UNIVERSITY OF LUCKNOW
SYLLABUS OF STATISTICS
B.A. Part- I
(For the Examination of 2009 and onwards)

Paper – I : Probability & Probability Distribution

UNIT – I

Random experiment, trial, sample point and sample space, events, operations of events, concepts of equally likely, mutually exclusive and exhaustive events.

Definition of probability : Classical, relative frequency and axiomatic approaches. Discrete probability space, properties of probability under set theoretic approach Independence of events, Conditional probability, total and compound probability theorems, Bayes theorem and its applications.

Random variables – discrete and continuous, probability mass function (pmf) and probability density function (pdf), Cumulative distribution function (cdf).

UNIT – II

Joint distribution of two random variables, marginal and conditional distributions, Independence of random variables. Expectation of a random variable (rv) and its properties., expectation of sum of random variables and product of independent random variables, conditional expectation. 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.

UNIT – III

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

UNIT – IV

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

REFERENCE:

1. Parzen, E.S. : Modern Probability Theory and its Applications.
2. Meyer, P. : Introductory Probability and Statistical Applications.
3. Stirzekar David (1994) : Elementry Probabilityu, Cambridge University Press.
4. Mood A.M., Graybill F.A. and Boes D.C. (1974) : Introduction to the theory of Statistics, McGraw Hill.

Paper – II : Statistical Methods and Numerical Analysis

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

UNIT-II

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

UNIT – III

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.

UNIT – IV

Calculus of finite differences, operators, separation of symbols, examples and problems. Interpolation formulae with remainder term. Newton's forward and backward formulae. Central difference formulae. Newton's divided difference formulae for interpolation. Lagrange's interpolation formulae. Numerical Integration: Derivation of general quadrature formula for equidistant ordinates. Derivation of trapezoidal, Simpson's $1\backslash 3^{rd}$ and $3\backslash 8^{th}$ rules. Weddle's rule. Real roots of numerical equation by method of iteration.

REFERENCES

1. Parzen, E.S. : Modern Probability Theory and Its Applications.
2. Meyer, P.: Introductory Probability and Statistical Applications.
3. Freeman : Finite Differences.
4. Scarborough: Numerical Analysis.
5. S.S. Sastry : Introductory Methods of Numerical Analysis; Prentice Hall of India Pvt. Limited.
6. Jain, M.K., Iyengar, SRK and Jain R.K.: Numerical Methods For Scientific And Engineering Computations; NEW AGE International (P) Limited.
7. Goon,Gupta & Dasgupta: Fundamentals of statistics. Vol. I. The world press Private Ltd., Calcutta.
8. Yule, G.U. and Kendall, M.G.: An Introduction to the theory of statistics. Charles Griffin & Company Ltd.
9. C. E. Weatherburn: Mathematical Statistics.

PRACTICAL

The practical examination will be based on papers I and II and will cover the following experiments.

List of Practical Experiments

1. Graphical representation of data by Histogram, Frequency polygons, frequency curves and Ogives, stem & Leaf Plot, Box Plot.
2. Calculation of measures of location.
3. Calculation of measures of dispersion.
4. Calculation of moments, measures of skewness and measures of 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. Construction of Index numbers.
10. Calculation of measures of association in contingency tables.
11. Construction of forward difference tables and divided difference tables.
12. Interpolation by Newton's forward difference formula for equal intervals and calculation of error.
13. Interpolation by Newton's divided difference formula for unequal intervals. Calculation of error.
14. Interpolation by Lagrange's formula for unequal intervals. Calculation of error.
15. Approximate integration (Trapezoidal rule, Simpson's one-third rules, simpson's three-eighth rule), Weddle's rule.
16. Real roots of numerical equation by method of iteration.

And

Other practicals based on Paper I & Paper II.

B.A. Part- II

(For the year 2010 and onwards)

Paper I : Statistical Inference & Analysis of variance

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 Hypotheses (simple and composite). Testing of hypotheses. 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 χ^2 distributions. 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.

UNIT-IV

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.

REFERENCE

1. Hogg & Craig : Mathematical Statistics.
2. Mood, Graybill and Boes : Introduction to the theory of Statistics.
3. Goon, Gupta and Dasgupta : Fundamentals of Statistics Vol.1 & II

Paper II : Survey Sampling & Design of Experiments

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.

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-II

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. 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.

UNIT-III

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. Latin square Design : Lay-out, ANOVA table. Comparison of efficiencies between LSD and RBD; LSD and CRD.

