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M.Sc. STATISTICS

FIRST YEAR

S. No.	Subject	Maximum Marks	Exam Hours
1	**Statistical Quality Management**	100	3
2	**Operations Research - I**	100	3
3	**Linear Model & Design of Experiments**	100	3
4	**Statistical Inference – I**	100	3
5	**Probability Theory**	100	3

SECOND YEAR

S. No.	Subject	Maximum Marks	Exam Hours
1	**Distribution Theory**	100	3
2	**Operations Research – II**	100	3
3	**Linear Algebra**	100	3
4	**Statistical Inference – II**	100	3
5	**Multivariate Analysis**	100	3

FIRST YEAR

Paper – 1

STATISTICAL QUALITY MANAGEMENT

UNIT – I

Quality Improvement in the Modern Business Environment. ; The meaning of Quality Improvement , The like between quality improvement and productivity, quality Costs – Prevention Costs, Appraisal costs, Internal failure costs, External failure costs. Methods of quality improvement. Total quality management, Quality circles, ISO Standards – 9000, 9001, 9002. Chapter – 1 (1.1 to 1.5) of D.C. Montogomery.

UNIT – II

Statistical Process Control – Cumulative Sum (Cusum) Control Chart – Moving Average and Exponentially Weighted Moving Average (EWMA) Control Charts. Special Purpose Charts, Control of Means and Control of Process Vatiability.

Chapter – 7 (7.1 & 7.2), 8 (8.4.) of D.C. Montgomery.

UNIT – III

Acceptance Sampling : Advantages and Disadvantages, Acceptance Sampling by attributes : Double, Multiple and Sequential Sampling Plan Curtailed Inspection – OC. AOQ, ATI, ASN Curve.

Acceptance Sampling by Variable : Advantages and Disadvantages – Assumptions, Single Sampling Plans – known sigma – unknown sigma plans. Chapter – 13 (13.1 to 123.3), 14 (14.1, 14.2) of D.C. Montgomery.

UNIT –IV

Special Purpose Sampling Plans – Continuous Sampling Plans – CSP – 1,

CSP – 2, CSP – 3, Chain Sampling Plans.

Taguchin Contributions to quilty Engineering : The Taguchin Pholosphy, the Taguchi's approach to parameter Design. Chapter – 15 (15.1 to 15.3) 12 (12.5 , 12.5) of D.C.Montgomery.

UNIT – V

Reliability and Life Testing Concept of Reliability, Aging – Hazard function. Rate function – Reliability function – Estimation of Parameters and Reliability functions in Exponential, Gamma and Weibull Distributions using Complete Samples.

Chapter – 1 (1.1 to 1.5) , 2 (2.1 to 2.9, 2.11) of S.K. Sinha.

Reference:

1. D.C. Montgomery – An Introduction of Statistical Quality Control.
2. S.K. Sinha – Reliability and Life Testing.

Paper – 2
OPERATIONS RESEARCH-I

UNIT – I

Linear Programming Problem : Simplex Method – Duality in LPP – Sensitivity Analysis – Changes in the profit (or cost) Contribution Coefficients of variability in the objective Functions. Changes in the availability of Resources – Changes in the input – Output Co-efficients. Operations Research – J.K. Sharma – Section 6.1, 6.2.

UNIT – II

LPP – Pure-Mixed Integer Programming cutting plane method Gomory's all integer cutting plane method – Mixed integer cutting Plane method – Branch and Bound method – Zero-One Programming problem. Optimization Theory – S.S. Roa, O.R. Taha – section 9.3.1 , 9.3.2.

UNIT – III

Non – Linear Programming problem – Unconstrained Optimization – Single Variable function – Multi – variable functions – Constrained Multi – variable optimization with inequality constraints – Larangian method – Kuhun – Tucker conditions – Quadratic Programming. O.R. Taha –Section 20.1, 20.2, 20.2.1, 20.3, 20.3.1, 20.3.2.

UNIT – IV

Quadratic programming problems – Wolfe's modified simplex method – Beal's method – separable programming – Convex Programming. O.R. Taha – Section 21.2, 21.2.1, 21.2.2.

UNIT – V

Dynamic Programming 0 Characteristics of DPP – Belman's principles of optimality – General Algorithm – Deterministic DPP – Stage Coach problem – Cargo – Loading model – Work Force size model – Investment model LP as DPP. O.R. Taha – sec 10.1 to 10.4, 10.4.1, 10.4.2, 10.4.3.

