

"Appendix A"

UNIVERSITY OF LUCKNOW  
SYLLABUS OF STATISTICS


B.A./B.Sc. (Statistics)

(FROM THE ACADEMIC SESSION OF 2018-19 AND ONWARDS)

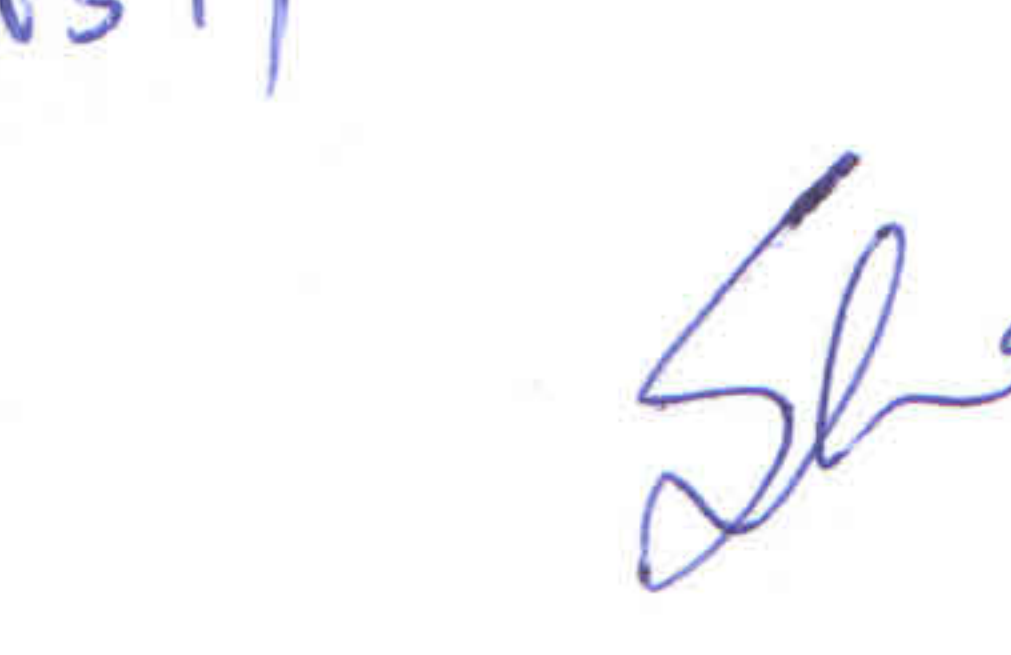
Note: Syllabus and examinations of Statistics as a subject for B.A. course will be exactly the same as that for B.Sc. course. The teaching hours, examination pattern, internal assessment and marks etc will be as per ordinances of University of Lucknow from 2018-19 Session onwards.

