BANARAS HINDU UNIVERSITY

DEPARTMENT OF STATISTICS
Faculty of Science

PROPOSED SYLLABI of

B.Sc. PROGRAMME
IN
STATISTICS

w.e.f. 2015-16

B.Sc. (Hons.) PROSPECTUS
IN
STATISTICS

The B. Sc. (Hons.) Programme in Statistics shall be spread over three years; each year consisting of two semesters. The details of the distribution of courses in semesters, credits assigned to papers, full marks assigned, etc., are given as follows:

1. There shall be ONE THEORY paper and ONE PRACTICAL paper of 100 marks each in Semester – I, Semester – II, Semester – III and Semester - IV. The Theory paper and the Practical paper shall be of 4 credits and 2 credits respectively in each of these semesters.

2. The theory papers in each of the I, II, III and IV semesters shall be of THREE HOURS duration consisting of eight full length questions in all out of which a student will be required to answer any five questions.

3. The Practical paper in Semester – I and Semester - II shall be of THREE HOURS duration. Each Practical paper will be of 100 marks out of which 30 marks will be assigned on sessionals / tutorials / class tests / seminars in class / group discussions and 70 marks will be assigned on the end semester examination out of which 50 marks will be on the performance in practical examination and 10 marks will be assigned each on practical record book and viva – voce.

4. The Practical paper in Semester – III and Semester – IV shall be of THREE HOURS duration. Each Practical paper will be of 100 marks out of which 30 marks will be assigned on sessionals / tutorials / class tests / seminars in class / group discussions and 70 marks will be assigned on the end semester examination out of which 50 marks will be on the performance in practical examination and 10 marks will be assigned each on practical record book and viva – voce.

5. There shall be FOUR THEORY papers and TWO PRACTICAL papers of 100 marks each in Semester - V and Semester – VI. Each Theory paper in Semester V shall be of 4 credits and Practical paper shall be of 3 credits. In Semester VI all theory as well as Practical paper is of 3 credits. Besides this, there shall be ONE PROJECT of 4 credits in Semester – VI.

6. The theory papers in each of the V and VI semesters shall be of THREE HOURS duration consisting of eight full length questions in all out of which a student will be required to answer any five questions.

7. The Practical paper in Semester – V and Semester – VI shall be of THREE HOURS duration. Each Practical paper will be of 100 marks out of which 30 marks will be assigned on sessionals / tutorials / class tests / seminars in class / group discussions and 70 marks will be assigned on the end semester examination out of which 50 marks will be on the performance in practical examination and 10 marks will be assigned each on practical record book and viva – voce.

8. The Project work shall be spread over the whole semester. A project is undertaken by a group of students. However, the project report shall be submitted by each member of the group separately. A project report shall clearly state the problem addressed, the methodology adopted, the assumptions and the hypotheses formulated, any previous reference to the study undertaken, statistical analyses performed and the broad conclusion drawn. There shall be an external examiner and an internal examiner (preferably the supervisor of the student) for the evaluation of the project work. Out of total 100 marks assigned to the project, 60 marks will be assigned on the evaluation of the project report separately by both the examiners and 40 marks will be assigned on the oral presentation and viva – voce.

9. Besides the Core Courses in Statistics, the Department will offer TWO ANCILLARY THEORY Papers of 100 marks each; ONE in each of the Semesters – II and IV. These Minor Elective papers will be of 2 credits each. The Ancillary courses will be offered by the students of Mathematics and Biology streams of the Faculty who have not opted Statistics as a subject in any of the semesters.

10. The Ancillary Theory papers in Semester – II and Semester – IV shall be of Three Hours duration consisting of eight full length questions in all out of which a student will be required to answer any five questions.

