Gavin Powell (2005). Beginning Database Design. Wiley Publication Inc.
3.   Ivan Bayross. (2002) SQL, PL?SQL The Programming Language of ORACLE. BPB Publications.

Books for reference:

1. Kevin Loney.(2004) Oracle Databse 10g : The Complete Reference.
2. LakshmanBulusu. (2002) ORACLE PL / SQL Programming. CENGAGE Learning.
3. Rick Greenwald, Robert Stackowiak, Gary Dodge, Daviv Klein, Ben Shapiro, Christopher G. Chelliah (2005). Professional ORACLE Programming. Wiley Publication Inc.

ST 1824 STATISTICS LAB – I

Semester : I   **Category: MC (Practical)**

Hours/Week : 6   **Credits : 3**

Objectives: 1)To expose students on the applications of Statistical Model Building using

R-Programming

2) To develop statistical model building skills through analysing real life problems

Basics of R Programming

- Importing and Exporting Datasets
- Usage of Inbuilt Mathematical, Statistical and Special Functions in R

- Subset Observations , Variables from Datasets
- Creating new variables from existing variables
- Merging Datasets – Inner Joins, Outer Join, Left Outer Join, Left Inner Join
- Coding user defined functions in R Language

Linear and Matrix Algebra

- Linear Dependency and Linear Independency
- Determining Matrix Determinant and Matrix Inverse
- Determining Characteristic Roots and Characteristic Vectors
- Determining Rank, Index and Signature of a Quadratic form

Advanced Distribution Theory

- Fitting of Binomial and Poisson Distribution
- Fitting of Truncated Binomial and Truncated Poisson Distribution
- Fitting of Mixture of Geometric and Poisson
- Fitting of Mixture of Two Poisson
- Generating Samples from Discrete and Continuous Distributions

Applied Regression Analysis

- Building Linear Regression Model with Categorical Explanatory Variable
- Testing for Overall Model fit and Individual Regression Coefficients
- Determining R-Square, Adjusted R-Square, MAE and MAPE
- Study of Interaction Effects among Explanatory variable
- Detection of Outliers by Standardised and Studentized Residuals
- Testing for Multicollinearity using VIF and Conditional Index
- Transformation and Combining Variables to deal Multicollinearity
- Residual Analysis – Testing for Normality of Residuals, Transformation
- Residual Analysis – Testing Functional form of explanatory variables
- Testing for Homoscadasticity, Weighted Least Squares Regression
- Model Validation, Bootstrap Regression Methods

ST 2814 ESTIMATION THEORY

Semester II   **Category: MC**

Hours/Week : 5   **Credits : 5**

Objectives: 1) To provide a strong theoretical foundation to aid in optimal inference strategies.

2) To illustrate the real life applications of estimation procedures.

Unit 1: Problem of point estimation-unbiasedness-uniformly minimum variance unbiased estimator. Necessary and sufficient condition for UMVUE.Properties of UMVUE, Examples.Cramer-Rao inequality.

Unit 2: Sufficiency, Fisher-Neyman factorization theorem, examples. Rao-Blackwell theorem,

Unit 3: Completeness and bounded completeness. Basu's theorem.Lehmann-Scheffe theorem, examples.

Unit 4: Method of maximum likelihood, consistent asymptotic normal (CAN) estimators, examples. Invariance property of CAN estimators.

Unit 5: Baye's and minimax estimation, examples. M-estimation, Jack knife and Bootstrap methods.

Books for study:

1. Kale, B.K.(2005): A first course on parametric inference, Narosa Publishing House.
2. Kendall, M.G and Stuart,A.(1967).The Advanced Theory of Statistics. Vol.2. Inference and Relationship. Hafner Publishing Co., New York.
3. Lehmann,E.L.andCasella,G.(1998).Theory of point estimation. Springer-Verlag

Books for reference:

1. Rohatgi,V.K. and SalehA.K.Md.E.,(2002).An Introduction to Probability and Statistics. John Wiley and Sons,N.Y.
2. Zacks, S. (1971). The Theory of Statistical inference. John Wiley and Sons,N.Y.

ST 2815 TESTING STATISTICAL HYPOTHESES

Semester: II   **Category: MC**

Hours/Week : 5   **Credits : 5**

Objectives: 1) To impart knowledge on techniques for testing of hypotheses towards
 decision support based on sample characteristics.

2) To illustrate the real life applications of testing problems and procedures

Unit 1 Statistical hypotheses, Neyman – Pearson fundamental lemma, distributions with monotone likelihood ratio, Generalization of the fundamental lemma (without proof).