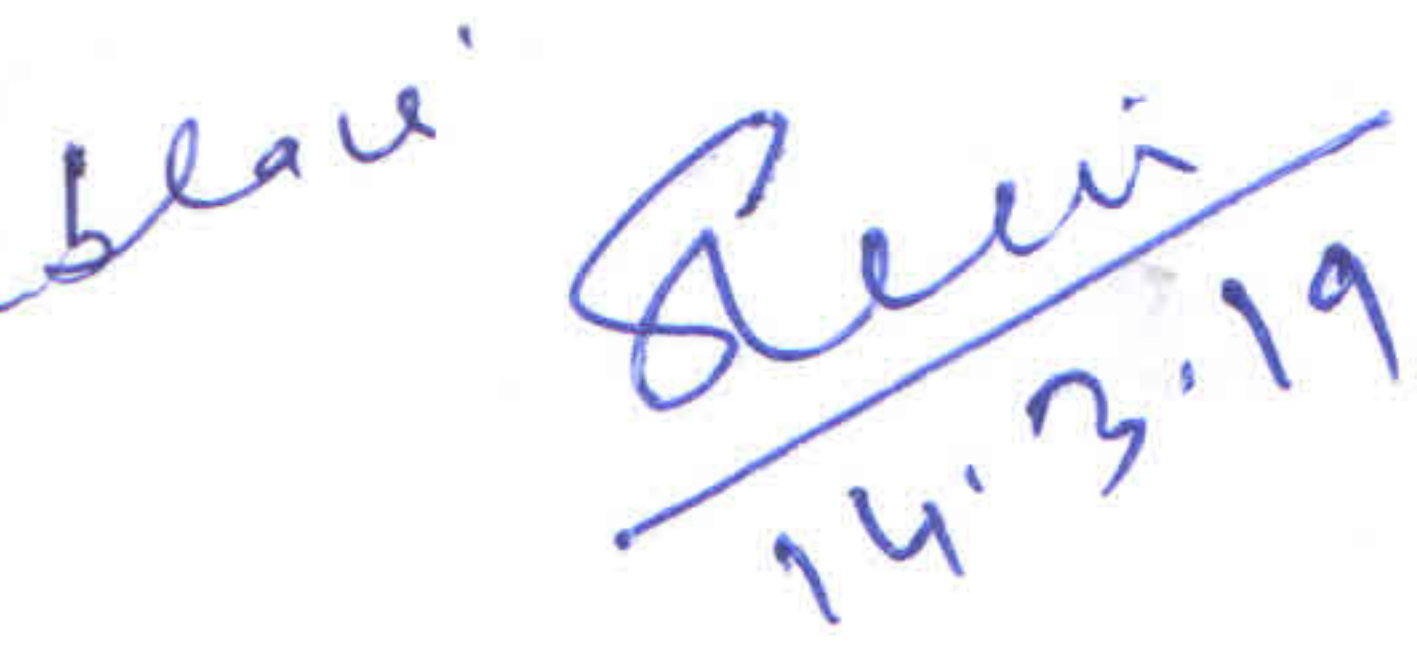
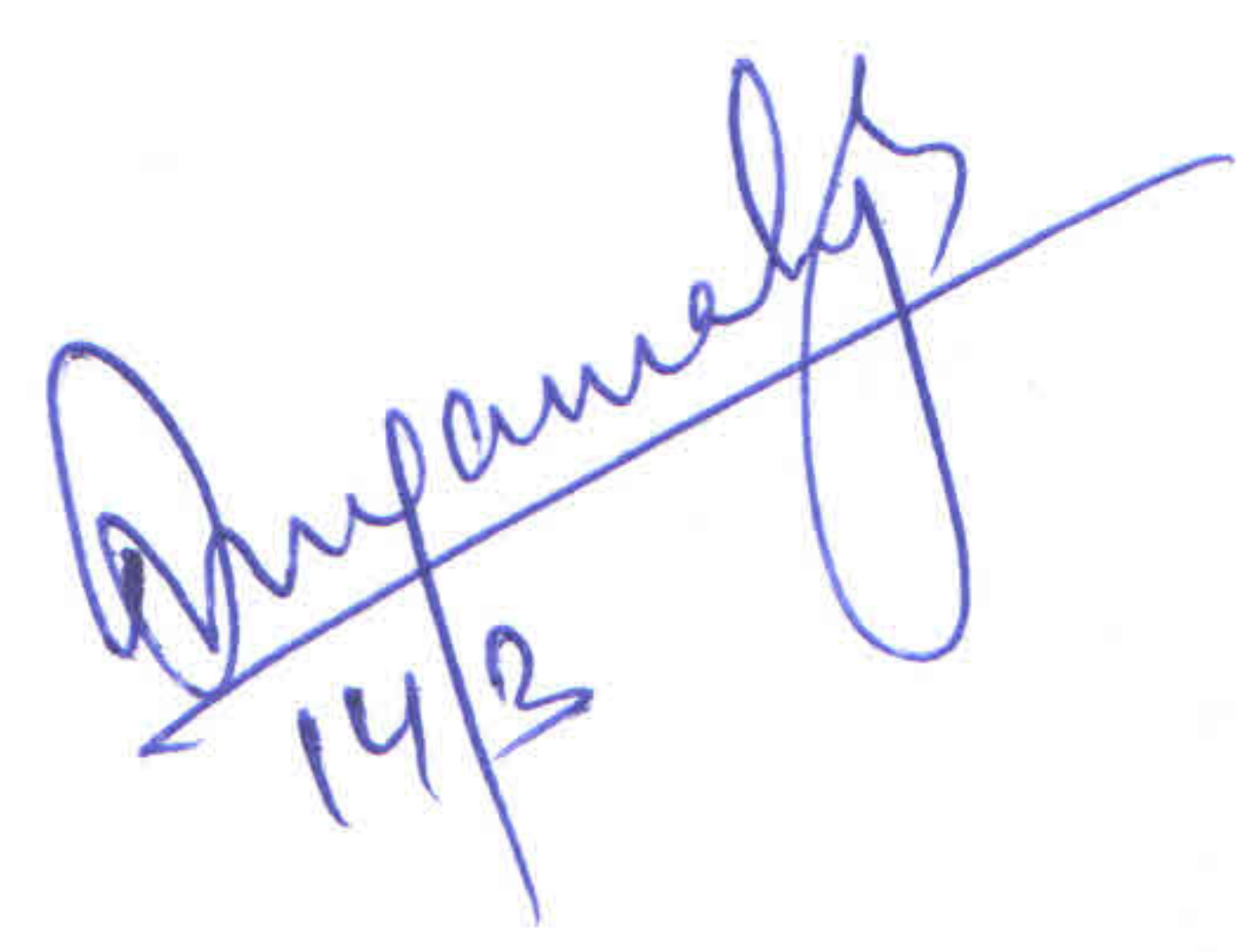
SEMESTER I	PAPER I	PROBABILITY
	PAPER II	STATISTICAL METHODS
SEMESTER II	PAPER I	PROBABILITY DISTRIBUTIONS AND NUMERICAL ANALYSIS
	PAPER II	<i>PRACTICAL BASED ON ALL THE PAPER OF SEMESTER I &amp; II</i>
SEMESTER III	PAPER I	STATISTICAL INFERENCE
	PAPER II	SURVEY SAMPLING
SEMESTER IV	PAPER I	ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS
	PAPER II	<i>PRACTICAL BASED ON ALL THE PAPER OF SEMESTER III &amp; IV</i>
SEMESTER V	PAPER I	REGRESSION ANALYSIS AND NON-PARAMETRIC METHODS
	PAPER II	EDUCATIONAL STATISTICS AND QUALITY CONTROL
	PAPER III	OPTIMIZATION TECHNIQUES
SEMESTER VI	PAPER I	OPERATIONS RESEARCH
	PAPER II	APPLIED STATISTICS
	PAPER III	<i>PRACTICAL BASED ON ALL THE PAPER OF SEMESTER V &amp; VI</i>

