RASHTRASANT TUKADOJI MAHARAJ NAGPUR

UNIVERSITY, NAGPUR

M. A. / M.Sc. STATISTICS

<u>SEMESTER PATTERN REVISED SYLLABUS (CBCS)</u>

TO BE IMPLEMENTED

FROM

2015 – 16

&

ONWARDS PHASE WISE

CHOICE BASED CREDIT SYSTEM FOR POST GRADUATE COURSES

IN FACULTY OF SCIENCE

M. Sc. (Statistics)

Credit Requirement for Post Graduate studies

P. G. M. Sc. Statistics

Semester	Theory Core	Practical core	Theory core Elective	Practical core elective	Foundation course/ Core Elective (Discipline Centric)	Project/ Review writing	Seminar	Total Credits per semester
I	**16**	**8**					**1**	**25**
II	**16**	**8**					**1**	**25**
III	**8**	**4**	**4**	**4**	**4**		**1**	**25**
IV	**8**	**4**	**4**		**4**	**4**	**1**	**25**
Total	**48**	**24**	**8**	**4**	**8**	**4**	**4**	**100**

Explanatory Terms

1 Core: Main theory papers in the concerned subjects

2 Core Elective: These papers will be specialization in the concerned subject

3 Foundation course: Students doing post graduation in subjects other than Statistics ,can opt for this paper .

4. Core Elective (Subject Centric) : Students doing post graduation in Statistics can opt for this paper in lieu of Foundation course of any other subject.

5. Project/ Review writing: Project / Review writing is in semester IV

6. Seminar: The Seminar in Semester shall be presented by the candidates in his/her parent department only.

Choice Based Credit System for Post Graduate Courses

Scheme of Examination for

M. Sc. STATISTICS

Semester – I

Paper Code	Name of the paper	Total Marks	Credits
MST 101	Elements of Mathematical analysis	80 + 20 Marks	4
MST 102	Distribution Theory	80 + 20 Marks	4
MST 103	Estimation Theory	80 + 20 Marks	4
MST 104	Sampling Theory	80 + 20 Marks	4
MST 105	Practical – I	80 + 20 Marks	4
MST 106	Practical – II	80 + 20 Marks	4
MST 107	Seminar	25	1
Total		625	25

Semester – II

Paper Code	Name of the paper	Total Marks	Credits
MST 201	Probability Theory	80 + 20 Marks	4
MST 202	Elementary Stochastic Processes	80 + 20 Marks	4
MST 203	Testing of Hypothesis	80 + 20 Marks	4
MST 204	Linear Models and Designs	80 + 20 Marks	4
MST 205	Practical – I	80 + 20 Marks	4
MST 206	Practical – II	80 + 20 Marks	4
MST 207	Seminar	25	1
Total		625	25

Semester III

Paper Code	**Name of the paper**	**Total Marks**	**Credits**
MST 301	Decision Theory and Non parametric methods	80 + 20 Marks	4
MST 302	Linear and Nonlinear modeling	80 + 20 Marks	4
MST 303	Core Elective I	80 + 20 Marks	4
MST 304	Foundation Course I / Core Elective II (Subject Centric)	80 + 20 Marks	4
MST 305	Practical – I	80 + 20 Marks	4
MST 306	Practical – II	80 + 20 Marks	4
MST 307	Seminar	25	1
Total		625	25

Semester IV

Paper Code	**Name of the paper**	**Total Marks**	**Credits**
MST 401	Multivariate Analysis	80 + 20 Marks	4
MST 402	Computational Statistics	80 + 20 Marks	4
MST 403	Core Elective III	80 + 20 Marks	4
MST 404	Foundation Course II / Core Elective IV (Subject Centric)	80 + 20 Marks	4
MST 405	Practical – I	80 + 20 Marks	4
MST 406	Project	100 Marks	4
MST 407	Seminar	25	1
Total		625	25

General Rules and Regulations regarding pattern of question paper:

A] Pattern of Question Papers

1. There will be four units in each paper.
2. Question paper will consist of five questions.
3. Four questions will be on four units with internal choice (one question on each unit)
4. Fifth question will be compulsory with questions from each of the four units having equal weight age and there will be no internal choice.
5. Maximum marks of each paper will be 80.
6. Each paper will be of three hours duration
7. Projects shall be evaluated by both Internal and External examiners.
8. Practical / laboratory examination of 100 marks. Distribution of marks shall be 20 internal and 80 external.
9 Minimum passing marks in each head (theory, practical & project) will be 40%.

B] Duration of practical examination will be of four hours
Distribution of marks of practical examination of 100 marks will be as follows:

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Practical performance	Viva Voce	Practical Record	Total
60	20	20	100

C] Project Work:
Project work will carry **100 marks** and distribution of these 100 marks will be as follows.
For written project work: **40 Marks-** Evaluated jointly by External and Internal Examiner
Presentation: **20 Marks-** Evaluated jointly by External and Internal Examiner
Internal Assessment: **20 Marks-** Evaluated by Internal Examiner
Viva Voce: **20 Marks-** Evaluated by External Examiner

Subject wise Core Elective Papers:

M.Sc Subject	Core Elective Paper to be opted in **Sem III**	Core Elective Paper to be opted in **Sem IV**
Statistics	Mathematical Programming	Operations Research
	Computer Programming	Reliability Theory
	Survival Analysis	Data Mining
	Bioassay	Time Series Analysis

Foundation Course

M.Sc Subject	Foundation Course 1 in **Sem III**	Foundation Course 2 in **Sem IV**
Statistics	Foundation Course in Mathematical Statistics	Foundation Course in Applied Statistics

Core Elective (Subject Centric)

M.Sc Subject	Core Elective(Subject Centric) I in **Sem III**	Core Elective (Subject Centric) II **in Sem IV**
Statistics	Industrial Process and Quality Control	Industrial Statistics
	Demography	Actuarial Statistics
	Statistical Ecology	Stochastic Models In Finance
	Statistical Genetics	Statistical Pattern Recognition

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M. A. / M.Sc. STATISTICS

SEMESTER PATTERN SYLLABUS (CBCS)

SEMESTER I

PAPER I – MST 101

Elements of Mathematical Analysis

Unit – I: Real valued functions. Riemann and Riemann Stieltjes integral, Integration by Parts, mean value theorem. Elements of complex integration, Analytic function, definition of line integral, Cauchy integration formula, Residue theorem.

Unit – II: Matrix algebra : characteristic roots of real matrices, right and left characteristic vectors. Independence of characteristic vectors their multiplicities. Generalized inverse Definiteness of a real quadratic form Reduction to quadratic form.

