COURSES OF STUDY
MA/M.Sc. STATISTICS
(2018-2020)

POST GRADUATE DEPARTMENT OF STATISTICS (AUTONOMOUS)
SAMBALPUR UNIVERSITY, JYOTI VIHAR
BURLA- 768019, ODISHA

OUTLINE OF COURSE STRUCTURE
MA/M.Sc. STATISTICS (Session: 2018-20)

Subject Code	Title of the Course	Credit Hours
I SEMESTER		
MSC 411	Mathematical Analysis	**4 CH**
MSC 412	Statistical Method-I	**4 CH**
MSC 413	Probability-1	**4 CH**
MSC 414	Linear Algebra And Numerical Analysis	**4 CH**
MSC 415	Data Structure and programming in C	**4 CH**
MSC 416	Laboratory in Data Structure and Programming in C	**2 CH**
	Semester Total	**22 CH**
II SEMESTER		
MSC 421	Statistical Methods-Il	**4 CH**
MSC 422	Statistical Inference-I	**4 CH**
MSC 423	Sampling Methods	**4 CH**
MSC 424	Applied Statistics	**4 CH**
MSC 425	Probability-II	**4 CH**
MSC 426	Laboratory in Statistical Methods, Sampling and Applied Statistics	**2 CH**
	Semester Total	**22 CH**
III SEMESTER		
MSC 511	Optimization Technique-I	**4 CH**
MSC 51 2	Statistical Inference-II	**4 CH**
MSC 513	Discrete Mathematical Structure	**4 CH**
MSC 514	Stochastic Modeling	**4 CH**
MSC 515	Statistics Laboratory on Computer (SPSS)	**2 CH**
MSE516( )	Special Paper- (anyone)	**4 CH**
	Semester Total	**22CH**
IV SEMESTER		
MSE 521	Time Series & Forecasting	**4 CH**
MSC 522	Multivariate Analysis	**4 CH**
MSC 523	Design and Analysis of Experiment	**4 CH**
MSC 524	Project and Viva Voce	**6 CH**
MSC 525	Practical and Viva Voce	**2 CH**
MSE 526( )	Special Paper-II (anyone)	**4 CH**
	Semester Total	**24 CH**
GRAND TOTAL		**90CH**

POST GRADUATE DEPARTMENT OF STATISTICS (AUTONOMOUS)
SAMBALPUR UNIVERSITY
M.A/M.Sc STATISTICS COURSES OF STUDY FOR 2018-2020

SPECIAL PAPERS

(In each of 3rd & 4th Semester one Special paper has to be chosen from the following list)

Subject code	Title of the course	Credit Hours
A	Advanced Stochastic Process	4CH
B	Computer Graphics	4CH
C	Statistical Quality Control and Reliability	4CH
D	Population Studies	4CH
E	Queuing Theory	4CH
F	Statistical Ecology	4CH
G	Stochastic Inference	4CH
H	Statistical Genetics	4CH
I	Data Ware Housing and Data Mining	4CH
J	Optimization-II	4CH
K	Pattern Recognition	4CH
L	Cryptography	4CH

Academic Programme

First Semester Examination	December 2019
Second Semester Examination	June 2020
Third Semester Examination	December 2020
Fourth Semester Examination	June 2021

PROGRAMME OUTCOME

PO-1	**Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions
PO-2	**Effective Communication:** Will be able to speak, read, write and listen clearly in person and through electronic media in English and in one Indian Language
PO-3	**Social Interaction (Interpersonal Relation):** Elicit views of others, mediate disagreements and prepared to work in team
PO-4	**Entrepreneurship Capability:** Demonstrate qualities to be prepared to become an entrepreneurship
PO-5	**Ethics:** Recognize different value systems including your own, understand the moral dimensions and accept responsibility for them
PO-6	**Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development
PO-7	**Life-Long Learning:** Acquire the ability to engage in independent and life-long learning in the context of socio-technological

MA/MSc. STATISTICS
SEMESTER-I

MATHEMATICAL ANALYSIS

MSC-411 **4CH**

Objective: To introduce fundamental concept of Mathematical analysis such as sequence, series of real numbers and their convergence, continuity, differentiability of real valued functions.

CO-1	Remember and understand the basic concepts/Principles of Mathematical Analysis
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Sequences, subsequences, convergence, divergence, bounded sequences, limits superior and inferior, monotone sequences, Cauchy sequences, completeness, Series of real numbers.

Unit-II
Bounded and unbounded subsets of the line, intervals, closed and open sets, characterizations, limit points, closures, interiors. Denseness. Compact sets. Heine-Borel Theorem, BolzanoWeierstrass Theorem.

Unit-III
Functions: limits, continuity, uniform continuity, intermediate value theorem, Differentiability; Chain rule, mean value theorem, Taylor's theorem (statement), extreme, Multivariate calculus: partial, directional and total derivatives mean value theorem, Gamma function and Beta function, Multiple integrals, change of variables, Jacobian formula.