  
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M. H. Khan  
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## SEMESTER I

### Paper I: Probability

#### UNIT I

Basic Concepts of probability, Random Experiment, Trial, Sample Point, Sample space, events, Definitions of Mutually Exclusive, Exhaustive and Equally Likely events. Preliminary Notions of Sets: Sets and Elements of Sets, Operations on sets, Algebra of sets. Algebra of Events. Definitions of Probability: Classical, relative frequency and axiomatic approaches and their limitations.

#### UNIT II

Theorems on Probability: Addition theorem of Probability for  $n$  Events, Theorem of Total Probability for  $n$  Events, Boole's Inequality, Conditional Probability, Multiplication Theorem of Probability for  $n$  events, Independent Events. Bayes' Theorem and its Applications.

#### UNIT - III

Random variables – discrete and continuous, probability mass function (pmf) and probability density function (pdf), Cumulative distribution function (cdf). Joint distribution of two random variables, marginal and conditional distributions. Independence of random variables. Expectation of a random variable and its properties, expectation of sum of random variables and product of independent random variables, conditional expectation and Conditional Variance.

#### UNIT - IV

Moments, moment generating function (m.g.f.) & their properties, continuity theorem for m.g.f. (without proof). Chebyshev's inequality. Weak law of large numbers and Central Limit Theorem for a sequence of independently and identically distributed random variables and their applications.

#### REFERENCE:

1. Goon, A.M., Gupta, M.K. & Dasgupta, B.: Fundamentals of Statistics, Volume I.
2. Yule, G.U. and Kendall, M.G.: An Introduction to the Theory of Statistics.
3. Weatherburn, C. E.: Mathematical Statistics.
4. Hogg, R.V., Craig, A.T. and McKean, J.W.: Introduction to Mathematical Statistics.
5. Mood, A.M., Graybill, F.A. and Boes, D.C.: Introduction to the Theory of Statistics.
6. Meyer, P.: Introductory Probability and Statistical Applications.
7. Parzen, E.S.: Modern Probability Theory and Its Applications.

### Paper II: Statistical Methods

#### UNIT-I

Concept of statistical population. Attributes and variables (discrete and Continuous). Different types of scales – nominal, ordinal, ratio and interval. Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency. Secondary data. scrutiny of data for internal consistency and detection of errors of recording. Ideas of cross validation. Presentation of data: classification, tabulation, diagrammatic & graphical

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representation of grouped data. Frequency distributions, cumulative frequency distributions and their graphical representations, histogram, frequency polygon and ogives. Stem and Leaf plot. Box Plot.