Reference:

1. O.R. – Taha   -   Prentice Hall – Nov- 1998.

2. O.R. – J.K. Sharma   -   Mc.Millan India Ltd, 1998.

3. S.S. Rao   -   Optimization.

4. O.R.   -   Kantiswarup, Man Mohan Gup

Paper – 3

LINEAR MODEL AND DESIGN OF EXPERIMENTS

UNIT – I   : Linear Models and NOVA

Theory of linear estimation, Estimability of linear parametric function, and BLUE, Method of least squares, Gauss-Markov theorem. Estimation of error variance.

UNIT – II   : Regression Analysis

Estimation and tests of regression parameters in uni-variate (linear, quadratic and cubic) and multivariate linear regression under usual assumptions and related interval estimation. Violation of usual assumptions concerning normality, homoscedasticity and collinearity. Diagonostics using probability plots.

UNIT – III   : ANOVA

Decomposition of sum of squares in one-way and two-way orthohgonal classifications. ANOVA Table.

UNIT – IV   : Design of Experiment

Need for design of experiments, Fundamental principles of design of experiments, Basic designs-CRD, RBD, LSD and their analyses, Orthogonality of classification in two-way lay-outs, advantages of orthosonality relation, simple illustrations. Analysis of co-variance, missing plot technique.

UNIT – V   : Factorial experiments

2n, 32 factorial experiments, illustrations, main effects and interactions, confounding and illustrations.

Reference:

1.   Saluja, M.P. : Indian official statistical systems. Statistical Publishing Society, Calcutta.
2.   Draper, N.R. and Smith, H, (1981) : Applied Regression Analysis, John Wiley.

3. Chatterjee, S. and Price, P. (1991) : Regression Analysis by example. Second edition John Wiley & Sons.

4. Mutrhy, M.N (1967) : Sampling theory and methods. Statistical Publishing Society, Calcutta.

5. Sukhatme et al. (1984) : Sample Theory of Surveys with applications. Indian Society of Agricultural Statistics.Cochran, S.G. (1984): Sampling Techniques Third edition. Wiley Eastern.

6. Federer, W.T. (1975): Experimental designs-theory and applications. Oxford & IBH.

Paper – 4
STATISTICAL INFERENCE – I

UNIT – I

Criteria of Estimation :

Unbiasedness, Consistency, : sufficiency, efficiency. Sufficient statistics, Neymann – Fisher factorization Theorem, Experimental family, completeness, Bounded completeness – Complete sufficiency. Chapter 8 (Sec 3 and Sec 4) of V.K.ROHATGI

UNIT – II

Optimal Estimation :

Uniformly Minimum Variance – Unbiased Estimation – Rao – Black well theorem – Lehmann scheffe's theorem – Chapman – Robbin Bound. Cramer Rao Bound and Bhattacharya Bound. Chapter 2 (Sec 6 and 7) of E.L. Lehmann.

UNIT – III

Methods of Estimation :

Maximum likelihood estimation. Asymptotic properties of MLE. The methodsd of scoring for the Estimation of parameters. Chapters 8 (Sec 7) of V.K. Tohatgi.
Chapter 5 (Sec 5g) of C.R. Rao.

UNIT – IV

Methods of Estimation :

Methods of moments – Minimum Chi-Square – Least Squares – Byes estimation – Bayes Minimax estimation. Chapter 8 (Sec 6) of V.U.K. Rohatgi.

UNIT – V

Interval Estimation :

Fundamental Notions of confidence Estimation, Shortest length, Confidence intervals, Bayes confidence intervals. Chapter 11 (Sec2,3 and 6) of V.K. Rohatgi.

Reference:

1. V.K. Rohatgi Introduction to probability theory & mathematical statistics. (Wiley Eastern Ltd - 1985).
2. E.L.Lehmann Theory of Point Estimation (John Wiley and Sons 1983).
3. C.R. Rao Linear Statistical Inference and its applications (wiley Eastern Ltd - 1984).

Paper – 5
PROBABILITY THEORY

UNIT – I

Probability measure on a sigma – field – probability space. Conditional probability measure – Random variables and vectors. Induced probability measure by Random variable.

UNIT – II

Distribution – function – properties. Distribution Function of Vector of Random Variables – Correspondence theorem. Conditional distribution function. Properties. Concept of Independence – Kolmogorov 0-1 law. Nprel 0-1 Cretierion and Borel – Cantelli Lemma.

UNIT – III

Mathematical expectation – properties. Conditional expectation – moment inequality – Cramer inequality. Holders inequality – Minkowisky inequality, Jensen inequality – Markov Inequality. Cheby sheve's inequality.

UNIT – IV

Characteristic Function inversion – Uniqueness and continuity theorems. Convergence of sequence of random variable – convergence in Y^{th} mean and their relationship.

UNIT – V

Law of large numbers – weak and strong law of large numbers – central limit theorem – Liapounov and Lindeberg – Feller theorem.