UNIT-IV

Missing plot technique ; estimation of missing plots by minimizing error sum of squares in RBD and LSD with one or two missing observations. Factorial Experiments : general description of factorial experiments; 2^2, 2^3 and 2^n factorial experiments arranged in RBD and LSD. 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, W.G. : Sampling Techniques
2. Sukhatme, Sukhatme, Sukhatme & Asok : Sampling Theory of Surveys with applications.
3. Murthy, M. N. : Sampling theory.
4. Cochran and Cox : Experimental Design
5. Kempthorne : Design of Experiments
6. Federer : Experimental Designs
7. Goon, Gupta and Dasgupta : Fundamentals of Statistics, Vol. II

PRACTICAL

The practical examination will be based on papers I and II will cover the following experiments:

List of Practical Experiments

1. Fitting of Binomial, Poisson and Normal distributions to observed data and testing of goodness of fit.
2. Testing of independence of attributes in m x n contingency table and calculation of measures of association.
3. t – test for (i) $\mu = \mu_0$ (ii) $\mu_1 = \mu_2$ (iii) $\alpha = \alpha_0$ (iv) $\beta = \beta_0$ (v) $\rho = 0$ (vi) $\rho_{12..3} = 0$
4. F-test for (i) $\sigma_1^2 = \sigma_2^2$ (ii) $\rho_{1.23} = 0$
5. Fisher's Z-transformation and its use in testing (i) $\rho_1 = \rho_2$ (ii) $\rho_1 = \rho_2 = \ldots = \rho_k$ (iii) $\rho = \rho_0$
6. Calculation of power curve for the test of $\mu = \mu_0$ against $\mu \neq \mu_0$ for a normal distribution with known variance.
7. Large sample tests.
8. Analysis of variance in one-way and two-way classification (with and without interaction terms).
9. Analysis of a Latin square design.
10. Analysis of variance in RBD and LS design with one or two missing observations.
11. Drawing a simple random sample with the help of table of random numbers.
12. Estimation of population means and variance in simple random sampling.
13. Stratified random sampling for population mean (proportional and optimum allocation).
14. Ratio and regression estimation of population mean and total.
15. Factorial Experiment Practical.

And

Other practicals based on Paper I and Paper II.

UNIVERSITY OF LUCKNOW
SYLLABUS OF STATISTICS
B.Sc. Part- I
(For the Examination of 2009 and onwards)

(In each class will be comprehensive based on units I to IV and will carry 40% marks.)

Paper – I : Probability

UNIT – I

Random experiment, trial, sample point and sample space, events, operations of events, concepts of equally likely, mutually exclusive and exhaustive events.

Definition of probability : Classical, relative frequency and axiomatic approaches. Discrete probability space, properties of probability under set theoretic approach. Independence of events, Conditional probability, total and compound probability theorems, Bayes theorem and its applications.

UNIT – II

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.

UNIT – III

Independence of random variables. Expectation of a random variable (rv) and its properties., expectation of sum of random variables and product of independent random variables, conditional expectation.

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.

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3. Stirzekar David (1994) : Elementry Probabilityu, Cambridge University Press.
4. Mood A.M., Graybill F.A. and Boes D.C. (1974) : Introduction to the theory of Statistics, McGraw Hill.

Paper – II : Probability distributions and Numerical Analysis

UNIT – I

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

UNIT – II

Distributions of function of random variables: Distribution of sum, product and quotient of two Variable. Reproductive property of standard distributions. χ^2(chi-square), t and F distributions (Central cases only) and their 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\3rd and 3\8th rules. Weddle's rule. Real roots of a numerical equation by method of iteration.

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11. Meyer, P.: Introductory Probability and Statistical Applications.
12. Freeman : Finite Differences.
13. Scarborough: Numerical Analysis.
14. S.S. Sastry : Introductory Methods of Numerical Analysis; Prentice Hall of India Pvt. Limited.
15. Jain, M.K., Iyengar, SRK and Jain R.K.: Numerical Methods For Scientific And Engineering Computations; NEW AGE International (P) Limited.

Paper III 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 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 quartiles. Bivariate data, Method of least squares for curve fitting.

UNIT-III

Correlation and regression, 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.

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2. Yule, G.U. and Kendall, M.G.: An Introduction to the theory of statistics. Charles Griffin & Company Ltd.
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PRACTICAL

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15. Approximate integration (Trapezoidal rule, Simpson's one-third rules, simpson's three-eighth rule), Weddle's rule.
16. Real roots of numerical equation by method of iteration.

And

Other practicals based on Paper II and Paper III

B.Sc. Part- II

(For the year 2010 and onwards)

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 χ^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.

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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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1. Cochran, W.G. : Sampling Techniques
1. Sukhatme, Sukhatme, Sukhatme & Asok : Sampling Theory of Surveys with applications.
2. Murthy, M. N. : Sampling theory.

Paper III : 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 arranged in RBD and LSD. 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).