11. Examination questions papers will be in English in all the semesters.

The titles and contents of Theory papers as well as Practical papers shall be as follows :

PROPOSED COURSE FOR B .Sc. (HONOURS) STATISTICS
Department of Statistics, Banaras Hindu University, Varanasi

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

SEMESTER - I

Course Code	Title	Credit
STB – 101	Statistical Methods and Probability	4
STB – 102	Practicals based on Course No. STB – 101	2
	Total	6

SEMESTER - II

Course Code	Title	Credit
STB – 201	Descriptive Statistics and Distribution Theory	4
STB – 202	Practicals based on Course No. STB – 201	2
	Total	6

SEMESTER - III

Course Code	Title	Credit
STB – 301	Statistical Inference	4
STB – 302	Practicals based on Course No. STB – 301	2
	Total	6

SEMESTER - IV

Course Code	Title	Credit
STB – 401	Sample Surveys and Design of Experiments	4
STB – 402	Practicals based on Course No. STB – 401	2
	Total	6

SEMESTER - V

Course Code	Title	Credit
STB – 501	Applied Statistics	4
STB – 502	Statistical Inference and Decision Theory	4
STB – 503	Programming with C	4
STB – 504	Operations Research	4
STB – 505	Practicals based on Course Nos. STB – 501 and STB – 502	3
STB – 506	Practicals based on Course Nos. STB – 503 and STB – 504	3
	Total	22

SEMESTER - VI

Course Code	Title	Credit
STB – 601	Numerical Methods	3
STB – 602	Demand Analysis, Analysis of Income Distribution and Queuing Theory	3
STB – 603	Elements of Stochastic Processes	3
STB – 604	Reliability	3
STB – 605	Practicals based on Course Nos. STB – 601 and STB – 603	3
STB – 606	Practicals based on Course Nos. STB – 602 and STB – 604	3
STB – 607	Project	4
	Total	22
	GRAND TOTAL	72*

*including the 4 credits of Ancillary subjects

ANCILIARY SUBJECTS

Course Code	Title	Credit
	SEMESTER II	
BSC07A	Statistics – I : Descriptive Statistics	2
	SEMESTER IV	
BSC13A	Statistics – II : Statistical Inference, Sampling and Design of Experiments	2
	TOTAL	4

B. Sc. (HONS.) IN STATISTICS

SEMESTER – I

STB – 101 : STATISTICAL METHODS AND PROBABILITY Credits : 4

Types of data: Discrete and continuous data, Frequency and non-frequency data, Different types of scales, Primary data (designing a questionnaire and schedule), Secondary data (major sources including some government publication).

Construction of tables (with one or more factors), diagrammatic and graphical representation of grouped data, frequency and cumulative frequency distribution and their applications, histogram, frequency polygon, ogives, stem and leaf charts, box plot.

Concept of central tendency and its measures, partition values, dispersion and relative dispersion, moments, Sheppard's correction for moments (without derivation), skewness, kurtosis and their measures.

Random experiment: Trial, sample point, sample space, definitions of equally likely, mutually exclusive and exhaustive events, definition of probability, classical and relative frequency approach to probability, axiomatic approach to probability and its properties, merits and demerits of these approaches, total and compound probability theorems, conditional probability, independence of events, Bayes theorem and its applications.

Random Variable: Concept of discrete random variable, probability mass function and distribution function, joint probability mass function of several discrete random variables, marginal and conditional probability mass functions. Expectation of random variables and its properties, conditional expectation, moments in terms of expectation.

Continuous random variable: Probability density function, distribution function, joint density function of two continuous variables, marginal and conditional probability density functions.

Books for references:

1. Bhat B.R., Srivenkataramana T. and Rao Madhava K.S. (1996): Statistics, A Beginner's Text, Vol. I and II, New Age International (P) Ltd.
2. Snedecors G.W. and Cochran W.G. (1967): Statistical Methods, Iowa State University Press.
3. Mood A.M., Greybill F.A. and Bose D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
4. Spiegel M.R. (1967): Theory and problem of Statistics, Schaum's Publishing Series.
5. Goon A.M., Gupta M.K. and Das Gupta B. (1991): Fundamental of Statistics, Vol. I, World Press, Calcutta
6. Meyer P.L. (1970): Introductory Probability and Statistical Applications, Addision Wesley.
7. Parzen E. (1960): Modern Probability Theory and its Applications, Wiley Eastern.
8. Hogg R.V. and Craig A.T. 91972): Introduction to mathematical Statistics, Amerind Publishing Co.
9. Hoel P.G. (1971): Introduction to Mathematical Statistics, Asia Publication.
10. Rohtagi, V.K. (1967) An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
12. Croxton F.E., Cowden D.J. and Karlin S. (1973) Applied General Statistics.

STB – 102 : PRACTICALS BASED ON COURSE No. STB - 101 Credits : 2

(The Practical Paper shall be of THREE HOURS duration. Out of total 70 marks, 50 marks will be assigned to the performance in practicals, 10 marks on the practical record book and 10 marks on the viva – voce).

