S. S. Jain Subodh P.G. College
(Autonomous)
Jaipur

DEPARTMENT OF STATISTICS

Two-Year Post-Graduate Programme In

Statistics

(Syllabus as per NEP-2020 And Choice Based Credit System)

w.e.f. Academic Session 2024-25

Scheme of Examination:

- Each Theory paper in End of Semester Examination (EoSE) will carry 70 marks. The EoSE will be of 3 hours duration.
- Part 'A' of the theory paper will comprise of 07 Short answer Questions, Covering entire syllabus and each question will carry 2(two) marks i.e. part A will be of total 14 marks.
- Part 'B' of the Question Paper will consist of Four (04) questions with internal choice and weightage of 14 marks each i.e. total of 70 marks.
- Each Laboratory EoSE will be of 60 marks and (4) hours duration and the internal assessment of the practical will be of 40 marks. Conduction of experiment \test and viva- voce examination with weightage in the ratio of 75:25 respectively.
- Each Project work will have Continuous Internal Assessment by the guiding teacher. Every EoSE will be of 60 marks and (4) hours duration and the internal assessment of the project work will be of 40 marks.
- Continuous Assessment will consist of two components, namely (1) Internal Assessment and (2) Assignment of 30 marks. The internal Assessment component will comprise of assessment of students performance in the test on the basis of factors like attendance, classroom participation etc.
- The student will require to earn minimum 120 credits out of total 144 credits, in four semesters, for PG degree.
- Each semester of PG courses shall have 36 credits. There will be three core papers and three elective papers (4 credits each) and one core laboratory and one elective laboratory(6 credits each).

Course Structure: The details of the courses with code, Nomenclature and credits assigned are as given below:

Semester Wise Course Plan

Semester	Paper	Subject Code	Nomenclature	Max. Marks	Duration of Exam
I	Core Theory	MAST\MSST 101	Statistical Mathematics	100	3 Hours
		MAST\MSST 102	Probability Theory	100	3 Hours
		MAST\MSST 103	Probability Distributions	100	3 Hours
	Elective Theory	MAST\MSST 104	Statistical Computing with C	100	3 Hours
		MAST\MSST 105	Official Statistics	100	3 Hours
		MAST\MSST 106	Statistical Quality Control	100	3 Hours
	Core Lab	MAST\MSST 151	Practical based on Core Papers (MAST\MSST 101 &103)	100	4 Hours
	Elective Lab	MAST\MSST 152	Practical based on Elective Papers	100	4 Hours
II	Core Theory	MAST\MSST 201	Sampling Distributions	100	3 Hours
		MAST\MSST 202	Statistical Inference- I	100	3 Hours
		MAST\MSST 203	Design of Experiment- I	100	3 Hours
	Elective Theory	MAST\MSST 204	Demography	100	3 Hours
		MAST\MSST 205	Measure Theory	100	3 Hours
		MAST\MSST 206	Operation Research -I	100	3 Hours
	Core Lab	MAST\MSST 251	Practical based on Core Papers (MAST\MSST 201,202 &203)	100	4 Hours
	Elective Lab	MAST\MSST 252	Practical Based on Elective Papers	100	4 Hours
III	Core Theory	MAST\MSST 301	Design of Experiment- II	100	3 Hours
		MAST\MSST 302	Statistical Inference- II	100	3 Hours
		MAST\MSST 303	Sample Surveys- I	100	3 Hours
	Elective Theory	MAST\MSST 304	Econometrics	100	3 Hours
		MAST\MSST 305	Numerical Analysis	100	3 Hours
		MAST\MSST 306	Operation Research- II	100	3 Hours
		MAST\MSST 307	Survival Analysis	100	3 Hours
	Core Lab	MAST\MSST 351	Practical based on Core Papers (MAST\MSST 301,302 &303)	100	4 Hours
	Elective Lab	MAST\MSST 352	Practical based on Elective Papers	100	4 Hours
IV	Core Theory	MAST\MSST 401	Multivariate Analysis	100	3 Hours
		MAST\MSST 402	Sample Survey-II	100	3 Hours
	Elective Theory	MAST\MSST 403	Applied Statistics	100	3 Hours
		MAST\MSST 404	Population Studies	100	3 Hours
		MAST\MSST 405	Stochastic Process	100	3 Hours
		MAST\MSST 406	Reliability Theory	100	3 Hours
		MAST\MSST 407	Basic Statistics*	100	3 Hours
		MAST\MSST 408	Statistics for Clinical Trials	100	3 Hours
	Project	MAST\MSST 409	Project Work	100	4 Hours
	Core Lab	MAST\MSST 451	Practical based on Core Papers (MAST\MSST 401&402)	100	4 Hours
	Elective Lab	MAST\MSST 452	Applied Statistics & Statistical Computing with R and SPSS**	100	4 Hours

M.A.\M.Sc. STATISTICS

First Semester

S. No	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			EoSE Duration (Hrs.)	
					L	T	P	Thy.	P
01	MAST\MSST 101	Statistical Mathematics	DSC	4	4	0	0	3	0
02	MAST\MSST 102	Probability Theory	DSC	4	4	0	0	3	0
03	MAST\MSST 103	Probability Distributions	DSC	4	4	0	0	3	0
04	MAST\MSST 104	Statistical Computing with C	DSE-1	4	4	0	0	3	0
05	MAST\MSST 105	Official Statistics	DSE-2	4	4	0	0	3	0
06	MAST\MSST 106	Statistical Quality Control	DSE-3	4	4	0	0	3	0
07	MAST\MSST 151	Practical based on Core Papers (MAST\MSST 101&103)	DSCP	6	0	0	9	0	4
08	MAST\MSST 152	Practical Based on Elective Papers	DSEP	6	0	0	9	0	4
Total Credit				36	24		18		

Second Semester

S. No	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			EoSE Duration (Hrs.)	
					L	T	P	Thy.	P
01	MAST\MSST 201	Sampling Distributions	DSC	4	4	0	0	3	0
02	MAST\MSST 202	Statistical Inference- I	DSC	4	4	0	0	3	0
03	MAST\MSST 203	Design of Experiments- I	DSC	4	4	0	0	3	0
04	MAST\MSST 204	Demography	DSE-1	4	4	0	0	3	0
05	MAST\MSST 205	Measure Theory	DSE-2	4	4	0	0	3	0
06	MAST\MSST 206	Operation Research -I	DSE-3	4	4	0	0	3	0
07	MAST\MSST 251	Practical Based on (MAST\MSST201,202&203)	DSCP	6	0	0	9	0	4
08	MAST\MSST 252	Practical Based on Elective Papers	DSEP	6	0	0	9	0	4
Total Credit				36	24		18		

Third Semester

S.No	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			EoSE Duration (Hrs.)	
					L	T	P	Thy.	P
01	MAST\MSST 301	Design of Experiment- II	DSC	4	4	0	0	3	0
02	MAST\MSST 302	Statistical Inference- II	DSC	4	4	0	0	3	0
03	MAST\MSST 303	Sample Surveys- I	DSC	4	4	0	0	3	0
04	MAST\MSST 304	Econometrics	DSE-1	4	4	0	0	3	0
05	MAST\MSST 305	Numerical Analysis	DSE-2	4	4	0	0	3	0
06	MAST\MSST 306	Operation Research- II	DSE-3	4	4	0	0	3	0
07	MAST\MSST 307	Survival Analysis	DSE-4	4	4	0	0	3	0
08	MAST\MSST 351	Practical Based on (MAST\MSST 301,302&303)	DSCP	6	0	0	9	0	4
09	MAST\MSST 352	Practical Based on Elective Papers	DSEP	6	0	0	9	0	4
Total Credit				36	24		18		

Fourth Semester

S. No	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			EoSE Duration (Hrs.)	
					L	T	P	Thy.	P
01	MAST\MSST 401	Multivariate Analysis	DSC	4	4	0	0	3	0
02	MAST\MSST 402	Sample Survey-II	DSC	4	4	0	0	3	0
03	MAST\MSST 403	Applied Statistics	DSE-1	4	4	0	0	3	0
04	MAST\MSST 404	Population Studies	DSE-2	4	4	0	0	3	0
05	MAST\MSST 405	Stochastic Process	DSE-3	4	4	0	0	3	0
06	MAST\MSST 406	Reliability Theory	DSE-4	4	4	0	0	3	0
07	MAST\MSST 407	Basic Statistics*	DSE-5	4	4	0	0	3	0
08	MAST\MSST 408	Statistics for Clinical Trials	DSE-6	4	4	0	0	3	0

09	MAST\MSST 409	Project Work	DSC	4	4	0	0	0	4
10	MAST\MSST 451	Practical Based on (MAST\MSST 401&402)	DSCP	6	0	0	9	0	4
11	MAST\MSST 452	Applied Statistics & Statistical Computing with R and SPSS**	DSEP	6	0	0	9	0	4
Total Credit				36	24		18		

*Only for Non- Statistics Students

**Non-Statistics Students may also opt for this elective lab (MAST\MSST 452: Statistical Computing with R and SPSS) if they have opted for Elective Theory paper MAST\MSST 40.

Note: Department will offer elective courses for the semester based on options submitted by the students and availability of faculty to teach the course.

Abbreviations Used

Course Category

DSC: Discipline Specific Core DSCP: Discipline Specific Core Practical

DSE: Discipline Specific Elective DSEP: Discipline Specific Elective Practical

Contact Hours

L: Lecture T: tutorial P: Practical

Program Outcomes

On successful completion of the M.Sc. Statistics program, the students will be able :

PO1 To get employment in government, public, private, industrial, health, business, banking, agricultural and educational sectors.

PO2 To expand their knowledge to set their career in research and higher studies.

PO3 To comprehend the statistical concepts and principles for interdisciplinary research.

PO4 To excel in statistical computing.

PO5 To acquire proficiency in adopting statistical software for data analysis.

PO6 To nurture advancement in statistical theory and applications.

Program Specific outcome

On successful completion of M.Sc. Statistics program, the students will be expected :

PSO1 To comprehend the theoretical aspects of statistics.