Unit 2 Two-sided hypotheses, Unbiasedness for hypothesis testing.Applications to one-parameter exponential family.Similarity and completeness.

Unit 3 UMP unbiased tests for multiparameter exponential family and applications. Confidence Intervals. Unbiased confidence sets.

Unit 4 Symmetry and invariance, maximal invariants, most powerful invariant tests, unbiasedness and invariance.

Unit 5 Likelihood ratio tests, large sample properties, asymptotic distribution of LRT statistic for simple null hypothesis.

Books for study:

 1.   Kale, B.K.(2005) A first course on parametric inference, Narosa publishing house,   New Delhi.

 2.   Lehmann, E.L. (1986) Testing Statistical Hypotheses, John Wiley and sons, NY.

Books for reference

1. Rohatgi, V.K. and Saleh, E.A.K. Md.(2002)An Introduction to Probability and Statistics, John Wiley and sons, NY

2. Kendall, M.G. and Stuart, A. (1967) The Advanced theory of Statistics, Vol-2, Hafner publishing co., New York.

ST 2816 SAMPLING THEORY

Semester: II   **Category:MC**
Hours/Week: 5   **Credits:5**

Objectives: 1) To impart knowledge on various sampling techniques useful in survey methodology.
2) To demonstrate sampling inspection procedures using sampling techniques.

Unit 1   Introduction to the theory of sampling – sampling designs – estimation procedures – properties of estimators – SRSWOR – properties of SRSWOR –optimal properties of the sample mean.

Unit 2   Sampling with varying probability – procedures for ppsselection –Desraj ordered and Murthy's unordered estimators – HT estimator – optimal properties of HT estimators – estimation of variance of HTE

Unit 3 Stratified sampling – estimation of the population mean – allocation problems. Systematic sampling – Methods for populations with linear trend – Comparison with SRSWOR and stratified sampling for standard populations.

Unit 4 Multi stage sampling- Multi phase sampling - Ratio estimation - approximation to bias and MSE – regression estimation - approximation to bias and MSE - Double sampling for ratio and regression .

Cluster sampling and multistage sampling under SRS methods.

Unit 5 Non-response – effects of non-response,Warner' model, Simmons randomized response technique. Planning and organization of large scale surveys

Books for Study:

1. Cochran W.G .(2000). Sampling Techniques. John Wiley and Sons, New York.
2. Deming, W.E.(2000). Some Theory of Sampling. John Wiley and Sons, New York.
3. Desraj and Chandok,P.(1998). Sampling theory.Narosa Publishing House, New Delhi.
4. Sampath,S.(2005). Sampling Theory and Methods. Narosa Publishing House.

Books for Reference:

1. Murthy.M.N.(1967).Sampling Theory and Methods. Statistical Publishing Society, Calcutta.
2. Sukhatme,P.V., Sukhatme,B.V., Sukhatme,S.and Asok,C. (2000).Sampling theory of Surveys with Applications.Indian Society of Agricultural Statistics, New Delhi

ST 2817 CATEGORICAL DATA ANALYSIS

Semester II   **Category: MC**

Hours/Week : 5   **Credits : 3**

Objectives: 1) To introduce students to the exciting new area of analysis of categorical data

2) To equip students with knowledge and techniques required to handle data-

modeling situations involving categorical data.

Unit 1: Categorical Response data – Inference procedures. Contingency tables – Comparison of proportions, partial association in 2 x 2 and I x J tables. Testing independence in two-way contingency tables.

Unit 2: Generalized Linear Model – For binary data & count data. Inference for & Fitting of GLMs.

Unit 3: Logistic Regression Model – Fitting & diagnostics. Conditional associations in 2 x 2 x K tables. Multinomial logit models – Baseline logit models for nominal responses & Cumulative logit model for ordinal responses.

Unit 4: Loglinear models for two-way tables; Loglinear models for Independence & Interaction in three-way tables. Loglinear - Logit model connection. Diagnostics for checking models.Ordinal Association Models.Probit Models.

Unit 5: Comparison of dependent proportions. Conditional logistic regression for Binary Matched pairs.Marginal models for square contingency tables.Symmetry, Quasi-Symmetry & Quasi-independence.