Students will be required to do practicals, listed below (based on the contents of the theory paper STB – 101), using MS Excel :

1. Presentation of data by frequency tables, diagrams and graphs.
2. Measures of central tendency, partition values,
3. Measures of dispersion, relative measure of dispersion.
4. Moments, measures of skewness and kurtosis.

STB – 201 : DESCRIPTIVE STATISTICS AND DISTRIBUTION THEORY

Credits : 4

Bivariate data: Scatter diagram, product moment correlation coefficient and its properties, coefficient of determination, correlation ratio, interclass correlation, concept of error in regression, principle of least square, fitting of linear regression and related results, rank correlation.

Partial and multiple correlation in three variables, their measures and related results.
Theory of attributes: Independence and Association of attributes, various measures of association for two way classified data.

Moment generating function of a random variable, their properties and uses, probability generating function.

Tchebycheff's inequality and its applications, basic ideas of convergence in probability and convergence in distribution.

Standard discrete and continuous distributions: degenerate, uniform, binomial, Poisson, geometric, negative Binomial, hypergeometric, normal, beta, gamma, bivariate Normal distributions and their applications.

Books for References

1. Goon A.M., Gupta A.K. and Das Gupta B. (1999): Fundamental of Statistics, Vol. I, World Press, Calcutta.
2. Mood A.M., Greybill, F.A. and Bose D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
3. Hogg R.V. and Craig A.T. (1972): Introduction to Mathematical Statistics, Amerind Publishing Co.
4. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
5. Rohtagi V.K. (1967) : An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
6. Hoel P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.

STB - 202 : PRACTICALS BASED ON COURSE No. STB - 201 Credits : 2

(The Practical Paper shall be of THREE HOURS duration. Out of total 70 marks, 50 marks will be assigned to the performance in practicals, 10 marks on the practical record book and 10 marks on the viva – voce).

The students will be required to do the practicals, listed below (based on the contents of the theory paper STB – 201), using MS Excel :

1. Product moment correlation coefficient, correlation ratio, interaclass correlation coefficient.
2. Fitting of curves by least square method.
3. Regression of two variables.
4. Rank correlation.
5. Partial and Multiple correlations and regressions.
6. Fitting of discrete and continuous distributions.

ANCILLARY PAPER:

Paper No. BSC07A : STATISTICS – I : DESCRIPTIVE STATISTICS

Credits : 2

Nature and scope of Statistics: Measurement scales, primary and secondary data, Methods of Collection of primary data, methods of data representation, text, tabular, diagrammatic and graphical representation.

Frequency distribution and principles governing their representation, graphical representation of frequency distributions.

Measures of central tendency and their properties, uses and limitations, partition values : quartiles, deciles and percentiles.

Dispersion and its various measures with their properties and uses. Coefficient of variation.

Central and raw moments up to fourth order. Skewness, kurtosis and their measures.

Bivariate Data: Scatter diagram, correlation, product moment correlation coefficient, regression lines and their uses, rank correlation.

Books for reference

1. Goon, A.M., Gupta, M.K., Dasgupta, B. : Fundamental of Statistics Vol.-I
2. Kapoor, V.K. and Saxena, H.C. : Mathematical Statistics
3. Yule, G.V. and Kendall, M.G. : Introduction to the Theory of Statistics
4. Kenny, J.F. and Keeping, E.S. : Mathematics of Statistics ,Vol.-I

SEMESTER - III

STB – 301 : STATISTICAL INFERENCE Credits : 4

Concept of random sample from a distribution, statistic and its sampling distribution, standard error of an estimate, standard errors of sample mean and proportion, sampling distribution of sum of Binomial, Poisson random variables and mean of normal distribution.

Simple, composite null and alternative hypotheses, critical region, types of error, level of significance, p-values, size and power of a test, chi-square, t and F distributions and their properties (without proof), testing of equality of two means and two variances of two normal distributions, testing for the significance of sample correlation coefficient and testing the equality of means and variances of bivariate normal distributions.

Statement of weak law of large number and central limit theorem, use of central limit theorem for testing a single mean, single proportion equality of two means and two proportions, Fisher's Z transformation and its uses, Pearson's chi-square test for goodness of fit, test of independence of two attributes.