PSO2 To recognize the application of statistics in diversified fields.

PSO3 To develop computer programs and codes for statistical computation.

PSO4 To utilize statistical software effectively for data analysis.

PSO5 To understand the conditions and limitations of statistical methods in application.

PSO6 To critically analyze statistical data and make interpretations.

Semester – I

MASST\MSST 101: Statistical Mathematics

Course Objective: The learning objectives include:

- Impart the understanding of the basic concepts of real analysis and linear algebra
- Enhance the ability of proving the theorems in real analysis and linear algebra
- Understand the meaning of convergence of sequence and series of real numbers
- Comprehend the concepts which are essential for learning other courses

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Identify the given functions are continuous or discontinuous.
- Examine the convergence of sequence and series of real numbers.
- Understand the conditions for integrability of a real valued function.
- Derive the characteristic roots and vectors.
- Determine the nature of quadratic forms and reduction of quadratic forms.

UNIT- I: Linear Algebra: Inverse and rank of a matrix, solution of linear equations, orthogonal matrix, orthogonal reduction of a real symmetric matrix to a diagonal form, generalized inverse and its simple properties, idempotent and nilpotent matrices, solutions of matrix equations.

UNIT- II: Bilinear and quadratic forms, reduction to canonical forms, definite, semi- definite and indefinite forms, index and signature, triangular reduction of a positive definite matrix, Hermitian canonical form, characteristic equation, its roots and vectors, Cayley-Hamilton theorem.

UNIT- III: Real Analysis: Real valued functions, limit, continuous function, differentiability of a function; Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, maxima-minima of functions, maxima-minima of a function of two independent variables, Lagrange's method of undetermined multipliers.

UNIT- IV: Differentiation under the sign of Integration, Multiple integrals, Transformation of Multiple Integrals, Dirichlets theorem, Liouville's Extension of Dirichlet's theorem, Beta and Gamma integrals.

References:

1. Apostol, T.M. (1985): Mathematical Analysis, Narosa Publishing House.
2. Burkill,J.C.(1980):A first Course in Mathematical Analysis, Vikas Publishing House.
3. Cournat, R.and John, F. (1965): Introduction to Calculus and Analysis, John Wiley.
4. Khuri,A.1(1983): Advanced Calculus with Applications in Statistics, John Wiley.
5. Miller,K.S.(1957): Advanced Real Calculus, Harper, New york.
6. Searle, S.R.(1982): Matrix Algebra Useful for Statistics, John Wiley
7. Shanti Narayan,(1998):A Textbook of Matrices , S. Chand & Co.

MAST\MSST 102: Probability Theory

Course Objectives: The learning objectives include:

- To provide students with a formal treatment of probability theory.
- To foster understanding through real-world statistical applications.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understand the concepts of random variables, sigma-fields generated by random variables, probability distributions and independence of random variables related to measurable functions.
- Gain the ability to understand the concepts of measurable functions, sequence of random variables, convergence, modes of convergence.
- Learn the concepts of weak and strong laws of large numbers and central limit theorem.

Unit -I: Probability space, various definitions of probability. Combinations of events: additive and multiplicative laws of probability. Conditional probability. Bayes theorem and its applications.

Unit -II: Concept of random variables, cumulative distribution function and probability functions, joint, marginal and conditional distributions. Functions of random variables and their distributions using Jacobian of transformation for one and two variables.

Unit -III: Mathematical expectation, conditional expectation, moments, moment generating functions, Cumulative generating functions and their applications, Characteristic function, Inversion uniqueness and continuity theorems. Chebyshev, Markov and Jensen's. Probability inequalities and their applications.

Unit -IV: Convergence in probability, Convergence in distribution. Weak law of large numbers. Central limit theorem for a sequence of independent random variables under Lindeberg's condition, central limit theorem for independent and identically distributed random variables with finite variance. Sequence of events and random variables: Borel 0-1 law, Kolmogorov's 0-1 law, Law of large numbers and central limit theorems for independent variables. Khintchine's weak law of large numbers, Tchebycheff's and Kolmogorov's inequalities and strong law of large numbers. Martingales.

Reference:

1. Kingman J.F. & Taylor.S.I. (1996): Introduction to Measure and Probability, Cambridge Univ.Press.
2. Loeve (1996): Probability Theory Affiliated East —West Press Pvt. Ltd. New Delhi.
3. Bf.att, B.R.(2000): Probability, New Age International India.
4. Feller,W.(1971): Introduction to Probability Theory and its Applications, Vol. I and II. V'iley, Eastern-Ltd.
5. Rohatgi, V.K (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
6. Billingsley, P. (1986): Probability and Measure, John Wiiey Publications.
7. Dudley, R.M. (1989): Real Analysis and Probability, Worlds Worth & Books.
8. Tucket H.G. (1967): A Graduate Course in Probability; Academic Press.
9. Basu, A.K. (1999): Measure Theory and Probability, PHI.

MAST\MSST-103: Probability Distributions

Course Objectives: The learning objectives include:

- To familiarize with basic concepts of Mathematical Statistics.
- To understand the nature of data with the help of various statistical tools.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Create Knowledge of Distribution function.
- Understand discrete distribution with their application.
- Understand and create knowledge of different types of continuous distribution.
- Understand, compare and relate different distributions.

Unit -I: Measures of location, dispersion, Skewness and Kurtosis, Moments, Sheppard's correction, moment and cumulant generating functions, probability generating function.

Unit -II: Bernoulli, Binomial (compound and truncated also), Poisson (compound and truncated also), negative binomial, geometric, hyper-geometric and multinomial distributions.

Unit-III: Rectangular, Normal (truncated also), Exponential, Lognormal and Triangular distributions.

Unit -IV: Gamma, Beta, Cauchy (truncated also), Laplace distributions, Pearson's distributions (Type I, IV and VI).

References:

1. Goon, Gupta & Das Gupta. (1991): Outline of Statistical Theory. 4'ol. I & Vol. II World Press.
2. Hogg, R.V. and Craig, A.T. (1971): Introduction to Mathematical Statistics, McMillan.
3. Johnson, S. and Kotz. (1972): Distribution in Statistics, Vol. I, II. And III. Houghton and Muffin.
4. Kendall, M.G. and Stuart. (1996): An Advanced Theory of Statistics, Vol. I, II. Charls Griffin.
5. Mood, A.M., Graybill, F.A. and Boes, D. C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
6. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency (P) Ltd.
7. Rohatgi, V.K. (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
8. Johnson, S. and Kotz. (1972): Distribution in Statistics, Vol.I, II and III, Houghton and Muffin.

MAST\MSST 104: Statistical Computing with C

Course Objectives: The learning objectives include:

- To understand computer programming and its roles in problem solving.
- To develop programming skills using the fundamentals and basics of C language.
- To enable effective usage of arrays, functions and pointers.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- The fundamental concepts of C programming language.
- Various data types, operators, library functions, Input/Output operations.
- Decision making and branching and looping.
- Arrays.
- User defined functions, recursion functions. Storage class of Variables.

Unit- I: Basics of C: Components of C language, structure of a C program, Data type, basic Data types, Enumerated data types, Derived data types, Variables. Variable declaration, Operators. Type modifiers and expressions. Basic input/output. Control statements: conditional statements, loops, go to and label declarations, break, continue, exit (). Arrays.

Unit- II: Storage classes: Automatic variables, External variables, Static variables, Scope and lifetime of declarations. Functions: classification of functions, functions definition and declaration, assessing a function, return statement, parameter passing in functions.

Unit- III: Pointers (concept only). Structure: Definition and declaration; structure (initialization) comparison of structure variable; Array of structures: array within structures, structures within structures, passing structures to functions; Unions accessing a union member, union of structure, initialization of a union variable, uses of union. Introduction to linked list, linear linked list, insertion of a node in list, removal of a node from list.

Unit- IV: Files in C: Defining and opening a file, input- output operation on a file, creating a file, reading a file. Statistics programming Using R. Introduction to SPSS, Data Entry, Data Analysis and Statistical Tests.

References:

1. Balaguruswamy, E.: Programming in ANSI C, Tata McGraw Hill Education Pvt. Ltd., Delhi
2. Kamthane, Ashok: Programming with ANSI and Turbo C, Pearson Education, N.Delhi.
3. Somashekera, N.T: Programming in C,PHI Learning Pvt.Ltd. New Delhi.
4. Somashekera, N.T: Problem Solving with C, PHI Learning Pvt.Ltd. New Delhi.
5. Verma J.P : Data Analysis in Management with SPSS Software, Spinger
6. Asthana, B.S. & Bhushan, B: Statistics for Social Sciences, PHI
7. Crawley, M.J., The R Book, John Wiley & Sond Ltd, England

MAST\MSST 105: Official Statistics

Course Objectives: The learning objectives include:

- To understand the functioning of government and policies.
- To Promote human resource development in the official statistics and encourage research and development in theoretical and applied statistics.
- To Execute the data handling tasks in various government records

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Interpret the role, functions and activities of Indian and international system of statistical organization.
- Understand the role of National Sample Survey organization.
- Understand and use the content of population census of India.
- Understand and use the system of collection of Agriculture Statistics.
- Describe the relation between Statistics and Industries.

Unit – I: National and International official statistical system: Official Statistics (a)Need, Uses, Users, Reliability, Relevance, Limitations, Transparency, its visibility (b) Compilation, Collection, Processing, Analysis and Dissemination of records. Agencies Involved, Methods.

Unit – II: National Statistical Organization: Vision and Mission, NSSO and CSO; roles and responsibilities; Important activities, Publications. National Statistical Commission: Need, Constitution, its role, functions Legal Acts/ Provisions/ Support for Official Statistics; Important Acts.

Unit – III: Sector Wise Statistics: Agriculture, Health, Education, Women and Child etc. Important Surveys & Census, Indicators, Agencies and Usages etc. National Accounts: Definition, Basic Concepts; issues; the Strategy. Collection of Data and its Release.

Unit –IV: Population Census: Need, Data Collected, Periodicity, Methods of data collection, dissemination, Agencies involved. Socio-Economic Indicators, Gender Awareness/ Statistics, Important Surveys and Censuses.