Book for Study:

1. Alan Agresti (2002): Categorical Data Analysis. John Wiley & Sons

Book for Reference:

1. Hosmer, D.W. &Lemeshow, S. (1989) Applied Logistic Regression (John Wiley).

ST 2818   STATISTICS LAB – II

Semester: II   **Category: MC**

Hours/Week : 4   **Credits : 2**

Objectives: 1)To Provide hands on experience in implementation of concepts in Estimation

theory, Testing of Statistical Hypothesis and Categorical Data Analysis

2) To apply advanced statistical software for relevant applications

Estimation Theory

- Estimation of unknown parameter through MLE Procedure
- Deriving Confidence Intervals for the unknown parameter
- Bayesian Estimation Procedure
- Bootstrap and Jackknife Procedures

Testing of Statistical Hypothesis

- Basic Parametric and Non Parametric Tests
- Determining Test Function, Level and Power of Test Function, Power Curve
- MP Test, Uniformly Most Powerful Test, Uniformly Most Powerful Unbiased test

Sampling Theory

- Simple Random Sampling With and Without Replacement
- Stratified Random Sampling, Midzuno Sampling

- Horwitz – Thompsonn Estimator
- Hansen – Horwitz Estimator
- Desraj Ordered Estimator
- Calculation of Inclusion Probabilities in Fixed and Varying Sampling Designs

Categorical Data Analysis

- Building Binary Logistic Regression Model
- Obtaining Estimated Probability, Optimal Cut Point
- Deriving Classification Table, Sensitivity and Specificity, AUC Measures
- Model Validation through AUC and Gains Chart
- Probit Model
- Multinomial Logistic Regression Model
- Cumulative / Ordinal Logistic Regression Model
- Poisson Regression Model

ST 2959   MODERN PROBABILITY THEORY

Semester : II   **Category: ES**

Hours/Week : 4   **Credits : 3**

Objectives: 1) To impart knowledge in the advanced probability theory

2) To illustrate probabilistic pre-requesites which are required for building statistical

models.

Unit 1: Classes of events: Classes - Fields and σ-Fields; Definition of Probability; Independence of Events, Properties, Discrete, General, and Induced Probability Spaces, Counting, Lebesgue- Stieltjes measures. Distribution Function of a random variable and random vector, Decomposition of Distribution Functions , Independence of Random variables.

Unit 2: Expectation and Moments: Definition and Properties of Expectation-Moments Inequalities, Characteristic Functions – Properties of Characteristic Functions – Inversion Formula. Convergence theorems for Expectations.Conditional Expectation.

Unit 3 : Modes of Convergence of Random Variables : Limits of Random Variables, Convergence in Probability, Convergence Almost Surely, Convergence in Distribution, Convergence in r^{th} mean,

Unit 4 : Laws of Large Numbers: Weak and Strong law of large Numbers

Unit 5: Central Limit Theorem : Central Limit Theorems for Independent Random Variables – Lindeberg – Levy, Liapunov and Lindeberg – Feller Theorems.

Book for Study:

1. Bhat,B.R.(2007) Modern Probability Theory, 3 Ed. New Age International Publishers.,
2. Rohatgi, V.K. and Saleh, A.K.Md.E (2002). Introduction to Probability and Statistics, Pearson Education, Asia.

Books for Reference:

1. Ash,R.B.(1972). Real Analysis and Probability, Academic Press.
2. Billingsley,P.(1991). Probability and Measure. John Wiley & Sons, New York.
3. Loeve,M.(2000). Probability Theory. Van Nostrand, Princeton
4. Parthasarathy,K.R.(1977). Introduction to Probability and Measure. Thomson wadsworth

ST 2960 ACTUARIAL STATISTICS

Semester : II   **Category: ES**

Hours/Week : 4   **Credits : 3**

Objectives: 1) To educate interested students about the applications of statistics in insurance

industry.

2) To compute several measures which are relevant to actuarial statistics.

Unit 1: Compound Interest-Accumulated value and present value annuities certain, present values, amounts, annuities, perpetuities, Redemption of loans.

Unit 2: Further compound interest and Annuities certain, Nominal and effective rates of discount – capital redemption of policies

Unit 3: Mortality tables – construction of mortality tables comparison of different mortality tables.

Unit 4: Life Assurance premiums – Assurance benefits – Life annuities and temporary annuities – Net premiums for assurance plans – Net premiums for Annuity plans-premium conversion table.