Unit – III: Sets : Classes of sets, Sequences of sets, lim sup and lim inf of sequences of sets, field, σ-field, σfield generated by a class, Borel σ- field. Set functions, additive set functions & their properties. Measure, Measure spaces, Measurable function, simple function, Integral of measure function w.r.t. measure.

Unit – IV:Sequences of measurable functions, convergence a.e. and in measure. Monotone convergence theorem, Fatous lemma, Dominated convergence theorem and their application.

References :

1) T Apostol : Mathematical analysis

2) Churchill : Functions of a complex variable

3) M E Munroe : Introduction to measure and Integration

4) R Ash : Real analysis and Probability theory

5) A. K. Basu : Measure Theory and Probability

PAPER II – MST 102

DISTRIBUTION THEORY

Unit – I: Brief review of basic distribution theory, joint, marginal and conditional pmfs and pdfs, conditional expectation. Some discrete distributions - Binomial, Poisson, negative binomial, geometric, uniform, multinomial and hyper geometric distribution. Comparison between binomial and hyper geometric distributions.

Unit – II: Continuous distributions- Normal, bivariate normal, exponential uniform. Functions of random variables and their distributions. Joint distribution of sample and induced sampling distribution of a statistic. Beta, Gamma, Cauchy, Log-normal, Weibull, Laplace distributions. Chi-square distribution and its properties

Unit – III: t and F distributions and their properties. Markov, Holder, Jensen, Liaponov inequalities. Approximating distributions of sample.

Unit – IV: Compound, truncated and mixture distributions. Distributions of quadratic forms under normality and related distribution theory. Order statistics, their distribution and their properties, joint and marginal distribution of order statistics. Extreme values and their asymptotic distributions. (statement only) with applications.

References :

1) Rohatgi V. K. : An introduction to probability theory and mathematical statistics
2) Rao C.R. : Linear statistical inference and its applications.
3) Johnson S and Kotz : Distributions in statistics Vol I, II and III.

PAPER III – MST 103

Estimation Theory

Unit – I: Problem of Point estimation, unbiased estimator, minimum variance unbiased estimator (MVUE), consistent estimators likelihood function Methods of estimation:Maximum likelihood, Minimum chi square, method of moments. Method of scoring, Properties of maximum likelihood estimator.

Unit – II: Fisher information and information matrix, Cramer Rao inequality Sufficiency Principle, Factorization theorem, minimal sufficiency, construction of minimal sufficient statistic, minimal sufficient statistic for exponential family. Pitman's family

Unit – III: Rao-Blackwell theorem, completeness, bounded completeness, Lehman-Scheffe theorem and their use.

Unit – IV: Interval estimation : Confidence level , construction of confidence intervals using Pivots. Uniparametric case multi-parametric case (up to 2 parameters)

References :

1) E. L. Lehman : Theory of Point estimation
2) B. K. Kale : First course on Parametric inference
3) C.R. Rao : Linear statistical inference and its applications

Paper IV – MST 104

<u>Sampling Theory</u>

Unit – I: Basic methods of sample selection : - Simple random sampling with replacement, Simple random sampling without replacement & Sampling with replacement. Unequal probability sampling : PPS WR/WOR (including Lahiri's scheme) and related estimators of finite population mean (Hansen – Horvitz and Des-Raj estimators for general sample size and Murthy's estimators for a sample of size two.) Horvitz Thompson's estimator

Unit – II: Stratified random sampling : Estimation of population mean, total and variance, Allocation problem and estimation problem, Construction of strata and number of strata, Systematic sampling and comparison with SRS and stratified random sampling.

Unit – III: Use of supplementary information for estimation :- Ratio and Regression method of estimation based on SRSWOR. Unbiased ratio estimate. Cluster sampling, equal and unequal sizes, Two stage sampling with equal number of second stage units.

Unit – IV: Double sampling for estimating strata sizes in ratio and regression method of estimation. Randomized response technique (Warners model, Related and Unrelated questionnaire methods.)

References:

1) Sukhatme : Sampling theory of surveys with applications.
2) Singh D and Chaudhary F. S. : Theory and analysis of sample survey designs.
3) Murthy M. N. : Sampling theory and methods.
4) Des Raj and Chandak : Sampling theory.

MST 105 - Practical I : will based on MST 101, 102 and 103.

MST 106- Practical II : will based on MST 104.

Semester II

Paper I – MST - 201

Probability Theory

Unit – I: Probability measure on a sigma field Probability space, Properties of Probability measure, Continuity, mixture of Probability measures Axiomatic definition of Probability. Independence of two events and more than two events Mutual independence sequence of independent events, independent classes of events, Borel-Cantelli lemma, Random variables, Expectation of random variables, Linear Properties of expectations.

Unit – II: Distribution function and its properties. Convergence of a sequence of rvs, convergence a.s, convergence in probability convergence in distribution, convergence in rth mean their interrelations, Yule-Slutsky results

Unit – III: Weak and Strong law of large numbers; Chebyshev Weak Law of large numbers Khinchins weak law of large numbers, Kolmogorov strong law of large numbers (statement only). Kolmogorov inequality.

Unit – IV: Characteristic function, simple properties Inversion theorem and uniqueness Property, Continuity theorem. Central limit theorem – De-Moivre Laplace, Lindeberg Levy, Lindeberg-Feller (Sufficiency only)

References :

1) B. R. Bhat : Modern Probability theory
2) A. K. Basu : Measure and Probability Theory
3) M Fisz : Probability theory and Mathematical Statistics.
4) V. K. Rohatgi : Introduction to Probability theory and its application.

Paper II – MST- 202
Elementary Stochastic Processes

Unit – I: Definition of Stochastic Process, Classification of Stochastic processes according to state space and time domain. Examples of various Stochastic Processes. Definition of Markov Chain, Examples of Markov Chain Formulation of Markov Chain models, initial distribution, Stationary transition Probability Matrix, Chapman-Kolmogorov equation, calculation of n-step transition probabilities.

Classification of states, closed and irreducible classes, transient, recurrent, and null states, Periodic States, Criteria for the various types of states, Ergodic theorem.

Unit – II: Algebraic treatment for finite Markov chains.Random walk and Gambler's Ruin problem Absorbing and reflecting barriers. First Passage Probability. Expected duration of game. Random walk in 2 and 3 dimensions.

Unit – III: Discrete state space continuous time Markov Chain, Poisson Process, Pure birth process, pure death process, Birth and death process.

Continuous state space continuous time Markov chain : Kolmogrov's equation Wiener process as a limit of random walk model, properties of Wiener process. Covariance stationary processes.

Unit IV : Renewal Theory: Elementary renewal theorem and its applications. Statement and uses of key renewal theorem; study of residual life time processes.