References:

1. Kaul, R. & Chawdhury: Applied Statistics, lndian Official Statistics (free downloadable).
2. Saluja, M.R.: Indian official statistical systems, Statistical Pub. Society, India.
3. Asthan, B.N. & Shrivastav, S.S.; Applied Statistics of India, Chaitanya Publishing House, India
4. Reports of MOSPI, CSO etc.

MAST\MSST 106: Statistical Quality Controls

Course Objectives: The learning objectives include:

- This course will help students to learn techniques and approach of SQC being used in industry to manufacture goods and services of high quality at low cost.
- This course will also give exposure to Sampling Inspection Plans.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Statistical process control tools- Control charts for variables, attributes.
- Statistical product control tools- Sampling inspection plans.

Unit – I: Basic Concepts of Statistical Process and Product Control. Need for Quality Control. Objectives of SQC. Concepts of Process monitoring, control, process capability and process optimization and Product Control.

Unit – II: General Theory of Control Charts, Causes of Variation in Quality, Control Limits, Sub-Grouping. Control-Charts: Concept and construction of control charts for variables and attributes and their Operating Characteristic (O.C.) Curve. Modified control limits. Average Run Length (A.R.L.) of control charts; moving average and exponentially weighted moving average charts; Cu-Sum charts using V-masks and decision intervals; Economic design of X-bar chart.

Unit – III: Acceptance Sampling Plans by Attribute: Acceptable Quality Level (A.Q.L.), Average Outgoing Quality Limit (A.O.Q.L.), Producer's Risk and Consumer's Risk. Rectification, Operating Characteristic (O.C.) functions and curve, Average Sample Number (A.S.N.) and Average Total Inspection (A.T.I.) Single and double sequence sampling plans and their mathematical analysis.

Unit – IV: Idea of Standard sampling tables: Dodge and Romig tables. Sampling Inspection Plans for Variables (single, double, multiple and sequential) One sided specification standard (Known and Unknown Cases), two sided specifications (for known standards).

References:

1. Montgomery, D.C.: Introduction of Statistical Quality Control, John Wiley & Sons, Inc., 6 edition.
2. Chandra, M. Jeya: Statistical Quality Contro1, CRC Press.
3. Mahajan, M.: Statistical Quality Control, Dhanpat Rai and Co. Delhi.
4. Burr, John T.: Elementary Statistical Quality Control, 2nd Edition, Statistics: A Series of Textbooks and Monographs by Marcel Dekker, CRC Press.

MAST\MSST 151: Practical Paper Based on MAST\MSST 101 &103

Course Objectives: The learning objectives include:

- It will provide grounds for Statistical Mathematics and help them in theoretical and applied researches in Statistics.
- Understanding of various distributions along with their applications.

Course learning Outcomes: After successful completion of this course, student will be able to:

- Understand the basic concepts of real analysis including completeness of set, suprimum, infimum, sequence and series.
- Understand the basic principles of probability distribution.

List of Practical:

(MAST\MSST 101)

1. Determinants - by row and column operations, by partitioning.
2. Inverses of a matrix - by row and column operations, by partitioning
3. Rank of a matrix
4. Solutions of matrix equations.
5. Characteristic roots and vectors of a matrix.

(MAST\MSST 103)

1. Coefficient of variation.
2. Calculation of central moments, coefficient of variation, Beta-1, Beta-2, and Gamma-1, Gamma-2, coefficients, Sheppard's correction to moments.
3. Plot binomial curve for different values of n and p.
4. Fitting of binomial distributions, Poisson distribution, Negative Binomial distribution and Normal distribution.

MAST\MSST 152: Practical Paper Based on Elective Papers

Course Objectives: The learning objectives include:

- This practical paper aims at introducing C programming.
- Perform the methods of statistical quality control.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understand fundamentals of C.
- Learn input and output of variables and analyse data using C programming.
- Methods of process control by using the different kinds of quality control charts for variables as well as for attributes along with the methods for product control.

MAST\MSST 104: Statistical Computing with C

1. Practical based on Conditional Statements.
2. Practical based on Loops Statements.
3. Practical based on Structures and Unions.
4. Solving Statistical Problems with C Programming.
5. Data Entry and applying Statistical tools Using SPSS
6. Elementary Statistical Programming using R.

MAST\MSST 106: Statistical Quality Control

1. Control charts for yariables.
   (i) $\bar{x}$ & R charts with known parameters.
   (ii) $\bar{x}$ & R charts with unknown parameters.
   (iii) $\bar{x}$ & s charts with known parameters.
   (iv) $\bar{x}$ & s charts with unknown parameters.

2. Control Charts for Attributes
   (i) c - charts with known & unknown.
   (ii) p - charts with known & unknown.
   (iii) np - charts with known & unknown.

3. Control charts for varying sample size.

4. Draw O.C. & A.S.N. curve of:
   (i) Single sampling Plan.
   (ii) Double sample Plan.

5. Find producer's risk and consumer's risk.

6. Construction of single sample plan.

SEMESTER-II

MAST\MSST 201: Sampling Distributions

Course Objectives: The learning objectives include:

- This course will give understanding to students about jointly distributed random variables, distribution function of joint distribution, Simple correlation and regression, non-linear regression, regression of second kind, Sampling distribution of a function of random variables.
- This course gives knowledge of sampling distributions- Chi- Square, t and F distributions, Distribution arising from the bivariate normal distribution.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Students will have in depth knowledge of advance distribution theory including sampling distributions, non- central distributions and bivariate normal distribution.
- After this course, students will be in position to apply distributions in drawing inference.

UNIT I: Sampling Distributions: basic concepts, standard error, Chi-square test, t and F distributions (central and non -central) and their applications. Fisher's Z -distribution and its applications.

UNIT II: Standard errors of functions of moments, order statistics and their distributions and properties, joint and marginal distributions, sampling distributions of range and median of univariate population.

UNIT III: Bivariate Normal Distribution: Joint, marginal and conditional distributions and their properties.

UNIT IV: Correlation and Regression: Correlation, linear regression, intra class correlation and correlation ratio, Null and non-null distribution of sample correlation coefficient, power series distribution.

References:

1. Amold, B.C. Balakrishnan, N. and Nagaraja, H.N. (1992): A First Course in Order Statistics, Wiley.
2. Goon, Gupta & Das Gupta (1991): Outline of Statistical Theory, Vol.I, World Press.
3. Hogg, R.V. and craig, A.T. (1971): Introduction to Mathematical Statistics, McMillan.
4. Jonson, S. and Kotz, S. (1972): Distribution in Statistics, Vol.I,II and III, Houghton and Muffin.
5. Kendall, M.G. and Stuart, A. (1996): An Advanced Theory of Statistics, Vol. I, II. Charles Griffin.
6. Mood, A.M., Graybill, F.A. and Boes, D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
7. Mukhopadhyay P. (1996): Mathematical Statistics, New Central Book Agency(P)Ltd. Calcutta.
8. Rao, C.R. (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.
9. Rohatgi, V.K. (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

MAST\MSST 202: Statistical inference-I

Course Objectives: The learning objectives include:

- This course will give understanding to students about point estimation, Cramer –Rao inequality, Rao –Blackwell theorem, Lehman-Scheffe theorem
- This course gives very much knowledge of various methods of estimation and testing of hypothesis.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Apply various estimation and testing procedures to deal with real life problems.
- Understand Fisher Information, Lower bounds to variance of estimators, MVUE.
- Understand Neyman-Pearson fundamental lemma, UMP test, Interval estimation and confidence interval.

UNIT I: Point Estimation, Criteria of a good estimator: Unbiasedness, Consistency, Efficiency, Sufficiency. Fisher Neyman Factorization theorem, Rao-Blackwell theorem, minimum variance unbiased estimators, uniformly minimum variance unbiased estimator (UMVUE), Cramer-Rao inequality.

UNIT II: Methods of estimation: Method of maximum likelihood, properties of maximum likelihood estimators (with proof), method of moments, minimum chi-square and modified minimum chi-square. Confidence interval and Determination of confidence intervals based on large samples & small samples. Statistical hypothesis: Simple and composite, critical region, types of errors, level of significance, power of a test, most powerful test and Neyman-Pearson lemma.

UNIT III: Sequential Analysis: Definition and construction of S.P.R.T. Fundamental relation among $\propto, \beta,$ A and B. Wald's inequality. Determination of A and B in practice. Average sample number and operating characteristic curve.

UNIT V: Non - Parametric Tests: Parametric v/s non-parametric methods, Test for one sample problems- Sign test, signed rank test, Kolmogorov-Smirnov one sample test, Tests for two sample problems: Wald Wolfowitz Run test, Kolmogorov-Smirnov two sample test(for sample of equal size), Median test, Mann-Whitney U-test, Test of randomness using run test based on the total number of runs and the length of a run. Kruskal-Wallis k-sample Test. Concept of asymptotic efficiency (ARE).

References:

1. Goon, A. M., Gupta,M. K. and Dasgupta, B: An Outline of Statistical Theory, Vol.I, World Press.
2. Gupta, S .C. and Kapoor,V. K. : Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
3. Lehmann, E. L.: Theory of Point Estimation, Springer.
4. Lehmann, E. L.: Testing of Statistical Hypothesis, Springer.
5. Rao, C. R. : Linear Statistical Inference and its Application,John Wiley & Sons.
6. Mood, M. A., Graybill, F. A and. Boes, D. C.: Introduction to the Theory of Statistics, McGraw Hill.
7. Rohtagi.,V.K. : An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
8. Mukhopadhyay, P: Mathematical Statistics, Books & Allied.

MAST\MSST 203: Design of Experiments-I

Course Objectives: The learning objectives include:

- To learn to design and conduct experiments.
- To analyze and interpret the data.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Linear Model.
- One-way and two-way analysis of variance.
- Basic concepts of design of experiments.
- Completely randomized Design, Randomized Block Design, Latin Square Design.
- Split-Plot Design, strip plot designs, BIBD.
- Confounded factorial experiments

UNIT I: Analysis of experimental model by least square. Regression Analysis (case of full rank). Variance and Covariance.