Unit- IV
Algebra of complex numbers, operations of absolute value and conjugate, standard inequalities for absolute value, concept of analytic functions via power series and differentiability methods, Exponential and logarithmic functions, trigonometric functions of a complex variable, complex line integral, Cauchy integral formula, Holomorphic functions, Laurent Series, Singularity, calculus of residues, evaluation of integration using contour integration.

Books Recommended

l. Bartle G.R. & Sherbert D. R. (2000): Introduction to Real Analysis- John Wiley & Son Inc.
2. Royden (1988): Principles of Real Analysis - Macmillian.
3. Widder (1989): Advanced Calculus - Dover Publication.
4. W, Rudin (2013): Real and Complex Analysis, Tata Mc-Graw Hill. 5. E. M. Strein, R, Shakarchi (2003): Complex Analysis, Princeton University Press.

STATISTICAL METHODS-I

MSC-412 **4CH**

Objective: To learn scientific view to conduct the survey in proper way to collect the data about specific perspective. To learn how to develop regression model and apply for the specific perspective data appropriate manner. To present the general theory of statistical distributions as well as the standard distributions found .

CO-1	Remember and understand the basic concepts/Principles of Statistical Methods-I
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Introduction to different measures such as measures of location, dispersion and skew ness, Basic concept of discrete and continuous probability distributions and their properties. Basic discrete distributions:- Bernoulli, Binomial, Poisson, Negative Binomial, Uniform and Hyper geometric distributions, Computations of their moments , means , Variances and Beta-l and Beta-2 coefficients, recurrence relations between moments, M.G.F. and C.F. Basic continuous distributions: - Uniform and lognormal, Beta, Gamma, normal distributions their properties and applications. Computation of their M.G.F., C.F. and Moments.

Unit-II

Analytical Statistics: - Bivariate data, Scatter diagram, Simple correlations and linear regression. Their properties and applications. Curve fitting, linear and second degree curve and their applications. Associations of attributes: - Contingency table and coefficients of contingency and their interpretations.

Unit-III

Random vectors, joint distribution, joint M. G.F., Independence of random variables. Multinomial distributions and its mean vector and variance and co-variance matrix, bivariate normal distributions, conditional expectation and conditional variance. Its marginal and conditional distributions.

Unit-IV

Sampling distributions of Statistics: sampling distribution of functions of independent observations from univariate normal distributions such as linear and quadratic functions, Derivations of Chi- square, t and f distributions and their applications

Books Recommended:¬

(1) Yule, G.U and Kendall; M.G. (1953):- An introduction to theory of statistics,Charles Griffin.
(2) Rohategi; VK. and others: - Introduction to theory and Mathematical statistics,Wiley.
(3) Roo; C.R. (1975):- Linear Statistical inference and its applications; Wiley.

PROBABILITY-I

MSC-413 **4CH**

Objective: To understand the uncertain occurrence situations with logical manner.

CO-1	Remember and understand the basic concepts/Principles of Probability-I
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Algebra of sets, Fields and Sigma fields, Llimits of sequence of subsets, Sigma field generated by a class of subsets, Borel fields. Probability space, continuity of probability measure.

Unit-II

Sample space, Probability axioms, Conditional probability, Independence of events. Bayes' theorem, Real and vector valued random variables, Distribution function, Discrete and continuous random variables, Distribution of L.V.S. Marginal and conditional distribution. Independence of random variables.

Unit-III

Poisson theorem, Interchangeable events and their limiting properties, Expectation of a random variable. Linear properties of expectations. Conditional expectation, Moment generating function. Moment inequalities. Characteristic function and its properties.

Unit-IV

Convergence of a sequence of random variables, Convergence in distribution, Convergence in probability, Almost sure convergence and Convergence in quadratic mean and their interrelations. Monotone and dominated convergence theorem, Central limit theorem: Lindberg-Levy and Demoivre-Lapalce theorem.

Books Recommended:

1. Bhat, B.R. (1985): Modern probability theory (Wiley).
2. Billingsley, P. (1986): Probability and measure (Wiley).
3. Feller, W. (1969): Introduction to probability theory and applications, Vol . II (Wiley)
4. Rohatgi, V.K. (1976): Introduction to theory of probability and mathematical Statistics (Wiley).
5. H.G.Tucker(1967) : A graduate course in probability theory (AP)
6. Y.S.Chow and H Teicher(1979) : Probability theory (Springer-Verlag),

LINEAR ALGEBRA AND NUMERICAL ANALYSIS

MSC- 414 **4 CH**

Objective: To learn the basic ideas of abstract algebra and techniques with proof in pure mathematics and further, it can be use in many other courses. To provide the numerical methods of solving the non-linear equations, interpolation, differentiation, and integration.

CO-1	Remember and understand the basic concepts/Principles of Linear Algebra and Numerical Analysis
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Vector Spaces, Subspaces. Linear independence, Basis, Dimensions, Calculus of subspaces, Algebra of matrices, Operation on matrices, Properties of matrix, operation and special structure. Rank ,row space,column space and inverse of a matrix. Rank factorization and rank of a sum and projectors. Elementary operation, Echolon, normal and Hermite canonical forms, linear equations.