### UNIT-II

Measure of central tendency and dispersion, merits and demerits of these measures. Moments and factorial moments. Shephard's correction for moments. Skewness and Kurtosis and their Measures., Measures based on quantiles (Quartiles, Deciles and percentiles).

### UNIT-III

Bivariate data: Method of least squares for curve fitting. Correlation and regression, Correlation for bivariate frequency distribution, rank Correlation (Spearman's and Kendall's measure), Intra-class correlation, correlation ratio. Partial and Multiple Correlation & Multiple Regression for Tri-variate data.

### UNIT-IV

Attributes- Notion and terminology, contingency table, class frequencies, and ultimate class frequencies, consistency. Association of attributes, Independence, Measure of association for 2x2 table. Chi-square, Karl Pearson's and Tschuprow's coefficient of association. Contingency tables with ordered categories.

### REFERENCES:

1. Goon, A.M., Gupta, M.K. & Dasgupta, B.: Fundamentals of Statistics, Volume I.
2. Yule, G.U. and Kendall, M.G.: An Introduction to the Theory of Statistics.
3. Weatherburn, C. E.: Mathematical Statistics.

## SEMESTER II

### Paper I: Probability distributions and Numerical Analysis

#### UNIT - I

Univariate distributions: Binomial, Poisson, Hypergeometric, Geometric and Negative Binomial, Uniform (discrete & continuous), Normal, Normal and Poisson distributions as limiting case of binomial distribution, Exponential, Gamma, Beta distributions. Cauchy, Laplace, Pareto, Weibull, Log normal Distributions.

#### UNIT - II

Distributions of function of random variables: Distribution of sum, product and quotient of two Variable.  $\chi^2$  (chi-square), t and F distributions (Central cases only), their relationships and limiting forms. Bivariate normal distribution and its properties.

#### UNIT - III

Calculus of finite differences, operators, separation of symbols, examples and problems. Interpolation formulas with remainder term. Newton's forward and backward formulae. Central difference formulae. Newton's divided difference formulae for interpolation. Lagrange's interpolation formulae.

#### UNIT - IV

Numerical Integration: Derivation of general quadrature formula for equidistant ordinates. Derivation of trapezoidal, Simpson's  $1/3^{\text{rd}}$  and  $3/8^{\text{th}}$  rules. Weddle's rule.

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## REFERENCES

1. Goon, A.M., Gupta, M.K. & Dasgupta, B.: Fundamentals of Statistics, Volume I.
2. Parzen, E.S.: Modern Probability Theory and Its Applications.
3. Meyer, P.: Introductory Probability and Statistical Applications.
4. Freeman: Finite Differences.
5. Scarborough: Numerical Analysis.
6. Sastry, S.S.: Introductory Methods of Numerical Analysis; Prentice Hall of India Pvt. Limited.
7. Jain, M.K., Iyengar, S.R.K. and Jain, R.K.: Numerical Methods For Scientific And Engineering Computations; NEW AGE International (P) Limited.

## **Paper II: PRACTICAL**

The practical examination will be based on all papers of Semester I and Semester II and will include but not limited to the following experiments.

### List of Practical Experiments

1. Graphical representation of data by Histogram, Frequency polygons, frequency curves and Ogives. Stem and Leaf Plot, Box Plot.
2. Calculation of measures of Central Tendency.
3. Calculation of measures of dispersion.
4. Calculation of moments, measures of Skewness and Kurtosis.
5. Fitting of curves by method of least squares.
6. Determination of regression lines and calculation of correlation coefficient – grouped and ungrouped data.
7. Calculation of correlation ratios, rank and intra -class correlation coefficients.
8. Calculation of multiple and partial correlation coefficients for three variables
9. Calculation of measures of association in contingency tables.
10. Construction of forward difference tables and divided difference tables.
11. Interpolation by Newton's forward difference formula for equal intervals and calculation of error.
12. Interpolation by Newton's divided difference formula for unequal intervals. Calculation of error.
13. Interpolation by Lagrange's formula for unequal intervals. Calculation of error.
14. Approximate integration (Trapezoidal rule, Simpson's one-third rules, Simpson's three-eighth rule), Weddle's rule.