UNIT II: One-way and two-way classification, fixed, random and mixed effects models. Analysis of variance (one way and two-way classification).

UNIT III: Principles of Design of Experiments, uniformity trails, randomized experiments, Completely Randomized design, Randomized block design, Latin Square Design, Factorial Experiment 2^n and 3^2, total and Partial confounding, Construction of confounded factorial experiments belonging 2^n series.

UNIT IV: Analysis of non orthogonal data, analysis of missing plot and mixed plot data. Split Plot Design, strip plot designs. Balanced and Incomplete Block Design (intra- block analysis.)

References:

1. Kshirsagar, A.M. (1983): A Course in linear Models, M. Dekker.
2. Rao, C.R. (1973): Linera Statistical Inference and its Application, Wiley Eastern.
3. Gupta, S.C. and Kapoor, V.K. (2011): Fundamental of Applied Statistics, Sultan Chand & Sons.
4. Cochran, W.G. and Cox, G.M. (1950): Experimental Design, Wiley; Chapman & Hall.
5. Das, M.N. and Giri, N.C.(1979) : Design and Analysis of experiments, Wiley Eastern.

MAST\MSST 204: Demography

Course Objective: The learning objectives include:

- This paper aims at teaching the students to develop their knowledge to make comparisons between countries demography.
- Vital Statistic deals with laws of human mortality, morbidity and fertility

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Utilizing information sources and indicators on the population, including censuses, vital statistics and surveys, and understanding how to access and use such data.
- Analyze the basic concepts used in the description and study of a population with a particular focus on three fundamental demographic processes in the dynamics and composition of a population: mortality, fertility and migration.
- Analyze the results and research in Demography.

UNIT I: Sources of Demographic data, census, registration, ad-hoc surveys, Vital Rates and Ratios. Demographic profiles of the Indian Census.

UNIT II: Measurement of Mortality: Crude Death Rate, Standardized Death Rates, Age-Specific Death Rates, Infant Mortality Rate, Maternal Mortality Rate, Death Rate by cause. Measurement of Fertility: Crude Birth Rate, General Fertility Rate, Age- Specific Birth Rate, Total Fertility Rate, Gross Reproduction rate, Net Reproduction Rate.

UNIT III: Complete life table and its main features, Uses of life table. Makeham's and Gompertz curves. Abridged life tables (Greville's Formula, Reed-Merrels's Formula and King's Method). Stable and stationary populations.

UNIT IV: Internal migration and its measurement, migration models, concept of international migration. Net migration. International and post censal estimates. Projection method including logistic curve fitting. Decennial population census in India.

References:

1. Kaul, R. & Chawdhary: Applied Statistics, Indian Official Statistics (free downloadable).
2. Saluja, M.R.: Indian Official Statistical Systems, Statistical Pub. Society, India.
3. Asthana, B.N. & Shrivastav, S.S.: Applied Statistics of India, Chaitanya Publishing House, India.
4. Reports of MOSPI, CSO etc.
5. Cox., P.R. (1970): Demography, Cambridge University Press.

MAST\MSST 205: Measure Theory

Course Objectives: The learning objectives include:

- To understand the concept of measure theory.
- To explore the basic and advance concepts available in measure theory.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understand the meaning of measure theory.
- Comprehend the concepts of sets, functions, measure and probability space.
- Provide basic and advanced application.

Unit-I: Classes of sets: semi ring, ring, field, sigma field, monotone classes. Sequence of sets, limit supremum and limit infimum of a sequence of sets. Additive set functions, measure, outer measure and their properties.

Unit-II: Cartheodry extension theorem (statement only) definition of complete measure. Lebesgue and Lebsegue Stieltjes measure (one dimension only) Probability measure, distribution function and its correspondence with Lebesgue Stieltjes.

Unit-III: Measurable sets and measurable space. Simple, elementary and measurable functions. Sequence of measurable functions. Integrability of measurable function, properties of integrals.

Unit-IV: Lebesgue monotone convergence theorems, Fatous lemma, dominance convergence theorem, Absolute continuity, Random Nikodym theorem (statement only) and applications, product measure (idea only), Fubinies theorem.

Reference:

1.Kingman J.F. & Taylor. S.J. (1996): Introduction to Measure and Probability, Cambridge Univ. Press.
2. Billingsley, P. (1986): Probability and measure, \Viley Publications.
3. Dudley, R.M. (1989): Real Analysis and Probability, Worlds Worth & Books.
4. Tucket, H.G. (1967): A graduate course in Probability, Academic Press.
5. Basu, A.K. (1999): Measure Theory and Probability, PHI.

MAST\MSST 206: Operation Research -I

Course Objective: The learning objectives include:

- The objective of this paper is to introduce the basic concepts of Operational Research.
- Give concepts of Sequencing Problem and Inventory Control System to the students.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- To know the scope of Operations Research.
- To link the OR techniques with business environment and life sciences.
- To convert real life problems into mathematical models.
- To inculcate logical thinking to find a solution to the problem

UNIT I: Operational Research: Definition, Scope, phases, principles, models. Allocation Problems-LPP with Duality Problems, Transportation and Assignment Problems. Monte-Carlo Simulation Technique and its Application.

UNIT II: Sequencing Problem: Assumption, Solution of n jobs 2 machines system, Johnson Algorithm, Processing of n jobs and 3 Machines.

UNIT III: Inventory Control System: Inventory models, costs, advantages, EOQ models without shortages, reorder level and optimum buffer stock, EOQ models with shortages and quantity discounts. ABC analysis, Multi-item inventory subject to constraints. Models with random demand, the static risk model. P and Q-systems with constant and random lead times.

UNIT IV: Queuing System: Characteristics of queuing system, Poisson process, pure birth and pure death process. Steady state solution of (M/M/1) and (M/M/C) models. (M/M/1) model-Pollaczek khintchine formula.

References:

1. Sharma, S.D.: Operation Research, Kedarnath Ramnath & Co. 5.
2. Kanti swaroop, Gupta P.K. & Singh, M.: Operation Research, Sultan Chand and Sons.
3. Gass, S.L.(1969): Linear Programming, 3/e Me Graw-Hill Kogakusha, Tokyo.
4. Hardly, G. (1962): Linear programming Addison Wesley, Reading Mass Masachusetts.
5. Vohra, N.D.: Quantitative Techniques in Management, Tata Mc Grew Hill Pub. Co. New Delhi.
6. Makinsey, J.C.: Introduction to Game Theory, Me Grew Hill.
7. Taha H.A. (2017): Operations Research An Introduction

MAST\MSST 251: Practical based on MAST\MSST 201,202&203

Course Objective: The learning objectives include:

- To understand the role of statistics in analyzing and interpreting data meaningfully, and to develop problem-solving skills in sampling distribution, statistical Inference- I and Design of Experiment - I.

Course Learning Outcome: After successful completion of this course, student will be able to:

- A clear understanding of the skill to select appropriate methods to present data and gain the skills to evaluate sampling distribution, statistical Inference- I and Design of Experiment - I.

List of Practical:

MAST\MSST 201: Sampling Distributions:

1.Correlation and regression coefficients for Bivariate frequency distributions.
2. Large sample tests. (i) For population mean (ii) equality of two population means. (iii) For population variance (iv) equality of two population variances.
3. Small sample tests viz. t, F, x^2 and Z tests.
4. Bartlett's test for homogeneity of variances.

MAST\MSST 202: Statistical Inference-I

1. Test of significance of sample correlation coefficient.
2. Sign, median and run tests for small and large samples.
3. Sequential probability ratio test and calculation of constants and graphical representation for testing simple null against simple alternative for
(i) Binomial (ii) Poission (iii) Normal (iv) Exponential distributions.

MAST\MSST 203: Design of Experiment -I

1. One-way classified data.
2. Two -way classification with single and equal observations.
3. Two -way classification with unequal observations
4. Analysis of CRD, RBD, LSD with and without missing observations.
7. Analysis of BIBD.
8. Yates method for analysis
9. 2^n factorial experiments for n=3
10. 2^n factorial experiments for n = 4
11. Total confounding in 2^n, n = 3, 4
12. Partial confounding in 2^n, n = 3, 4
13. 3^2 factorial experiments.
14. Analysis of a confounded factorial experiment.
15. Analysis of covariance in one- way classified data.
16. Analysis of covariance in two- way classified data.

MAST\MSST 252: Practical Based on Elective Papers

Course Objectives: The learning objectives include:

- To familiarize the students with the handling of demography, Applied Statistics and Operation Research which are useful in day-to- day life.

Course Outcomes: After successful completion of this course, student will be able to:

- A clear understanding of analyzing the death & birth rate of the data by various mortality & morbidity methods. Students are able to analyze operation research problem by different methods.

List of Practical:

MAST\MSST 204: Demography

1. Computation of various Death rates.
2. Computation of various Birth rates, NRR, GRR.
3. Construction of Life tables- Abridged, Lotka Life Tables
4. Construction of Makeham's and Gompertz curves.
5. Logistic curve fitting for projection.

MAST\MSST 206: Operation Research

1. Problems based on Monte Carlo Simulation
2. Duality problems
3. Transportation Problems
4. Assignment Problems
5. Replacement Problems and Sequencing Problems
6. Simulation Problems based on Inventory Control and Queuing Problems

SEMESTER -III

MAST\MSST 301: Design of Experiment -II

Course Objectives: The learning objectives include:

- To learn linear models and analysis of experimental design.
- To analyse and interpret the linked block designs and intra-block design.
- Construction of Latin squares.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- A clear understanding of different linear models, experimental designs, block designs, PBIBD.

UNIT I: Linear Models: Theory of linear estimation, Gauss-Markov Theorem, estimable functions, error and estimation space, normal equations and least square estimators, estimation of Error variance, estimation with correlated observations, properties of least square estimators, generalized inverse of a matrix and solution of normal equations, variances and covariances of least square estimators. Testing of hypothesis: involving several linear functions, test of sub-hypothesis and test involving equality of the parameters.