Reference:

1. Bhat B.R.   - Modern probability Theory, "wiley" Eastern (1980).
2. Tucker HG   - A graduate course in statistics, Academic press (1976).
3. Loeve. M.   - Probaility theory. Van-Nostrand (1968).

SECOND-YEAR

Paper – 1

DISTRIBUTION THEORY

UNIT – I

Distribution function of two dimensional random variable properties – Distribution of sum, difference. Product and quotient of two independent random variables. Elementary ideas on Logarithmic series distribution.

UNIT – II

Non-central Chi-square, t and F distributions – Distribution of order statistics – Distribution of range and median – limiting distribution of extreme order statistics.

UNIT – III

Bivariate and multivariate normal distribution – properties – marginal and conditional distributions.

UNIT – IV

Distribution of Quadratic forms in normal variables – Necessary and sufficient condition for a quadratic form to be distributed as Chi – Square distribution – Cochran's theorem – James theorem (Statement only).

UNIT – V

Maximum likelihood estimate of parameters of multivariate normal distribution – Distribution of sample mean vector – Inference about mean vector of one and two multivariate normal population when $\sum$ is known.

Reference:

1. Johnson & Kotz (1972): Discrete distributions & Continuous univariate distributions-2.
2. David, H.A. (1981) : Order statistics – Second edition, John Wiley.
3. Rao, C.R. – Linear statistical Inference and its Applications – Wiley Eastern.
4. Anderson T.W. (1983) – An Introduction to Multivariate Statistical Analysis IIedn. MGraw Hill.

5. Hogg, R.V. and Craig A.T. (1972) : Introduction to mathematical Statistics, 3rd edn, Amerind.

6. Rohatgi, V.K. (1984).: An Introduction to probability theory and mathematical statistics

Paper – 2

OPERATIONS RESEARCH – II

UNT – I

Theory of Games – Introduction – Pure Strategies – Mixed Strategies – Rules of Dominance – Games without Saddle Point – Algebric method. Arithmetic Games – Matrix method – graphical methods – Linear Programming method.

O.R. – J.K. Sharma – Section 11.1 to 11.6.

UNIT – II

Inventory Control – Meaning – Classification – Advantages – Characteristics – Inventory model Building – Deterministic Inventory model with No shortage – Model

I – I (a), I(b), I (c) – with shortage – Model – 2(a) , 2(b), 2(c) – Multi item inventory model – Model – 3(a), 3(b)- Probabilistic inventory control – Stationary Demand Models – Model 1(a), Model 2(a) , Model 3 (a).

O.R. – J.K. Sharma – Section 13.1 to 13.9.

O.R. – Taha – Section 16.3, 16.3.1. 16.3.2.

UNIT – III Queuing Theory :

Introduction – Features – Characteristics – Classification – Solution of Queuing Models – (M/M/1) : (O/FCFS) (Q/S/RO) (M/M/1) : (N/FCFS) (M/M/S) : (N/FCFS) – (M/EK/1) : (O/FCCS) – (M/G/1) AND (G1/M/1).

O.R. – J.K. Sharma – section 15.1 to 15.6

Stochastic process – J. Medhi – Section 10.6.

UNIT – IV

Replacement Model :

Introduction – Failure – Gradual failure, Sudden failure – Replacement of items Deteriorate with Time – Replacement of items whose maintenance cost increase with time – Selection of best item amongst two – Replacement of items that fil completely – Group Replacement. O.R. – J.K. sharma – Section 16.1 to 16.4.

UNIT – V

Simulation :

Introduction – Monte Carlo simulation – Types of Simulation – Steps in Simulation – Advantages – Discrete even Simulations – Generalization of Random numbers – Mechanics of Discrete Simulation. O.R. – J.K. Sharma – Section 18.1 to 18.8.

O.R. Taha – Section 18.1 to 18.6.

Reference:

1. Jerry Banks. John S. Carson II, Barry L. Nelson – Discrete Event System Simulation Second Edition 1996 – Prentice Hail.
2. O.R. – J.K. Sharma – Mc Millan India Ltd., 1998.
3. J. Methi – Stochastic Process – Wiley Eastern Ltd.

Paper – 3
LINEAR ALGEBRA

UNIT – I

Fields, vector spaces, subspaces, linear dependence and independence, basis and dimension of a vector space, finite dimensional vector spaces, completion theorem, examples of vector over real and complex fields, linear equations. Vector spaces with an inner product, gram-Schmidt orthogonalization process, orhtonormal basis and orthogonal projection of a vector.

UNIT – II

Linear transformations,k algebra of matrices, row and column spaces of a matrix, elementary matrices, determinants, rank and inverse of a matrix, null spaces and nullity, partitioned matrices, kronecker product.