Unit-II

Inner product, norm, orthogonality and orthogonal basis.Characteristic roots of real matrices, right and left characteristic vectors, Eigen values and Eigen vectors. Independence of characteristic vectors corresponding to distinct characteristic roots. Generalized inverse. Definition of a real quadratic form, Classification of quadratic forms.

Unit-III

Root finding using Newton-Raphson, Secant, Regula-Falsi methods and their convergence, Newton's method for system of nonlinear equations. Interpolation - Newton's formulae, Lagrange, Hermite, Spline interpolation with error analysis. Numerical differentiation.

Unit-IV

Numerical integration - Newton-Cotes formulae - open and closed type -Trapezoidal, Simpson and Weddle rules, Gaussian quadrature formulae -Gauss-Laguerre, Gauss-Hermite integration, Transcendental Algebraic equations- Gauss elimination, Jacobi, Gauss-Seidel, relaxation methods and their convergence.

Books Recommended:

1. Rao, A.R. and Bhimasankaram,P .(2000): Linear Algebra, Hindustan Book Agency, New Delhi.
2. Scoule, S.R. (1982): Matrix Algebra Useful for Statistics, John Wiley & Sons.
3. Rao, C.R. (1995): Linear Statistical Inference and its Applications (Wiley Eastern).
4. Hohn, F .E. (1973): Elements of Matrix Algebra, McMillan.
5. M.K. Jain, S.R.K. Iyengar, R.K. Jain (1995): Numerical Methods for Scientific and Engineering Computation, Willey Eastern Ltd, New Delhi.

DATA STRUCTURE AND PROGRAMMING IN C

MSC-415 **4CH**

Objective: To teach programming (with an emphasis on problem solving) and introduce elementary data structures.

CO-1	Remember and understand the basic concepts/Principles of Data Structure and Programming in C
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Introductory concepts, C fundamentals, Data types, Constant and variables, Operators, Operations and Expression, Data input and output, Control statements, Loops, Do loop, Do While Loop, For Loop, Switch case statement, break and continue statement

Unit-II

Overview of Functions, built in and user defined functions, recursive function, Function call by value and call by reference, Arrays and it's applications, Strings, Pointers, Structures and Unions, Data Files.

Unit-III

Time and space complexity of algorithm, Representation of stack and queue using arrays and it's operations, Conversion of Infix to Postfix expression, Evaluation of Postfix expression using stack. Single linked list and it's operations, Doubly linked list and it's operations

Unit-IV

Binary Tree representation, Binary Tree traversal methods and it's algorithm, Binary search tree and it's operations, Graph representation, Adjacency matrix, Depth first search, Breadth first search, Sequential and Binary Searching, Bubble sort, selection sort,

Books Recommended:

1. Balguruswamy E.: Programming in ANSI C; Tata-McGraw Hill New Delhi
2. Byron S. Gottfried: Theory and Problems of Programming wih C; Tata- McGraw Hill Edition (Schaum's Outline Series)

LABORATORY IN DATA STRUCTURE AND PROGRAMMING IN C

MSC-416 **2 CH**

Objective: Use of MS EXCEL to draw graphs, diagrams, charts, classification and tabulation of data, frequency distribution, computation of summary statistics and analytical statistics.

CO-1	Remember and understand the basic concepts/Principles of Lab in Data Structure and Programming in C
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Revision of C programming. Write following programs in both the languages.

1. Calculation of summary statistics (Mean, deviation, Median, Max, Min, Standard, near absolute Deviation, etc.)
2. Calculation of regression and correlation coefficients.
3. Numerical Integration by Simpson's Rule.
4. Preparation of frequency distributions. Random.
5. number generation.
6. Matrix Inversion.
7. Calculation of determinant.
8. Solution of simultaneous linear equations.
9. Fitting of curves and lines.
10. Formation of 2x2 contingency table. Create a linked list (i) Traverse it (ii) Insert a node (a) in the middle, (b) at beginning, (c) at the end. Join 2 linked list.
11. Search from a linked list.
12. Sorting of linked list.
13. Delete a node from a linked list. (i) Delete from beginning. (ii) Delete from middle (iii) Delete list node.
14. Polynomial representation.
15. Polynomial evaluation.
16. Addition of polynomial
17. Push and pop operation of stack.
18. Insert and delete operation of queue.

Examination: Practical (80%) and Record & Viva Voce (20%).

MA/MSc. STATISTICS
SEMESTER-II
STATISTICAL METHODS-II

MSC-421 **4 CH**

Objective: To identify appropriate sources of data and to perform basic demographic analyses using various techniques across populations. To develop a deeper understanding of the linear and non-linear regression model and its limitations. To develop scientific view to analyze the industrial data about specific perspective. To learn the statistical quality control techniques used in industries such as control charts, acceptance sampling plans etc.