UNIT II: General theory of analysis of experimental designs. Desirable properties of a good design: orthogonality, connectedness and balancing. Various optimality criteria and their interpretations. Relation between blocks of incomplete block designs, duality, resolvability and affine resolvability. Theorems on bounds.

UNIT III: Group divisible, lattice and linked block designs-intra-block analysis. Designs for two-way elimination of heterogeneity and Youden square designs. Elementary ideas of response-surface and rotatable designs.

UNIT IV: Constructions of orthogonal Latin squares - (i) for prime power numbers and (ii) by Mann-Mechneish theorem. Simple methods of construction of BIB, PBID designs. Constructions of symmetrical fractional experiments.

References:

1. Atkinson, A.C. and Donev. A.N.(1992): Optimal Experimental Design, Oxford University Press.
2. Raghava Rao. (1971): Construction and Combinatorial Problems in Design of Experiments, John Wiley.
3. Chakravarti, M.C. (1962): Mathematics of Design of Experiments, Asia Publishing House.
4. John, P.W.N. (1971): Statistical Design and Analysis of Experiments, Mc Milian.
5. Khuri, A.N. and Cornell, M. (1991): Response Surface Methodology, Marchell & Decker.
6. Shah, K.R. and Sinha, 13;1 (1989): Theory of Optimal Design, Springer-Verlog.
7. Dey, Alok, (1987): Theory of Block Designs, John Wiley & Sons
8. Montgomery, D.C.: Design and Analysis of Experiments, John Wiley & Sons Inc., Eighth Edition

MAST\MSST 302: Statistical Inference-II

Course Objectives: The learning objectives include:

- To impart the in-depth knowledge of nonconventional methods of statistical decision making such as decision theory, sequential analysis.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Inferences in different critical circumstances using decision theory, sequential analysis, Statistical Decision Problem and Game theory.

UNIT I: Location Invariance, scale invariance. Pitmann's estimators for location and scale parameters. Proof of the properties of M.L.E, Huzur Bazaar theorem, consistent asymptotic normal (CAN) estimator, invariance property. Resampling, Bookstrap and Jacknife.

UNIT II: Completeness and Lehmann-Scheffe theorem, minimal sufficient statistic, Wilks likelihood ratio tests estimator, invariance of consistent asymptotic normal estimator. Asymptotic distribution of likelihood ratio statistic. Bartlett's test for homogeneity of variances.

UNIT III: Generalized Neyman- Pearson lemma. Randomized tests. Uniformly most powerful tests for two-sided hypothesis. Unbiased tests. Uniformly most powerful unbiased tests. Tests with Neyman's Structures and its relation with complete family of distributions.

UNIT IV: Basic Elements of Statistical Decision Problem and Game theory. Various inference problems viewed as decision problem. Randomization optimal decision rules. Bayes and minimax decision rule. Generalized Bayes rule.

Reference:

1. Cramer, H. (1946): Mathematical methods of Statistics, Princeton University Press.
2. Goon and others. (1991): Outline of Statistical theory, Vol. I, World Press.
3. Kendall, M.G. and Stuart, A. (1971): Advanced Theory of Statistic Vol. I and II, Charles Griffin.
4. Mood, Graybill and Boes. (1974): Introduction to the theory of Statistics 3rd ed, McGraw-Hill.
5. Hogg, R.V. and Craig, A.T. (1971): Introduction to Mathematical Statistics, Princeton University Press.

MAST\MSST 303: Sample Surveys-I

Course Objectives: The learning objectives include:

- To learn scientific view to conduct the survey in proper way to collect the data about specific perspective. ·
- To learn variety of probability sampling methods for selecting a sample from a population.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understand the basic principles underlying survey design and estimation.
- Apply the different sampling methods for designing and selecting a sample from a population.

UNIT I: Planning, execution and analyses of sample surveys with illustrative examples. Errors in survey, sources of non-sampling errors. Determination of sample size.

UNIT II: Basic finite population sampling techniques: Simple random sampling with and without replacement. Stratified sampling. Sample allocation problems in stratified sampling and related results on estimator of mean/total.

UNIT III: Systematic sampling, cluster sampling, two-stage sampling with equal and unequal number of second stage units, Multistage sampling. Estimation of their Population Mean, Total and Standard Errors.

UNIT IV: Use of Auxiliary Information: Ratio, product and regression methods of estimation, their comparisons among them, and with sample mean under SRSWOR. Concept of double sampling and its uses in ratio, product and regression methods of estimation.

References:

1. Chaudhuri,. A. and Mukerjee, R. (1988): Randornized Responses. Theory and Techniques, New York: Marcel Dekker Inc.
2. Cochran,W.G. (1984):Sampling -Techniques (3rd ed.),Wiley.
3. Des Raj & Chandak (1998): Sampling Theory, Narosa Publishing House.
4. Murthy, M.N. (1971): Sampling Theory and Methods, Statistical Publishing Society, Calcutta
5. Sampath, S. (2000): Sampling theory and Methods, Narosa Publishing House
6. Singh, D., and Chaudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, New Age International Publishers.
7. Sukhatme, B.V. (1984): Sample Survey methods and its Applications, Indian Society of Agricultural Statistics.

MAST\MSST 304: Econometrics

Course Objectives: The Learning objectives includes:

- This course introduces students to the econometric methods used to conduct empirical analysis based on the basic statistics.
- It offers the basic quantitative techniques needed to undertake applied research projects to establish the relationship between variables of interests across wide variety of disciplines.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- To estimate simple estimation and inferences about population parameters, to formulate empirical models and analyse data.
- An expertise in econometrics increases the job prospect of the students significantly.

UNIT I: Nature of econometrics, the general linear model (GLM) and its extensions, ordinary least squares (OLS) estimation and prediction, generalized least squares (GLS) estimation and prediction, heteroscedastic disturbances, pure and mixed estimation.

UNIT II: Autocorrelation, its consequences and tests. Theil BLUS procedure, estimation and prediction, multi-collinearity problem, its implications and tools for handling the problem, ridge regression.

UNIT III: Linear regression and stochastic regression, instrumental variable estimation, Errors invariables, auto regressive linear regression, lagged variables, distributed Lag models, estimation of lags by OLS method, Koyck's geometric lag model. Simultaneous linear equations model and its generalization, identification problem, restrictions on structural parameters, rank and order conditions.

UNIT IV: Estimation in simultaneous equations model, recursive systems, 2SLS estimators, limited information estimators, k-class estimators, 3SLS estimator, full information. Maximum likelihood method, prediction and simultaneous confidence intervals.

References:

1. Gujarati, Porter & Gunaseker: Basic Econometrics, (Special Indian Edition), Vth Edition, McGrawHill Edition.
2. Anderson, T W.: The Statistical Analysis of Time series, Wiley, New York.
3. Barclay, : Techniques of Population Analysis, Wiley.
4. Brock well, P.J. and Davis, R.A.: Time Series-Theory and Methods (r^d Ed.) Springer-Verlag.
5. Chatfield, C.: The Analysis of Time Series- An Introduction, (2 Edn.) Chapman and Hall.
6. Croxton, Cowden and Klein :Applied General Statistics, PHI
7. Goon, A.M., Gupta. M.K. and Dasgupta, B. Fundamentals of Statistics. Vol. 2, World Press, Calcutta
8. Montgomery, D.C. and Johnson, L.A.: Forecasting in Time series Analysis, McGraw- Hill.
9. Kendall Sir Mourice and Ord, J.K.: Time Series, Edwards Arnolds.
10. Johnston, J. : Econometric Methods, 2nd Edition ,International Student Edition McGraw-Hill Kogakusha, Ltd. Tokyo

MAST\MSST 305: Numerical Analysis

Course Objective: The learning objectives include:

- To understand and implement various concepts of numerical analysis and statistics
- To solve real life problems.

Course Learning Outcome: After successful completion of this course, student will be able to:

- Understand the various approaches dealing the data using theory of numerical analysis.
- Analyze the different samples of data at different level of significance using various hypothesis testing.
- Develop a framework for estimating and predicting the different sample of data for handling the uncertainties.

UNIT I: Interpolation formulae (with remainder term) due to Lagrange's Newton-Gregory, Newton's Divided difference formulae. Central difference formulae: Gauss, Sterling& Bessel. Concept of Error terms in interpolation formulae.

UNIT II: Numerical differentiation and Integration: Trapezoidal, Simpson's $1/3^{rd}$ and 3/8 rules, Weddle's Rules. Numerical solution of ordinary differential equations. Euler, Milne, Picard and Runge-Kutta Methods.

UNIT III: Eular-Maclaurin's summation formula. Summation of series with first difference of function and Geometric Progression. Inverse interpolation. Difference equations: Linear difference equations with constant coefficients.

UNIT IV: Iterative solution of Non-Linear Equations- Bisection Method, Regula-Falsi method, Secant method, Newton -Raphson method, Method of Successive Approximation. Solution of Simultaneous Linear equation: Gauss elimination method, Factorization method, Jacobi's method, Cramer's rule, Gauss- Seidel Iterative math.

References

1. Goel, B. S. and Kumar , S. (1972) : Numerical Analysis, Ist Edition, Pragati Prakashan.
2. Goel, B. S. and Mittal, S. K. (1977) : Numerical Analysis, IInd Edition, Pragati Prakashan.
3. Jacques, I and Colin, J. (1987) : Numerical Analysis, Chapman and Hall, London New York.
4. Stanton, R. G. (1985) : Numerical Methods for Science and Engineering, Prentice Hall of India Pvt. Limited, New Delhi.
5. Kress, R: Numerical Analysis Paperback, Springer.

MAST\MSST 306: Operation Research-II

Course Objectives: The learning objectives include:

- To educate students for building and applying mathematical and statistical models for real life problems faced in different situations.
- Methods to be covered in this course dynamic programming, theory of games, PERT and CPM, decision analysis etc.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Building and applying mathematical and statistical models for real life problems.
- To apply solution methods such as dynamic programming, theory of games, PERT and CPM, decision analysis etc. in real life situations.