UNIT – III

Hermite canonical form, generalized inverse, Moore-Penrose generalized inverse, Idempotent matrices, Solutions of matrix equations. Real quadratic forms, reduction and classification of quadratic forms, index and signature, triangular reduction of a positive definite matrix.

UNIT – IV

Characteristic roots and vectors, Cayley – Hamition theorem, minimal polynomial, similar matrices, algebraic and geometric multiplicity of a characteristic root, spectral decomposition of a real symmetric matric, reduction of a pair of real symmetric matrices, Hermitian matrices.

UNIT – V

Singular values and singular value decomposition, extrema of quadratic forms, vector and matrix differentiation.

Reference:

1. Graybil, F.A. (1983). Matrices with applications in statistics, 2nd Ed. Wadsworth.
2. Rao, C.R. (1973). Linear statistical inference and its applications, 2nd Ed. Ojhn Wiley and Sons, Inc.
3. Searle, S.R. (1982). Matrix algebra useful for Statistics, John Wiley and Sons, Inc.
4. Rao, A.R. and Bhimasankaram, P. (1992). Tata McGraw Hill Publishing company Ltd.
5. Hoffman, K. and Kunze, R. (1971). Linear Algebra, 2nd ed., Prentice Hall, Inc.

Paper – 4
STATISTICAL INFERENCE – II

UNIT – I

Most Powerful Test :

Fundamental Notions of Hypothesis – Testing Randomized and Non-Randomized tests. Most powerful tests. The Neyman-Pearson Fundamental Lemma. Chapter 3 (Sec 1 and Sec 2) of E.L. Lehmann.

UNIT – II

Uniformly Most Powerful Test :

UMP test. Distributions with Monotone Likelihood Ratio, Generalization of the Fundamental Lemma (with out Proof) UMP test for two sided hypothesis. Chapters 3 (Sec 3.6 and 7) of E.L.Lehmann.

UNIT – III

Unbiased and UMPU test :

Unbiasedness for hypothesis testing – UMPU tests for one Parameter exponential family, similar test, Test with Neymann – Structure, Likelkhood Ratio test. Relatiionship between testing of hypothesis and confidence interval. Chapter 4 (Sec2 and 3) of E.L. Lehmann. Chapter 11 (Sec 4) of V.K. Rohatgi.

UNIT – IV

Sequential Probability Ratio Test :

Sequential Probability Ratio Test, Properties of SPRT, Efficiency of the SPRT, Economy of Sequential Testing, The fundamental identify of the SPRT. Chapter 7 (Sec7c.1 to 7c.5) of C.R. Rao.

UNIT – V

Non-parametric Test :

Single sample problems – Kolmogrov – simirnov test, the sign test, the Wilcoxon Signed Ranks Test. Two sample problems – Kolmogro –Simirnov two sample test. The Median Test, The Mann –Whitney-Wilcoxon test. Chapter 13 (sec 3,4) of V.K.Rohatgi.

Reference:

1. V.K. Rohatgi (1985) – Introduction to Probability Theory and Mathematical Statistics.
2. C.R.Rao (1984) – Linear Statistical Inference and its applications.
3. E.L. Lehmann (1983) – Testing Statistical Hyposthesis.

Paper – 5

MULTIVARIATE ANALYSIS

UNIT – I

Estimators of Total, Partial and Multiple correlation coefficient and their null distributions. Test for total, partial, and multiple correlation coefficient and multiple regression coefficients.

UNIT – II

Distribution of sample dispersion matrix – wishart distribution – properties – Hotellings T^2 and Mahalanobis of D^2 statistics – their null distributions.

UNIT – III

Test for mean vector of one and two multivariate normal populations based on T^2 (or D^2) distribution – Classification problem – Classification of two multivariate normal populations – Baye's procedure – Calculation of the probabilities of misclassification.

UNIT – IV

Discriminant Analysis – Fishers discriminant function – Test for assigned discriminant function – Canonical correlations and canonical variates.

UNIT – V

Principal Component Analysis – Extraction – properties – Factor Analysis – Orthogonal factor model – Principal component solution to factor model.

Reference:

1. Anderson, T.W. (1983)   -   An Introduction to Multivariate Analysis-Second edition, John Wiley.

2. Johnson & Kotz (1972)   -   Continuous Univariate Distributions & continuous Multivariate Distributions-Wiley Eastern.

3. Rao. C.R.   -   Introduction Linear Statistical Inference and its applications – Wiley Eastern.

4. Morrison. D.F. (1976)   -   Mulltivariate Statistical Methods – Second edn,McGraw Hill.

5. Johnson. A.R. &

Wichern, W.D. (1988) - An Introduction to Applied Multivariate Analysis – Academic press.