Definition of order statistics and their distributions, sign test, run test, median test, Spearmen's rank correlation test, Wilcoxon Mann-Whitney test, Kolmogorov Smirnov - one sample and two sample tests.

Books for References

1. Mood A.M., Greybill F.A. and Bose D.C. (1974) : Introduction to the Theory of Statistics, McGraw Hill.
2. Freund J.E. (2001) : Mathematical Statistics, Prentice hall of India.
3. Goom A.M., Gupta M.K. and Das Gupta B. (1991) : Fundamental of Statistics, Vol. I, World press, Calcutta.
4. Rohtagi V.K. (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
5. Rao C.R. (1973) : Linear Statistical Inference and its Applications, Revised edition, Weley Eastern.
6. Hoges J.L. and Lehmann E.L. (1964): Basic Concepts of Probability and Statistics, Holden Day.
7. Snedecor G.W. and Cochran W.G. (1967) : Statistical Methods, Iowa State University Press.

STB – 302 : PRACTICAL BASED ON COURSE No. 301

Credits : 2

(The Practical Paper shall be of THREE HOURS duration. Out of total 70 marks, 50 marks will be assigned to the performance in practicals, 10 marks on the practical record book and 10 marks on the viva – voce).

1. Test of significance based on t, chi-square and F.
2. Testing of significance of sample correlation coefficient.
3. Use of Z transformation.
4. Large sample tests for means and proportion, tests of goodness of fit and independence of attributes in contingency tables.
5. Sign, run, median, Wilcoxon – Mann Whitney non-parametric test.

All these practicals will be done using Excel.

SEMESTER - IV

STB – 401 : SAMPLE SURVEYS AND DESIGN OF EXPERIMENTS Credits : 4

Concept of population and sample, need for sampling, complete enumeration versus sampling, Basic concepts in sampling, sampling and Non-sampling errors, Acquaintance with the working (questionnaires, sampling design, methods followed in field investigation, principal findings, etc.) of NSSO and other agencies under taking sample surveys.

Simple random sampling with and without replacement, estimation of population mean, population proportions and their standard errors. Stratified random sampling, proportional and optimum allocation, comparison with simple random sampling for fixed sample size.

Ratio, product and regression methods of estimation, estimation of population mean, evaluation of bias and variance to the first order of approximation, comparison with simple random sampling.

Systematic sampling (when population size (N) is an integer multiple of sampling size (n)). Estimation of population mean and standard error of this estimate, comparison with simple random sampling. Elementary idea of cluster sampling.

Analysis of variance for one way and two way classifications one observation per cell, need for design of experiments, basic principle of experimental design: randomization, replication and local control, complete analysis and layout of completely randomized design, randomized block design and Latin square design.

Books for References

1. Cochran W.G. (1977) :Sampling Techniques, John Wiley and Sons, New York.
2. Sukhtme P.V., Sukhatme B.V., Sukhatme S. and Asok C. (1984) : Sampling Theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi.
3. Goon A.M., Gupta M.K. and Das Gupta B. (1986) : Fundamentals of Statistics, Vol. II, world Press, Calcutta.
4. Sampath S. (2000) : Sampling Theory and Methods, Narosa Publishing House, New Delhi.
5. Des Raj (2000) : Sample Survey Theory, Narosa Publishing House, New Delhi.
6. Murthy M.N. (1967) : Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
7. Kish L (1965): Survey Sampling, John Wiley and Sons, New York.
8. Hansen M.H., Hurwitz W.N. and Madow W.G. (1975) : Sample Survey Method and Theory, Vol. I, Methods and Applications, Vol. II, New York and London, Wiley Publication.
9. Cochran W.G. and Cox G.M. (1957) : Experimental Design, John Wiley and Sons.
10. Das, M.N. and Giri J. (1986) : Design and Analysis of Experiments, Springer Verlag.
11. Kempthorne O. (1965) : The Design and Analysis of Experiments, Wiley Eastern.

STB – 402 : PRACTICALS BASED ON COURSE No. 401

Credits : 2

(The Practical Paper shall be of THREE HOURS duration. Out of total 70 marks, 50 marks will be assigned to the performance in practicals, 10 marks on the practical record book and 10 marks on the viva – voce).