UNIT I: Dynamic Programming: Definition, Algorithm,, Formulation of Dynamic Programming, Bellman's principle of optimality, Computational methods and application of dynamic programming to LPP.

UNIT II: PERT & CPM: Definitions**,** Basic Steps of PERT/CPM, Terminologies, Rules, Uses, Disadvantages, Time Estimate and Network Analysis, Resources Allocation.

UNIT III: Game Theory: Basics, Decision-making in the face of competition, Characteristics of Games, Two-Person Zero Sum Games, Saddle Point, Mixed Strategy, dominance criteria, Minimax-Maximax Criterion, Solution of mxn games, Solution by LPP.

UNIT IV: Decision Analysis: Types, Components, Laplace Criteria, Hurwitz Criteria, Decision under Risk. Replacement Models for items that fail or deteriorate.

References:

1. Taha, H.A. (1999): Operation Research, McMillan Publishing Co. Inc 6th Edition,
2. Kanti Swaroop et. al Operation Research, Sultan Chand & Sons.
3. Gross, D. & Harris C.M., Fundamentals of Queueing Theory, John Wiley & Sons.
4. Sharma, S.D., Operation Research, Kedar Nath Pub. Meerut.
5. Bronso, R. et. al. (1983), Schaum's outlines Operation Research, Tata McGraw Hill Edition
6. Klienrock, L. (1975): Queueing System, Vol. 1 Theory, John Wiley.
7. Mckinsey, J. C. C. (1952): Introduction to the theory of games, McGraw Hill

MAST\MSST 307: Survival Analysis

Course Objective: The learning objectives include:

- The broad goal of survival analysis is to address scientific queries about a time-to-event distribution while appropriately accounting for the data incompleteness that often characterizes biomedical data.
- This course covers the foundations of survival analysis, with a particular emphasis on topics relevant to epidemiology, public health and medicine.
- The focus of the course is on non-parametric and semiparametric techniques although common parametric approaches are also discussed.

Course Learning Outcomes: After successful completion of this course, the student will be able to:

- Give basic definitions or descriptions of central concepts in survival analysis. Estimate survival curves, Life distribution-Exponential Gamma, Weibull, Lognormal, Pareto.
- Give Linear Failure rate, Estimate survival curves, hazard rates and measures of central tendency using simple parametric models.
- To Describe the methods and results of a survival analysis to a non-statistical reader.

UNIT I: Concepts of time, order and random censoring, likelihood in these cases. Life distribution-Exponential Gamma, Weibull, Lognormal, Pareto. Linear Failure rate. Accelerated Failure Time Distribution, Mean Residual Life and properties. Log-Logistic Distribution. Censoring techniques.

UNIT II: Parametric inference (Point estimation, Confidence intervals Scores, LR, MLE tests (Rao-Willks-Wald) for these distribution life tables failure rate, mean residual life and their elementary properties. Ageing classes-and their properties, Bathtub failure rate.

UNIT III: Estimation of survival function- Actuarial estimator, Kaplan-Meier estimator, estimation under the assumption of IFRIDFR. Tests of exponentially against non-parametric classes, total time on test, Deshpande test. Two sample problem-Gehan test, log rank test Mantel—Haenszel test, Tarone-Ware tests.

UNIT IV: Cox's proportional hazards model with one and several covariates. Rank test for the regression coefficients. Competing risks model, parametric and non-parametric inference for this model. Assumptions, extended Cox model, MLE of Cox PH model, hazard ratio, survival curves.

References:

1. Gross A.J. and Clark, V.A. (1975) Survival Distribution: Reliability applications in the Biomedical Sciences, John Wiley and Sons.
2. Elandt - Johnson, R.E. Johnson N.L. (1980) : Survival Models and Data Analysis, John Wiley and Sons.
3. Miller, R.G. (1981): Survival Analysis, John Wiley.
4. Kalbfleisch J.D. and Prentice R.L. (1980): The Statistical Analysis of Failure Time Data, John Wiley.
5. Kleinbaum, D.G. & Klein, Mitchel (2008): Survival Analysis —A Self Learning Text, Springer International Edition, Spinger

MAST\MSST 351: Practical Based on paper MAST\MSST 301,302&303

Course Objectives: The learning objectives include:

- These papers are focused on the study of Design of Experiment, Statistical Inference-II, Sample Survey. Design of Experiment deals with testing of hypothesis. Role of binomial, poisson, normal & exponential distribution in hypothesis. In sample survey, we will study about different methods of sampling.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Developed a clear understanding of Design of Experiment, Statistical Inference and Sample Surveys.

List of Practical:

MAST\MSST 301: Design of Experiment -II

1. Testing of Hypotheses regarding equality of some treatment effects in one and two way classifications.
2. Analysis of Incomplete block designs without specific form of C matrix.
3. Group divisible designs.
4. Linked Block designs.
5. Simple lattice designs with 2 or more replications.
6. Youden square Designs.

MAST\MSST 302: Statistical Inference -II

1. Power curve for testing one sided Null Hypothesis, hypothesis against one sided and two sided alternative for Binomial distribution, Poisson distribution, Normal distribution & Exponential distribution
2. Construction of Randomized test of a desired size for testing simple null against simple alternative hypothesis for (i) Bernoulli's trial (ii) Poisson distribution.
3. Test of hypothesis using generalized likelihood ratio test for testing equality of (i) two means (ii) two variances in normal distribution(s).

MAST\MSST 303: (Sample Surveys -I)

1.Drawing of random samples from finite populations.
2. Drawing of random samples from Binomial and Normal populations.
3. Estimation of population mean & estimation of variance in SRS with and without replacement.
4. Estimation of mean & variance in stratified sampling under proportional and optimum allocations.
5. Gain in precision due to stratification.
6. Estimation of mean variance in systematic sampling and comparison with S.R.S.
7. Estimation of mean & variance in cluster sampling and comparison with S.R.S.
8. Estimation of mean & variance by (i) ratio and (ii) regression methods of estimation

MAST\MSST 352: Practical Based on elective papers

Course Objectives: The learning objectives include:

- The students would be exposed to concepts of Econometrics, Numerical Analysis and Operation Research -II so as to enable them to understand the concepts involved in estimation, analysing & programming their models, methods and fitting various curves.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understanding of various Econometrics estimation, various methods of estimation of equations, programming of game theory & apply these techniques in real life situations.

List of Practical:

MAST\MSST 304: Econometrics

1. OLS estimation and prediction in GLM.
2. Use of dummy variables (dummy variable trap) and seasonal adjustment.
3. GLS estimation and prediction.
4. Tests for Heteroscedasticity : pure and mixed estimation.
5. Tests for autocorrelation. BLUS procedure.
6. Ridge regression.
7. Instrumental variable estimation.
8. Estimation with lagged dependent variables.
9. Identification problems - checking rank and order conditions.
10. Estimation in recursive systems.
11. 2SLS and 3SLS estimation.

MAST\MSST 305: Numerical Analysis

1. Interpolation formulae: Langrange's, Newton-Gregory, Newton divided formulae.
2. Central difference formulae: Gauss, Sterling.
3. Trapezoidal, Simpon's 1/3rd and 3/8 rules
4. Differential equations: Euler, Milne. Runga-Kutta Methods.
5. Inverse interpolation.
6. Difference equations.

MAST\MSST 306: Operation Research — II

1. Practical based on Dynamic Programming
2. PERT CPM
3. Game Theory
4. Decision Analysis
5. Replacement Problems.

MAST\MSST 307: Survival Analysis

1. Fitting of Exponential, Gamma, Weibull, Lognormal, Pareto Distributions.
2. Deshpande test.
3. Two sample problem-Gehan test, log rank test, Mantel - Haenszel test, Tarone-Ware tests.
4. Rank test for the regression coefficients.

Semester IV
MAST\MSST 401: Multivariate Analysis

Course Objectives: The learning objectives include:

- To introduce students to the analysis of observations on several correlated random variables for a number of individuals.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Account for important theorems and concepts in multivariate analysis.
- Summarize and interpret multivariate data.
- Appreciate the range of multivariate techniques available.
- Understand the link between multivariate techniques and corresponding univariate techniques.
- Conduct statistical inference about multivariate means including hypothesis testing, confidence region calculation, etc.
- Use multivariate techniques appropriately, and draw appropriate conclusions.

Unit-I: Multivariate normal distribution, marginal and conditional distributions, joint distribution of linear function of correlated normal variates. Characteristic function of multivariate normal distribution. Distribution of quadratic forms. Canonical variates.

Unit-II: Maximum likelihood estimator of the mean vector and covariance, their independence and related distributions. Partial and multiple correlation coefficients.

Unit-III: Classification and discrimination procedure for discrimination between two multivariate normal populations, sample discriminate function, test associated with discriminate functions probabilities of misclassification and their estimation.

Unit-IV: Hotel1ing-T^2 and its properties and applications, Mahalanobis -D^2. Wishart distributions and its properties. Principal Components. Wilk's criterion, canonical variates and correlation.

References:

1. Anderson, T.W. (1984): An Introduction to Multivariate Statistical Analysis, 2nd ed, John Wiley
2. Rao, C.R. (1973): Linear Statistical Inference and its Applications ,2nd ed, Wiley.
3. Srlvastava, M.S. and Khatri, C.G. (1970): An Introduction to Multivariate Statistics, Holland.
4. Morrison, D.F. (1976): Multivariate Statistical Methods, McGraw- Hill.
5. Muirhead, R.J.(1982): Aspects of Multivariate Statistical Theory, John Wiley.
6. Kshirsagar, A.M. (1972). Multivariate Analysis, Marshell & Decker.
7. Roy, S.N. (1957): Some Aspects of Multivariate Analysis, John Wiley.

MAST\MSST 402: Sample Survey-II

Course Objectives: The learning objectives include:

- This paper shall expose the students to different aspects of sample survey in estimation of parameters.
- Necessary theoretical deductions of different sampling techniques

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understand various sampling procedure and its applications
- Understand auxiliary information and its use in sampling estimation

Unit – I: Rational behind the use of unequal probability sampling: Probability proportional to size with and without replacement method (including cumulative total method and Lahri's method), related estimators of finite population mean (Hansen-Hourwitz, Desraj's estimators for general sample size & Murthy's estimator for a sample of size of 2). Horvitz Thompson estimator (HTE) of a finite population total/mean and expression for variance of HTE and its unbiased estimator due to Horvitz-Thompson and Yates & Grundy.