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## SEMSTER III

### PAPER I: STATISTICAL INFERENCE

#### UNIT - I

Point estimation. Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency. Method of maximum likelihood and properties of maximum likelihood estimators (without proof). Method of minimum Chi-square. Method of Least squares and method of moments for estimation of parameters. Problems and examples.

#### UNIT - II

Sufficient Statistics, Cramer-Rao inequality and its use in finding MVU estimators. Statistical Hypothesis (simple and composite). Testing of hypothesis. Type I and Type II errors, significance level, p-values, power of a test. Definitions of Most Powerful (MP), Uniformly Most Powerful (UMP) and Uniformly Most Powerful Unbiased (UMPU) tests.

#### UNIT - III

Neyman-Pearson's lemma and its applications for finding most powerful tests for simple hypothesis against simple alternative. Tests based on t, F and  $\chi^2$  distributions.

#### UNIT-IV

Likelihood ratio tests and their reduction to standard tests. Large sample tests, variance - stabilizing transformations. Interval estimation, Pivotal quantity and its use in finding confidence intervals, concept of best confidence intervals.

### PAPER II: SURVEY SAMPLING

#### UNIT - I

Sampling vs. complete enumeration : sampling units and frame. Precision and efficiency of estimators. Simple Random sampling with and without replacement. Use of random number tables in selection of simple random sample. Estimation of population mean and proportion. Derivation of expression for variance of these estimators. Estimation of variances. Sample size determination.

#### UNIT-II

Stratified random sampling. Problem of allocation, proportional allocation, optimum allocation. Derivation of the expressions for the standard errors of the usual estimators when these allocations are used. Gain in precision due to stratification. Role of sampling cost in the sample allocation. Minimization of variance for fixed cost. Systematic sampling : estimation of population mean and population total, standard errors of these estimators.

#### UNIT-III

Regression and ratio methods of estimation in simple random sampling. Cluster sampling with equal and unequal clusters. Estimators of population mean and their mean square error.

#### UNIT-IV

Double sampling in ratio method of estimation. Two-stage sampling with equal first stage units : estimator of population mean and its variance. Multi-stage sampling with examples (definition only). Non-sampling errors.

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## SEMESTER IV

### PAPER I: ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENT.

#### UNIT-I

Analysis of Variance. One way classification. Assumptions regarding model. Two way classification with equal number of observations per cell. Duncan's multiple comparison test. Analysis of covariance.

#### UNIT-II

Principles of Design of experiments: Randomization, Replication and local control. Choice of size and type of a plot using uniformity trials. CRD, Randomized block design. Concept and definition of efficiency of design. Comparison of efficiency between CRD and RBD.

#### UNIT - III

Latin square Design, Lay-out, ANOVA table. Comparison of efficiencies between LSD and RBD; LSD and CRD. Missing plot technique : estimation of missing plots by minimizing error sum of squares in RBD and LSD with one or two missing observations.

#### UNIT-IV


Factorial Experiments: general description of factorial experiments;  $2^2$ ,  $2^3$  and  $2^n$  factorial experiments, definition of main effects and interactions in  $2^2$  and  $2^3$  factorial experiments. Preparation of ANOVA by Yates procedure. Estimates and tests for main and interaction effects (Analysis without confounding).

#### REFERENCES

1. Cochran and Cox : Experimental Design
2. Kempthorne : Design of Experiments
3. Federer : Experimental Designs
4. Goon, Gupta and Dasgupta : Fundamentals of Statistics. Vol. II

#### PAPER II: PRACTICAL

Practicals will be based on all the papers of Semester III and Semester IV


  
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## SEMESTER V

### PAPER I: REGRESSION ANALYSIS AND NON-PARAMETRIC METHODS

#### UNIT - I

Multivariate normal distributions, marginal and conditional distribution, Moment Generating and Characteristics functions, Maximum likelihood estimation of mean vector and covariance matrix, Distribution of linear combination of components of multivariate normal.

#### UNIT - II

Linear regression model of full rank, Least squares theory, Estimation of parameters: OLSE and MLE of  $\beta$  and test of hypotheses,  $R^2$  and adjusted  $R^2$ , ANOVA table for regression.

#### UNIT - III

Order Statistics, Distributions of minimum,  $r^{\text{th}}$  and maximum order statistic, Joint distribution of  $r^{\text{th}}$  and  $s^{\text{th}}$  order statistics (in continuous case), Distribution of sample range & sample median (for uniform and exponential distributions), Confidence interval for quantiles of order  $p$ , tolerance and coverages.