Stationary Processes: Weakly stationary and Strongly stationary processes, Moving average and auto regressive processes.

Branching process: Galton-Watson branching process, probability of ultimate extinction, distribution of population size.

References :

1. J. Medhi : Stochastic Processes.
2. S. Karlin and H Taylor : First course in stochastic processes.
3. W. Feller : Introduction to probability theory and its applications Vol. 1.

Paper – III – MST-203

Testing of Hypothesis

Unit – I: Test of hypothesis, concept of critical regions, test functions, two kinds of errors, size function, power function, level, MP and UMP test in the class of size $\propto$ tests. N.P lemma, MP test for simple against simple alternative hypothesis.

Unit – II: UMP tests for simple null hypothesis against one sided alternative and for one sided null against one sided alternative in one parameter exponential family. Extension of the above results to Pitman family when only upper or lower end depends on the parameter and to distributions with MLR property.

Unit III : Non existence of UMP test for simple null against two-sided alternatives in one parameter exponential family. UMPT for two sided null hypothesis in one parameter exponential family. Likelihood ratio test. Consistency of LRT and unbiasedness of LRT. UMPUT and their existence in case of exponential family , similar tests and tests with Neyman structure. Generalized Neyman Pearson lemma (Statement only),

Unit – IV: Wald test, Rao's score test, Pearson's chi-square test for goodness of fit. Bartlett's test for homogeneity of variances. (without proof).

Sequential testing. Sequential probability ratio test. Relation among parameters Application of SPRT to Binomial, Poisson, Normal Distribution. unbiased test,

References:

1) Lehmann E. L. : Testing statistical hypothesis.
2) Rao C.R. : Linear statistical inference and its applications
3) Ferguson T. S. : Mathematical statistics.
4) Zacks S. : Theory of statistical inference.

Paper IV - MST 204

Linear models and Designs of experiments

Unit – I: Gauss- Markov theorem, Analysis of variance, elementary concepts (one and 2 way classified data) Review of elementary design (CRD, RBD, LSD) Missing plot technique in RBD and LSD with one and two missing values (only estimation of missing values)

Unit – II: BIBD : Elementary parametric relations, Analysis. Definitions and parametric relations of SBIBD, RBIBD ARBIBD, PBIBD. Youden square design - Definition and analysis.

Unit – III: Analysis of covariance of one way and two way classified data., split plot design : construction and analysis. General factorial experiments, factorial effects, best estimates and testing the significance of factorial effects, study of 2^3 and 2^4 factorial experiments in RBD.

Unit – IV: Confounding in factorial experiments, complete and partial confounding. Simultaneous confounding, double confounding concept of generalized interaction.

References :

1. Alok Dey (1986) : Theory of block designs. Wiley Eastern.
2. Das M. N. and Giri N (1997) : Design and Analysis of experiments . Wiley Eastern.
3. Joshi D. D. (1987) : Linear estimation and design of experiments. Wiley Eastern.
4. Montgomery. C. D. (1976) : Design and analysis of experiments. Wiley, New York.

MST 205 - Practical I : will based on MST 202 and 203.

MST 206- Practical II : will based on MST 204.

Semester III

Paper I – MST 301

Decision Theory & Non Parametric methods

Unit – I: Decision problem, loss function, expected loss, decision rules (nonrandomized and randomized), decision principles (conditional Bayes, frequentist) inference and estimation problems as decision problems, criterion of optimal decision rules. Concepts of admissibility and completeness, Bayes rules, minimax rules, admissibility of Bayes rules. Existence of Bayes decision rules.

Unit – II: Definition of non-parametric test, Advantages and disadvantages of Non-parametric tests. Single sample problems :

a) test of randomness
b) test of goodness of fit : Empirical distribution function.
   Kolmogorov – Smirnov test, χ^2 test, Comparison of χ^2 test & KS test
c) One sample problem of location : sign. Test, Wilcoxon's signed rank test, Wilcoxons paired sample signed rank test

Unit –III: Two sample problems : different types of alternatives, sign test, Wilcoxans two sample rank sum test, Wald-Wolfowitz run test, Mann-Whitney-Wilcoxons test, Median test, KS-two sample test. Klotz Normal score test.

One sample U-statistic, Kernel and symmetric Kernel Variance of U-Statistic, two-sample U-statistic, Linear rank statistics and their distributional properties under null hypothesis.

Unit – IV: Concept of time order and random censoring, likelihood in these cases, survival function, hazard function Non-parametric Estimation of Survival function, Cox's proportional hazards model, the actuarial estimator, Kaplan – Meier Estimator.

References:

1) Ferguson T. S. : Mathematical Statistics – A decision theoretic approach
2) Berger J. O. : statistical decision theory and Bayesian analysis
3) Gibbons J.D. : Non parametric Statistical inference
4) Randles and Wolfe : Introduction to the theory of non parametric statistics.

Paper II MST – 302

Linear and Non-Linear Modeling

Unit – I: Multiple Linear regression : Model assumptions and checking for the violations of model assumption., Residual analysis – definition of residuals, standardized residuals, residual plots, statistical tests on residuals, Press statistics. Transformation of variables, Box-Cox power transformation.

Outliers : Detection and remedial measures, Influential observations : leverage, measures of influence, Cook's D, DFITS AND DFBETAS.

Unit –II: Multicolinearity : Concept and definition of M.C., sources of M.C. consequences of M.C. identification of M.C. using the correlation matrix, VIF remedial measures (collecting additional data, model respecification,), concept of ridge regression. Auto correlation: consequences, Durbin-Watson test, Estimation of parameters in the presence of autocorrelation.

Unit – III: Variable selection : Problem of variable selection, criteria for evaluation subset regression models (choosing subsets), coefficient of multiple determination, residual mean square, Mallow's Cp Statistics. Computational Techniques for variable selection-Forward selection, Backward elimination, stepwise regression.

Non-linear regression: Difference between Linear and Non-Linear Regression Models, transformation to a linear model, Intrinsically linear and non-linear models. Parameter estimation using the Newton-Gauss method, Hypothesis testing.

Unit – IV: Generalized linear models : Exponential families, Definition of GLM, Link function, Estimation of parameters and inference in GLM.

Logistic regression model : Link function, logit, probit, complementary log-log, estimation of parameters, odds ratio, hypothesis testing using model deviance.

References :

1) Draper N. R. and Smith H. :Applied Regression analysis
2) Montgomery D. C. : Linear regression analysis.

<u>Core Elective I</u>

Paper III -MST 303-A

<u>Mathematical Programming</u>

Unit – I: L. P. : Simplex method, variants of simplex method, duality in L. P. duality theorem, complementary slackness theorem, dual simplex method, transportation & assignment problems, method of solving transportation & assignment problems.