Unit – II: P.P.S. Schemes of sampling due to Midzuno-Sen, Brewer, Durbin and JNK Rao (sample size of 2 only), Rao-Hartley and Cochran sampling scheme and their estimation procedure. Theory of multi-stage sampling with varying probabilities (with or without replacement) due to Durbin. Narain and Sukhatme sampling schemes.

Unit –III: Quenouille's technique of bias reduction and its application to ratio type estimator, Hartley and Ross unbiased ratio type estimator. Ratio method of estimator under Midzuno scheme of sampling when X is known.

Unit – IV: Non-Sampling Errors: Hansen-Hurwitz approach of estimations from incomplete sample. Politz and Simmon's techniques of estimation, randomized response model due to Warner. Simmons unrelated question randomized response model.

References:

1. Cocharan,W.G (1997): Sampling Techniques III ed, John Wiley Pub. New Yark.
2. Des Raj and Chandok (1998): Sampling Theory, Norsa Pub. New Delhi.
3. Murthy, M.N. (1962): Sampling Theory and Methods, Statistical Pub. Society, Kolkata.
4. Chaudhary, A and. Mukherjee R (1988): Randomised Response: Theory & Techniques, Marcel Dekker Inc New Yark.
5. Shukhatme, P.V.et al(1984): Sampling Theory of Surveys in the Applications, lawa State press & Ind.Soc. of Agri. Stat.
6. Mukhopadhy, P.(1996): Inferencial Problems in Survey Sampling, New Age International.
7. Singh, D. & Choudhary,F.S.(1986): Theory and Analysis of Sample Surveys and its Applications, New Age international Publication.

MAST\MSST 403: Applied Statistics

Course Objectives: The learning objectives include:

- Understand the concept of Index numbers, time series and its components and their estimation. Application of time series.
- Demand Function. Price and income elasticity of demand.
- To learn techniques and approach of stationary processes.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- To appreciate, formulate solutions, analyze use of index numbers and time series,
- Demand Analysis to real world problems and understanding of Stationary process and its different methods.

UNIT I: Index Numbers: Price, Quantity and Volume Relative Index, Link and Chain relative composition of index numbers: Laspeyre's, Paasche's, Drobish and Bowley, Edgeworth-Marshall, Fisher index numbers; chain base index number, tests for index number. Construction of index numbers of wholesale and consumer prices.

UNIT II: Income Distribution: Pareto Curve, Concentration Curve, Methods of estimating national income, Inter-Sectoral flows, Inter-industry table. Demand Analysis-Price Elasticity of Demand and Supply. Partial Elasticity of Demand. Elasticity Estimation-Leontief's, Pigou Methods.

UNIT III: Time Series Analysis: Economic time series, different components, illustration, additive and multiplicative models, determination of trend, seasonal and cyclical fluctuations. Time-series as discrete parameter stochastic process, auto covariance and auto-correlation functions and their properties. Exploratory time series analysis, tests for trend and seasonality, exponential and moving average smoothing. Holt and Winters smoothing, forecasting based on smoothing.

UNIT IV: Detailed study of the stationary processes: Moving Average (MA), Auto Regressive (AR), ARMA and AR integrated MA (ARIMA) models. Box-Jenkins models, choice of AR and MA periods. Discussion (without proof) of estimation of mean, auto covariance and auto-correlation functions under large sample theory, estimation of ARIMA model parameters. Spectral analysis of weakly stationary process, periodogram and correlogram analysis, computations based on Fourier transform.

References:

1. Anderson, T.W. (1971): The Statistical Analysis of Time series, Wiley, New York.
2. Brock well, P.J. and Davis, R.A. (1991): Time Series- Theory and Methods (2nd Ed.) Springer-Verlag.
3. Chatfield, C. (1980): The Analysis of Time Series-An Introduction (2nd Ed.) Chapman and Hall.
4. Croxton, Cowden and Klein (1971): Applied General Statistics, PHI
5. Goon, A.M., Gupta, M.K. and Dasgupta, B. (1986): Fundamentals of Statistics. Vol.2, World Press.
6. Montgomery, D.C. and Johnson, L.A. (1977): Forecasting in Time Series Analysis, McGraw-Hill.
7. Kendall Sir Mourice and Ord, J.K. (1990): Time Series, Edwards Amolds.
8. Gujarati, Porter & Gunaseker: Basic Econometrics, (Special Indian Edition), Vth Edition, McGrawHill Edition.

MAST\MSST 404: Population Studies

Course Objectives: The learning objectives include:

- To study established theories of population.
- To explore various aspects of the population policy and to study its impact on socio economic issues.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Gain a sound command over the basic tenents of population as well as key population issues and illustrations in the context of a large and diverse country like India.
- Grasp a clear understanding of the inter-relationship between population and the process of economic development.
- Comprehend the basic components of population(fertility, mortality and migration).

Unit-I: Source of Population Data & Methods of Population Analysis: Population Registers. India Census, Civil Registration System (CRS). Rates of population growth: arithmetic, geometric and exponential rates of growth; doubling time; location of events in time. Cohort and cross-sectional indicators. Crude rates and standardized methods.

Unit-II: Population Theories: Theories of population Growth- Malthus to modern; limits to population growth. Theory of Demographic Transition. Theories related to fertility. Methods of population projections. Inter-censual/Post-censual estimates of population.

Unit-III: Migration and Urbanization: Trends and differentials of migration. Determinants and consequences of migration. Concepts and definitions of urban; trends and patterns of urbanization in India. Issues in urbanization and urban problems in developing countries with focus on India.

Unit-IV: Population and Gender: Concept of gender-its relationship with components of population. Population policies in the context of growth, structure, distribution and quality of life. Nuptiality and Fertility: Concepts and measures of Nuptiality and Fertility. Levels, trends and differentials of Fertility in India. Sources of data on fertility. Determinants of fertility—Framework of fertility analysis; Bongaarfs proximate determinants of fertility.

References:

1. Bhede,A.A. & Kanitkar,T(2017): Principles of Population Studies, Himalaya Publishing House.
2. Pathak,K.B. & Ram,F.(2013): Techniques of Demographic Analysis, Himalaya Publishing House.
3. Yusuf,F,Martin,J.H, & Swanson, D.A.: Methods of Demographic Analysis, Springer Publication.
4. Chramichaei , Gorden,S. ()Fundamentals of Demographic Analysis-Concepts, Measures & Methods.
5. Jhingan,M.L.,Bhatt,B.K. & Desai,J.N.(2016) :Demography, Vrinda Publication Pvt.Ltd., N.Delhi
6. Mishra,B.D.(1982) :An Introduction to the Study of Population, South Eastern. Publishers,N.Delhi.
7. Barclay,George (1958) : Techniques of Population Analysis, John Wiley and Sons
8. Saluja,M.R(1972). : Indian official statistical systems, Statistical Pub. Society, India
9. Asthan,B.N. & Shrivastav,S.S.(1967): Applied Statistics of India, Chaitanya Publishing House,lndia

MAST\MSST 405: Stochastic Process

Course Objectives: The learning objectives include:

- To develop awareness for the use of stochastic models for representing random phenomena evolving in time such as inventory or queueing situations or stock prices behavior.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Use notions of long-time behaviour including transience, recurrence, and equilibrium in applied situations such as branching processes and random walk.
- Construct transition matrices for Markov dependent behaviour and summarize process information.
- Use selected statistical distributions for modeling various phenomena.
- Understand the principles and objectives of model building based on Markov chains, Poisson processes and Brownian motion.

Unit-I: Introduction of Stochastic Processes: Specifications of stochastic process, Markov process and Markov Chain. Classification of states. Determination of higher order transition probability and its limits. Limit theorems for Markov Chain, stationary distribution.

Unit-II: Stationary processes and its types. Discrete time Markov Chain, order of Markov Chain, Chapman-Kolmogorov Equations. Markov-Process with discrete state space: Poisson process and its generalization.

Unit-III: Pure Birth Process, Birth & death process, Erlangian Process. Marko Process with continuous state space, Wiener Process. Renewal Process., Renewal Theorem and its examples.

Unit-IV: Branching Process: Galeton-Watson's branching process, properties of generating function of branching process. Probability of ' extinction, distribution of total number of Progeny. Random walk, gambler's ruin's problem.

References:

1. Adke, S.R. & Manjunath S.M. (1984): An Introduction of Finite Markov Processes, Wiley Eastern.
2. Bhatt ,B.R. (2000): Stochastic Models: Analysis and applications, New Age International, India
3. Harris, T.E. (1963): The Theory of Branching processes, Springer-Verlag.
4. Medhi, J (1982): Stochastic Processes, Wiley Eastern.
5. Ballingsley, P (1962): Statistical Inference for Markov Chains, Chicago University Press, Chicago.
6. Ross, S.M (1983); Stochastic Processes, Wiley.

MAST\MSST 406: Reliability Theory

Course Objectives: The learning objectives include:

- To knowledge students in different probability models in the reliability evaluation of the system and its components.
- To reduce failures, ensure effective maintenance and optimize repair time in the industry.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Demonstrate the understanding of basic concepts of reliability.
- Analyse system reliability using probability models.
- Evaluate reliability from the lifetime data using common estimation procedures.
- Create a stress – strength model for system reliability.

Unit-I: Reliability: Concepts and measures, components and systems, coherent systems, reliability of coherent systems; cuts and paths, modular decomposition, bounds on system reliability, structural and reliability importance of components. Life distributions, reliability function; hazard rate; common life distributions-exponential, Weibull, Gamma etc. Estimation of parameters and tests in these models.

Unit-II: Notions of ageing, IFR, IFRA, NBU, DMRL and NBUE classes and their duals, loss of memory property of the exponential distribution; closures or these classes under formation of coherent systems, convolutions and mixtures. Univariate shock models and life distributions arising out of them; bivariate shock models; common bivariate exponential distribuations and their properties.