CO-1	Remember and understand the basic concepts/Principles of Statistical Methods-II
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Statistical data-: types, sources and their methods of collection, Statistical system in India and Orissa; Population statistics, Agricultural statistics, Functions of NSSO and CSO. Vital statistics-Rates, Ratios of Births and Deaths, Their merits, demerits, and relative comparisons.

Unit-II
Statistical Quality Control- Basic concept of SQC, Statistical Quality Control charts (X, R, P C. Acceptance sampling plans (single and double only).
Reliability- Hazards rate, IFR and DFR. Failure time distribution¬Normal, Exponential and Weibull. Reliability of systems.

Unit-III
Theory of residues and their properties. Multiple and partial correlation coefficients. Their relationship and properties. Rank correlation coefficient and correlation ratio. Their applications. Test of significance of multiple, partial and simple correlation coefficient. .

Unit-IV
statistics- Distribution of range, smallest and biggest observations, distribution of rth order statistics and their functions, probability integral transformation,
Curve fitting- Polynomial, Orthogonal, Exponential, Logarithmic and Growth curves. Their applications.

Books Recommended:

1. Introduction to Theory and Mathematical Statistics (1988) - Wiley Rohatgi,
2. V.K Statistical Theory of Reliability and Life Testing (1975) - Holt, Revehowlv Winston Barlow, R.E. And Proschan, F.
3. An Introduction to Theory of Statistics - Charles Griffiu Yale, G.U. and Kendall, M.G. (1953)
4. Probability and Statistics with Engineering and Computer Science Applications (2005) – Kalyani Swain, A.K.P.C.

STATISTICAL INFERENCE - I

MSC-422 **4 CH**

Objective: To derive suitable point estimators of the parameters of the distribution of a random variable and give a measure of their precision. To perform Test of Hypothesis as well as obtain MP, UMP tests. To derive suitable point estimators of the parameters of the distribution of a random variable and give a measure of their precision. To learn computational skills to implement various statistical inferential approaches.

CO-1	Remember and understand the basic concepts/Principles of Statistical Inference-I
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Parametric Point estimation: properties of estimators – Unbiasedness, Sufficiency, Completeness. Uniformly minimum variance unbiased estimators. Rao-Blackwell theorem. Cramer-Rao inequality. Fishers Information measure and its properties.

Unit-II

Asymptotic properties of estimators- Consistency and Efficiency. Their relationship and properties. Some special classes of distribution admitting complete sufficient statistics. Methods of estimation- Method of maximum likelihood estimation and it's properties. Methods of moments and it's properties.

Unit-III

Bayesian estimation, prior distributions, posteiror distributions, loss function and risk function, Quadratic loss function and other common loss functions. Bayes and minimax estimators and their inter relationship. Properties of Bayes and minimax estimators.

Unit-IV

Theory of Least squares. Gauss-Markov set-up, Normal equations, least squares estimators of linear parametric functions. Variances and Co¬variances of the estimators of linear parametric functions. Estimation of error vanance.

Books Recommended:

1. Linear Statistical Inference and its Applications (1973) - Wiley Eastern. Rao, C.R.
2. An Outline of Statistical Theory - Vol-II, World Press, Calcutta Goon, M.A., Gupta, M.K., and Dasgupta, B
3. Introduction to Theory of Probability and Mathematical Statistics (1970) - Wiley Rohatgi, V.K

SAMPLING METHODS

MSC-423 **4 CH**

Objective: To Learn variety of probability and non-probability sampling methods for selecting a sample from a population.

CO-1	Remember and understand the basic concepts/Principles of Sampling Methods
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Basic concepts in survey sampling. Major steps in sample survey. Basic methods of sample selection. Simple random sampling with and without replacement. Probability proportional to size sampling with and without replacement. DesRaj, murthy, and Rao Harthy cosmic estimation. Harvetz-Thompson estimator and its properties.

Unit-II

Stratification: Allocation problems and estimation problems, formation of strata and number of strata. Double sampling stratification, systematic sampling, Cluster sampling, Multi-stage sampling.

Unit-III

Use of supplementary information for estimation, ratio, product and regression estimators with their properties and generalizations. Double sampling reudeues, Estimators with mutli-auxiliary variables.

Unit-IV

Super-population regression models. Non-sampling error - response and non-response errors and their control, randomised response technique. Variance estimation Techniques.

Books Recommended:

1. Des, Raj and Chandok, P. (1998): Sample Survey Theory (Narosa).
2. Sukhatme, P.V; Sukhatme, B.V. and Asok, C. (1984): Sampling Theory of Surveys with Applications, Indian Soc. of Ag. Stats., New Delhi.
3. Cochran, W.G. (1984): Sampling Technique (Wiley).
4. Swain, A.K.P .C. (2003): Finite Population Sampling - Theory and Methods, South Asian Publishers.

