SYLLABUS

DIBRUGARH UNIVERSITY
THREE YEAR DEGREE PROGRAMME
(Under CBCS)

STATISTICS

[2017 – 2018]

PREAMBLE

Statistics is the language of the uncertainties riddled modern information age. Statistics facilitates the decision making process by quantifying the element of chance or uncertainties. It's descriptive and inferential roles not only formulate the basis of the growth of almost all the disciplines of the contemporary world, but also provide an array of non-traditional employment avenues ranging from that of sportanalysts to business analysts. The thrust of the course is to prepare students to enter into a promising professional life even after graduation, as also provide to them a platform for pursuing higher studies leading to post-graduate or doctorate degrees.

B. Sc. Honours (Statistics)

Proposed Scheme for Choice Based Credit System in
B.Sc. Honours (Statistics)

	Core Course (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Elective Course (SEEC) (2)	Elective : Discipline Specific DSE (4)	Elective : Generic (GE) (4)
I	Descriptive Statistics (Theory + Practical)	(English/MIL Communication) /Environmental Science			STAT-GE-1
	Calculus				
II	Probability and Prob. Distributions (Theory + Practical)	Environmental Science/ (English/MIL Communication)			STAT-GE-2
	Algebra				
III	Sampling Distributions (Theory + Practical)		STAT-SEE-1		STAT-GE-3
	Survey Sampling & Indian Official Statistics (Theory + Practical)				
	Mathematical Analysis				
IV	Statistical Inference (Theory + Practical)		STAT-SEE-2		STAT-GE-4
	Linear Models (Theory + Practical)				
	Statistical Quality Control (Theory + Practical)				
V	Stochastic Processes and Queuing Theory (Theory + Practical)			STAT-DSE-1	
	Statistical Computing Using C / C++ Programming (Theory + Practical)			STAT-DSE-2	
VI	Design of Experiments (Theory + Practical)			STAT-DSE-3	
	Multivariate Analysis and Nonparametric Methods (Theory + Practical)			STAT-DSE-4	

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Semester I			
Paper Code	**Course Name**		**Credits**
STAT-AEC-1	English/MIL Communication) /Environmental Science	Ability Enhancement	2
STAT-C-101	Descriptive Statistics	Core Discipline	4
	Practical/Lab. work		2
STAT-C-102	Calculus	Core Discipline	5
	Tutorial		1
STAT-GE-1	Any one from the List of **Generic Elective / Interdisciplinary Courses** from other Subjects	Generic Elective / Interdisciplinary	4
	Practical/Lab. Work		2
Semester II			
STAT-AEC-2	Environmental Science/ (English/MIL Communication)	Ability Enhancement	2
STAT-C-201	Probability and Probability Distributions	Core Discipline	4
	Practical/Lab. work		2
STAT-C-202	Algebra	Core Discipline	5
	Tutorial		1
STAT-GE-2	Any one from the List of **Generic Elective / Interdisciplinary Courses** from other Subjects	Generic Elective / Interdisciplinary	4
	Practical/Lab. Work		2
Semester III			
STAT-C-301	Sampling Distributions	Core Discipline	4
	Practical/Lab. Work		2
STAT-C-302	Survey Sampling & Indian Official Statistics	Core Discipline	4
	Practical/Lab. Work		2
STAT-C-303	Mathematical Analysis	Core Discipline	5
	Tutorial		1
STAT-SEE-1	Any one from the List of Skill Enhancement Electives	Skill Enhancement Electives	2
STAT-GE-3	Any one from the List of **Generic Elective / Interdisciplinary Courses** from other Subjects	Generic Elective / Interdisciplinary	4
	Practical/Lab. Work		2
Semester IV			
STAT-C-401	Statistical Inference	Core Discipline	4
	Practical/Lab. Work		2
STAT-C-402	Linear Models	Core Discipline	4
	Practical/Lab. Work		2
STAT-C-403	Statistical Quality Control	Core Discipline	4
	Practical/Lab. Work		2
STAT-SEE-2	Any one from the List of Skill Enhancement Electives	Skill Enhancement Electives	2
STAT-GE-4	Any one from the List of **Generic Elective / Interdisciplinary Courses** from other Subjects	Generic Elective / Interdisciplinary	4
	Practical/Lab. Work		2
Semester V			
STAT-C-501	Stochastic Processes and Queuing Theory	Core Discipline	4
	Practical/Lab. Work		2
STAT-C-502	Statistical Computing Using C / C++ Programming	Core Discipline	4
	Practical/Lab. Work		2
STAT-DSE-1	Any one from the List of Discipline Specific Elective (DSE)	Discipline Specific Elective	4
	Practical/Lab. Work		2
STAT-DSE-2	Any one from the List of Discipline Specific Elective (DSE)	Discipline Specific Elective	4
	Practical/Lab. Work		2

Semester VI			
STAT-C-601	Design of Experiments	Core Discipline	4
	Practical/Lab. Work		2
STAT-C-602	Multivariate Analysis and Nonparametric Methods	Core Discipline	4
	Practical/Lab. Work		2
STAT-DSE-3	Any one from the List of Discipline Specific Elective (DSE)	Discipline Specific Elective	4
	Practical/Lab. Work		2
STAT-DSE-4*	Any one from the List of Discipline Specific Elective (DSE)	Discipline Specific Elective	4
	Practical/Lab. Work		2

* Project Work will be offered in the Sixth Semester

B. Sc. Honours (Statistics)

Core Papers (Credit: 6 each) (14 papers)
STAT-C-101 Descriptive Statistics (Theory+ Practical)
STAT C-102 Calculus
STAT-C-201 Probability and Probability Distributions (Theory+ Practical)
STAT C-202 Algebra
STAT-C-301 Sampling Distributions (Theory+ Practical)
STAT-C-302 Survey Sampling and Indian Official Statistics (Theory+ Practical)
STAT C-303 Mathematical Analysis
STAT-C-401 Statistical Inference (Theory+ Practical)
STAT-C-402 Linear Models (Theory+ Practical)
STAT-C-403 Statistical Quality Control (Theory+ Practical)
STAT-C-501 Stochastic Processes and Queuing Theory (Theory+ Practical)
STAT-C-502 Statistical Computing Using C/C++ Programming (Theory+ Practical)
STAT-C-601 Design of Experiments (Theory+ Practical)
STAT-C-602 Multivariate Analysis and Nonparametric Methods (Theory+ Practical)

Discipline Specific Elective Papers (Credit: 6 each) (4 papers to be selected)
1. Operations Research(Theory+ Practical)
2. Time Series Analysis(Theory+ Practical)
3. Econometrics(Theory+ Practical)
4. Demography and Vital Statistics (Theory+ Practical)
5. Financial Statistics(Theory+ Practical)
6. Actuarial Statistics(Theory+ Practical)
7. Survival Analysis and Biostatistics(Theory+ Practical)
8. Project Work (Sixth Semester)

Generic Elective Papers (GE) (Credit: 6 each) (4 papers of any discipline to be selected from other Departments/Disciplines)
Skill Enhancement Electives (Credit: 2 each) (2 papers to be selected)
1. Statistical-Data Analysis Using Software Packages
2. Statistical Data Analysis Using R
3. Statistical Techniques for Research Methods
4. Data Base Management Systems

Generic Elective Papers (GE) (Credit: 6 each) (Any four to be offered to other Departments/Disciplines)
1. Statistical Methods
2. Introductory Probability
3. Sample Survey
4. Basics of Statistical Inference
5. Introduction to Operations Research
6. Applied Statistics
7. Mathematical Economics
8. Research Methodology

Core Papers in Statistics
STAT-C-101 Descriptive Statistics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurementnominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes.   10 (5L + 1T)

UNIT II
Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections.

20(9L + 2T)
UNIT III
Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.

10 (5L + 1T)
UNIT IV
Index Numbers: Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers.