#### UNIT - IV

Non-parametric tests – Tests for randomness, test for goodness of fit, One sample tests: sign test, Wilcoxon signed rank tests, Two sample tests: run test, Kolmogorov – Smirnov's test. Median test and Mann-Whitney U test. Mood tests and Sukhatme test for scale parameter

### PAPER II: EDUCATIONAL STATISTICS AND QUALITY CONTROL

#### UNIT - I

Educational Statistics: Different Scaling procedures: scaling of test items, test scores, rating of qualitative answers and judgements, scaling in terms of normal curve, equivalent scale, percentile scaling, z-scores, t-scores.

#### UNIT - II

Test theory, linear models, parallel tests, true score, reliability and different methods for assessing it: Parallel test method, test-retest method, split half method, Kuder-Richardson method, Cronbach's  $\alpha$ . Validity of tests: Construct validity, construct validity, criterion validity. Tetra-choric, bi-serial and point bi-serial correlation coefficients.

#### UNIT - III

Statistical Quality Control, Process control, different control charts for variables and attributes, modified control charts, group control charts, CUSUM charts, V mask.

#### UNIT - IV

Sampling inspection by attributes – single and double sampling plans, Producer's and consumer's risk, OC, ASN, ATI functions AOQL and LTPD for these sampling plans. Sampling inspection by variables – simple cases.

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**PAPER III: OPTIMIZATION TECHNIQUES**

**UNIT - I**

General linear programming problems and their formulations, Method for solving LPP: Graphical Method, Simplex method, Big - M method, Two phase Method, Duality in LPP (introduction only).

**UNIT - II**

Transportation problem, Methods for obtaining IBFS: North-west corner rule, Least cost method, Vogel's approximation method, Methods for determining optimum solution: Stepping stone method, Method of Multipliers (MODI Method). Assignment Problem, Hungarian Algorithm.

**UNIT - III**

Inventory Control, Different costs involved in inventory control, factors affecting inventory control, Deterministic EOQ models, Deterministic EOQ with shortages allowed.

**UNIT - IV**

Job sequencing: n jobs - 2 machines problem, n jobs - K machines problem, 2 jobs - n machines problem.

Dynamic Programming Problem, Bellman's optimality Principal

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## SEMESTER VI

### PAPER – I: OPERATIONS RESEARCH

#### UNIT – I

Queuing Theory: Queuing system and its elements, Distribution of arrivals, Distribution of inter-arrival time, distribution of departures, distribution of service time, classification of queuing models.

#### UNIT – II

Different queuing models with their characteristics:  $(M|M|1):(\infty|FCFS)$ ,  $(M|M|1):(N|FCFS)$ ,  $(M|M|C):(\infty|FCFS)$ , Little's formula.

#### UNIT – III

Network Analysis: Minimum spanning tree, Shortest-route problem and Maximal flow model.

#### UNIT – IV

Project Management: PERT/CPM, determination of floats, construction of time chart.

### PAPER II: APPLIED STATISTICS

#### UNIT – I

Time series, its different components: Trend, Seasonal fluctuation, cyclical fluctuation and Irregular component, additive model, multiplicative models and mixed model (overview), determination of trend: free hand curve fitting method, semi average method, mathematical curve fitting method, method of moving averages, analysis of seasonal fluctuations, Methods for construction of seasonal indices: Ratio to trend method, ration to moving averages method and method of link relatives.

#### UNIT – II

Index number – its definition, its applications, problem involved in computation of index number, price relative and quantity or volume relatives, use of averages, simple aggregative and weighted average method. Laspeyre's, Paashe's, Fisher's and Marshall-Edgeworth's index number, Tests for good index number: Unit test, time reversal test, factor reversal test and circular test, consumer price index number (Overview only)

#### UNIT – III

Demographic methods: Sources of demographic data – census, register, ad-hoc survey, hospital records, Measurement of fertility – crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate.

#### UNIT – IV

Measurement of mortality: crude death rates, age specific death rates, infant mortality rates, death rate by cause, standardized death rates, Life tables: complete life table, its main features and construction.