Unit-III: Reliability estimation based on failure times in variously censored life tests and in tests with replacement of failed items stress-strength reliability and its estimation. Maintenance and replacement policies, availability of repairable systems, modeling of a repairable system by q non-homogeneous Poisson process.

Unit-IV: Reliability growth models, probability plotting techniques, Hollander- Proschan and Deshpande tests for exponentiality; tests for HPP vs. NHPP with repairable systems. Basic ideas of accelerated life testing.

REFERENCES

1. Barlow R.E. and Proschan F. (1985): Statistical Theory of Reliability and Life Testing, Holt, Rinehart and Winston.
2. Lawless J.F. (1982): Statistical Models and Methods of Life Time Data, John Wiley.
3. Bain L.J. and Engelhardt (1991): Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker.
4. Nelson, W (1982): Applied Life Data Analysis, John Wiley.
5. Zacks S. (2004): Reliability Theory, Springer.
6. Sinha S.K. (1986): Reliability & Life Testing, Wiley7.Cox, D.R. and Oakes, D (1984): Analysis of Survival Data, Chapman and hall, New York.

MAST\MSST 407: Basic Statistics*

Course Objectives: The learning objectives include:

- To introduce the basics of statistics.
- Instill knowledge to compute statistical measures for analysing data.
- Instruct the basic theory and applications of probability.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understand the theory and applications of basic statistics.
- Compute statistical measures for decision making.
- Solve problems on basic probability.
- Performs correlation and regression analysis.
- Make interpretations of results from the derived results.

Unit-I: Concept of statistical Population and Data. Types of Data. Data Collection, Classification, Organizations, Representation (Diagrammatic & Graphical). Graphical presentation of data- Histogram, frequency polygon, frequency curve and ogives. Measures of central tendency, dispersion, skewness and kurtosis and its computation from data.
Correlation analysis- Assumption, Types-Scatter diagram, Karl-Pearson and Spearman's correlation. Regression analysis-Fitting of regression lines, regression coefficients and their properties and its computation from data.

Unit-II: Probability Theory: Random Experiment, Trial, Events and their types. Definitions-a priori and Axiomatic Probability Law of Probability- Addition and Multiplication. Conditional Probability. Computation of Probability. Random Variable: Definition with illustrations, Types of Random Variables. Basic Idea of Mathematical Expectation and its Laws. Probability Mass Function, Probability Density Function. Probability Distributions- Bernoulli, Binomial, Poisson and Normal with their properties, applications and computations.

Unit-III: Sampling &Samp1ing Distributions: Concepts of population and sample, need for sampling, census & Sample surveys. Advantages of sample survey. Simple, Random Sampling, Stratified and Systematic Sampling and their illustrations, advantages and disadvantages. Basic Concepts of Sampling Distributions. Idea of t, z, chi-square and F-distributions with their properties.

Unit-IV: Hypothesis and its Types. Test of Significance- t-test, z-test, Chi-Square Test and their applications. Analysis of Variance-Need, Assumptions, Applications. One way and Two ways ANOVA. Large Sample Tests-Single Mean and Two means. Basic Concept of Design of Experiments and types with layouts.

References:

1. Agrawal, B.L.: Basic Statistics, New Age International Pub.
2. Gupta, S.P.: Statistical Methods, Sultan Chand and Sons.
3. Elhance, D.N.: Fundamentals of Statistics
4. Croxton F.E., Cowden D.J. and Kelin S (1973): Applied General Statistics, PHI
5. Goon A.M., Gupta M.K., Das Gupta B. (1991): Fundamentals of Statistics, Vol-I, World Press, Kolkata.

MAST\MSST 408: Statistics for Clinical Trials

Course Objectives: The learning objectives include:

- To train the students in the design and conduct of clinical trials and provide knowledge about the methods of statistical data analysis of clinical trials.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understand the study designs of randomized clinical trials.
- Apply statistical principles, concepts and methods for the analysis of data in clinical trials.
- Demonstrate competencies in evaluating clinical research data and communicating results.
- Demonstrate advanced critical thinking skills necessary to advance within the biopharmaceutical industry.

Unit-I: Introduction to clinical trials: The need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, Phase I-IV trials, multi-center trials. Data management: data definitions, case report forms, database design, data collection systems for good clinical practice.

Unit-II: Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, review of factorial designs, objectives and endpoints of clinical trials.

Unit-III: Design of Phase I trials, design of single-stage and multi-stage Phase II trials, design and monitoring of Phase III trials with sequential stopping, design of bioequivalence trials.

Unit-IV: Reporting and analysis: analysis of categorical outcomes from Phase I-III trials, analysis of survival data from clinical trials. Surrogate endpoints: selection and design of trials with surrogate endpoints, analysis of surrogate endpoint data. Meta analysis of clinical trials.

REFERENCES:

1. C. Jennison and B.W. Tumbul (1999). Group Sequential Methods with Applications to Clinical Trials, CRC Preṣs.
2. E. Marubeni and M.G. Valsecchi (1994). Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley and Sons.
3. J.L. Fleiss (1989). The Dcsign and Analysis of Clinical Experiments. Wiley and Sons.
4. L.M. Friedman,C.Furburg, D.L.Demets (1998). Fundamentals of Clinical Trials, Springer Verlag.
5. S. Piantadosi t1997). Clinical Trials: A Methodologic Perspective. Wiley and Sons.

MAST\MSST 409: Project Work

Guidelines for Project Report

Project Duration: 1st January to 30th April. (Students may start preliminary related to their project after third semester.)

Project Guide: Teachers from the Department of Statistics. Each project group will be guided by concerned teacher (guide) for one hour per week throughout the semester.

Fieldwork: Students will be given 4 to 6 weeks during last semester for their industrial work/data collection/survey or any other fieldwork involved in the project.

Project Topic: Students in consultation with the guide will decide Project Topic/Area. Topic may be decided after completion of third semester. Project work may be carried out in a group of students depending upon the depth of fieldwork/ problem involved.

Project report: Project report should be submitted as per norms.

Project Evaluation: Project valuation will be done according norms.

(i) Project Report (60marks)

(ii) Presentation by student or group of students. (40 marks)

Project report will be evaluated from the external examiners.

MAST\MSST 451: Practical Paper Based on core papers

Course Objectives: The learning objectives include:

- This practical paper deals with the data analysis involving several variables simultaneously with special reference to multivariate distribution.
- learn techniques in survey sampling with practical applications in daily life which would be beneficial for the students to their further research.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Perform multivariate data analysis on real life data, interpret the results and in addition shall develop necessary theoretical and mathematical understanding of the multivariate processes.
- Explore various sampling techniques.

List of Practical:

MAST\MSST 401: Multivariate Analysis

1. Linear combination of correlated normal variates and evaluation of Probabilities.
2. Estimation of mean vector and covariance matrix.
3. Estimation and testing of partial and multiple correlation coefficients.
4. Discriminate function.

MAST\MSST 402: Sample Surveys-II

1. PPSWR Sampling Cumulative total method, Lahri's method of sample selection/section, estimation of total and its variance.
2. Horvitz arid Thompson's procedure of estimating jean (total) and variance of the population.
3. Yates and Grundy estimator of variance.
4. Midzuno's sampling schemes.
5. Rao-Hartley-Cocharan schemes.
6. Two-stage sampling method where f.s.u. being selected with pps with replacement and s.s.u. with equal prob. without replacement. Estimation of optimum number of s.u. and s.s.u.

MAST\MSST 452: Applied Statistics & Statistical Computing with R and SPSS

Course Objectives: The learning objectives include:

- To understand SPSS/R and its roles in problem solving.
- To understand data handling and its analysis.
- Learning the basic statistical software will help students to easily switch over to any other statistical software in future.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Understand the basic workings of SPSS/R, and perform basic statistical analyses.
- Perform descriptive statistics and graphics, and basic inferential statistics for comparisons and correlations using SPSS/R.
- Importing data, Code editing in SPSS/R.
- Appreciate, formulate solutions, analyze use of income distribution, demand analysis, index numbers and time series

Unit-I: Introduction to R: The R package Starting and quitting R. Basic features of R. Calculating with R Vectors. Logical operations in R, Relational operators, Data input and output, Lists Vector arithmetics, Character vectors. Data Import.

Unit-II: Matrices and Arrays, Triangular matrices, Matrix arithmetic, Matrix multiplication and Inverse. Flow control- The if() statement, for() loop, while() loop. Repeated loops, break and next Statements.

Unit-III: Data frames, read table function. Programming Statistical Graphics: Bar charts, Pie charts, Histograms, Box plots, Scatter plots, QQ plots. Programming for Univariate, Bivariate and Multivariate data analysis, Statistical Tests. Generation of pseudorandom numbers, Simulation of other random variables- Bernoulli, Binomial, Poisson, Exponential, Normal random variables. Monte Carlo Simulation.

Unit-IV: SPSS: Creating Variables, Input data, Saving and opening Data. Frequency Distribution, Creating Bar Chart, Histogram. Univariate and Bivariate Data Analysis. Parametric and Non -Parametric Tests. Multivariate Data Analysis.

List of Practical:

MAST\MSST 404: Applied Statistics

1. Practical based on Index Number
2. Practical based on Income Distribution & Demand Analysis
3. Practical based on Time Series Analysis

References:

1. Crawley, M.J., The R Book, John Wiley and Sond Ltd, England.
2. Braun, W.J and Murdoch, D.J.: A First Course in Statistical Progg. with R, Cambridge Univ. Press.
3. Horton, N.J. & Kleinman, Ken: Using R and R Studio for Data Management, Statistical Analysis and Graphics, CRC Press. USA
4. Gaur S.A & Gaur, S.S.: Statistical Methods for Practice and Research, Response Books (A division of Sage Publications), N. Delhi.
5. Carver, R.H. & Nash, J.G: Data Analysis with SPSS (India Edition), Cengage Learning, N. Delhi.
6. Asthana, B.S. & Bhushan, B.: Statistics for Social Sciences, PHI