10 (5L + 1T)
SUGGESTED READING:
1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I
& II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics
with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of
Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

PRACTICAL/LAB. WORK: 30 **(7L = 14 Class)**
List of Practical
1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of polynomials, exponential curves.
7. Karl Pearson correlation coefficient.
8. Correlation coefficient for a bivariate frequency distribution.
9. Lines of regression, angle between lines and estimated values of variables.
10. Spearman rank correlation with and without ties.

11. Partial and multiple correlations.
12. Planes of regression and variances of residuals for given simple correlations.
13. Planes of regression and variances of residuals for raw data.
14. Calculate price and quantity index numbers using simple and weighted average of price relatives.
15. To calculate the Chain Base index numbers.
16. To calculate consumer price index number.

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Core Papers in Statistics
STAT C-102 – Calculus
Marks : 100 [In-sem : 20 + End Sem. : 80]

Credit 6

UNIT I
Differential Calculus**:** Limits of function, continuous functions, properties of continuous functions, partial differentiation and total differentiation. Indeterminate forms: L-Hospital's rule, Leibnitz rule for successive differentiation. Euler's theorem on homogeneous functions. Maxima and minima of functions of one and two variables, constrained optimization techniques (with Lagrange multiplier) along with some problems. Jacobian, concavity and convexity, points of inflexion of function, singular points.   30 (14L+3T)

UNIT II
Integral Calculus**:** Review of integration and definite integral. Differentiation under integral sign, double integral, change of order of integration, transformation of variables. Beta and Gamma functions: properties and relationship between them.   20 (8L+2T)

UNIT III
Differential Equations**:** Exact differential equations, Integrating factors, change of variables, Total differential equations, Differential equations of first order and first degree, Differential equations of first order but not of first degree, Equations solvable for x, y, q, Equations of the first degree in x and y, Clairaut's equations. Higher Order Differential Equations**:** Linear differential equations of order n, Homogeneous and non-homogeneous linear differential equations of order n with constant coefficients   20 (8L+2T)

UNIT IV:
Formation and solution of simple partial differential equations. Linear partial differential equations of first order. Non-linear partial differential equation of first order and their different forms. Charpit's method. Homogeneous & Non-homogeneous linear partial differential equations with constant coefficients. Different cases for complimentary functions and particular integrals.   10 (4L+1T)

SUGGESTED READINGS:
1. Gorakh Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition - 1997).
2. Gorakh Prasad: Integral Calculus, PothishalaPvt. Ltd., Allahabad (14th Edition -2000).
3. Zafar Ahsan: Differential Equations and their Applications, Prentice-Hall of India Pvt. Ltd., New Delhi (2nd Edition -2004).
4. Piskunov, N: Differential and Integral Calculus, Peace Publishers, Moscow.

Core Papers in Statistics
STAT-C-201 Probability and Probability Distributions
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications. 10 (5L+1T)

UNIT II
Random variables: discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations with illustrations. 10 (5L+1T)

UNIT III
Mathematical Expectation and Generating Functions: Expectation of single and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations. 10 (5L+1T)

UNIT IV
Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties and limiting/approximation cases. 20 (9L+2T)

SUGGESTED READING:
1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

PRACTICAL/LAB. WORK: 30 **(7L = 14 Class)**
List of Practical
1. Fitting of binomial distributions for n and p = q = ½.
2. Fitting of binomial distributions for given n and p.

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3. Fitting of binomial distributions after computing mean and variance.
4. Fitting of Poisson distributions for given value of lambda.
5. Fitting of Poisson distributions after computing mean.
6. Fitting of negative binomial.
7. Fitting of suitable distribution.
8. Application problems based on binomial distribution.
9. Application problems based on Poisson distribution.
10. Application problems based on negative binomial distribution.
11. Problems based on area property of normal distribution.
12. To find the ordinate for a given area for normal distribution.
13. Application based problems using normal distribution.
14. Fitting of normal distribution when parameters are given.
15. Fitting of normal distribution when parameters are not given.

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Core Papers in Statistics
STAT C- 202- Algebra
Marks : 100 [In-sem : 20 + End Sem. : 80]

Credit 6

UNIT I
Theory of equations, statement of the fundamental theorem of algebra and its consequences. Relation between roots and coefficients or any polynomial equations. Solutions of cubic and biquadratic equations when some conditions on roots of equations are given. Evaluation of the symmetric polynomials and roots of cubic and biquadratic equations. Vector spaces, Subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem (without proof).   20 (8L+2T)

UNIT II
Algebra of matrices - Types of Matrices: triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices related results and their properties. Trace of a matrix, unitary, involutory and nilpotent matrices.   15 (6L+1T)

UNIT III
Determinants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, Circulant determinants and Vandermonde determinants for nth order, Jacobi's Theorem, product of determinants. Adjoint and inverse of a matrix and related properties. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix.
                                          30 (14L+3T)

UNIT IV
Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Generalized inverse (concept with illustrations).Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, useful Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms definition and classifications; Linear orthogonal transformation and their diagonalization.
                                          15 (6L+1T)

SUGGESTED READINGS:
1. Lay David C.: Linear Algebra and its Applications, Addison Wesley, 2000.
2. Schaum's Outlines : Linear Algebra, Tata McGraw-Hill Edition, 3rdEdition, 2006.
3. Krishnamurthy V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
4. Jain P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1973
5. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International, 1997.
6. Gupta S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.
7. Artin M.: Algebra. Prentice Hall of India, 1994.
8. Datta K.B.: Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., 2002.
9. Hadley G.: Linear Algrbra. Narosa Publishing House (Reprint), 2002.
10. Searle S.R.: Matrix Algebra Useful for Statistics. John Wiley &Sons., 1982.

<div align="right">**B. Sc. Honours (Statistics)**</div>

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Core Papers in Statistics
STAT-C-301 Sampling Distributions
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

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<div align="right">**Credit 6**</div>

UNIT I

Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their inter relations, Chebyshev's inequality, W.L.L.N., S.L.L.N. and their applications, De-Moivre Laplace theorem, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. and Liapunov Theorem (without proof).

Order Statistics: Introduction, distribution of the rth order statistic, smallest and largest order statistics. Joint distribution of rth and sth order statistics, distribution of sample median and sample range.   12 (6L+1T)

UNIT II

Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.

<div align="right">14 (8L+1T)</div>

UNIT III

Exact sampling distribution: Definition and derivation of p.d.f. of $\chi2$ with n degrees of freedom (d.f.) using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of $\chi2$ distribution. Tests of significance and confidence intervals based on distribution.

<div align="right">12 (6L+1T)</div>

UNIT IV[*]

Exact sampling distributions: Student's and Fishers t-distribution, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution.
Snedecore's F-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n1,n2)$. Relationship between t, F and $\chi2$ distributions. Test of significance and confidence Intervals based on t and F distributions.
*only Central distributions

<div align="right">12 (6L+1T)</div>

SUGGESTED READING:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): *An Outline of Statistical Theory*, Vol. I, 4th Edn. World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.

3. Hogg, R.V. and Tanis, E.A. (2009): *A Brief Course in Mathematical Statistics*. Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K. (2001): *Statistics-Principles and Methods*, 4th Edn. John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): *Introduction to the Theory of Statistics*, 3rd Edn. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.