Dynamic Programming : Dynamic programming approach for solving optimization problems, forward & backward recursion formula, minimum path problem, single additive constraint & additively separable return, single multiplicative constraint & additively separable return, single additive constraint & multiplicatively separable return.

Unit – II:Sensitivity analysis of L. P. : Changes in R. H. S. constraint bi, changes in cost coefficient cj, changes in coefficient of constraints aij, addition of new variables, addition of new constraints. I.L.P.P. : Pure & mixed I.L.P.P. , methods for solving pure & mixed I.L.P.P. Gomory's cutting plane method.

Unit – III: N.L.P.P. : General N.L.P.P., convex & concave functions, text for concavity & convexity, local optimum, global optimum, basic results for local optimum & global optimum, Lagrange's methods for optimality, KT conditions, Q.P.P. Wolfe's & Beale's method for solving Q.P.P.

Unit – IV:Game theory : 2 person zero sum game, pure & mixed strategies, saddle point of a matrix game, matrix game without saddle point, methods for solving matrix game without saddle point, 2X2 , mxn, mx2, 2Xn matrix games, dominance principle, use of dominance principle in game theory, solving game problems by simplex method.

References:

1) Gass : Linear programming
2) Taha H. A. : Operations Research
3) Philips, Ravindran and Solberg : Operations research – Principles and practice

Paper III- MST 303 B

Computer Programming

Unit I: Fundaments of C++, difference between C & C++, additional operators in C++, scope resolution operator, operator overloading, operator precedence. Functions in C++, function prototyping, call by reference, return by reference, inline function, default arguments, function overloading(polymorphism).

Unit II: Classes and objects: definition of class declaration, data members, member functions, private & public members, data hiding and encapsulation, abstraction. Arrays within a class, class function definition, member function definition inside in the class declaration and outside the class definition, scope resolution operator, private and public member functions, nesting of member functions. Creating objects, accessing class data members, accessing member functions, arrays of objects, objects as function argument, friend functions, constructor & destructor. Constructor: declaration, definition, default constructer, parameterized constructer, copy constructor, constructor with default argument ,Destructor, Definition and use.

Unit III: Inheritance: Extending classes: concept of inheritance, base class, derived class, visibility models: private, public, protected, single inheritance, multilevel inheritance multiple inheritance, nesting of classes.

Unit IV: Pointers: dynamic allocation operators: New, delete, reference variables & use of alias pointers to objects, 'This' pointer, pointers to derived classes, virtual function.
File:_basic file operations, classes for file stream operations, opening and closing a file, detecting end-of-files, file pointers their manipulation sequential input/output operation, random access to file.

References:

1. Programming in ANSI C- E. BalguruSwamy. Tata McGraw Hill Publication Company Ltd New Delhi.
2. The complete reference C & C++ by Hebert Shielf (Tata McGraw Hill Publication Company Ltd New Delhi.)
3. Object oriented programming with C++ by E. BalguruSwamy. Tata McGraw Hill Publication Company Ltd New Delhi.
4. C++ Programming for absolute beiginner by Henkemans Lee (PHI)
5. Object oriented programming through C++ by ParimalaN . (Macmillan India Ltd, Publication).

Paper III -MST 303-C

Survival Analysis

Unit – I:Concepts of Time, order and Random Censoring.

Life distributions Exponntial, Gamma, Weiball, Lognormal, Pareto, Linear failure rate, parameteric inference, point estimation, confidence intervals, scores, tests based on LR, MLE.

Unit – II: Life tables, Failure rate, mean residual life and their elementary propertics Ageing classes IFR ,IFRA, NBU, NBUE, HNBUE and their duals, Bathtub Failure rate.

Unit – III: Estimation of survival function Actuarial estimator, Kaplan Meier Estimator, Estimation under the assumption of IFR/DFR.

Tests of exponntiality against nonparametric classes Total time on test, Deshpande test, Two sample Problem, Gehan test, Long rank test, Mantel Haenszd Test, Tarone Ware tests.

Unit – IV:Semi Parametric regression for failure rate Cox's Proportional hazards model with one and several covariates.

References:

1. Cox, D.R. and Oakes, D.(1984) Analysis of Survival Data, Chapman and Hall, Newyork.

2. Gross A. J. and Clark VA (1975) survival Distrubutions : Reliability Applications in Biomedical Sciences, John Wiley & Sons.
3. Elandt Johnson, R.E. Johnso9n NL (1980) Survival models and Data Analysis, John Wiley and sons.
4. Miller, R.G. (1981) Survival Analysis
5. Zacks, S. Reliability.

Paper III - MST 303- D

<u>Bioassay</u>

Unit I: Types of biological assays, Direct assays, ratio estimators, asymptotic distributions, Fieller's theorem. Regression approaches to estimating dose-response relationships, Logit and Probit approaches when dose-response curve for standard preparation is unknown.

Unit II:. Methods of estimation of parameters, estimation of extreme quantiles., dose allocation schemes. Quantal Responses, Polychotomousquantal responses. estimation of points on the quantal response function.

Unit III: Sequential procedures, estimation of safe doses.

Unit IV: ANOVA and Bayesian approach to Bioassay.

References:

1. GovindRajulu,Z.(2000):Statistical Techniques in Bioassay, S.Karger.
2. Finney, D.J.(1971):Statistical Methods in Bioassay, Griffin.
3. Finney, D.J.(1971): Probit Analysis 3rd ED.), Griffin.
4. Weatherile, G.B.(1966):Sequential Methods in Statistics, Methuen.

<u>Semester III : Core Elective II – (Discipline Centric)</u>

Paper IV MST 304-A

<u>Industrial Process and Quality Control</u>

Unit – I: Basic concept of process monitoring General theory and review of Shewhart control charts for measurements and attributes (p, d = np, C, X and R chart) O.C. and ARL for X control chart. General ideas on economic designing of control chart. Assumptions and costs. Duncan's model for the economic design of X chart. Moving average and exponentially weighted moving average charts. Cu-sum charts using v masks and decision intervals.

Unit – II: Classification of nonconformities and their weighting modification of the c chart for Quality scores and Demerit classifications ,Q chart for no. of nonconformities per (u chart) Multivariate Quality control. Hotelling's T^2 .

Unit – III: Concept of six sigma. Evolution of six sigma Quality approach practical approach to six sigma quality Basic steps involved in application of six sigma Define-measure-Analyze improve and control approach, Barriers in implementation of six sigma in Indian manufacturing industries(small and medium enterprises).Impact of six sigma in a developing economy .