APPLIED STATISTICS

MSC-424 **4CH**

Objective: To learn and develop scientific view to understand the time series data and its analysis.
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CO-1	Remember and understand the basic concepts/Principles of Applied Statistics
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
The Problem of Index Numbers, Calculation of Indices, Errors in Index numbers formulae, Different test of good index number, Cost of living Index number.

Unit-II
Decomposition of a Time series, Measurement of Trends, Seasonal Variation & Cyclic Components, Adoptive forecasting.

Unit-III
Deterministic and Stochastic Model, Stationary stochastic process in time series and stationary time series, Forecasting of future value of a time series, Different types of Stochastic Time series model.

Unit –IV
Auto covariance generating function of a general linear process, The spectral density function, Properties of the models, Moving Average Process, Auto covariance Function and Variance Function, Diagnostic Checking, Forecasting(Three form of forecast function, conducting and updating of forecast function)

Books Recommended:

1. Mukhopadhaya,P.(2005) : Applied Statistics, Books & Allied(P) Ltd.
2. Anderson, TW(1971) : Statistical Analysis of Time Series, Willey.
3. Box,GEP and Jenkins, GM and Reinsel,CG(1994) : Time Series Analysis- Forecasting and Control- Pearson Education.

PROBABILITY-II

MSC-425 **4CH**

Objective: to provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.

CO-1	Remember and understand the basic concepts/Principles of Probability-II
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Definition and properties of Lebegue integral, Monotone Convergence Theorem, Indefinite integral, Uniform integrability, Jensen's, Holder's, Cauchy and Schwartz, Luaponov inequalities.

Unit-II

Levy inversion Theorem and Levy continuity Theorem. Conditional expectation and properties, Three series theorem for independent random variables.

Unit-III

Bernoulli's Theorem, Borel Theorem, Borel-Canteili Lemma. Convergence of Distribution Functions. Reily-Compactness Theorem, Reily-Bray Theorem.

Unit-IV

Central Limit Theorem for binomial random variables. Law of Large Numbers and Law of the Iterated Logarithm.

Recommed Books:

1. Same as for Prob. Theory-I

(MA/MSc. STATISTICS)
SEMESTER-III

OPTIMIZATION TECHNIQUE-I

MSC-511 **4CH**

Objective: To develop the optimization techniques that will be useful in the personal and professional life.

CO-1	Remember and understand the basic concepts/Principles of Optimization Technique-I
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Introduction to LPP, Mathematical fomulation, Standard form and canonical form, Graphical solution, Simplex Method including Big-M and two phase method, Degeneracy, Solution of simultaneous equations and inver~ion matrix by simplex method.

Unit-II
Duality in Linear Programming, Duality Theorems, Dual simplex method with justifications, Transportation and Assignment algorithms.

Unit-III
Introduction to sensitivity analysis, variation in cost and requirement vectors, coefficient matrix and applications, Parametric programming and revised siplplex methods.

Unit-IV
Game Theory, Two persons zero sum game, Maxmin Minimax principle, Mixed strategy, Graphical solutions, Dominance Property, Arithmatic Method and general solution.

Books recommended:

2. Kambo.,NS(1991) : Mathemetical Pro.gramming Tech., Affiliated
3. East-West press. Hadley, G. (1987): Linear Programming
4. Taha H.A(l992) :.Operations Research, 5th Ed. (McMillan)

STATISTICAL INFERENCE-II

MSC-512 **4CH**

Objective: To learn computational skills to implement various statistical inferential approaches. To learn types of errors, non-parametric tests. ·

CO-1	Remember and understand the basic concepts/Principles of Statistical Inference-II
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Basic concept of test of Hypothesis, Neyman-Pearson Lemma. Most powerful (MP) test Application of Neyman-Pearson Lemma for the test of simple hypothesis, Generalised Neyman-Pearson Lemma Uniformly most powerful (UMP) test. UMPU tests. Similar Regions, Application of Neyman- Pearson Lemma for the test of composite hypothesis.

Unit-II

Non-parametric tests:- One sample problem, Goodness of fit, Kolmogrov test, Sign test, Run test, U statistic and its properties. Two sample problem- Kolmogrov-Smirnov test and its consistency, run test, Location problem, Wilcoxon-Mann Whitny test, median test, and their asymptotic normality.

Unit-III

Likelihood Ratio Test (LRT), Consistency of the test, Asymptotic distribution of LRT, Application of Likelihood Ratio Test (LRT), Comparison between Likelihood Ratio Test and Neyman- Pearson test procedure.

Unit-IV

Sequential probability ratio test (SPRT), procedures, Properties of SPRT, Fundamental identity of SPRT, Wald 's fundamental Identity. OC and ASN functions.

Books recommended :

1. An Outline of Statistical Theory - Vol-II, World Press, Calcutta Goon, M.A., Gupta, M.K., and Dasgupta, B
2. Non-parametric Methods in Statistics - Second Edition, Marcel Dekker Gibbons, J
3. Linear Statistical Inference and its Applications (1973) - Wiley Eastern. Rao, CR

DISCRETE MATHEMATICAL STRUCTURE

MSC-513 **4-CH**

Objective: To provide students with an overview of discrete mathematics. Students will learn about topics such as logic and proofs, sets and functions, probability, recursion, graph theory, matrices, Boolean algebra and other important discrete math concepts.

