B.Sc. (Honours)
Statistics

Objectives:

- **To provide an understanding on Descriptive, Inferential, Applied Statistics along with basics of Mathematics applied in Statistics, Computer Programming and Statistical Soft wares etc.**
- **To provide a platform for pursuing higher studies in Statistics.**
- **To open up new arena in modern Statistical Techniques.**

Outcomes

After completing this programme beneficiaries will be enabled to

- **Apply various Statistical Methods in different fields**
- **Handle complex problems in Data analysis and Research Design.**

Course Structure- STATISTICS (Honours)

Sem	Course No.	Course Code	Course Title	Course Type	Marks Distribution					Remark
					TH	TH-IA	PR	PR-IA	Total	
1st	C-01	STSC-101	Descriptive Statistics	Theory+ Practical	50	15	30	05	100	
	C-02	STSC-102	Calculus	Theory	80	20			100	
2nd	C-03	STSC-201	Probability &Probability Distribution	Theory+ Practical	50	15	30	05	100	
	C-04	STSC-202	Algebra	Theory	80	20			100	
3rd	C-05	STSC-301	Sampling Distribution	Theory+ Practical	50	15	30	05	100	
	C-06	STSC-302	Sample Survey & Indian Official Statistics	Theory+ Practical	50	15	30	05	100	
	C-07	STSC-303	Mathematical Analysis	Theory	80	20			100	
	SEC-01	STSS-301	Statistical data analysis using SPSS	Practical			**40**	**10**	**50**	
4th	C-08	STSC-401	Statistical Inference	Theory+ Practical	50	15	30	05	100	
	C-09	STSC-402	Linear Models	Theory+ Practical	50	15	30	05	100	
	C-10	STSC-403	Statistical Quality Control	Theory+ Practical	50	15	30	05	100	
	SEC-02	STSS-401	Statistical Techniques for Research Methods	Practical			**40**	**10**	**50**	
5th	C-11	STSC-501	Stochastic Processes & Queuing Theory	Theory+ Practical	50	15	30	05	100	
	C-12	STSC-502	Statistical Computing using C Programming	Theory+ Practical	50	15	30	05	100	
	DSE01 A	STSD501A	Demography& Vital Statistics	Theory+ Practical	50	15	30	05	100	Currently Available
	DSE01 B	STSD501B	Operations Research	Theory+ Practical	50	15	30	05	100	
	DSE-02A	STSD502A	Time Series Analysis	Theory+ Practical	50	15	30	05	100	Currently Available
	DSE-02B	STSD502B	Survival Analysis & Bio Statistics	Theory+ Practical	50	15	30	05	100	
6th	C-13	STSC-601	Design of Experiments	Theory+ Practical	50	15	30	05	100	
	C-14	STSC-602	Multivariate Analysis& Non Parametric Methods	Theory+ Practical	50	15	30	05	100	
	DSE-03A	STSD601A	Econometrics	Theory+ Practical	50	15	30	05	100	Currently Available
	DSE-03B	STSD601B	Actuarial Statistics	Theory+ Practical	50	15	30	05	100	
	DSE04	STSD602	Project work	Project			80	20	100	Compulsory

Generic Elective- Statistics

Sem	Course No.	Course Code	Course Title	Course Type	Marks Distribution					Remark
					TH	TH-IA	PR	PR-IA	Total	
1st	C-01	STSG-101	Statistical Methods	Theory+ Practical	50	15	30	05	100	
2nd	C-02	STSG-201	Introductory Probability	Theory+ Practical	50	15	30	05	100	
3rd	C-03	STSG-301	Applied Statistics	Theory+ Practical	50	15	30	05	100	
4th	C-04	STSG-401	Basics of Statistical Inference	Theory+ Practical	50	15	30	05	100	

Project-80 (Report-50, Presentation and Viva-30); IA-20

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER-I
COURSE TITLE: DESCRIPTIVE STATISTICS
COURSE CODE: STSC-101 **COURSE NO: C- 01**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100

Theory: 65	**End Semester: 50**	**In Semester: 15**
Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To Develop knowledge of the various aspects of tools of Descriptive Statistics

UNIT I **(Lecture-12, Marks- 12)**
Statistical Methods: 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 graphical, including histogram and ogives, consistency and independence of data with special reference to attributes.