Unit 5: Office premiums – policy values – Further life contingencies - methods of valuation – Data for valuation – special reserves and adjustments

Books for Study:

1. Bowers N.L.,.GerberH.U,.Hickman, J.C and Nesbitt, C.J.(2006) Acturial Mathematics, Society of Actuaries, Itasca, USA second edition.
2. Dixit. S.P.Modi .C.S and Joshi R.V. (2000) Mathematical basics of Life Assurance, Insurance Institute of India, Bombay.
3. Donald, D.W.A.(1970) Compound Interest and annuities. Heinemann, London

Books for reference:

1. MccutcheonJ.J.and Scot (1989).Mathematics of Finance, Heinemann, London
2. Neil, A (1977)..Life contingencies, Heinemann, London
3. Spurgeon, E.T(1972) Life Contingencies Cambridge University Press

ST 3815 MULTIVARIATE ANALYSIS

Semester : III   **Category: MC**

Hours/Week : 6   **Credits : 5**

Objectives: 1) To provide students the requisite knowledge and skills to handle multi-dimensional

data and extract useful information from the data.

2) To derive statistical inference based on multivariate statistical analysis

Unit 1 (Basic Preparation): Multivariate Normal distribution – Properties, Distributions of linear combinations, independence, marginal distributions, conditional distributions, Partial and Multiple correlation coefficient. Moment generating function.

Unit 2 (Inference Means of MV normal populations)): Estimation of Mean and Var-Cov matrix. Distributions of Sample correlation coefficient, partial correlation coefficient &Multiple correlation coefficient. The Generalised T^2Statistic – Distribution & Applications.

Unit 3 (Inference for several populations): Paired comparisons & Repeated Measures design, Multivariate ANOVA – One way &Two way. Profile analysis.

Unit 4 (Analysis of Covariance structure): Principal Components. Factor Analysis – Orthogonal Factor model, Factor rotation, Factor scores. Canonical Correlation Analysis.

Unit 5 (Grouping Techniques): Discrimination & Classification – Fisher's method. Optimality of classification rules.Discrimination & classification for several populations. Cluster Analysis – Similarity measures, Hierarchical & Non-Hierarchical methods.

Books for study:

1. Anderson, T. W. (2003): An Introduction to Multivariate Statistical Analysis – 3[rd]edn. John Wiley & Sons.
2. Johnson, R. A., &Wichern, D. W. (2007): Applied Multivariate Statistical Analysis – 2[nd]edn. Prentice Hall International

Books for Reference:

1. Everitt, B.S & Dunn, G (2001): Applied multivariate Dataanalysis, second edition, Arnold publishers, London.
2. Morrison, D.F (1990): amultivariate statistical methods, Third edition, Mc graw hall, New delhi.

ST 3816 STOCHASTIC PROCESSES

Semester : III   **Category: MC**

Hours/Week: 6   **Credits: 5**

Objectives: 1) To introduce the variety of situations that can be handled by the theory of

Stochastic Processes

2) To expose students to several processes in disciplines like Biology, Engineering and

 Economics that are stochastic in nature.

Unit 1: Elements of Stochastic processes – simple examples, Classification of general stochastic processes. Stationary independent increment process. Properties.

Unit 2: Markov Chains – discrete in time.Examples.Classification of states of a Markov Chain.Recurrence.Basic limit theorem of Markov Chains.Absorption probabilities.Criteria for recurrence.

Unit 3: Markov Chains continuous in time.Examples.General Pure birth process, Poisson process, Birth – Death process.Finite state continuous time Markov Chains.Bivariate Poisson process.

Unit 4: Renewal process – Definition and examples, Elementary Renewal Theorem, Martingales – Examples.Super and Sub - martingales.

Unit 5: Branching process – generating function relations, estimation probabilities, two – type branching process – Description of continuous time branching process. Stationary process – mean square distance, prediction and covariance stationary process.

Books for study:

1. Medhi, J(1996). Stochastic Processes, Wiley Eastern Limited.
2. Karlin, S and Taylor, H.M.(1978). A first course in Stochastic Processes. Academic Press, New York.

Books for Reference.

1. Karlin, S and Taylor, H.M.(1981). A second course in Stochastic Processes. Academic Press, New York.
2. Ross, S.M.(1983). Stochastic Processes, John Wiley and Sons.

ST 3817 STATISTICAL QUALITY CONTROL

Semester: III   **Category: MC**

Hours/Week : 4   **Credits : 3**

Objectives: 1) To train students in modern statistical process control techniques.

2) To detect variation in production process and suggests inspection plans

Unit 1: Meaning and Scope of Statistical process control (spc), Shewart Control Charts for X-bar, R, np, p, c charts. and their uses. OC and ARL of control charts.Uses of runs and related patterns of points.

Unit 2: control charts based on C.V. extreme values, moving averages, geometric moving averages, modified control charts

CUSUM procedures, use of V mask, derivation of ARL. Multivariate control charts.

Unit 3: Process capability, tolerance limits, beta content and beta expectation, Normal theory and non-parametric approaches.