CO-1	Remember and understand the basic concepts/Principles of Discrete Mathematical Structure
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Review of set theory, Relation, Function, Methods of proof and problem solving strategies, Logic, FW1damentals of mathematical induction.

Unit-II

Basic terminology, Directed and Undirected graph, Paths and Circuits, Multi graph, Weighted graphs, Eulerian paths and circuits, Hamiltonian Paths and circuits, Trees, Rooted tree, Binary tree, Spanning tree, Cut set, Minimal spanning tree .

Unit-III

Basic ideas of Semi-groups and groups and application to coding,. Generating function and Recurrence relation as advanced counting techniques.

Unit-IV

Boolean Algebras: Lattices and Algebraic systems, Basic Properties of Algebraic systems defined by Lattices, Distributive and complemented Lattices, Boolean lattices and Boolean algebras, Uniqueness of finite Boolean algebra, Boolean function and Boolean expressions.

Books for Reference:

1. Discrete Mathematics for Computer scientists and Mathematician -: Mott, Kandell, Baker, Prentice Hall of India.
2. Applied Discrete Structure for Computer Science -: Doerr and Levasseur, Gagotia Publication PVT Ltd.
3. Elements of Discrete Mathematics -: Liu, Mc Grow Hill (International student edition)
4. Discrete Mathematics -: Nanda, Allied publication.

STOCHASTIC MODELING

MSC-514 **4CH**

Objective: To learn and to understand stochastic processes predictive approach. · To develop an ability to analyze and apply some basic stochastic processes for solving real life situations.

CO-1	Remember and understand the basic concepts/Principles of Stochastic Modeling
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Definition and classification of stochastic processes, Random walk, gambler's ruin problem, Poisson process, Markov chain - transition probabilities.

Unit-II

Classification of states of a markov chain, Periodicity, Recurrence, Basic limit theorems of markov chain, Absorption probability, Criteria for recurrence.

Unit-III

Birth and death processes, renewal processes.

Unit-IV

Martingale-Elementary results. Brownian Motion-Definition, Continuity of paths. Branching Processes-Definition, generating function relation.

Books Recommended:

1. Karlin, S and Taylor, H.M (1975): A First Course in Stochastic Processes. Academic Press.
2. Bhat, B.R.(2000): Stochastic Models: Analysis and application, New Age International Publication.

STATISTICAL LABORATORY ON COMPUTER

MSC-515 **2CH**

Objective: To learn statistical techniques and their implementation using comprehensive SPSS software.

CO-1	Remember and understand the basic concepts/Principles of Statistical Laboratory on Computer
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

SPSS Software

MSE 516() SPECIAL PAPER-I (ANY ONE) 4CH

C: STATISTICAL QUALITY CONTROL AND RELIABILITY

Objective: To learn the statistical quality control techniques used in industries such as control charts, acceptance sampling plans etc. To learn some advanced control charts, capability indices and the concept of six-sigma. To learn the reliability theory and to distinguish censored and uncensored data. To visualize and communicate time-to event data, to fit and interpret failure time model.

CO-1	Remember and understand the basic concepts/Principles of Statistical Quality Control & Reliability
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Acceptance sampling plans: classification and general properties of sampling plans by variables. Defmitions of O.C. and A.S.N. functions, AOQL and ATI. Single and double sampling plans, sequential sampling plan.

Unit-ll

Reliability concepts and measures components and systems, coherent systems, reliability of coherent systems, cuts and paths, life distributions, survival functions, Hazard rate, Hazard function and residual life time, survival function of residual life time, mean residual life function, one-one correspondence of these functions, common life distributions, Exponential, Weobull, Gama, Malhehom, Pareto, Releigh, Log-Normal etc.

Unit-III

Notation of aging: IFR, IFRA, DMRL, NBU, BBUE classes and their duals, exponential distribution and its no-aging properties, aging properties of other common life distribution, closure under formation of coherent structures, controlution and mixture of these cases.

Unit-IV

Reliability growth models, probability plotting techniques, parameteric inference from various life distributions, moments and maximwn likelihood estimation, likelihood ratio tests, tests based on MLE (Rao and Wald techiques) Type-I, Type-II and random censoring schemes, likelihood functions based on these sampling schemes, estimation based on these schemes for various parametric models.

Books Recommended:

1. RE. Ballo and F. Proschan: Statistical Theory of Reliability and Life Testing. Holt, Reinhart and Wonston
2. RC. Miller: Survival Analysis. John Wiley.
3. J.L. Bain: Statistical Analysis of Reliability and Life Testing Models. Morcel Bekker.
4. Gupta and Kapoor: Applied Statistics.
5. E.L. Groant and RS. Leavenworth: Statistical Quality Control. Sixth Edn., McGraw Hill Publication.