UNIT II **(Lecture-12, Marks- 14)**
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.

UNIT III **(Lecture-12, Marks- 12)**
Bi-variate 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.

UNIT IV **(Lecture-12, Marks- 12)**
Index Numbers: Definition, construction of index numbers and problems thereof for weighted and un-weighted 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.

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

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.

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER-I
COURSE TITLE: CALCULUS
COURSE CODE: STSC-102 **COURSE NO: C- 02**
CREDITS: 06 **NO. OF CLASSES: 72**
TOTAL MARKS: 100
End Semester: 80 **In Semester: 20**

Course Objectives: To impart basic background knowledge of calculus essential for Statistics

UNIT I **(Lecture-20, Marks- 25)**

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.

UNIT II **(Lecture-20, Marks- 25)**

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.

UNIT III **(Lecture-16, Marks- 15)**

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, Different forms of particular integrals, Linear differential equations with non-constant coefficients, Reduction of order method, The Cauchy-Euler's equation of order n, Legendre's linear equation.

UNIT IV: **(Lecture-16, Marks- 15)**

Formation and solution of a partial differential equations**.** Equations easily integrable. Linear partial differential equations of first order. Non-linear partial differential equation of first order and their different forms. Statement and application of Charpit's method. Homogeneous linear partial differential equations with constant coefficients. Different cases for complimentary functions and particular integrals.

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., New Delhi (2nd Edition -2004).
4. Piskunov, N: Differential and Integral Calculus, Peace Publishers, Moscow.

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER-II
COURSE TITLE: PROBABILITY AND PROBABILITY DISTRIBUTIONS
COURSE CODE: STSC-201 **COURSE NO: C- 03**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100
Total Marks- Theory: 65 **End Semester: 50** **In Semester: 15**
Practical: 35 **End Semester: 30** **In Semester: 05**

Course Objectives: To provide basic knowledge of different discrete and continuous probability distributions

UNIT I **(Marks: 12, Lecture-12)**
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.

UNIT II **(Marks: 12, Lecture-12)**
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.

UNIT III **(Marks: 12, Lecture-12)**
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.

UNIT IV **(Marks: 14, Lecture-12)**
Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties and limiting/approximation cases.

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 Ed.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford &IBH Publishing, New Delhi

Practical

List of Practical

1. Fitting of binomial distributions for n and p = q = ½.
2. Fitting of binomial distributions for given n and p.
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.

Detailed Syllabus for Core Course
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SEMESTER-II
COURSE TITLE: ALGEBRA
COURSE CODE: STSC-202 **COURSE NO: C- 04**
CREDITS: 06 **NO. OF CLASSES: 72**
TOTAL MARKS: 100
Total Marks- Theory: 100 **End Semester: 80** **In Semester: 20**

Course Objectives: To impart basic background knowledge of algebra

UNIT I **(Marks: 20, Lecture-18)**

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 bi quadratic equations when some conditions on roots of equations are given. Evaluation of the symmetric polynomials and roots of cubic and bi quadratic equations. Vector spaces, Sub spaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension
and basis, dimension theorem.

UNIT II **(Marks: 20, Lecture-18)**

Algebra of matrices - A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary, involuntary and nilpotent matrices. Adjoint and inverse of a matrix and related
properties.

UNIT III **(Marks: 20, Lecture-18)**

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. 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.

UNIT IV **(Marks: 20, Lecture-18)**

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, Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms, Linear orthogonal transformation and their digitalization

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. Krishnamurthy V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
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.

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER-III
COURSE TITLE: Sampling Distributions
COURSE CODE: STSC-301 **COURSE NO: C- 05**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100
Total Marks- Theory: 65 **End Semester: 50** **In Semester: 15**
Practical: 35 **End Semester: 30** **In Semester: 05**

Course Objectives: To provide knowledge of sampling distribution and tests of significance

UNIT I **(Lecture-14, Marks- 15)**

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.

UNIT II **(Lecture-10, Marks- 10)**

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.

UNIT III **(Lecture-10, Marks- 10)**

Exact sampling distribution: Definition and derivation of p.d.f. of $\chi 2$ 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 $\chi 2$ distribution. Tests of significance and confidence intervals based on distribution.