### PAPER III: PRACTICAL:

Practicals based on all the papers of semester V and semester VI

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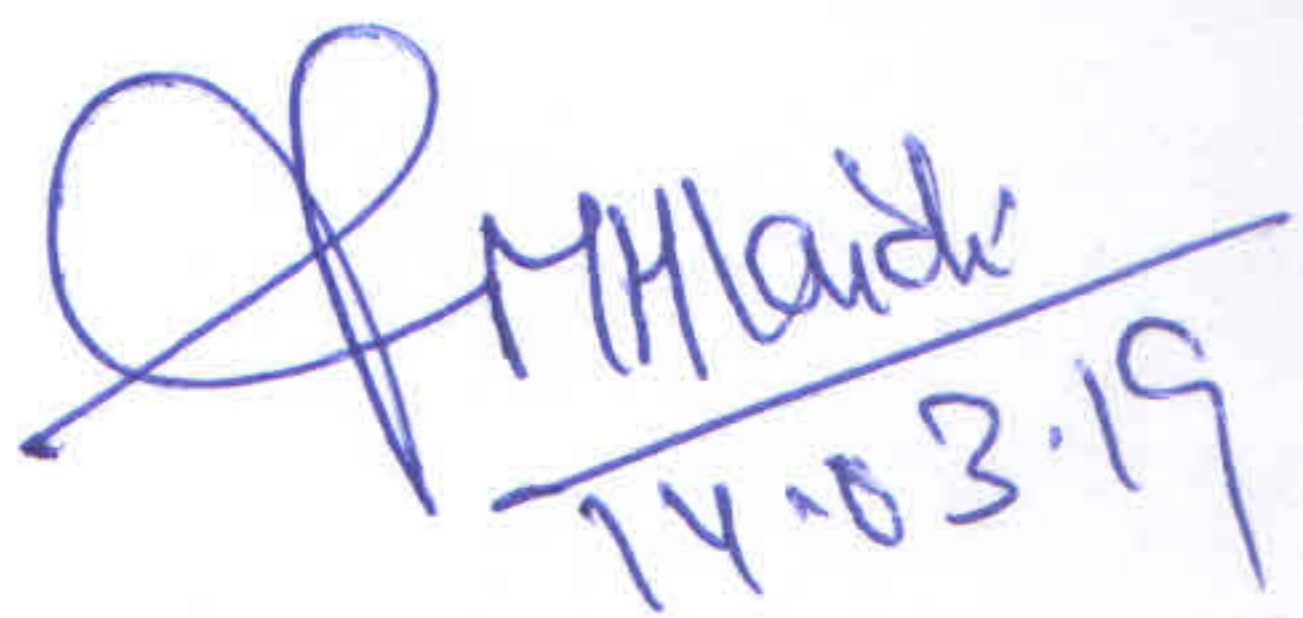
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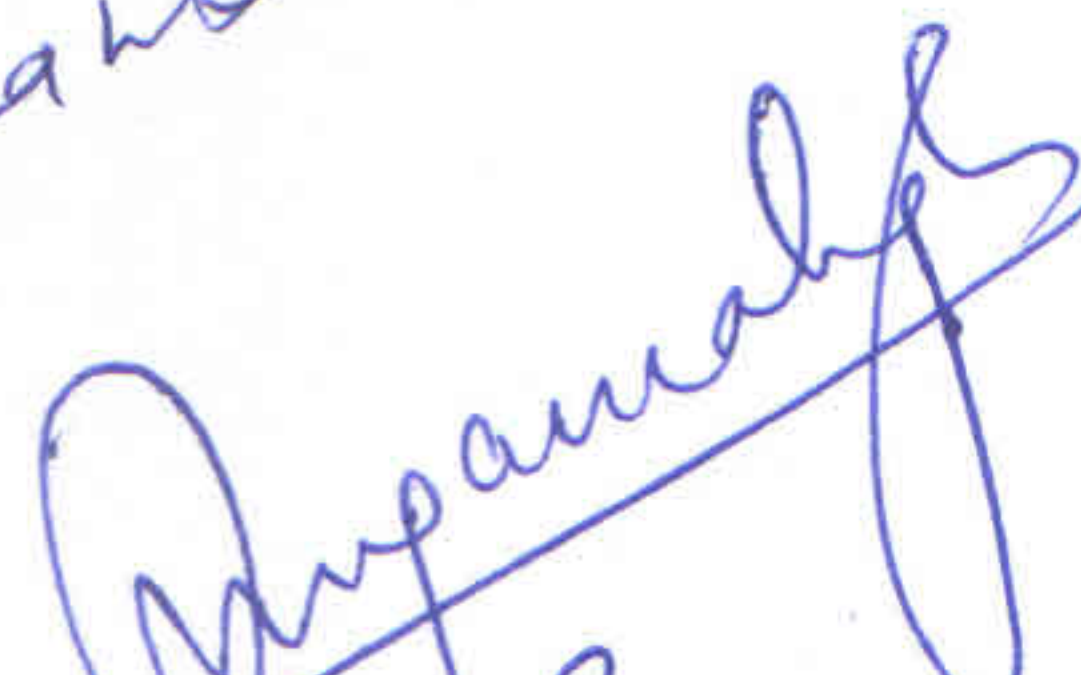
1. Mood, A.M., Graybill F and Boes D.C. : Introduction to the theory of Statistics.
2. Gibbons, J.D. : Non-parametric statistical inference
3. Conover, W.J. : Practical Non-parametric Statistics
4. David, H.A. : Order Statistics
5. Johnston : Econometric Methods
6. Anderson : Introduction to Multivariate Statistical Analysis, Chaps 1,2 & 3
7. Montgomery D.C. (1985) : Introduction to Statistical Quality Control (Wiley).
8. Draper & Smith : Applied Regression Analysis
9. Burr : Industrial Quality Control.
10. Wetherill and Brown : Statistical Quality Control
11. Croxton F.E. and Cowden D.J. : Applied General Statistics
12. Goon, Gupta and Dasgupta : Fundamentals of Statistics, Vol. I & II
13. Siya Ram : Applied Statistics.
14. Swarup Kanti, Gupta P.K. and Man Mohan : Operations Research, Sultan Chand & Sons.
15. Taha, H.A. : Operations Research, Mac Millan publishing.