PRACTICAL/LAB. WORK: 30 (**7L = 14 Class**)

List of Practical
1. Testing of significance and confidence intervals for single proportion and difference of two proportions
2. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.
3. Testing of significance and confidence intervals for difference of two standard deviations.
4. Exact Sample Tests based on Chi-Square Distribution.
5. Testing if the population variance has a specific value and its confidence intervals.
6. Testing of goodness of fit.
7. Testing of independence of attributes.
8. Testing based on 2 X 2 contingency table without and with Yates' corrections.
9. Testing of significance and confidence intervals of an observed sample correlation coefficient.
10. Testing and confidence intervals of equality of two population variances

Core Papers in Statistics
STAT-C-302 Survey Sampling and Indian Official Statistics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

15 (8L+1T)

UNIT II
Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates (N=nxk). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

15 (8L+1T)

UNIT III
Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS. Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters). Relative efficiency of cluster sampling with SRS in terms of intra class correlation. Concept of sub sampling

10 (5L+1T)

UNIT IV
Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.   10 (5L+1T)

SUGGESTED READING:
1. Cochran W.G. (1984):Sampling Techniques(3rd Ed.), Wiley Eastern.
2. Sukhatme,P.V., Sukhatme,B.V. Sukhatme,S. Asok,C.(1984). Sampling Theories of
Survey With Application, IOWA State University Press and Indian Society of
Agricultural Statistics
3. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub.
Society, Calcutta.
4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.

5. Goon A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2), World Press.
6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
7. http://mospi.nic.in/

PRACTICAL/LAB. WORK: **30 (7L = 14 Class)**

List of Practical
1. To select a SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WR and WOR and establish all properties relative to SRS.
3. For SRSWOR, estimate mean, standard error, the sample size
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods Compare the efficiencies of above two methods relative to SRS
5. Estimation of gain in precision in stratified sampling.
6. Comparison of systematic sampling with stratified sampling and SRS in the presence of a linear trend.
7. Ratio and Regression estimation: Calculate the population mean or total of the population. Calculate mean squares. Compare the efficiencies of ratio and regression estimators relative to SRS.
8. Cluster sampling: estimation of mean or total, variance of the estimate, estimate of intra-class correlation coefficient, efficiency as compared to SRS.

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Core Papers in Statistics
STAT C- 303- Mathematical Analysis
Marks : 100 [In-sem : 20 + End Sem. : 80]

Credit 6

UNIT-I

Real Analysis: Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets, neighborhoods and limit points, Superimum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.   20 (8L+2T)

UNIT-II

Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test. Gauss test, Cauchy's condensation test and integral test (Statements and Examples only). Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence. Indeterminate form, L' Hospital's rule.

20 (8L+2T)

UNIT-III

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with lagrange's and Cauchy's form of remainder(without proof). Taylor's and Maclaurin's series expansions of sinx, cosx, log (1+x).   20 (8L+2T)

UNIT-IV

Numerical Analysis: Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae. Lagrange's interpolation formulae. Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eights rule, Weddle's rule with error terms. Difference equations of first order and their solutions. Solution of Transcendental equations with NR method.

20 (8L+2T)

SUGGESTED READINGS

1. Malik S.C. and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi, 1994.
2. Somasundram D. and Chaudhary B.: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1987.
3. Gupta S.L. and Nisha Rani: Principles of Real Analysis, Vikas Publ. House Pvt. Ltd., New Delhi, 1995.

4. Appostol T.M.: Mathematical Analysis, Second Edition, Narosa Publishing House, NewDelhi, 1987.

5. Shanti Narayan: A course of Mathematical Analysis, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi, 1987.

6. Singal M.K. and Singal A.R.: A First Course in Real Analysis, 24th Edition, R. Chand & Co., New Delhi, 2003.

7. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis(3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.

8. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis,Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.

9. Jain,M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.

10. Mukherjee, Kr. Kalyan (1990): Numerical Analysis. New Central Book Agency.

11. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Del

B. Sc. Honours (Statistics)
Core Papers in Statistics
STAT-C-401 Statistical Inference
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Estimation: Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators (statement and applications).   15 (8L+1T)

UNIT II
Methods of Estimation: Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Bayes estimators.
                                                                              8 (4L+1T)
UNIT III
Principles of test of significance: Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).   15 (8L+1T)

UNIT IV
Sequential Analysis: Sequential probability ratio test (SPRT) for simple vs simple hypotheses. Fundamental relations among α, β, A and B, determination of A and B in practice. Wald's fundamental identity (sans proof) and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal, Poisson, binomial and exponential distributions.   12 (6L+1T)

SUGGESTED READINGS:
1. Goon A.M., Gupta M.K.: Das Gupta.B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
3. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
5. Mood A.M, Graybill F.A. and Boes D.C,: Introduction to the Theory of Statistics, McGraw Hill.
6. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7. Snedecor G.W and Cochran W.G.(1967) Statistical Methods. Iowa State University Press.

B. Sc. Honours (Statistics)

PRACTICAL/LABWORK: **30 (7L = 14 Class)**

List of Practical
1. Unbiased estimators (including unbiased but absurd estimators)
2. Consistent estimators, efficient estimators and relative efficiency of estimators.
3. Cramer-Rao inequality and MVB estimators
4. Sufficient Estimators – Factorization Theorem, Rao-Blackwell theorem, Complete Sufficient estimators
5. Lehman-Scheffe theorem and UMVUE
6. Maximum Likelihood Estimation
7. Asymptotic distribution of maximum likelihood estimators
8. Estimation by the method of moments, minimum Chi-square
9. Type I and Type II errors
10. Most powerful critical region (NP Lemma)
11. Uniformly most powerful critical region
12. Unbiased critical region
13. Power curves
14. Likelihood ratio tests for simple null hypothesis against simple alternative hypothesis
15. Likelihood ratio tests for simple null hypothesis against composite alternative hypothesis
16. Asymptotic properties of LR tests
17. SPRT procedure
18. OC function and OC curve
19. ASN function and ASN curve

B. Sc. Honours (Statistics)
Core Papers in Statistics
STAT-C-402 Linear Models
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

10 (5L+1T)

UNIT II
Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models (Matrix and scalar versions) and estimation.

10 (5L+1T)

UNIT III
Analysis of variance: Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models

20 (9L+2T)

UNIT IV
Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots.

10 (5L+1T)

SUGGESTED READINGS:
1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.

PRACTICAL/LAB. WORK: 30 **(7L = 14 Class)**
List of Practical
1. Estimability when X is a full rank matrix and not a full rank matrix
2. Distribution of Quadratic forms
3. Simple Linear Regression
4. Multiple Regression
5. Tests for Linear Hypothesis
6. Bias in regression estimates
7. Lack of fit
8. Orthogonal Polynomials
9. Analysis of Variance of a one way classified data
10. Analysis of Variance of a two way classified data with one observation per cell
11. Analysis of Covariance of a one way classified data
12. Analysis of Covariance of a two way classified data

B. Sc. Honours (Statistics)
Core Papers in Statistics
STAT-C-403 Statistical Quality Control
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II, historical perspective of Quality Gurus and Quality Hall of Fame. Quality system and standards: Introduction to ISO quality standards, Quality registration. Statistical Process Control - Seven tools of SPC, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3-σ Control charts, Rational Sub-grouping.   15 (6L+2T)

UNIT II
Control charts for variables: X-bar & R-chart, X-bar & s-chart. Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability.

15 (6L+2T)

UNIT III
Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.

10 (5L+1T)

UNIT IV
Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total Quality Management (TQM). Organizational Structure and Six Sigma training plans- Selection Criteria for Six-Sigma roles and training plans. Voice of customers (VOC): Importance and VOC data collection. Critical to Quality (CTQ).Introduction to DMAIC using one case study: Define Phase, Measure Phase, Analyse Phase, Improve Phase and Control Phase.

10 (5L+1T)

SUGGESTED READING:
1. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay, P (2011):Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press.
6. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.