Unit – IV: Principle of acceptance sampling problem of lot acceptance . Acceptance sampling plans for attributes. Single double and sequential sampling plans and their properties Dodge Romig sampling plans for attributes (AOQL and LTPD), MIL std plans, continuous sampling plans, Dodge type CSPI, CSPII and CSPIII .

References:

1] Montgomery D.C. (1985) Introduction to statistical quality control. Wiley.

2) Montgomery D.C. (1985) Design and Analysis of Experiments Wiley

3) Grant E. L. & Leaver worth R. S. statistical Quality control McGraHill publica

Paper IV MST 304-B

<u>Demography</u>

Unit – I: Definition and scope : Development of demography as a interdisciplinary discipline, Basic demographic concept and components of population dynamics coverage and content errors in demographic data, use of balancing equations and Chandras Kharan Deming formula to check completeness of registration data. Adjustment of age data Use of whipple, myer and UN indices.Population composition, dependency ratio.

Unit – II:Measure of Fertility : Stochastic models for reproduction, distribution of time to first birth, inter live birth intervals and of number of births (for both homogeneous and non homogeneous groups of women) estimation of Parameters estimation of parity preregression ratios from open birth interval data.

Unit – III: Measure of Mortality : Various measures of mortality, infant mortality rate, cause specific death rate and standardized death rates. Construction of a bridge life table Distribution of life table functions and their estimation.

Migration : Migration Rates and Ratios : Indirect measures of net-internet migration National growth rate method stochastic models for migration and for social and occupational mo0bility based on Markov Chains estimation of Measures of Mobility.

Unit – IV:Measurement of population change : Linear, Geometric exponential, Gompretz, Logistic population growth models, Methods of population projection, Use of Leslie matrix. Stable and Quasi stable populations, intrinsic growth rate, Models for population growth and their fitting to population data. Stochastic models for population growth.

References :

1. Benjamin, B (1969) Demographic analysis. (Georage, Akllen & Unwin).
2. Cox, P.R. (1970) Demography, Cambridge University Press.
3. Keyfitz, N. (1977) : Applied Mathematical Demographic analysis, Springer-Verlag .
4. Spiegelman M (1969) : Introduction to Demographic analysis (Harward University Press)
5. Bartholomew , D.J. (1982) Stochastic models for social processes, John-Wiley.

Paper IV MST 304-C

Statistical Ecology

Unit – I:Population Dynamics One species exponential, logistic and Gompertz models,. Two species competition, coexistence, predator prey oscillation, Lotka-Volterra Equations, isoclines, Lestie matrix model for age structured populations. Survivorship curves constant hazard rate, monotone hazard rate and bath tub shaped hazard rates.

Unit – II:Population density estimation: Capture recapture modesls, nearest neighbor models, Line transect sampling, Ecological Diversin, Simpsons index, Diversity as average rarity.

Unit – III:Optimal Harvesting of Natural Resources, Maximum Sustainble field, tragedy of the commons Game theory in ecology, concepts of Evolutionarily stable strategy, its Properties, simple cases such as Hawk-Dove geme.

Unit – IV:Foraging Theory : Diet choice Problem, patch choice problem meanvariance trade off.

References:

1. Gore, A.P. and Paranjpe S.A. (2000) A course on Mathematical and Statistical Ecology, Kluwer Academic Publishers.
2. Pielou, E.C. (1977) An Introduction to Mathematical Ecology (Wiley)
3. Seber, G.A.F (1982) The Estimation of animal abundance and related parameters (2nd Ed) (Grittin)
4. Clark, C.W. (1976) Mathematical bio-economics : the optimal management of renewable resources (John wiley)
5. Maynard Smith J. (1982) Evolution and the theory of games (Cambridge University Press)
6. Stephenes, D.W. & Krebs JR (1986) Foraging Theory (Princeton University Press)

Paper IV -MST 304- D

<u>Statistical Genetics</u>

Unit I: Basic biological concepts in genetics. Mendel's law. Hardy Weinberge equilibrium. Matrix theory of random mating. Mating tables. Estimation of allel frequency for dominant and co dominant cases. Approach to equilibrium for X-linked gene.

Unit II:. Non random mating. Inbreeding. Coefficients of inbreeding. Inbreeding in randomly mating populations of finite size. Phenotypic assortative mating.

Unit III: Natural selection, mutation, genetic drift. Equilibrium when both natural selection and mutation are operative. Statistical problems in human genetics, Blood group analysis.

Unit IV: Analysis of family data : (a) Relative pair data, I ,T,O matrices, identity by descent. (b) Family data- estimation of segregation ratio under ascertainment bias. (c) Pedigree data –Elston- Stewart algorithm for calculation of likelihoods, linkage, Detection and estimation of linkage, estimation of recombination fraction, inheritance of quantitative trials models and estimation of parameters.

References:

1. Li,C.C.(1976):First Course on Population genetics. Boxwood Press, California.

2. Ewens, W.J.(1979):Mathematical Population genetics ,Springer Verlag.
3. Nagylaki, T.(1992): Introduction to theoretical population genetics. Springer Verlag

4. Elandt – Johnson Probability Models and Statistical Methods in Genetics. John Wiley

Semester III - Foundation Course I

(***Students shall opt for this paper from any other subject other than his/her main subject for post graduation)***

Paper IV MST 304-F-1

Foundation course in Mathematical Statistics

Unit I : Concept of Statistical Population and sample from a Population, Types of data : Qualitative and quantitative data, nominal and ordinal data, cross sectional and time series data, Discrete and Continuous data, Collection and scrutiny of data : - Primary data, Secondary data its major sources, Methods of collecting data.

Unit II : Presentation of data :

Construction of tables with one or more factors of classification, Diagrammatic and graphical representation of data Frequency distribution : Cumulative frequency distribution and its graphical representation, Histogram, frequency Polygon and Ogives, Box plot.
Analysis of quantitative data: Univariate data concepts of central tendency or location, dispersion, Skewness Kurtosis and their measures.

Unit III : Important concepts in probability:

Random experiment, trial, sample point, sample space, Events, operation of events, mutually exclusive and exhaustive events Definition of Probability, classical and relative frequency approach to probability. conditional Probability, independence of events. Law of addition and multiplication. Bayes theorem and its application.

Unit IV : Random variables :

Definition of discrete random variables Probability mass function, idea of continuous random variables, Probability density function. Examples of random variables Expectation of random variables. Standard Univariate distributions: Binomial, Poisson, Normal, exponential and their Properties.