1. Selection of sample and determination of sample size.
2. Simple random sampling and stratified random sampling.
3. Allocation problems in stratified random sampling
4. Ratio, Product, Regression method of estimation and comparison with simple random sampling.
5. Analysis of variance for one way and two way classifications.
6. Analysis of CRD, RBD and LSD.

<u>All these practicals will be done using Excel.</u>

BSC13A : STATISTICS - II : STATISTICAL INFERENCE AND SAMPLING TECHNIQUES

Credits : 2

Concept of probability, classical and statistical definition of probability, additive and multiplicative theorem of probability (Statement only), conditional probability and Baye's theorem (elementary idea only)

Random variable, probability mass function, probability density function and distribution function. Definition and important applications of binomial, Poisson and normal distributions.

Testing of hypotheses, large sample tests for mean and proportions, chi-squire, application of t and F tests.

Concept and scope of sampling: Population, complete enumeration verses sampling, sampling frame.

Methods of sampling: Simple Random Sampling & Stratified Random Sampling.

Books for reference

1. Goon, A.M., Gupta, M.K. Dasgupta, B.: Fundamental of Statistics
2. Cochran, W.G. : Sampling Techniques
3. Sukhatme, P.V. Sukhatme, B.V. : Sampling Theory of Surveys with Applications
4. Kapoor, V.K. and Saxena, H.C. : Mathematical Statistics
5. Yule, G.V. and Kendall, M.G. : Introduction to the Theory of Statistics
6. Kenny, J.F. and Keeping, E.S. : Mathematics of Statistics ,Vol.-I

SEMESTER - V

STB – 501 : APPLIED STATISTICS Credits : 4

Demographic Methods: Sources of demographic data, census, registration, ad hoc surveys, hospital records, demographic profiles of the Indian census.

Measurement of Mortality and Life Table: Crude death rate, Standardized death rates, Age-specific death rates, Infant Mortality rate, Death rate by cause, Complete life table and its main features, Uses of life table.

Measurement of Fertility: Crude birth rate, general fertility rate, age specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate.

Index Numbers: Price relatives and quantity or volume relatives, Link and chain relatives composition of index numbers; Laspeyre's, Paasche's, Marshal Edgeworth's and Fisher's index numbers; chain base index number, tests for index number, cost of living index number.

Time Series Analysis: Economic time series, different components, illustration, additive and multiplicative models, determination of trend, seasonal and cyclical fluctuations.

Statistical process and product control: Quality of a product, need for quality control, basic concept of process control, process capability and product control, general theory of control charts, causes of variation in quality, control limits, sub grouping summary of out of control criteria. Charts for attributes : p chart, np chart, c-chart, Charts for variables: R, ($\bar{X}$, R), ($\bar{X}$, σ) charts.

Books for References

1. Mukhopadhyay, P. (1994) :Applied Statistics, new Central Book Agency Pvt. Ltd., Calcutta.
2. Srivastava O.S. (1983) : A Text Book of Demography, Vikas Publishing House, new Delhi.
3. Benjamin B. (1959): Health and Vital Statistics, Allen and Unuwin.
4. Goon A.M., Gupta M.K. and Das Gupta B. (1986): Fundamentals of Statistics, Vol. II, World Press, Calcutta.
5. Duncan A.J. (1974) : Quality Control and Industrial Statistics, IV Edision, Taraporewala and Sons.
6. Montomery, D.C. (1991): Introduction to the Statistical Quality Control, IInd Editions, John Wiley and Sons.
7. Brown R.G. (1963): Smoothing, Forecasting and Prediction of Discrete Time Series, Prentice Hall.
8. Chatfield C. (1980) : The Analysis of Time Series, IInd Edision Chapman and Hall.

STB – 502 : STATISTICAL INFERENCE AND DECISION THEORY Credits :4

Parametric model, parameter, random sample and its likelihood, statistics and its sampling distribution.

Point estimation : properties of estimators, mean square and minimum mean square error estimator, unbiasedness and minimum variance unbiased estimator, Cramer-Rao lower bound, amount of information, consistency of estimators and sufficient conditions for consistency, relative efficiency of an estimator, asymptotic efficiency, sufficiency, factorization theorem (without proof), concept of complete sufficient statistics, Rao-Blackwell theorem.

Methods of estimation : moments, maximum likelihood, minimum chi-square, least square with examples, BAN and CAN estimators, point estimates of measures of location, dispersion, regression, correlation and other useful parameters.