H: STATISTICAL GENETICS

Objective: To learn the theory of mathematical modeling and its applications in the analysis of biological systems including populations of molecules, cells and organisms. To develop skills in mathematical modeling.

CO-1	Remember and understand the basic concepts/Principles of Statistical Genetics
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Gene frequency, random mating, Hardy-Weinberg equilibrium, Matrix theory of random mating with application.

Unit-II
Inbreeding, coefficient of inbreeding, inbreeding in randomly mating populations of finite size. Detection and estimation of linkage.

Unit-III
Statistical problems in human genetics, blood group analysis Natural selection.

Unit-IV
Quantitative genetics, study of inheritance of quantitative characters in random and non¬random mating diploid populations. Biological sequence analysis.

Books Recommended:

H. L. C.C. (1972): Population Genetics, Univ. Chicago Press.
I. Ewens, w.J. (1979): Mathematical Population Genetics. Springer Verlag.
J. Prem Narayan (1990): Statistical Genetics, Wiley Eastern.
K. Kempthorne, O. (1977): An Introduction to Genetic Statistics. Iowa State Univ. Press.
L. Elandt-Johnson (1971): Probability, Models and Statistical Methods in Genetics, Wiley.
M. Durbin, R., Eddy, S.R; Krog, A. and Mitchison, G. (1998): Biological Sequence Analysis.

K: PATTERN RECOGNITION

Objective: To Summarize, analyze, and relate research in the pattern recognition area verbally and in writing. Apply pattern recognition techniques to real-world problems such as document analysis and recognition. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

CO-1	Remember and understand the basic concepts/Principles of Pattern Recognition
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Linear classifiers: Linear discriminant function (LDF) for minimum square error, LDF for binary outputs, perception learning algorithm.

Unit-II

Nearest neighbour decision rules: description, convergence, finite sample considerations, use of branch and bound methods.

Unit-III

Probability of errors: two classes, normal distribution, equal covariance matrix assumptions, Chern off bounds and Bhattacharya distance, estimation of probability of error.

Unit-IV

Feature selection and extraction: interclass distance measures, discriminant analysis, Probabilistic distance measures, principal components.

Books Recommended:

1. Duda, RO. and Hart, P.E. (1973): Pattern Recognition and Scene Analysis. Wiley.
2. Fukunaga, K (1990): Introduction to Statistical Pattern Recognition, 2nd 00. Academic Press.
3. McLachlan, GJ. (1992): Dismiminant Analysis and Statistical Pattern Recognition. Wiley.
4. Ripley, B.D. (1996): Pattern Recognition and Neural Networks. Cambridge University Press.

MA/MSc. STATISTICS
SEMESTER- IV
TIME SERIES AND FORECASTING

MSC-521 **4 CH**

Objective: To learn and develop scientific view to understand the time series data and its analysis. To learn stationary and non-stationary, and seasonal and nonseasonal time series models. Learn to estimate model parameters and compare different models developed for the same dataset in terms of their estimation and prediction accuracy.

CO-1	Remember and understand the basic concepts/Principles of Time Series and Forecasting
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Classical techniques. of time series analysis. Time series as discrete parameter stochastic process. Auto. covariance and auto correlation functions and their properties.

Unit-II
Stationary and Non stationary models. Detailed study of stationary processes - moving average (MA), Auto-regressive (AR), ARMA, AR integrated MA (ARIMA) models.

Unit-III
Spectral properties of stationary models, Forecasting, Periodgram and Correlogram.

Unit-IV
Linear non-stationary models-The auto-regressive integrated moving Average problem (ARIMA), three explicit forms of ARIMA, integrated moving average problems.

Books Recommended:

1. Box, GEP and Jenkins, G.M. (1976): Time Series Analysis - Forecasting and Control, Holdenday, Sanfransico.
2. Anderson, T.W. (1971): The Statistical Analysis of Time Series. Wiley.
3. Brockwell, P .J. and Davis, RA ( ): Time Series: Theory and Methods, 2nd Ed., Springer- Verlas.

MULTIVARIATE ANALYSIS

MSC-522 **4 CH**

Objective: To learn and develop scientific view to deal with multidimensional datasets and its uses in the analysis of research data. · To understand the extensions of univariate techniques to multivariate frameworks and learn to apply dimension reduction techniques used in the data analysis.

CO-1	Remember and understand the basic concepts/Principles of Multivariate Analysis
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I:
Multivariate normal distribution: probability density function, moment generating function. Distribution of linear and quadratic form of normal variables, Marginal and conditional distributions. Multiple Regression. Multiple and partial correlations and related tests.

Unit-II
Maximum likelihood estimators of parameters of multivariate normal distribution and their sampling distributions. Wishart distribution and its properties.

Unit-III
Tests on mean vector for one or two multivariate normal populations. Hotellings T^2 and Mahalanobes D^2 distributions (null case only) and related confidence regions. Rao's U -statistic au de to distribution, Introduction to canonical variables and canonical correlations. Cluster Analysis.