References :

1) Bhat B. R. Sriventyaramana T, Rao Mahadava K. S. (1996) Statistics : A beginners Text Vol I, Vol II, New Age International (P) Ltd.
2) Goon A M, Gupta M. K. Das Gupta A. B. (1999) fundamentals of Statistics Vol I
3) Croxton F. E., Cowden D. J. and Ketins (1973) Applied general Statistics.

4) B. L. Agrawal :- Basic Statistics
5) Gupta S. P. : Statistical Methods.

MST 305 - Practical I : will based on MST 301 and 302 .

MST 306- Practical II : will based on Elective I and Elective II .

Semester IV

Paper I-MST-401

Multivariate Analysis

Unit – I: Correlation : multiple and partial correlation. Linear and multiple regression co-efficient of determination and its uses. Tests of significance of multiple and partial correlation coefficient. Multivariate normal distribution, singular and nonsingular normal distribution, characteristic function, moments, marginal and conditional distributions maximum likelihood estimators of the parameters of multivariate normal distribution and their sampling distribution, distribution of sample mean vector.

Unit – II: Wishart matrix-its distribution without proof and properties. Distribution of sample generalized variance, Applications in testing and interval estimation, Wilks λ [Introduction, definition, distribution (statement only)].

Unit – III: Hotelling's T^2 statistic and its null distribution. Application in tests on mean vector for one and more multivariate normal populations and also on the equality of the components of a mean vector in a multivariate normal population. Application of T^2 statistic and its relationship with Mahalanobis' D^2 statistic. Confidence region for the mean vector. Applications of D^2 statistics.

Unit – IV: Classification and discrimination : procedures for discrimination between two multivariate normal populations. Fisher's discriminant function, tests associated with discriminant function, Sample discriminant function. Probabilities of misclassification and their estimation. Classification into more than two multivariate populations. Principal components. Dimension reduction. Canonical variables and anonical correlation, definition, uses, estimation and computation.

References :

1) Anderson T. W. : An introduction to multivariate statistical analysis.
2) Kshirsagar A. M. : Multivariate analysis
3) Rao C. R. : Linear statistical inference and its applications

PaperII-MST-402

Computational Statistics

Unit – I: Exploratory data analysis: Components of EDA, transforming data, Clustering : Similarity measures, similarity coefficients, Heirarchical clustering methods : single, complete and average linkage methods, dendrograms. Graphical Methods: Quintile plots, Box Plots, Histogram, Stem & leaf diagram, Q-Q plots, P-P plots,

Unit –II: Stochastic simulation: generating random variables from discrete and continuous distributions, simulation bivariate/ multivariate distributions, simulating stochastic processes such as simple queues. Variance reduction technique: Importance sampling for integration, control variates, antithetic variables.

Unit III : MCMC methods : Essence of MCMC methods, Time reversible MC, Law of large numbers for MC. Metropolis-Hastings algorithm, Gibbs sampling for bivariate/ multivariate simulation.

Simulated annealing for optimization, simulated annealing for M.C. Simulation based testing : simulating test statistics and power functions, permutation/randomization tests.

Resampling paradigms: Jack knife and Bootstrap : Delete one J-K, pseudo values, Bias and S.E. Efron's bootstrap, Bootstrap C.I. Bootstrap-t C.I, Bootstrap C.I. (percentile method), Bootstrap in regression, Bootstrap C.I. for linear regression parameters.

Unit – IV: EM algorithm: Application to missing and incomplete data problems. Mixture models. Smoothing with Kernels: Density estimation, kernel density estimator for univariate data, Bandwidth selection and cross validation, Max likelihood L CV, Least square CV.

References :

1. Jun S. Liu : Monte Carlo Strategies in Scientific Computing, Springer series in statistics, 2001.
2. Efron B. and Tibsirani J. R. : An Introduction to Bootstrap
3. Ross S. M. : Applied Probability models

Semester IV: Core Elective III

Paper III -MST 403-A

Operations Research

Unit – I:Inventory problems : Structure of inventory problem, EOQ formula, EOQ model with uniform rate of demand & having no shortages, EOQ model with different rate of demand in different cycles having no shortages, EOQ model with uniform rate of demand & finite rate of replenishment having no shortages, EOQ model with uniform rate of demand & finite rate of replenishment having shortages, EOQ model with uniform rate of demand, infinite rate of replenishment having shortages, EOQ model with single & double price breaks.

Unit – II: Single period probabilistic inventory models with

i) instantaneous demand & discrete units
ii) instantaneous demand& continuous units
iii) Continuous demand & discrete units
iv) Continuous demand & continuous units

Unit – III: Sequencing Problems :

Processing n jobs through two machines,
Processing n jobs through three machines,
Processing 2 jobs through m machines,
Processing n jobs through m machines,
Traveling salesman problem
Queuing Models : M/M/1 : FCFS/∞ / ∞ / & its generalization
M/M/1 : FCFs/N/∞ ,
M/M/C/ : FCFS/ ∞ / ∞,
$M/E_k/1$: FCFS /∞ /∞ ,

Unit – IV: Networking : Basic steps in PERT & CPM, methods of solving PERT problem, crashing the network, updating (PERT & CPM) max. flow min. cut theorem, problems based on max. flow min. cut theorem.

References:

1) Taha H. A. : Operations Research
2) Hiller & Liberman ; Introduction to Operations research.
3) Kantiswaroop Gupta and Singh : Operations research.
4) Gross D and Harris C. M. : Fundamentals of queueing theory.

Paper III -MST 403 B

Reliability Theory

Unit I:.Reliability concepts and measures ,components and systems, coherent systems, reliability of coherent systems, cuts and paths, modular compositions, bounds on system reliability, structural and reliability importance of components. Life distributions, reliability functions, hazard rate, common life distributions, exponential, Gamma , Weibull, Lognormal etc. Estimation of parameters, confidence intervals, LR and MLE tests for these distributions.

Unit II:. Notions of ageing: IFR, IFRA, NBU, DMRL and NBUE classes and their duals, loss of memory property of the exponential distribution, closures of these classes under formation of coherent systems, convolutions and mixtures. Univariate shock models and life distributions arising out of them, bivariate shock model, common bivariate exponential distributions 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 and strength reliability and its estimation. aintenance and replacement policies, availability of repairable systems, modeling of repairable system by a non-homogeneous Poisson process.

Unit IV: Reliability growth models, probability plotting techniques, Hollander- Proschan and Deshpande tests for exponentially, tests for HPP vs. NHPP with repairable systems.