Unit 4: Sampling inspection plans. Classification and general properties Sampling plans by variables, estimation of lot defective and plan parameter determination in known and unknown cases. Continuous sampling plans – CSP- 1 and its modifications. Derivation of AOQL for CSP-1, operations of MLP's and Wald- Wolfowitz plans.

Unit 5: Implementing six sigma. Six sigma overview and implementations- smarter six sigma solutions(S^4) measurements : converting defect retes(DPMO or PPM) to six sigma quality levels- six sigma relationships- six sigma assumptions- S^4 assessment- basic control charts and S^4 assessments- examples.

Books for study :

1. Duncan A.J. – Quality Control and Industrial Statistics (2010), 2nd edition, Homewood,
2. I. Grant, E.L. and R.S. Leaven worth (2004)- Statistical Quality Control, 2nd edition, Mc-Graw Hill Book Co.
3. Montogomery D.C (2007).- Introduction to Statistical Quality Control, John Wiley
4. Shilling, E.G.(2010) – Acceptance Sampling in Quality Control, second edition,A Chapman & Hall book.
5. Juran, J.M. and Gryana, F.M (2008).-Quality planning and analysis, Tata Mc-Graw Hill.

Books for reference:

1. Wetherill, G.B. (1977) - Sampling Inspection and Quality Control, Halsted Press, N.Y.Ott, E.R.-Process QualityControl, Mc-Graw Hill.
2. Forrest W. BreyfogleIII(1999)- Implementing Six Sigma: Smarter solutions using statistical methods, John Wiley and Sons, Inc.

ST 3818 STATISTICS LAB – III

Semester : III   **Category: MC (Practical)**

Hours/Week : 4   **Credits : 2**

Objectives: 1) To enable students to use statistical packages for analyzing Multivariate Data,

Stochastic process and Quality Control.

2) To expose students to interpret the output and provide recommendations

Multivariate Analysis

1. Computation of Means, Variances, Covariance and Correlations from a Multivariate dataset.
2. Computation of Partial correlation coefficients from the Var-Cov matrix of a multivariate normal population.
3. Computation of Multiple Correlation coefficients from the Var-Cov matrix of a multivariate normal population.
4. Tests for significance of correlation coefficient using samples from multivariate normal populations– Simple Correlation, Partial correlation and Multiple correlation coefficients.
5. Applications of T^2 Statistics to different situations – Test for mean of a single MV normal population, Test for equality of mean vectors of two MV normal populations with equal var-cov matrices & unequal var-cov matrices, Special Applications.
6. MANOVA – One-way & Two-way models.
7. Principal component analysis.
8. Factor Analysis
9. Canonical Correlation Analysis
10. Fishers Discriminant Analysis – Two populations, several populations. Classification with Prior Probabilities.
11. Cluster Analysis – Hierarchical method with different linkages, K-Means method.

Statistical Process Control

1. Control Chart for Attributes – p-chart, np- chart, c-chart, u-chart.
2. Control charts for variables – $\overline{X}$-chart, R-chart, S-chart.
3. Process capability computations.
4. Special charts – Moving range chart, CUSUM charts, Exponentially Weighted Moving Average charts.
5. OC Curves for various charts.
6. Single Sampling Plan – OC curve, AOQ curve, ATI curve.
7. Double Sampling Plan – OC curve, ASN curve, AOQ curve, ATI curve

Stochastic Process:

1. Determination of P^n for a transition probability matrix.
2.   Determination of stationary distribution.
3. Generating a Poisson process; waiting time distribution.
4. Extinction probability in a branching process.

ST 3957   DATA WAREHOUSING AND DATA MINING

Semester : III   Category: ES

Hours/Week : 4   Credits : 3

Objectives: 1) To recourse knowledge discovery through database which leads to Business
        Intelligence.
        2) To illustrate the applications of data warehousing and data mining in statistical
        tools

Unit 1 : Data Warehouse Basics: Definition of a Data Warehouse - Basic Elements of the Data Warehouse - Data Warehouse and OLTP Database Design, Differences - Data Warehouse Features - Manage Data, Decision Support System (DSS) - Data Warehousing Process - Comparing Warehouses and Data Marts - Dependent Data Mart Model - Independent Data Mart Model - Enterprise Model Architecture. Defining the Business and Logical Models: Documenting Business Measures and Documenting Business Dimensions Creating the Metadata -Designing the Dimensional Model: Data Warehouse Database Design Objectives - Data Warehouse Data Types - Star Dimensional Modeling - Fact Tables - Dimension Tables