B. Sc. Honours (Statistics)

PRACTICAL/LAB. WORK: 30 **(7L = 14 Class)**

List of Practical

1. Construction and interpretation of statistical control charts

☐ X-bar & R-chart

☐ X-bar & s-chart

☐ np-chart

☐ p-chart

☐ c-chart

☐ u-chart

2. Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves

3. Calculation of process capability and comparison of 3-sigma control limits with specification limits.

4. Use a case study to apply the concept of six sigma application in DMAIC: practical application.

B. Sc. Honours (Statistics)
Core Papers in Statistics
STAT-C-501 Stochastic Processes and Queuing Theory
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.   10 (5L+1T)

UNIT II
Markov Chains: Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains, stability of Markov system, graph theoretic approach.   20 (9L+2T)

UNIT III
Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, pure birth process, Yule Furry process, birth and death process, pure death process.
                    10 (5L+1T)

UNIT IV
Queuing System: General concept, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity, waiting time distribution in stationary cases only (without proof).
                    10 (5L+1T)

SUGGESTED READING:
1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
2. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.
3. Bhat,B.R.(2000): Stochastic Models: Analysis and Applications, New Age International Publishers.
4. Taha, H. (1995): Operations Research: An Introduction, Prentice- Hall India.
5. Feller, William (1968): Introduction to probability Theory and Its Applications, Vol I, 3rd Edition, Wiley International.

PRACTICAL/LAB. WORK   **30 (7L = 14 Class)**

List of Practical
1. Calculation of transition probability matrix
2. Identification of characteristics of reducible and irreducible chains.
3. Identification of types of classes
4. Identification of ergodic transition probability matrix
5. Stationarity of Markov chain and graphical representation of Markov chain
6. Computation of probabilities in case of generalizations of independent Bernoulli trials
7. Calculation of probabilities for given birth and death rates and vice versa
8. Calculation of probabilities for Birth and Death Process

9. Calculation of probabilities for Yule Furry Process
10. Computation of inter-arrival time for a Poisson process.
11. Calculation of Probability and parameters for (M/M/1) model and change in behaviour of queue as N tends to infinity.
12. Calculation of generating function and expected duration for different amounts of stake.
13. Computation of probabilities and expected duration between players.

B. Sc. Honours (Statistics)
Core Papers in Statistics
STAT-C-502 Statistical Computing Using C Programming
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
History and importance of C. Components, basic structure programming, character set, C tokens, Keywords and Identifiers and execution of a C program. Data types: Basic data types, Enumerated data types, derived data types. Constants and variables: declaration and assignment of variables, Symbolic Constants, overflow and underflow of data.
Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions. Managing input and output operations: reading and printing formatted and unformatted data   20 (9L+2T)

UNIT II
Decision making and branching - if…else, nesting of if…else, else if ladder, switch, conditional operator. Looping in C for, nested for, while, do…while, jumps in and out of loops.
Arrays: Declaration and initialization of one-dim and two-dim arrays. Character arrays and strings: Declaring and initializing string variables, reading and writing strings from Terminal (using scanf and printf only).   10 (5L+1T)

UNIT III
User- defined functions: A multi-function program using user-defined functions, definition of functions, return values and their types, function prototypes and calls. Category of Functions: no arguments and no return values, arguments but no return values , arguments with return values, no arguments but returns a value, functions that return multiple values. Recursion function. Passing arrays to functions, Storage class of Variables.   10 (5L+1T)

UNIT IV
Pointers: Declaration and initialization of pointer variables, accessing the address of a variable, accessing a variable through its pointer, pointer expressions, pointer increments/decrement and scale factor. Pointers and arrays, arrays of pointers, pointers as function arguments, functions returning pointers.   10 (5L+1T)

SUGGESTED READING:

1. Kernighan, B.W. and Ritchie, D. (1988): C Programming Language, 2ndEdition,Prentice Hall.
2. Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition, Tata McGraw Hill.
3. Gottfried, B.S. (1998): Schaum's Outlines: Programming with C, 2nd Edition, Tata McGraw Hill

PRACTICAL/ LAB WORK(Using C/C++ Programming Language)   30 **(7L = 14 Class)**

List of Practical

1. Plot of a graph y = f(x)
2. Roots of a quadratic equation (with imaginary roots also)
3. Sorting of an array and hence finding median
4. Mean, Median and Mode of a Grouped Frequency Data
5. Variance and coefficient of variation of a Grouped Frequency Data
6. Preparing a frequency table
7. Value of n! using recursion
8. Random number generation from uniform, exponential, normal(using CLT) and gamma distribution, calculate sample mean and variance and compare with population parameters.
9. Matrix addition, subtraction, multiplication Transpose and Trace
10. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit
11. Chi-square contingency table
12. t-test for difference of means
13. Paired t-test
14. F-ratio test
15. Multiple and Partial correlation.
16. Compute ranks and then calculate rank correlation(without tied ranks)
17. Fitting of lines of regression

B. Sc. Honours (Statistics)
Core Papers in Statistics
STAT-C-601 Design of Experiments
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks.
Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with single missing observation.   20 (7L+2T)

UNIT II
Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties,   10 (4L+1T)

UNIT III
Factorial experiments: advantages, notations and concepts, 2^2, 2^3…2^n and 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$) and 3^2.
                                                                                                      20 (7L+2T)
UNIT IV
Factorial experiments in a single replicate. Fractional factorial experiments: Construction of one-half and one-quarter fractions of 2^n ($n \leq 5$) factorial experiments   10 (4L+1T)

SUGGESTED READINGS:
1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8thEdn. World Press, Kolkata.
4. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
5. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

PRACTICAL/LAB. WORK: 30 (7L = 14 Class)

List of Practical
1. Analysis of a CRD
2. Analysis of an RBD
3. Analysis of an LSD

B. Sc. Honours (Statistics)

4. Analysis of an RBD with one missing observation
5. Analysis of an LSD with one missing observation
6. Intra Block analysis of a BIBD
7. Analysis of 22 and23 factorial in CRD and RBD
8. Analysis of 22 and23 factorial in LSD
9. Analysis of a completely confounded two level factorial design in 2 blocks
10. Analysis of a completely confounded two level factorial design in 4 blocks
11. Analysis of a partially confounded two level factorial design
12. Analysis of a single replicate of a 2n design
13. Analysis of a fraction of 2n factorial design

Core Papers in Statistics
STAT-C-602 Multivariate Analysis and Nonparametric Methods
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN.
Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.   10 (5L+1T)

UNIT II
Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance-covariance matrix (sans deduction). Multiple and partial correlation coefficient and their properties.   15 (6L+2T)

UNIT III
Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis.   10 (5L+1T)

UNIT IV
Nonparametric Tests: Introduction and Concept, Test for randomness based on total number of runs, Empirical distribution function, Kolmogrov Smirnov test for one sample, Sign tests- one sample and two samples, Wilcoxon-Mann-Whitney test, Kruskal-Wallis test.
        15 (6L+2T)

SUGGESTED READING:
1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rdEdn., John Wiley
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
3. Kshirsagar, A.M. (1972) :Multivariate Analysis, 1stEdn. Marcel Dekker.
4. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall
5. Mukhopadhyay, P. :Mathematical Statistics.
6. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

PRACTICALS/ LAB WORK: 30 (7L = 14 Class)

List of Practical
1. Multiple Correlation
2. Partial Correlation
3. Bivariate Normal Distribution,
4. Multivariate Normal Distribution
5. Discriminant Analysis

6. Principal Components Analysis
7. Factor Analysis
8. Test for randomness based on total number of runs,
9. Kolmogrov Smirnov test for one sample.
10. Sign test: one sample, two samples, large samples.
11. Wilcoxon-Mann-Whitney U-test
12. Kruskal-Wallis test

B. Sc. Honours (Statistics)
DSE Papers in Statistics
STAT-DSE-1 Operations Research
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Introduction to Operations Research, phases of O.R., model building, various types of O.R. problems. Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P. Simplex method for solving L.P.P. Charne's M-technique for solving L.P.P. involving artificial variables. Special cases of L.P.P. Concept of Duality in L.P.P.

16 (7L+2T)

UNIT II
Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM), MODI's method to find the optimal solution, special cases of transportation problem. Assignment problem: Hungarian method to find optimal assignment, special cases of assignment problem.   16 (7L+2T)

UNIT III
Game theory: Rectangular game, minimax-maximin principle, solution to rectangular game using graphical method, dominance and modified dominance property to reduce the game matrix and solution of 2 X 2, 2 X n, n X 2 rectangular game with mixed strategy.