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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

PRACTICAL

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4. F-test for (i) $\sigma_1^2 = \sigma_2^2$ (ii) $\rho_{1.23} = 0$
5. Fisher's Z-transformation and its use in testing (i) $\rho_1 = \rho_2$ (ii) $\rho_1 = \rho_2 = \ldots = \rho_k$ (iii) $\rho = \rho_0$
6. Calculation of power curve for the test of $\mu = \mu_0$ against $\mu \neq \mu_0$ for a normal distribution with known variance.
7. Large sample tests.
8. Analysis of variance in one-way and two-way classification (with and without interaction terms).
9. Analysis of a Latin square design.
10. Analysis of variance in RBD and LS design with one or two missing observations.
11. Drawing a simple random sample with the help of table of random numbers.
12. Estimation of population means and variance in simple random sampling.
13. Stratified random sampling for population mean (proportional and optimum allocation).
14. Ratio and regression estimation of population mean and total.
15. Factorial Experiment Practical.

And

Other practicals based on Paper I, Paper II and Paper III.

B.A. & B.Sc. Part- III

(For the Examination of 2011 and onwards)

Paper 1 : Non-parametric Methods and Regression Analysis

UNIT – I

Multivariate normal distributions, marginal and conditional distribution, Moment Generating and Characteristics functions, Maximum likelihood estimation of mean vector and co-variance matrix, independence and joint sufficiency of these estimates. Distribution of linear combination of components of multi normal variate.

UNIT – II

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

UNIT – III

Non-parametric tests – Tests for randomness and 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, Spearman's rank correlation test, Kurskall-Wallis Test.

UNIT – IV

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

REFERENCE :

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

Paper II : Applied Statistics

UNIT – I

Time series, its different components, illustrations, additive and multiplicative models, determination of trend, growth curves, analysis of seasonal fluctuations, construction of seasonal indices. Idea of Correlogram & periodogram.

Index number – its definition, application of index number, price relative and quantity or volume relatives, link and chain relative, problem involved in computation of index number, use of averages, simple aggregative and weighted average method. Laspeyre's, Paashe's and Fisher's index number, time and factor reversal tests of index numbers, consumer price index

UNIT – II

Educational Statistics: Scaling procedures – scaling of test items, test scores, rating of qualitative answers and judgements. Test theory, linear models, parallel tests, true score, reliability and validity of tests. Tetra-choric, bi-serial and point bi-serial correlation coefficients.

UNIT – III

Demographic methods : Sources of demographic data – census, register, ad-hoc survey, hospital records, demographic profiles of Indian Censuses. Measurement of mortality, crude death rates, age specific death rates, infant mortality rates, death rate by cause. Measurement of fertility – crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate, standardized death rates, age pyramid of sex composition , other measures of fertility. Graduation of mortality rates by Gompertz and Makeham formulae, logistic curve fitting and its use in population projection. Complete life table, its main features and construction.

UNIT – IV

Control charts for variables and attributes, modified control charts, group control charts, CUSUM charts, V mask. Sampling inspection by attributes – single and double sampling plans. Producer's and consumer's risk, OC, ASN, ATI functions AOQL and LTPD of sampling plans. Sampling inspection by variables – simple cases.

REFERENCE :

1. Montgomery D.C. (1985) : Introduction to Statistical Quality Control (Wiley).
2. Draper & Smith : Applied Regression Analysis
3. Burr : Industrial Quality Control.
4. Wetherill and Brown : Statistical Quality Control
5. Croxton F.E. and Cowden D.J. : Applied General Statistics
6. Goon, Gupta and Dasgupta : Fundamentals of Statistics, Vol. I & II
7. Siya Ram : Applied Statistics.

Paper III : Operations Research

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

Transportation problem: North-west corner rule, Least cost method, Vogel's approximation method. Optimum solution : Stepping stone method, Method of Multipliers. Assignment Problem : Hungarian Algorithm.

UNIT – II

Queueing Models – M/M/1, M/M/C models waiting time distribution for M/M/1, Little's formulae. M/G/1 Queueing system, cost profit models in queueing theory.

UNIT – III

Network Analysis : Minimal Spanning Tree, Model Shortest-route problems, Maximal Flow Model.

Project Management : PERT/CPM determination of floats construction of time chart and resources labelling.

UNIT – IV

Inventory Models : FOQ models, Non-zero, land time, EOQ with shortages allowed.

Dynamic Programming : Bellman's optimality principle. Applications. Job sequencing : n jobs – machines, n jobs – K machines, 2 jobs – n machines.

REFERENCES :

1. Swarup Kanti, Gupta P.K. and Man Mohan : Operations Research, Sultan Chand & Sons.
2. Taha, H.A. : Operations Research, Mac Millan publishing.

PRACTICALS :

Based on Paper I, Paper II and Paper III.