Unit-IV
Principal component analysis. Disciminant Analysis, Classification problems. Methods and applications of MANOV A (Derivation not included).

Books Recommended:

1. Anderson, T.W. (1984): Introduction to Multivariate Analysis, Wiley.
2. Kshirsagar, A.M. (1983): Multivariate Analysis, Marcel Dekkar.
3. Morrison, D.F. (1990): Multivariate statistical methods, McGraw Hill.
4. Rao, C .R. (1995): Linear statistical Inference and its Applications (Wiley).
5. Johnson, R.A. and Wichern, D.W. (1988): Applied Multivariate Statistical Analysis (Prentice Hall).

DESIGN AND ANALYSIS OF EXPERIMENTS

MSC-523 **4 CH**

Objective: To learn the basic principles in the design of simple experiments. · To learn different tests for comparing pairs of treatment means, ANCOVA, factorial experiments, fractional factorial experiments, confounding, BIBD, PBIBD with solving real life examples. · To learn the applications of different designs in agriculture.

CO-1	Remember and understand the basic concepts/Principles of Design and Analysis of Experiments
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Linear estimation. Theory of least squares. Gauss Markov Theorem. Normal equations, least square estimators of linear parameteric functions. Variance and covariance of estimators.

Analysis of variance - fixed, random and mixed models. Analysis of variance. One-way and two-way classification with unequal and equal number of obsorvation per cell. Basic principles of designs - CRD, RBD and Latin square and their analysis - missing plot technique. Connectedness, balance, orthogonality.

Unit-II

Factorial experiments – 2^n and 3^2, 3^3 Presentation of main effects and interactions. Analysis. Asymmetrical factorial experiments.

Unit-III

Confounding - Total confounding of 2^n design in 2^P blocks, partial confounding in 2^P blocks. Fractional factorial experiments and their analysis, Total and partial confounding in 3^2 and 3^2 designs. Split plot designs.

Unit-IV

Incomplete block designs - BIBD and Lattice designs - Construction and analysis. Concept of rotable design. Control composite design. Response surface methodology.

Books Recommended:

1. Kshirasagar, A.M. (1983): Linear Models, Marcel Dekkar.
2. John, P. W.M. (1971): Linear Models, Wiley.
3. Montgomery, D.C. (2001). Design and Analysis of Experiments, Wiley.
4. Das, M.N. and Giri, N.C. ( ): Design of Experiments.

MSC-524	Project and Viva Voce	**6CH**
MSC-525	Practical & Viva Voce	**2CH**

MSE-526() SPECIAL PAPER-II (ANY ONE) 4CH

I: DATA WAREHOUSING AND DATA MINING

Objective: To understand the concept of data Mining for enterprise data management and as a cutting edge technology tool. To enable to identify data sources, processing and imparting knowledge tools to analyze sets of data to gain useful business understanding.

CO-1	Remember and understand the basic concepts/Principles of Data Warehousing and Mining
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Overview: Data warehousing, OLAP and Data mining, classification of data mining techniques, Discovery and analysis of pattents, trends, and deviations.

Unit-II
Data mining models: decosious trees, genetic algorithms.

Unit-III
Neural nets, clustering, Enabling data mining through data warehouse.

Unit-IV
Data marts, multidimensional databases, Data mining applications.

Books Recommended:

1. Pujari, A.K.: Data Mining, UBH, Bangalore

J: OPTIMIZATION-II

Objective: To learn the mathematical formulation of complex decision-making problems and arrives at optimal or near-optimal solutions using different techniques of operations research.

CO-1	Remember and understand the basic concepts/Principles of Optimization-II
CO-2	Analyze the Various Concepts to understand them through case studies
CO-3	Apply the knowledge in understanding practical problems
CO-4	Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Markov process, transition matrix, transition diagram, construction of transition matrix, n-step transition prob. Equilibrium condition, Markov analysis algorithm, Nerwork Scheduling by PERT/CPM.

Unit-II

inventory decision, cost associated with inventory, factors affecting inventories, EOQ, deterministic inventories with no shortage and shortage, inventory with uncertain demand, system of inventory control, Probabilistic inventory problems.

Unit-III

Queuing system, Operating characteristic, probability distribution, Classification of queuing models, transient and steady state, Poisson and non Poisson Queuing System, Cost model in queuing, Queuing control, queuing Theory and Inventory control.

Unit-IV

Formulation of Non Linear programming, Constrained optimization With equality constraint and inequality constraint, saddle point and NLLP. Graphical solution, Kuhn- Tucker conditions, Quadratic Programming,Wolfe's and Beales' method.

Books Recommended:

-I

Books recommended:

1. Kambo.,N.S. (1991) : Mathemetical Pro.gramming Tech., Affiliated
2. East-West press. Hadley, G. (1987): Linear Programming
3. Taha H.A(l992) :.Operations Research, 5th Ed. (McMillan)
4. Operations Research: Kanti Swarup; Gupta & Mohan (S. Chand)