10 (5L+1T)

UNIT IV
Inventory Management: ABC inventory system, characteristics of inventory system. EOQ Model and its variations, with and without shortages.

8 (3L+1T)

SUGGESTED READING:

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.
2. KantiSwarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.
3. Hadley, G: (2002) : Linear Programming, Narosa Publications
4. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research-Concepts and cases, 9th Edition, Tata McGraw Hill

B. Sc. Honours (Statistics)

PRACTICAL/ LAB WORK (Using TORA/WINQSB/LINGO)   30 (7L = 14 Class)

List of Practical

1. Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne's Big M method involving artificial variables.
2. Identifying Special cases by Graphical and Simplex method and interpretation
a. Degenerate solution
b. Unbounded solution
c. Alternate solution
d. Infeasible solution
3. Allocation problem using Transportation model
4. Allocation problem using Assignment model
5. Problems based on game matrix
a. Graphical solution to mx2, 2xn, 2x2 rectangular game
b. Mixed strategy
6. To find optimal inventory policy for EOQ modelsand its variations

B. Sc. Honours (Statistics)
DSE Papers in Statistics
STAT-DSE-2 Time Series Analysis
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Introduction to time series data, application of time series from various fields, Components of a times series, Decomposition of time series. Trend: Estimation of trend by free hand curve method, method of semi averages, fitting a various mathematical curve, and growth curves.
14 (6L+2T)

UNIT II
Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend. 14 (6L+2T)

UNIT III
Seasonal Component cont: Ratio to Moving Averages and Link Relative method, Deseasonalization. Cyclic Component: Harmonic Analysis. Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two.
14 (6L+2T)

UNIT IV
Random Component: Variate component method. Forecasting: Exponential smoothing methods of forecasting; Box-Jenkins method; Stationary Time series: Weak stationarity, autocorrelation function and correlogram. 8 (2L+1T)

SUGGESTED READING:
1. Kendall M.G. (1976): Time Series, Charles Griffin.
2. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
3. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied

PRACTICAL / LAB WORK   **30 (7L = 14 Class)**

List of Practical
1. Fitting and plotting of modified exponential curve
2. Fitting and plotting of Gompertz curve
3. Fitting and plotting of logistic curve
4. Fitting of trend by Moving Average Method
5. Measurement of Seasonal indices Ratio-to-Trend method
6. Measurement of Seasonal indices Ratio-to-Moving Average method
7. Measurement of seasonal indices Link Relative method
8. Calculation of variance of random component by variate difference method
9. Forecasting by exponential smoothing
.

B. Sc. Honours (Statistics)
DSE Papers in Statistics
STAT-DSE-3 Econometrics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Introduction: Econometric models and its essences. General linear model (GLM) and its estimation. Simultaneous equation model: structural and reduced forms.

14 (6L+2T)

UNIT II
Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences, detection and remedies of multicollinearity, specification errors.   14 (6L+2T)

UNIT III
Generalized least squares estimation, Aitken estimators. Autocorrelation: concept, consequences of autocorrelated disturbances, detection and remedies of autocorrelation.

14 (6L+2T)

UNIT IV
Heteroscedastic disturbances: Concepts and efficiency of Aitken estimator with OLS estimator under heteroscedasticity. Consequences of heteroscedasticity. Tests and solutions of heteroscedasticity. Autoregressive and Lag models.   8 (2L+1T)

SUGGESTED READING:

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw Hill Companies.
2. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
3. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave Macmillan Limited,
4. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, John Wiley & Sons.

PRACTICAL /LAB WORK   **30 (7L = 14 Class)**

List of Practical
1. Problems based on estimation of General linear model
2. Testing of parameters of General linear model
3. Forecasting of General linear model
4. Problems concerning specification errors
5. Problems related to consequences of Multicollinearity
6. Diagnostics of Multicollinearity
7. Problems related to consequences of Autocorrelation (AR(I))
8. Diagnostics of Autocorrelation

9. Estimation of problems of General linear model under Autocorrelation
10. Problems related to consequences Heteroscedasticity
11. Diagnostics of Heteroscedasticity
12. Estimation of problems of General linear model under Heteroscedastic distance terms
13. Problems related to General linear model under (Aitken Estimation)
14. Problems on Autoregressive and Lag models.

B. Sc. Honours (Statistics)
DSE Papers in Statistics
STAT-DSE-4 Demography and Vital Statistics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I

Nature and scope of Demography. Population theories – Malthus, Natural and Biological , Demographic transition. Demographic data- sources, coverage and content errors. Use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data- Myer and UN indices. Population composition, dependency ratio.   10 (4L+1T)

UNIT II

Sources of collecting data on Vital statistics, errors in census and registration data. Measurement of population: rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rates (SDR), Infant Mortality Rate (IMR) and Standardized Death Rates.   15 (7L+2T)

UNIT III

Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life (Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables. Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method, Greville's method and King's Method.   10 (4L+1T)

UNIT IV

Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).   15 (7L+2T)

SUGGESTED READING:
1. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition, World Press.
3. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
4. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
5. Keyfitz N., Beckman John A.: Demogrphy through Problems S-Verlag New york.

B. Sc. Honours (Statistics)

PRACTICAL/LAB. WORK: **30 (7L = 14 Class)**

List of Practical
1. To calculate CDR and Age Specific death rate for a given set of data
2. To find Standardized death rate by:- (i) Direct method (ii) Indirect method
3. To construct a complete life table
4. To fill in the missing entries in a life table
5. To calculate probabilities of death at pivotal ages and use it construct abridged life table using (i) Reed-Merrell Method, (ii) Greville's Method and (iii) King's Method
6. To calculate CBR, GFR, SFR, TFR for a given set of data
7. To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data
8. Calculate GRR and NRR for a given set of data and compare them

DSE Papers in Statistics
STAT-DSE-5 Financial Statistics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Probability review: Real valued random variables, expectation and variance, skewness and kurtosis, conditional probabilities and expectations. Discrete Stochastic Processes, Binomial processes, General random walks, Geometric random walks, Binomial models with state dependent increments. 12 (6L+1T)

UNIT II
Tools Needed For Option Pricing: Wiener process, stochastic integration, and stochastic differential equations. Introduction to derivatives: Forward contracts, spot price, forward price, future price. Call and put options, zero-coupon bonds and discount bonds
12 (6L+1T)

UNIT III
Pricing Derivatives: Arbitrage relations and perfect financial markets, pricing futures, put-call parity for European options, relationship between strike price and option price. Stochastic Models in Finance: Discrete time process- binomial model with period one.
12 (6L+1T)

UNIT IV
Stochastic Models in Finance: Continuous time process- geometric Brownian motion. Ito's lemma, Black-Scholes differential equation, Black-Scholes formula for European options, Hedging portfolios: Delta, Gamma and Theta hedging. Binomial Model for European options: Cox-Ross-Rubinstein approach to option pricing. Discrete dividends   14 (8L+1T)

SUGGESTED READING:

1. Franke, J., Hardle, W.K. And Hafner, C.M. (2011): Statistics of Financial Markets: An Introduction, 3rdEdition, Springer Publications.
2. Stanley L. S. (2012): A Course on Statistics for Finance, Chapman and Hall/CRC.

PRACTICAL / LAB WORK (Using spreadsheet/ R)   **30 (7L = 14 Class)**

List of Practical
1. To verify "no arbitrage" principle
2. To verify relationship between spot price, forward price, future price
3. To price future contracts
4. To verify put-call parity for European options
5. To construct binomial trees and to evaluate options using these trees
6. To price options using black – Scholes formula
7. To hedge portfolios using delta and gamma hedging

8. To hedge portfolios theta hedging
9. Pricing of call options using binomial model
10. Computation of dividends on call options as a percentage of stock price.
11. Computation of dividends on call options as a fixed amount of money.
12. Pricing of put options using binomial model
13. Call-put parity for options following binomial models.
14. Effect of dividends on put options.