Concepts of confidence interval and confidence coefficient, confidence intervals for the parameters of univariate normal, two independent normal distributions and exponential distributions.

Statistical hypotheses, critical region, size and power of a test, most powerful test, randomized and non randomized test, Neyman Pearson lemma and its applications, uniformly most powerful unbiased test, power likelihood ratio test and its applications, functions of UMP with simple illustration.

Elements of decision problems: Loss function, risk function, estimation and testing viewed as decision problems. Bayes rule.

Books for References

1. Freund J.E. (2001) : Mathematical Statistical, Prentice Hall of India.
2. Hogg R.V. and Craig A.T. (1978) : Introduction of Mathematical Statistics, Fourth Edition, Collier Macmillon Publishers.
3. Mood A.M., Graybill E.A. and Bose D.C. (1974) : Introduction to the Theory of Statistics, McGraw Hill.
4. Rao, C.R. (1973) : Linear Statistical Inference and its Applications, Revised edition Wiley Eastern.
5. Rohtagi V.K. (1967) : An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
6. Goon A.M., Gupta M.K. and Dasgupta B. (1980) : An Outline of Statistical Theory, Vol. 2, The World Press Publishers Pvt. Ltd. Calcutta.
7. Kale B.K. and Sinha S.K. : Life Testing and Reliability.

STB - 503 : PROGRAMMING WITH C Credits : 4

History and features of C language, components of C language, structure of a C program. Data type: Basic data types, enumerated data types, derived data types. Variable declaration, local, global, parametric variables, assignment of variables, numeric, character, real and string constants, arithmetic relation and logical operators, assignment operators, increment and decrement operators, conditional operators, Bitwise operators, type modifiers and expressions, writing and interpreting expressions, using expressions in statements. basic input / output.

Control Construct. I Control statements, conditional statements, if . . . . . else, nesting of if . . . . . else, elself ladder, swith statements. Loops in C: for, while, do . . . . . while loops

Control Constructs II

Break, continue, exit ( ), go to and label declarations.
One dimensional two dimensional and multidimensional arrays.
Storage classes: Automatic variables, External variables, Static variables, Scope and lifetime of declarations.

Functions, classification of functions, functions definition and declaration, assessing a function, return statement, parameter passing in functions, rewise on in Functions.

Structure: Definition and declaration; structure (initialization) comparison of structure variable array of structures : array within structures, structures within structures, passing structures to functions, unions accessing a union member, union of structure, initialization of a union variable, uses of union.

Books for References

1. Balagurusamy E. :Programming in ANSI C Tata McGraw Hill.
2. Kanetkar Y.P.: working with C. BPB Publication.
3. Gottfried Byron S. : Theory and problems of Programming with CTMH.
4. Schildt, Herbest:: C The Complete Reference, III ED TMH.
5. Schildt, Herbert : C Made Easy, McGraw Hill.

STB – 504 : OPERATIONS RESEARCH Credits :4

Definitions and scope of operation research, different types of models in operations research – their construction and general method of solution.

Elements of linear programming problem (LPP): Canonical and standard forms, formulation of LPP, graphical method to solve two variable LPP, solution of LPP using simplex procedure, use of artificial variables in LPP, generation of extreme point solutions, principle of duality in LPP, statement and proof of duality theorem, simple problems based on duality theorem.

Allocation Models: Transportation problem (T.P.), different methods of finding initial feasible solution of a T.P., UV method of finding optimal solution of a T.P., solution of assignment problem using Hungarian method.

Inventory Control: Definitions of various costs involved in inventory control. Deterministic Economic Lot Size problems with and without shortages.

Theory of games: Two person zero-sum games, pure and mixed strategies, saddle point, maximin-minimax principle of rectangular games, games without saddle point, dominance and modified dominance principles, graphical solution of 2xN and Mx2 games, reduction of game problems to a L.P.P.

Books for References

1. Taha, H.A. (1999): Operations Research, Macmillan Publishing Company.
2. Hiller F.S. and Libermann G.J. (1995): Introduction to Operations Research, McGraw Hill.
3. Hadley G. (1965) : Linear programming, Addison Wesley.
4. Gass G.I. (1958): Linear Programming- Methods and Applications, McGraw Hill.
5. McKinsey J.C.C. (1952): Introduction to the Theory and Games, McGraw Hill Book Co.
6. Kanti Swaroop, Gupta P.K. and Singh M.M. (1985) : Operations Research, Sultan Chand and Sons.