REFERENCES:

1. Barlow R E and Proschan F (1985), Statistical Theory of Reliability and Life Testing .
2. Lawless J.F. (1982) Statistical Models and Methods of Life Time Data.
3. Bain L. J Engelhardt (1991), Statistical Analysis of Reliability and Life Testing Model.
4. Zacks S, Reliability Theory.
5. D C Montgomery-Design and Analysis of Experiments.
6. R H Myers and D C Montgomery –Response Surface Methodology.
7. J Fox: Quality through Design
8. J A Nelder and P McCullasn Generalized Linear Models.

Paper III MST 403 -C

Data Mining

Unit – I: Review of classification methods from mullivariate analysis, classification and decision trees, clustering methods from both statistical and data mining viewpoints, vector quantization.

Unit – II: Unsupervised learning from univariate and multivariate data, Dimension reduction and feature selections.

Unit – III: Supervised learning from moderate to high dimensional input. Spaces, artificial neural networks and extensions of regression models, regression trees. Introduction to data bases, including simple relational databases, data ware houses and introduction to online analytical data processing.

Unit – IV: Association rules and prediction, data attributes, applications to electronic commerce.

References:

1. Berson, A and Smith, S.J. (1997) Data Ware housing, Data mining and OLAP (McGraw-Hill)

2. Brieman, L. Friedman, J.H. Olshen, RA, and Stone, C.J. (1984) Classification and regression Trees
3. Han, J and Kamber, M (2000) Data Mining, Concepts and Techniques (Morgan Kaufmann)
4. Mitchell, T.M. (1997) Machine Learning (McGraw Hill)
5. Ripley, B.D. (1996) Pattern Recognition and Neural Networks (Cambridge University Press)

Paper III MST 403-D
Time Series Analysis

Unit 1 : Exploratory time series analysis, tests for trend and seasonality. Exponential and Moving average smoothing. Holt -Winters smoothing. Forecasting based on smoothing, adaptive smoothing. Time - series as a discrete parameter stochastic process. Auto covariance and autocorrelation functions and their properties.

Unit 2: Stationary processes: General linear processes, moving average (MA), auto regressive (AR), and autoregressive moving average (ARMA). Auto regressive integrated moving average (ARIMA) models, Box –Jenkins models Stationarity and inevitability conditions. Nonstationary and seasonal time series models: Seasonal ARIMA (SARIMA) models, Transfer function models (Time series regression)

Unit 3 :Forecasting in time series models, Durbin-Levinson algorithm, innovation algorithm (without proof). Estimation of mean, auto covariance and autocorrelation functions, Yule-Walker estimation, Estimation of ARIMA model parameters, maximum likelihood method, large sample theory (without proofs). Choice of AR and MA periods, FPE, AIC, BIC, residual analysis and diagnostic checking.

Unit 4 :Multivariate Time series model, VAR models, Vector ARMA models. Conditional heteroschedastic models, ARCH and GARCH, properties, examples, estimation & forecasting, extensions of ARCH & GARCH.

References:

1. Brockwell, P.J. and Davis, R. A. (2003). Introduction to Time Series
Analysis, Springer

2. Chatfield, C. (2001). Time Series Forecasting, Chapmann & Hall, London

3. Fuller, W. A. (1996). Introduction to Statistical Time Series, 2nd Ed. Wiley.

4. Hamilton N. Y. (1994). Time Series Analysis. Princeton University press.

5. Box, G.E.P & Jenkins G.M (1976): Time Series Analysis – Forecasting & Coontrol , Holden-Day, San Francisco .

6. Lutkepohl, H. and Kratzing, M. (Ed.) (2004). Applied Time Series Econometrics, Cambridge University Press.

7. Shumway, R. H.and Stoffer D. S. (2010). Time Series Analysis & Its Applications, Springer.

8. Tsay, R. S. (2010). Analysis of Financial Time Series, Wiley.

9. Montgomery, D.C & Johnson ,L.A (1977) : Forecasting and Time Series Analysis, McGraw Hill

Core Elective IV : (Discipline Centric)

Paper IV- MST 404-A

Industrial Statistics

Unit – I: Quality Systems : ISO 9000 standards. QS 9000 standards.

Total quality management (TQM) : Different definitions and dimensions of quality,basic concept , Total Quality Management Models, Quality Management Tools, Six Sigma and Quality Management, What is Kaizen ? - Five S of Kaizen, Role of Managers in TQM, Role of Customers in Total Quality Management, Comparison of Six Sigma and TQM, Reasons for failure of TQM, Deming's 14 point program, Continuous quality improvement, PDSA cycle , Juran triology, Quality Gurus

Unit –II: Use of Design of experiments in SPC factorial experiments, fractional factorial design. Half fraction of the 2^3 factorial design Basic ideas of response surface methodology. Specification limits, Natural tolerance limits and control limits. Process capability analysis (PCA) : Process capability analysis using Histogram, and using control chart.

Unit – III: Probability plotting capability indices Cp, Cpk and Cpm comparison of capability indices. Estimation confidence intervals and tests of hypothesis relating to capability indices for Normally distributed characteristics. Index Cpc for non normal data.

Unit – IV: Quality at Design stage. Quality function deployment failure mode and effect analysis. Taguchi philosophy system parameter and tolerance designs. Loss functions. Determination of manufacturing Tolerances. Signal to noise ratio and performance measures critique of S/N ratios.]

References :

1) Montgomery D.C. :(1985) Introduction to statistical quality control. Wiley.

2) Montgomery D.C. : (1985) Design and Analysis of Experiments Wiley

3) Grant E. L. & Leaver worth R. S. :Statistical Quality control, McGraHill publications.

4) Amitava Mitra :Fundamentals of quality control and improvement

5) Oakland J. S. : (1989) Total quality management, Butterworth Heinemaah 14

6) K. Shridhara Bhat : Total quality management, Himalaya Publishing House

7) C. B. Michna: D. H. Besterfield Total quality management, Pearson Education.

8) Phadke M. S. (1989) Quality Engineering through Robust design. Practice Hall.

9) Logothelis N. (1992) Managing total quality, Prentice Hall of India.

10) Oakland J. S.: Statistical Process control Heinemach Professional publishing.

Paper IV - MST 404- B

Actuarial Statistics

Unit I: Life table and its relation with survival function, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables. Multiple life functions, joint and last survivor status, insurance and annuity benefits through multiple life functions. Multiple decrement models, deterministic and random survivor groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.

Unit II:.Principals of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

Life insurance : Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, diferred insurance and varying benefit insurance, recursion, commutation functions.

Unit III: Life annuities : Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursion, complete annuities- immediate and apportionable annuities-due. Net premiums : Continuous and discrete premiums, true monthly payments premiums, apportionable premiums, commutation functions, accumulation type benefits.