Unit 2 : Translating Business Dimensions into Dimension- Star Dimensional Model Characteristics - Snowflake Model - Designing the Physical Model - Translating the Dimensional Model into a Physical Model.-Storage Considerations for the Physical Model- Database Sizing - Estimating the Database Size - Indexing Types - B*tree Index, Bitmap Indexes - Partitioning Tables and Indexes, Strategies for Extracting, Transforming, and Transporting: Extraction – Transformation - and Transportation Process (ETT) - Data Staging Area - Extracting Data , -Examining Source Systems – Mapping - Designing Extraction Processes - Designing Transformation Processes and ETT Tools

Unit 3 : Naive Bayes Classification Method, Bayesian Networks, Path Analysis, Back Popagation Algorithm, Building Predictive Model using Artificial Neural Network, Support Vector Machine, Decision Tree Methods - Classification Tree, Regression Tree, Decision tree based on Statistical Significance - Chi Square Automated Interaction Detector(CHAID). Comparing Classifier Accuracy.

Unit 4 : Construction of Gains Chart, ROC Curve, Leave one out validation and N fold validation, ConstructionofLogit Model Tree, K th Nearest Neighbourhood Classification, Bagging and Boosting Principles, Adaptive Boosting Algorithm, Decision Stumps and Random Forest, Apriori Algorithm and Association Rule Mining

Unit 5 : Additive Regression, Logit Boost, Multi Class Classifier, Ordinal Class Classifier, Expectation Maximization Algorithm, Genetic Algorithm, Combining Classifiers, Cost Sensitive Classifier, Text Mining – Methods and Models

Books for Study:
1. Anahory S, Murray D(2001) Data Warehousing In The Real World: Practical Guide For Building Decision Support Systems, Addison Wesley.
2. Han J and Kamber M (2002) , Data Mining concepts and Techniques, Morgan Kaufmann Publishers (Only relevant sections)**,** SRI ESWAR ENTERPRISES

Books for Reference:
1. Pieter Adriaans and DolfZantinge (2000), Data Mining, Addison Wesley**.**
2. PujariA..K (2001) Data Mining Techniques, University Press, Hyderabad.

ST 3958 NON-PARAMETRIC METHODS

Semester : III   Category: ES
Hours/Week : 4   Credits : 3

Objectives: 1) To explore knowledge in the advanced methods of non-parametric inference.

2) To derive inference for samples drawn from distribution free population

Unit 1: Introduction, Run test for randomness.χ^2 goodness of fit test.Kolmogrov – Smirnov one sample test, .Kolmogrov – Smirnov two sample test , Binomial test , Point estimator and confidence interval for probability of success.

Unit 2: One sample location problems – Wilcoxon signed rank test.Fishers sign test. Asymptotic test of symmetry – Estimators and confidence interval.

Unit 3: Two sample problems – Wilcoxon rank sum test for location parameter (Mann – Whitney).

Test for dispersion parameter – Rank test , Rank like test (Moses) ,Millers asymptotic test based on Jackknife .

Unit 4: One way layout – Kruskal Wallis test. Test for ordered alternatives , Multiple comparison based on Kruskal Wallis rank sums .Two way layout - Friedman's rank sums test. Test for ordered alternatives , multiple comparisons.

Unit 5: Kendals test for independence. Theil's test for regression coefficients .Hollander's test for parallelism of two regression lines.

Books for Study :

1. Gibbons (2003), Non parametric Statistical Inference,McGraw –Hill Kogakusha, Ltd.
2. Hollander Myles & Wolfe D.A.(1973) , Non parametric Statistical Methods, John Wiley & Sons.

Book for Reference:

1. Rohatgi.V.K. (2011), An introduction to probability theory and Mathematical Statistics, John Wiley & Sons.

ST 3875 MATHEMATICAL FINANCE MODELS

Semester: III   **Category: ID**

Hours/Week : 6   **Credits : 5**

Objectives: 1) To expose the students of Statistics to the different aspects of Finance and

       modeling of Finance phenomena.

       2) To enable appropriate decisions and actions in finance matters.

Implementation: The topics under 'Deterministic Ideas' to be taught by Mathematics Faculty and those under 'Stochastic Ideas' to be taught by Statistics Faculty.

Unit 1: Deterministic Ideas – Introduction to Finance & Securities; Interest rates; Present value analysis; Rate of return; Continuous varying interest rates.

Stochastic Ideas – Brownian & Geometric Brownian Motion; The Arbitrage Theorem; Multiperiod Binomial model.

Unit 2: Deterministic Ideas – Options Pricing; Pricing via Arbitrage; The Delta Hedging Arbitrage Strategy;**Stochastic Ideas**– Black-Scholes Formula; Properties of Black-Scholes Option Cost.