STB – 505 : PRACTICALS BASED ON COURSE Nos . STB – 501 AND STB - 502

Credits : 3

(The Practical Paper shall be of THREE HOURS duration. Out of total 70 marks, 50 marks will be assigned to the performance in practicals, 10 marks on the practical record book and 10 marks on the viva – voce).

1. CDR, STDR, CBR, Age specific death rates, life tables, GRR, NRR, Logistic curve and related practicals.
2. Laspeyre's, Passche's, Fisher's index numbers.
3. Problems related to trend, seasonal and cyclical fluctuations.
4. Charts: p, np, c, R, ($\bar{X}$, R), ($\bar{X}$, σ).
5. Practicals on moment, maximum likelihood, Minimum chi-square, least squares methods of estimation.
6. Testing of hypothesis for mean, variance, correlations, etc.

STB – 506 : PRACTICALS BASED ON COURSE Nos. STB – 503 AND STB – 504

Credits : 3

(The Practical Paper shall be of THREE HOURS duration. Out of total 70 marks, 50 marks will be assigned to the performance in practicals, 10 marks on the practical record book and 10 marks on the viva – voce).

The practical will be based on the contents of Course Nos. STB – 503 and STB - 504.

SEMESTER – VI

STB – 601 : NUMERICAL METHODS Credits : 3

Finite differences of different orders, Δ, E and D operators, factorial representation of a polynomial, separation of symbols, differences of zero.

Concept of interpolation and extrapolation: Newton Gregory's forward and backward interpolation formulae for equal intervals, divided differences and their properties, Newton's formula for divided difference, Lagranges formula for unequal intervals, central difference formula due to Gauss, Stirling, Bessel, Laplace and Everett, remainder terms in interpolation formula.

Inverse interpolation: Different methods of inverse interpolation.

Numerical differentiation.

Numerical Quadrature : Trapezoidal rule, Simpson's one-third and three-eight rules, Weddle's rule, Newton-Cotes formula, Euler-Maclaurine's formula and its uses.

Summation of series: Series whose general term (i) is the first difference of a function (ii) is in geometric progression and is a product of two functions.

Difference equation: Linear difference equations (homogeneous and non-homogeneous) with constant coefficients.

Numerical solutions of differential equations: Euler's method, Milne's method, Picard's method and Runge-Kutta method. Method of solving linear and transcendental equations.

Books for References

1. Scarborough J.B.: Numerical Mathematical Analysis, Oxford University, Press and Oxford Book Co.
2. Saxena, H.C.: Calculas of finite Differences,
3. Freeman. H.: Finite Differences for Actuarial Students, Cambridge University Press.
4. Aitkinson U.: Eementary Numerical Analysis.
5. Sastry S.S.: Introductory Methods of Numerical Analysis, Fourth Edition, Prentice Hall of India.
6. Kunz, K.S.: Numerical Analysis, McGraw Hill.

STB – 602 : DEMAND ANALYSIS, ANALYSIS OF INCOME DISTRIBUTION AND QUEUING THEORY Credits : 3

Theory and analysis of consumer's demand, law of demand, price elasticity of demand, estimation of demand curves, forms of demand functions, Engel's curve, income elasticity of demand.

Analysis of income and allied distributions : Pareto distribution, graphical test, fitting of Pareto law, illustration, lognormal distribution and properties, Lorenz curve, Gini's coefficient.

Elements of queuing theory, characteristics of queues, Poisson process, distribution of inter-arrival time, definition of steady state condition, (M/M/1) : (∞ / FIFO) and (M/M/1) : (N/ FIFO models, birth and death process, (M/M/K) : (∞ / FIFO) and (M/M/K) : (N / FIFO) models.

Finite and infinite length models with associated distribution of queue length and waiting time, steady – state solutions of (M/E_k / 1) and (E_k / 1) queues, machine interface problem.