B. Sc. Honours (Statistics)
DSE Papers in Statistics
STAT-DSE-6 Actuarial Statistics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory: Utility functions, expected utility criterion, types of utility function, insurance and utility theory.
10 (5L+1T)

UNIT II
Principles of Premium Calculation: Properties of premium principles, examples of premium principles. Individual risk models: models for individual claims, the sum of independent claims, approximations and their applications.   10 (5L+1T)

UNIT III
Survival Distribution and Life Tables: Uncertainty of age at death, survival function, timeuntil-death for a person, curate future lifetime, force of mortality, life tables with examples, deterministic survivorship group, life table characteristics, assumptions for fractional age, some analytical laws of mortality.   15 (7L+1T)

UNIT IV
Life Insurance: Models for insurance payable at the moment of death, insurance payable at the end of the year of death and their relationships. Life annuities: continuous life annuities, discrete life annuities, life annuities with periodic payments. Premiums: continuous and discrete premiums.   15 (7L+2T)

SUGGESTED READING:

1. Dickson, C. M. D. (2005): Insurance Risk And Ruin (International Series On
Actuarial Science), Cambridge University Press.
2. Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A. And Nesbitt, C. J. (1997):
Actuarial Mathematics, Society Of Actuaries, Itasca, Illinois, U.S.A.

PRACTICAL / LAB WORK (Using Spreadsheet/R)   **30 (7L = 14 Class)**
List of Practical
1. Risk computation for different utility models
2. Discrete and continuous risk calculations
3. Calculation of aggregate claims for collective risks
4. Calculation of aggregate claim for individual risks
5. Computing Ruin probabilities and aggregate losses
6. Annuity and present value of contract
7. Computing premium for different insurance schemes
8. Practical based on life models and tables

B. Sc. Honours (Statistics)
DSE Papers in Statistics
STAT-DSE-7 Survival Analysis and Biostatistics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I

Survival Analysis: survival distributions and their applications exponential, gamma, Weibull, Rayleigh, lognormal, density functions for a distribution having bath-tub shaped hazard function.

Censoring Schemes: Type I, Type II and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator for Type I and Type II censored data with numerical examples. Non-parametric methods: Kaplan-Meier methods for estimating survival function and variance of the Estimator.   22 (11L+2T)

UNIT II

Competing Risk Theory: Indices for measurement of probability of death under competing risks and their inter-relations. Estimation of probabilities of death using maximum likelihood principle and modified minimum Chi-square methods.   8 (3L+1T)

UNIT III

Basic concepts of Epidemiology. Stochastic Epidemic Models: Simple epidemic models, general epidemic model definition and concept (without derivation). Duration of an epidemic.
                8 (4L+1T)

UNIT IV

Statistical Genetics: Introduction, concepts-Genotype, Phenotype, Dominance, Recessiveness, Linkage and Recombination, Coupling and Repulsion. Mendelian laws of Heredity, Random mating, Gametic Array .relation between genotypic array and gametic array under random mating. Distribution of genotypes under random mating. Clinical Trials : definition, ethics, blinding and phases.

                12 (6L+1T)

SUGGESTED READING:

1. Lee, E.T. and Wang, J.W. (2003): Statistical Methods for Survival data Analysis, 3rd Edition, John Wiley and Sons.
2. Biswas, S. (2007): Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, Reprinted 2ndCentral Edition, New Central Book Agency.
3. Kleinbaum, D.G. (1996): Survival Analysis, Springer.
4. Chiang, C.L. (1968): Introduction to Stochastic Processes in Bio Statistics, John Wiley and Sons.
5. Indrayan, A. (2008): Medical Biostatistics, 2nd Edition Chapman and Hall/CRC.

PRACTICAL / LAB WORK   **30 (7L = 14 Class)**

List of Practical
1. To estimate survival function
2. To determine death density function and hazard function
3. To identify type of censoring and to estimate survival time for type I censored data
4. To identify type of censoring and to estimate survival time for type II censored data
5. To identify type of censoring and to estimate survival time for progressively type I censored data
6. Estimation of mean survival time and variance of the estimator for type I censored data
7. Estimation of mean survival time and variance of the estimator for type II censored data
8. Estimation of mean survival time and variance of the estimator for progressively type I censored data
9. To estimate the survival function and variance of the estimator using Non-parametric methods with Actuarial methods
10. To estimate the survival function and variance of the estimator using Non-parametric methods with Kaplan-Meier method
11. To estimate Crude probability of death
12. To estimate Net-type I probability of death
13. To estimate Net-type II probability of death
14. To estimate partially crude probability of death
15. To estimate gene frequencies

B. Sc. Honours (Statistics)

DSE Papers in Statistics
STAT-DSE-8 Project Work

Credit 6

Objective: The aim of the course is to initiate students to write and present a statistical report, under the supervision of a faculty, on some area of human interest. The project work will provide hands on training to the students to deal with data emanating from some real life situation and propel them to dwell on some theory or relate it to some theoretical concepts.

<div align="right">**B. Sc. Honours (Statistics)**</div>

<div align="center">

Generic Elective
STAT-GE-1 Statistical Methods
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

</div>

<div align="right">**Credit 6**</div>

UNIT I

Introduction: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio. Presentation: tabular and graphic, including histogram and ogives.

<div align="right">**10** (5L+1T)</div>

UNIT II

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis. <div align="right">16 (7L+2T)</div>

UNIT III

Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves. <div align="right">16 (7L+2T)</div>

UNIT IV

Theory of attributes, consistency of data, independence and association of attributes, measures of association and contingency. <div align="right">8 (3L+1T)</div>

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

PRACTICAL/ LAB WORK <div align="right">30 (7L = 14 Class)</div>
List of Practical
1. Graphical representation of data
2. Problems based on measures of central tendency
3. Problems based on measures of dispersion
4. Problems based on combined mean and variance and coefficient of variation
5. Problems based on moments, skewness and kurtosis
6. Fitting of polynomials, exponential curves
7. Karl Pearson correlation coefficient
8. Partial and multiple correlations
9. Spearman rank correlation with and without ties.
10. Correlation coefficient for a bivariate frequency distribution
11. Lines of regression, angle between lines and estimated values of variables.
12. Checking consistency of data and finding association among attributes.

B. Sc. Honours (Statistics)
Generic Elective
STAT-GE-2 Introductory Probability
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.   15 (6L+2T)

UNIT II
Random Variables: Discrete and continuous random variables, p.m.f., p.d.f. ,c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.   10 (5L+1T)

UNIT III
Convergence in probability, almost sure convergence, Chebyshev's inequality, weak law of large numbers, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.).
                                                                10 (5L+1T)
UNIT IV
Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, beta, gamma.   15 (6L+2T)

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

PRACTICAL/LAB. WORK: **30 (7L = 14 Class)**

List of Practical
1. Fitting of binomial distributions for n and p = q = ½ given
2. Fitting of binomial distributions for n and p given
3. Fitting of binomial distributions computing mean and variance
4. Fitting of Poisson distributions for given value of lambda
5. Fitting of Poisson distributions after computing mean
6. Application problems based on binomial distribution
7. Application problems based on Poisson distribution
8. Problems based on area property of normal distribution
9. To find the ordinate for a given area for normal distribution

10. Application based problems using normal distribution
11. Fitting of normal distribution when parameters are given
12. Fitting of normal distribution when parameters are not given

B. Sc. Honours (Statistics)
Generic Elective
STAT-GE-3 Sample Survey
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I

Concept of population and sample, parameter and statistic, Census and sample survey (sampling unit and sampling frame. Needs for sampling). Steps in a sample survey. Probability and non-probability sampling. Sampling and non-sampling errors. Limitations of sampling.