Unit 3: Deterministic Ideas – Call options on Dividend-Paying Securities; Limitations of Arbitrage Pricing; Valuing investments by Expected Utility.**Stochastic Ideas**– Adding jumps to GB Motion; Estimating the Volatility Parameter; Portfolio selection problem.

Unit 4: Deterministic Ideas – Capital Assets Pricing Model; Deterministic Optimization Model.

Stochastic Ideas – Value at risk & Conditional value at risk; Mean Variance analysis of Risk-Neutral-Priced Call Options; Rate of return: Single Period and GB Motion.

Unit 5:Deterministic Ideas – Exotic options; Barrier Options; Monte Carlo Simulation; Pricing Exotic Options by Simulation. **Stochastic Ideas** – Probabilistic Optimization Problems; Efficient Simulation Estimators; Options with non-linear payoffs; Pricing Approximations via Multiperiod Binomial Models.

Book for study:

1. Sheldon M. Ross (2003): **An Elementary Introduction to Mathematical Finance.** Cambridge University Press.

ST 4809 APPLIED EXPERIMENTAL DESIGNS

Semester : IV   **Category: MC**

Hours/Week : 6   **Credits : 5**

Objectives: 1)To provide both basic and advanced experimental designs applied in Agriculture,

   Pharmaceutical, Industrial and Biological sciences.

   2) To derive solutions for statistical inference problems

Unit 1: Review of Linear models – Block Design, C-matrix and its properties- Analysis of block design – (CRD) completely Randomized design – (RBD)- Randomized Block Design – (LSD)- Latin Square Design – (RLSD) Repeated Latin Square Design – Missing plot techniques – ANOCOVA.

Unit 2: Factorial Design – 2^n; 3^n factorial designs. Finite fields and design of experiments. Partial confounding and complete confounding – confounding in more than two blocks. Fractional factorials – construction and analysis-concept of resolution plans.

Unit 3: Asymmetrical factorial designs (AFD)- AFD- confounded asymmetrical factorial design construction of balanced confounded asymmetrical factorials-split and strip-plot experiment.

Unit 4: Incomplete block designs – varietal Trials – incomplete block design balanced incomplete block designs (BIBD) construction of BIBD – analysis of BIBD, Youden square design – Lattice designs. Partially balanced incomplete block design (PBIBD) – analysis and construction of PBIBD - Group divisible- simple- triangular- Latin square type and cyclic PBIBD.

Unit 5: Orthogonal Latin square – maximum number of orthogonal Latin squares – construction of orthogonal Latin squares – construction of BIBD using orthogonal Latin squares. Response surface designs- definition of response surface design – first order and second order response surface design.

Books for study:

1. Das, M.N. and Giri,N. (2008). Design and Analysis of Experiments, Wiley Eastern.
2. Federer, W.T. (1993). Experimental Designs – Theory and Applications, McMillan.

Books for reference:

1. Joshi,D.D (1987). Linear estimation and design of experiments. Wiley Eastern.
2. Kempthorne, O. (2000). Design and Analysis of Experiments, Wiley Eastern.
3. Montgomery, D.C.(2012) Design and Analysis of Experiments, John Wiley & Sons.

ST 4814 ADVANCED OPERATIONS RESEARCH

Semester IV   **Category: MC**
Hours/Week : 6   **Credits : 5**

Objectives: 1)To introduce students the statistical and mathematicalformulations for handling a range

 of business based problems.

        2) To develop a broad appreciation of different types of decision-making environments.

Unit 1: General Linear programming problem-Formulation- Solution through Graphical, Simplex, Big-M and Two phase Methods – Duality in Linear programming – Goal programming problem.

Unit 2: Non-linear programming-Kuhn Tucker theorem- Lagrangian multipliers method-Wolfe's and Beale's algorithm for solving Quadratic programming problems.

Unit3: Inventory control: Deterministic Models – Economic Order Quantity – Problems with no shortages – The fundamental EOQ Problems, EOQ problems with several production runs of unequal length – Problems with price breaks – One price break, More than one price break - Probabilistic models – Single Period Problem without set-up cost – I and II.

Unit 4: Queuing theory- (M/M/1): (GD/∞/∞), (M/M/1): (GD/N/∞), (M/M/C): (GD/∞/∞), (M/M/C): (GD/N/∞).

Unit 5: Integer Programming-Branch and Bound and Cutting plane methods- Dynamic Programming - Solution of LPP by DPP. Simulation- Formulating and Implementing a Simulation model.