Books for References

1. Kanti Swaroop, Gupta P.K. and Singh M.M. (1985) : Operations Research, Sultan Chand and Sons.
2. Hiller F.S. and Libermann G.J. (1995): Introduction to Operation Research, McGraw Hill.
3. Taha H.A. (1999) : Operation Research, Macmillan Publishing Company.
4. Mukhopadhyay P. (1999): Applied Statistics, New Central Book Agency Pvt. Ltd., Calcutta.
5. Goon A.M., Gupta M.K. and Dasgupta B. (1986): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
6. Croxton F.E. and Cowden, D.F.: Applied General Statistics.
7. Asthana B.N. and Srivastava S.S.: Applied Statistics in India.

STB – 603 : ELEMENTS OF STOCHASTIC PROCESSES Credits : 3

Definition and examples of stochastic process: classification of general stochastic processes into discrete/continuous time, discrete/continuous state spaces, types of stochastic processes elementary problems, random walk, gambler's ruin problem.

Markov chains: Definition and examples of Markov chain, transition probability matrix, classification of states, recurrence, simple problems, basic limit theorem of Markov Chain (statement only).

Continuous time Markov Chain: Poisson process and related inter-arrival time distribution, pure birth process, pure death process, birth and death process, problems.

Branching process: Definition and examples of discrete time branching process, probability generating function, mean and variance, probability of extinction problems.

Books for References

1. Karlin S. and Taylor H.M. (1995): A First Course in Stochastic Process, Academic Press
2. Hoel P.G., Port S.C. and Stone C.J. (1991): Introduction to Stochastic Process, Universal Book Stall.
3. Parzen E. (1962): Stochastic Process, Holden-Day
4. Cinlar E. (1975) : Introduction to Stochastic Processes, Prentice Hall.
5. Adke S.R. and Manjunath S.M. (1984) : An Introduction to Finite Markov Processes, Wiley Eastern.
6. Medli J. (1996) : Stochastic Processes, new Age International (P) Ltd.
7. Ross S.M. (1983) : Stochastic Process, John Wiley.
8. Taylor H.M. and Karlin S. (1999) : Stochastic Modeling, Academic Press.

STB – 604 : RELIABILITY Credits : 3

Basic concepts: Reliability, Mean time to failure and hazard rate and their relationships.

System Reliability: Evaluation of reliability function and mean time to system failure for Series, Parallel, k-out of-n, series-parallel, parallel-series and Bridge system configurations.

Coherent Structures: Structure functions of various configurations, Paths and Cuts, Relative importance of components in a system.

Elementary notion of censoring: type-I and type-II censoring schemes.

Life time Models: Estimation procedures for exponential, Weibull, Gamma, normal and lognormal distributions.
Testing of hypothesis: Tests and confidence intervals for the reliability and mean life of exponential distribution.

Books for References

1. Bain, L. J. and Engelhardt, M. : Statistical Analysis of Reliability and Life Testing Models, Marcel Deckker.
2. Zack, S. : Introduction to Reliability Analysis : Probasbility Model and Statistical Methods, Springer Verlag.
3. Barlow, R. E. and Proschan, F. : Statistical Theory of Reliability and Life Testing : Probability Models, Holit Rinechart and Winston.
4. Gnedenko, Bylyayer and Solovyer : Mathematical Methods of Reliability Theory.
5. Kale, B. K. and Sinha, S. K. : Life Testing and Reliability.

STB – 605 : PRACTICALS BASED ON COURSE Nos. STB – 601

Credits : 3

(The Practical Paper shall be of THREE HOURS duration. Out of total 70 marks, 50 marks will be assigned to the performance in practicals, 10 marks on the practical record book and 10 marks on the viva – voce).

STB – 606 : PRACTICALS BASED ON COURSE Nos. SBT – 602 AND STB - 604

Credits : 3

(The Practical Paper shall be of THREE HOURS duration. Out of total 70 marks, 50 marks will be assigned to the performance in practicals, 10 marks on the practical record book and 10 marks on the viva – voce).

STB – 607 : PROJECT Credits : 4

The project work shall be spread over the whole semester. A project be undertaken by a group of students. However, the project report shall be submitted by each member of the group separately. A project report shall clearly state the problem addressed, the methodology adopted, the assumptions and the hypotheses formulated, any previous reference to the study undertaken, statistical analyses performed and the broad conclusion drawn. There shall be an external examiner and an internal examiner (preferably the supervisor of the student) for the evaluation of the project work. Out of total 100 marks assigned to the project, 60 marks will be assigned on the evaluation of the project report separately by both the examiners and 40 marks will be assigned on the oral presentation and viva – voce.

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