12 (5L + 1T)

UNIT II

Basic methods of sampling . SRS with and without replacement. Selection of random sample using lottery method & random numbers table. Estimation of population mean, total and proportion.   14 (6L + 2T)

UNIT III

Stratified random sampling – necessity, estimation of population mean, total and proportional and their variances. Allocation of samples into different strata using proportional method, Idea of Linear & Circular Systematic sampling, PPS sampling, Cluster sampling with equal size of clusters- illustration with examples.

14 (6L + 2T)

UNIT IV

Idea of two –stage, multi stage and multi phase sampling – their uses. Needs of determination of sample size, simple examples in SRS and stratified random sampling. Acquaintance with the working of NSSO & NFHS : objective, questionnaire, sampling design, methods of field investigation.

10 (5L + 1T)

SUGGESTED READING:

1. Cochran William G. (1984): Sampling Techniques, Third Edition, Wiley India Pvt. Ltd, New Delhi
2. Gupta, S.C , Kapoor V.K. (2007) : Fundamentals of Applied Statistics, Forth Edition, Sultan Chand & Sons.
3. Murthy M.N. : Sampling Theory and Methods, Statistical Publishing Society, Calcutta
4. Sampath S. : Sampling Theory and Methods, Narosa Publishing House
5. Sukhatme B.V. : Sample Survey Methods and its Applications, Indian Society of Agricultural Statistics
6. Des Raj : Sample Survey Theory, Narosa Publishing House

7. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C (1984) : Sampling Theory of Surveys with Applications, Iowa State University Press, Iowa, USA
8. Murthy M.N. (1977) : Sampling Theory and Methods, Statistical Pub. Soc. Calcutta
9. Des Raj & Chandhok P (1998) : Sample Survey Theory, Narosa Publishing House
10. Mukhopadhyay. P (1998) : Theory and Methods of Survey Sampling, Prentice Hall
11. NSSO Publications

PRACTICAL/LAB WORK   **30 (7L = 14 Class)**
List of Practical
1. To select a SRS without replacement.
2. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WOR and establish all properties relative to SRS.
3. For SRSWOR : estimation of mean, standard error, the sample size
4. Stratified Sampling: allocation of sample to strata by proportional method
5. Estimation of gain in precision in stratified sampling.
6. Preparation of questionnaire, sample size determination for mean, proportion with primary data ($n < 100$)

<div align="right">**B. Sc. Honours (Statistics)**</div>

<div align="center">**Generic Elective**</div>
<div align="center">**STAT-GE-4 Basics of Statistical Inference**</div>
<div align="center">Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]</div>

<div align="right">**Credit 6**</div>

UNIT I
Sampling distribution. Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample and two sample problems). The basic idea of significance test. Null and alternative hypotheses. Type I & Type II errors, level of significance, concept of p-value. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).   15 (7L+2T)

UNIT II
Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chi-square test, Yates' correction.   10 (4L+1T)

UNIT III
Tests for the significance of correlation coefficient. Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.   10 (4L+1T)

UNIT IV
Analysis of variance, one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block. Analysis of completely randomized design, randomized complete block design.   15 (7L+2T)

SUGGESTED READING:

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005).
2. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II (2005).
3. Dass, M. N. &Giri, N. C.: Design and analysis of experiments. John Wiley.
4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences .(1964, 1977) by John Wiley.
5. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
6. Goldstein, A Biostatistics-An introductory text (1971). The Macmillion New York.

PRACTICAL/LAB WORK   **30 (7L = 14 Class)**
List of Practical
1. Estimators of population mean.
2. Confidence interval for the parameters of a normal distribution (one sample and two sample problems).
3. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).
4. Chi-square test of proportions.

5. Chi-square tests of association.
6. Chi-square test of goodness-of-fit.
7. Test for correlation coefficient.
8. Sign test for median.
9. Sign test for symmetry.
10. Wilcoxon two-sample test.
11. Analysis of Variance of a one way classified data
12. Analysis of Variance of a two way classified data.
13. Analysis of a CRD.
14. Analysis of an RBD.

B. Sc. Honours (Statistics)
Generic Elective
STAT-GE-5 Introduction to Operations Research
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Introduction to Operations Research, phases of O.R., model building, various types of O.R. problems. Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P.   16 (7L+2T)

UNIT II
Optimum solution to a L.P.P: slack and surplus variables, Simplex method, concept of artificial variables Graphically identifying special cases of L.P.P. Concept of duality in L.P.P.
16 (7L+2T)
UNIT III
Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM), MODI's method to find the optimal solution. Assignment problem: Hungarian method to find optimal assignment.   10 (5L+1T)

UNIT IV
Game theory: Rectangular game, minimax-maximin principle, solution to rectangular game using graphical method, dominance property to reduce the game matrix and solution to rectangular game with mixed strategy (2X2, 2Xn, 2x2)   8 (3L+1T)

SUGGESTED READING:

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice
Hall of India.
2. SwarupKanti, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition,
Sultan Chand and Sons.
3. Ravindran, A, Phillips, D.T., Solberg,J.J.(2005): Operations Research- Principles and
Practice, John Wiley & Sons.

PRACTICAL/LAB WORK: Using TORA/WINQSB/LINGO   30 (7L = 14 Class)
List of Practical
1. Mathematical formulation of L.P.P and solving the problem using graphical method
2. Simplex technique to solve L.P.P and reading dual solution from the optimal table
3. Charne's Big M method involving artificial variables.
4. Identifying Special cases: Degenerate solution, Unbounded solution, Alternate
solution and Infeasible solution by Graphical method and interpretation
5. Allocation problem using Transportation model
6. Allocation problem using Assignment model
7. Networking : Shortest route problem
8. Problems based on game matrix: mx2 / 2xn rectangular and Mixed strategy

B. Sc. Honours (Statistics)

Generic Elective
STAT-GE-6 Applied Statistics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Educational and Psychological Statistics :
Scaling individual test items in terms of difficulty (σ scaling); scaling scores on a test - σ scores and standard scores, normalizing the frequency distribution : the T scale, constructing a T scale, advantages of T scale; the Staning scale, comparison T scores and standard scores, percentile scaling; scaling judgments. Examples. 10 (4L + 1T)

UNIT II
Index numbers: Definition, Criteria for a good index number, different types of index numbers. Construction of index numbers of prices and quantities, consumer price index number. Uses and limitations of index numbers. Base shifting, Splicing and deflating of Index numbers 10 (4L+1T)

UNIT III
Statistical Quality Control: Importance of statistical methods in industrial research and practice. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts. 15 (7L+2T)

UNIT IV
Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates.
Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.
15 (7L+2T)

SUGGESTED READING:

1. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.
3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals Of Applied Statistics, 4th Edition(Reprint), Sultan Chand & Sons
4. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

B. Sc. Honours (Statistics)

PRACTICAL/LAB WORK   **30 (7L = 14 Class)**
List of Practical
1. Standardization of Raw scores
2. Comparison of performance of students using Z scores
3. Construction of price and quantity index numbers by Laspeyre's formula, Paasche's formula, Marshall-Edgeworth's formula, Fisher's Formula. Comparison and interpretation.
4. Construction of wholesale price index number, fixed base index number and consumer price index number with interpretation
5. Construction and interpretation of X bar & R-chart
6. Construction and interpretation p-chart (fixed sample size) and c-chart
7. Computation of measures of mortality
8. Completion of life table
9. Computation of measures of fertility and population growth

B. Sc. Honours (Statistics)
Generic Elective
STAT-GE-7   Mathematical Economics
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Economic Time Series: Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential).Measurement of seasonal variations by method of ratio to trend.   10 (4L+1T)

UNIT II
Demand and Supply Analysis :
Laws of Demand and Supply of demand, Price elasticity of Demand, Significance of elasticity of Demand, Price elasticity of Supply, Demand and Supply function with constant Price elasticity. Types of Data required for estimating elasticity – Family budget data and Time series data, Engel's Curve, different forms of Engel Curve and their estimation using least squares methods.
Utility function and its maximization – Simple (Direct) method and the method of Lagrange's multiplier ; Examples up to two commodities only.   20 (9L + 2T)

UNIT III
The production function :
Meaning and Nature of Production function; the law of variable proportion; Isoquants; marginal technical rates of substitution; producer equilibrium; expansion path; the elasticity of substitution; Euler's theorem; homogeneous production function; Cobb-Douglas production function and their properties.   10 (4L + 1T)

UNIT IV
Input – Output Analysis and Income Distribution :
Meaning of Input-Output, Assumptions, Leontief's static Model - the technological coefficient matrix, the viability of the system (the Hawkins –Simon conditions). Solution for two industries (real life examples).
Pareto's law of Income Distribution – Formulation of the problem; curves of concentration and its derivation – Gini's coefficient, Line of equal distribution.   10 (5L + 2 T)

SUGGESTED READING:

1. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.
3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals Of Applied Statistics, 4th Edition(Reprint), Sultan Chand & Sons

4. Chiang Alpha C. (1984) : Fundamental Methods for Mathematical Economics, 3rd Edition, McGraw Hill International Editions.