Books for study:
1. Hiller, S.F. and Lieberman J.G. (2000)- Operations Research, CBS Publishers & Distributors, New Delhi.
2. Hadley, G. (1997)- Non-Linear Programming and Dynamic Programming, Addison- Wesley, New York.
3. Nirmal Singh Kambo (1982)- Mathematical Programming Techniques, East-West press.

Books for reference:

1. Philips, D.T. and Ravindra, A.& Solberg, J. (1976)- Operation Research, Principles &Practice, John Wiley, New York**.**
2. Taha, H.A. (1999) – Operations Research-An Introduction, Macmillan Publishing, Company, New York.
3. Wagner (1973)- Principles of Operations Research: with applications to managerial decisions, Prentice Hall of India, New Delhi.

ST 4815 BIOSTATISTICS AND SURVIVAL ANALYSIS

Semester : IV   **Category: MC**

Hours/Week : 6   **Credits : 5**

Objectives: 1) To develop sound judgment about data applicable to clinical care

2) To emphasize study design and interpretation of results of medical research

Unit 1: Introduction to Medical research – Study Designs – Observational studies; Experimental Studies & Clinical trials; Meta Analysis, Research questions about mean of a group & proportions in a group. Repeated measures design – Paired comparison of means; Kappa statistic; McNemar test. Sign test for median; Wilcoxon Signed Rank test.

Unit 2: Research questions about means and variances of two groups; Levene test; Wilcoxon Rank Sum test. Decisions on proportions in two groups – z-test; Chi-Square test.Diagnostic Procedures with Threshold model. Measuring the accuracy of diagnosis – Sensitivity, Specificity; ROC curve.

Unit 3: Analytical Estimation procedures for survival distributions- The Exponential Distribution, Weibull Distribution, Lognormal Distribution, Gamma Distribution. Hazard Plotting. Relative, Corrected Survival Rates, Standardised Rates and Ratios.

Unit 4: Kaplan Meier Survival Curve, Life Table Analysis, Comparison of Survival Distribution – Log Rank Test for comparing two groups, Log rank test for comparing n-groups.

Unit 5: Cox Proportional Hazard Model, Meaning of PH Assumption, ML Estimation of Cox Proportional PH Model, Adjusted Survival Curves using Cox PH Models, Evaluating the Proportional Hazard Assumption – Graphical Approach, Goodness of fit test approach,

Book for Study and Reference:

1. Dawson, Beth & Robert G. (2001): Basic & Clinical Biostatistics. McGraw-Hill

2. Daniel, Wayne W. (1995): Biostatistics: A Foundation For Analysis in the Health Sciences – 6[th]edn. John Wiley & Sons.

Book for Reference:

1. David G.Kleinbaum (1996): Survival Analysis, Springer

2. Elisa.T.Lee (1992) Statistical Methods for Survival Data Analysis , 2e, John Wiley and Sons

ST 4816 STATISTICS LAB – IV

Semester : IV   **Category: MC (Practical)**

Hours/Week : 4   **Credits : 2**

Objectives: 1)To Provide Practical Knowledge in Analysing problems in Design of

Experiments,Operations Research, Biostatistics and Survival Analysis

2) To demonstrate hands on experience for problems using statistical software

Design of Experiments

- Complete Randomized Design, Randomized Block Design, Latin Square Design
- Balanced Incomplete Block Design, Split Plot Design
- Factorial Design - 2^2, 2^3, 2^4 , 3^2, 3^3, 3^4
- Construction of Contours, Response Surface Methods.
- ANOCOVA

Advanced Operations Research

- Graphical Method, Simplex Method - Linear Programming Problems
- Branch and Bound , Cutting Plan Method – I.P.P
- Queueing Theory – (M|M|1) : (GD|∞|∞), (M|M|1);(GD|N|∞),

  (M|M|C): (GD|∞|∞), (M|M|C): (GD|N|∞)
- Wolf's Algorithm – Beales Algorithm

Biostatistics and Survival Analysis

- Paired comparison of means; Kappa statistic; McNemar test. Sign test for median
- Wilcoxon Signed Rank test, Levenetest,Wilcoxon Rank Sum test,Chi-Square test
- Survival Function, Hazard Function, Kappa Statistic, Relative Risk, Likelihood Ratio
- Odds Ratio, Sensitivity and Specificity, Mortality Rates, Adjusted Rates,
- Kaplan – Meier Survival Curves, Life Table Method
- Log Rank Test, Wilcoxon Test, Likelihood Ratio Test
- Cox Proportional Hazard Model, Cox Model with time dependent Covariates