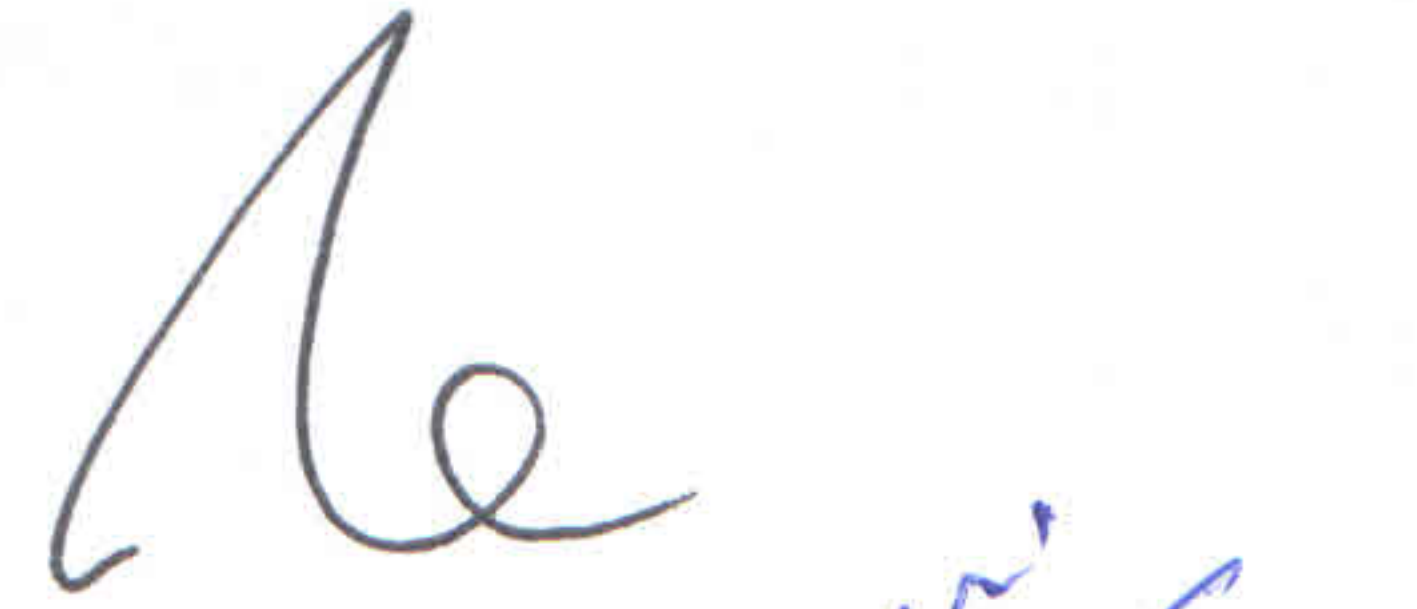
  
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