Unit IV: Net premium reserves : Continuous and discrete net premium reserves on a semicontinuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis, reserves at fractional duration, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions. Some practical considerations: Premiums that include expenses – general expenses, types of expenses, per policy expenses. Claim amount distributions, approximating the individual model, stop-loss insurance.

References:

1. Bowers, N.L.; Gerber, H.U.; Hickman,J.C.; Jones D.A. and Nesbitt, C.J.(1986) : Actuarial Mathematics. Society of Actuarials, Ithaca, Illiois, U.S.A. Second Ed (1977).
2. Deshmukh S.R (2009): An introduction to Actuarial Statistics using R, Uni.Press
3. Spurgeon E.T (1972): Life Contingencies, Cambridge University.

Paper IV MST 404-C

Stochastic Models in Finance

Unit 1: Derivatives hedging: forward and future contracts. Markets, prices, arbitrage and hedging Complete market, market risk and credit risks in the use of derivatives.

Options markets, properties of stock option prices. American and European options. Binomial model: One-step and two-step models, Binomial trees. Risk neutral valuation.

***Unit 2**:* Behaviour of stock prices: Conditional expectation, martingales, Brownian motion and Geometric Brownian motion, Markov property, Ito integral, Ito/diffusion and mean reverting processes process, Ito Lemma.

Unit 3: Black Scholes model: Distribution of returns, volatility, risk neutral pricing, equivalent martingale measure, Black-Scholes-Merton differential equation. Estimating volatility (historical data, implied volatility). Options on stock indices, currencies and futures.

Unit 4: Some exotic equity and foreign exchange derivatives. Greek Letters and hedging. Value-at-risk as a measure of risk. Interest rate derivatives, Black model. Models of the term structure of interest rates: one factor diffusion model, Vasicek, Cox-Ingersoll-Ross and Hull white models.

References:

1. Baxter, M. and Rennie,.A. (1996). Financial Calculus, Cambridge University Press.
2. Bingham, N. and Keisel, R. (1998). Risk-Neutral Valuation, Springer.
3. Hull John , (2008). Options, futures and other derivatives, International 7th Edn, Pearson Prentice Hall.
4. Ross.S. (2003). Introduction to Mathematical Finance, Cambridge University Press.

Paper IV MST 404-D

Statistical Pattern Recognition.

Unit 1: Linear classifiers: linear discriminant function(LDF)for minimum squared error, LDF for binary outputs, perception learning algorithm.

Unit 2: Nearest neighbor decision rules: description, convergence, finite sample considerations, use of branch and bound methods.

Unit 3: Probability of errors: two classes, normal distribution, equal covariance matrix assumptions, Chernoff bounds and Bhattacharya distance, estimation of probability of error.

Unit 4: Feature selection and extraction : interclass distance measures, discriminant analysis, probabilistic distance measures, principal components

References:

1. Duda R.O & Hard ,P.E (1973): Pattern recognition and Scene Analysis, Wiley.
2. Fukunaga K (1990): Introduction to Statistical Pattern Recognition, 2nd Ed, Academic Press.
3. McLachian , G.J (1992): Discriminant Analysis and Statistical Pattern Recognition, Wiley
4. Ripley , B.D (1996): Pattern Recognition and Neural Networks, Cambridge University Press.

Foundation Course II

(*Students shall opt for this paper from any other subject other than his/her main subject for post graduation)*

Paper IV MST 404-F2

<u>Foundation course in Applied Statistics</u>

Unit I : Bivariate data : Scatter diagram, correlation coefficient and its Properties, Regression, Principle of least squares, fitting of linear regression, Rank correlation.

Statistical tests, Null and alternative hypothesis, types of errors, concept of statistic and its sampling distribution. Definition of chisquare, t and F Statistic and their applications 'p' value.

Unit II : Sample survey : Sampling unit, frames, Sampling errors, complete enumeration vs Sampling. Simple random sampling with and without replacement.Stratified random sampling.

Analysis of variance one way and two way classification. Basic ideas of designs of experiments and CRD, RBD LSD.

Unit III : Statistical quality control :

Importance of Statistical methods in industrial research and Practice. General theory of control charts, causes of variation in quality control limits, charts for attributes P chart, np chart, c chart. Charts for variable's mean, range and S.D.

Unit IV : Psychological and Educational Statistics :

Scaling scores, normalized scores, T scores, Percentile scores, Scaling of ranking and rating in terms of normal Probability distribution, Reliability and validity of tests Comparison between reliability and validity. Intelligence quotient.

References:

1) Goon A. M. and Gupta M. K. Dasgupta A.B. Fundamentals of Statistics Vol I, Vol II

2) Sukhatme B. V. (1984) Sample Survey methods and its applications, Indian Society of Agricultural Statistics.

3) Desraj (2000) Sample survey Theory Narosa publishing house

4) Das M. N. and Giri (1986) Designs and analysis of experiments, Springer Verlag.

5) Grant E. L. (1964) Statistical Quality control McGraw Hill.

6) Parimal Mukhopadhyay (2009) Theory and methods of Survey Sampling

7) Montgomery D. C. (1985) Introduction to Statistical Quality control. Wiley.

MST 405 - Practical I : will based on MST 401 ,402 and electives III & IV .

MST 406 : Project / Review writing .

Special Task Force in the subject STATISTICS

Subject wise Core Elective Papers:

M.Sc Subject	Core Elective Paper to be opted in **Sem III**	Core Elective Paper to be opted in **Sem IV**
Statistics	Mathematical Programming	Operations Research
	Computer Programming	Reliability Theory
	Survival Analysis	Data Mining
	Bioassay	Time Series Analysis

Foundation Course: Candidate can opt for the foundation course as shown below in semester III and IV. However , students shall opt for this paper from any other subject other than his/ her main subject for post graduation. If the candidate decides to opt for foundation course papers then he/she shall not be eligible to opt for core (Discipline Centric) papers in their respective subjects.

M.Sc Subject	Foundation Course 1 in **Sem III**	Foundation Course 2 in **Sem IV**

Statistics	Foundation Course in Mathematical Statistics	Foundation Course in Applied Statistics

Core (Discipline Centric) : Candidate can opt for this paper as shown below in semester III and IV in their main subject of post graduation only. If the candidate decides to opt for core (Discipline Centric) paper in their main subject of post graduation , then he/she shall not be eligible to opt for foundation course papers neither in their own subject nor in any other subject.

M.Sc Subject	Core(Discipline Centric) I in **Sem III**	Core (Discipline Centric) II **in Sem IV**
Statistics	Industrial Process and Quality Control	Industrial Statistics
	Demography	Actuarial Statistics
	Statistical Ecology	Stochastic Models In Finance
	Statistical Genetics	Statistical Pattern Recognition