PRACTICAL/LAB WORK   **30 (7L = 14 Class)**
List of Practical
1. Measurement of trend: Fitting of linear, quadratic trend, exponential curve and plotting of trend values and comparing with given data graphically.
2. Measurement of seasonal indices by Ratio-to-trend method and plotting of trend values and comparing with given data graphically.
3. Fitting of different forms Engel's function and Estimation of Price / Income elasticity
4. Fitting of Pareto's Income Distribution and Calculation of Gini's Coefficient
5. Fitting of Cobb-Douglas production function
6. Input Output analysis for two industries

B. Sc. Honours (Statistics)
GE Papers in Statistics
STAT-GE-8 Non Research Methodology
Marks : 100 [In-sem : 20 + End Sem. : 80 (Theory : 50 Practical : 30]

Credit 6

UNIT I
Sampling Techniques: sampling, advantage of sampling over census,, sampling frame, errors in sampling, non sampling errors, error reduction techniques, sample size determination, probabilistic and non probabilistic sampling.   8 (4L+1T)

UNIT II
Data**:** primary and secondary data, methods of collecting primary data, merits and demerits of different methods of collecting primary data, designing a questionnaire, pretesting a questionnaire, editing of primary data, technique of interview, collection of secondary data, scrutiny of secondary data,
Data Processing: editing of data, coding of data, classification of data, tables as data presentation devices, graphical presentation of data.   20 (9L+2T)

UNIT III
Methods of sampling: simple random sampling stratified random sampling with proportional allocation, other methods of sampling, sampling design, non probability sampling methods, simulation models.   12 (6L+1T)

UNIT IV
Formats of Reports: introduction, parts of a report, cover and title page, introductory pages, text, reference section, typing instructions, copy reading, proof reading.
Presentation of a report: introduction, communication dimensions, presentation package, audio-visual aids, presenter's poise.   10 (5L+1T)

SUGGESTED READING:

1. Kotahri, C.R (2009): Research Methodology: Methods and Techniques, 2nd Revised
Ed. Reprint, New Age International Publishers
2. Lilien, Gary L. and Philip Kotler, 1983. Marketing Decision Making; A Model
Building Approach, Harper & Row, New York.
3. Shenoy, GVS, et al., (1983). Quantitative Techniques for Managerial Decision
Making, Wiley Eastern

PRACTICAL/LAB WORK   **30 (7L = 14 Class)**
Submit a Research Report based on empirical study on some real life situation. The student will personally collect, analyse, interpret the data and prepare a report under the supervision of a faculty.

Skill Enhancement Elective
STAT-SEE-1 Statistical-Data Analysis Using Software Packages
Marks : 32 [In-sem : 6 + End Sem. : 26]

Credit 2

UNIT I
Data loading, plot viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data.
5 (3L)

UNIT II
Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.   5 (3L)

UNIT III
Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.   8 (5L)

UNIT IV
Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.   8 (5L)

SUGGESTED READING:

1. Moore, D.S. and McCabe, G.P. and Craig, B.A. (2014): Introduction to the Practice of Statistics, W.H. Freeman
2. Cunningham, B.J (2012):Using SPSS: An Interactive Hands- on approach
3. Cho, M,J., Martinez, W.L. (2014) Statistics in MATLAB: A Primer, Chapman and Hall/CRC

B. Sc. Honours (Statistics)

Skill Enhancement Elective
STAT-SEE-2 Statistical Data Analysis Using R
(Experiential Learning)
Evaluation Practical
Marks : 32 [In-sem : 6 + End Sem. : 26]

Credit 2

This course will review and expand upon core topics in probability and statistics through the study and practice of data analysis and graphical interpretation using `R'.

UNIT I
Data Loading, bar charts, pie charts, histograms (equal class intervals and unequal class intervals), frequency polygon, ogives, box plot, stem-leaf.   5 (3L)
UNIT II
Generate automated reports giving detailed descriptive statistics, lines of regression and correlation.   5 (3L)

UNIT III
Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.   8 (5L)

UNIT IV
Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.   8 (5L)

SUGGESTED READING:

1. Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley Publications.
2. Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York

B. Sc. Honours (Statistics)
Skill Enhancement Elective
STAT-SEE-3 Statistical Techniques for Research Methods
Marks : 32 [In-sem : 6 + End Sem. : 26]

Credit 2

Statistical Techniques provide scientific approaches to develop the domain of human knowledge largely through empirical studies. The course aims at enabling students understand basic concepts and aspects related to research, data collection, analyses and interpretation.

UNIT I

Introduction: Meaning, objection and motivation in research, types of research, research approach, significance of research. Research problems: definition, selection and necessity of research problems.   6 (4L)

UNIT II

Survey Methodology and Data Collection, inference and error in surveys, the target populations, sampling frames and coverage error, methods of data collection, non-response, questions and answers in surveys.   6 (4L)

UNIT III

Processing, Data Analysis and Interpretation: Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation.
7 (4L)

UNIT IV

Develop a questionnaire, collect survey data pertaining to a research problem (such as gender discriminations in private v/s government sector, unemployment rates, removal of subsidy, impact on service class v/s unorganized sectors), interpret the results and draw inferences.
7 (4L)

SUGGESTED READING:

1. Kothari, C.R. (2009): Research Methodology: Methods and Techniques, 2nd Revised Edition reprint, New Age International Publishers.
2. Kumar, R (2011): Research Methodology: A Step - by - Step Guide for Beginners, SAGE publications.

B. Sc. Honours (Statistics)
Skill Enhancement Elective
STAT-SEE-4 Data Base Management Systems
Marks : 32 [In-sem : 6 + End Sem. : 26]

Credit 2

UNIT I
Introduction: Overview of Database Management System, Introduction to Database Languages, advantages of DBMS over file processing systems.   5 (3L)

UNIT II
Relational Database Management System: The Relational Model, Introduction to SQL: Basic Data Types, Working with relations of RDBMS: Creating relations e.g. Bank, College Database (create table statement)   8 (5L)

UNIT III
Modifying relations (alter table statement), Integrity constraints over the relation like Primary Key , Foreign key, NOT NULL to the tables, advantages and disadvantages of relational Database System   5 (3L)

UNIT IV
Database Structure: Introduction, Levels of abstraction in DBMS, View of data, Role of Database users and administrators, Database Structure: DDL, DML, Data Manager (Database Control System).Types of Data Models Hierarchical databases, Network databases, Relational databases, Object oriented databases   8 (5L)

SUGGESTED READING:

1. Gruber, M(1990): Understanding SQL, BPB publication
2. Silberschatz, A, Korth, H and Sudarshan,S(2011) "Database System and Concepts",
6th Edition McGraw-Hill.
3. Desai, B. (1991): Introduction to Database Management system, Galgotia Publications.

**** X ***