UNIT IV **(Lecture-14, Marks- 15)**

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 $\chi 2$ distributions. Test of significance and confidence Intervals based on t and F distributions. 12L

SUGGESTED READING:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): *An Outline of Statistical Theory*, Vol. I, 4th Ed. World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Ed. (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 Ed. John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): *Introduction to the Theory of Statistics*, 3rd Ed. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.

Practical

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 x2 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

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER-III
COURSE TITLE: Survey Sampling and Indian Official Statistics
COURSE CODE: STSC-302 **COURSE NO: C- 06**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100

Total Marks-	**Theory: 65**	**End Semester: 50**	**In Semester: 15**
	Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To introduce concepts and methodology of sample survey and Official Statistical System in India.

UNIT I **(Lecture-14, Marks- 15)**

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.

UNIT II **(Lecture-14, Marks- 15)**

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.

UNIT III **(Lecture-10, Marks- 12)**

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

UNIT IV **(Lecture-10, Marks- 8)**

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.

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

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.

Detailed Syllabus for Core Course
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SEMESTER-III
COURSE TITLE: Mathematical Analysis
COURSE CODE: STSC-303 **COURSE NO: C- 07**
CREDITS: 06 **NO. OF CLASSES: 72**
TOTAL MARKS: 100
Total Marks- Theory: 100 **End Semester: 80** **In Semester: 20**
Course Objectives: To impart basic knowledge of Mathematical analysis and Numerical analysis.

UNIT-I **(Lecture-18, Marks- 20)**
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.

UNIT-II **(Lecture-18, Marks- 20)**
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.

UNIT-III **(Lecture-14, Marks- 15)**
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).

UNIT-IV **(Lecture-22, Marks- 25)**
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. Central differences, Gauss and Stirling interpolation formulae. Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eights rule, Weddle's rule with error terms. Stirling's approximation to factorial n. Solution of difference equations of first order.

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, New Delhi, 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

Detailed Syllabus for Skill Enhancement Course
Sub: Statistics

SEMESTER-III
COURSE TITLE: Statistical Data Analysis Using SPSS
COURSE CODE: STSS-301 **COURSE NO: SEC- 01**
CREDITS: 02 **NO. OF CLASSES: 48**
TOTAL MARKS: 50 (End Semester-40, Insemester-10)

Course Objectives: To review and expand upon Core topics in Statistics using SPSS

UNIT I
Learn how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data

UNIT II
Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.

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.

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.

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

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER-IV
COURSE TITLE: Statistical Inference
COURSE CODE: STSC-401 **COURSE NO: C- 08**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100
Total Marks- Theory: 65 **End Semester: 50** **In Semester: 15**
Practical: 35 **End Semester: 30** **In Semester: 05**

Course Objectives: To impart basic knowledge of Parametric and Non Parametric techniques of Testing of Hypothesis

UNIT I **(Lecture-14, Marks- 15)**
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).

UNIT II **(Lecture-10, Marks- 10)**
Methods of Estimation: Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Bayes estimators.

UNIT III **(Lecture-12, Marks- 13)**
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).

UNIT IV **(Lecture-12, Marks- 12)**
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 and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal, Poisson, binomial and exponential distributions.

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 andStatistics. 2ndEdn. (Reprint) John Wiley and Sons.
3. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6^{th}addition, low price edition), Prentice Hall of India.
4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. JohnWiley & 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'sText, Vol. I, New Age International (P) Ltd.
7. Snedecor G.W and Cochran W.G.(1967) Statistical Methods. lowa State University

Practical
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 Maximum Likelihood Estimation
5. Asymptotic distribution of maximum likelihood estimators
6. Estimation by the method of moments, minimum Chi-square
7. Type I and Type II errors
8. Most powerful critical region (NP Lemma)
9. Uniformly most powerful critical region
10. Unbiased critical region
11. Power curves
12. Likelihood ratio tests for simple null hypothesis against simple alternative hypothesis
13. Likelihood ratio tests for simple null hypothesis against composite alternative hypothesis
14. Asymptotic properties of LR tests
15. SPRT procedure- Binomial and Poisson
16. OC function and OC curve
17. ASN function and ASN curve

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER-IV
COURSE TITLE Linear Models
COURSE CODE: STSC-402 **COURSE NO: C- 09**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100
Total Marks- Theory: 65 **End Semester: 50** **In Semester: 15**
Practical: 35 **End Semester: 30** **In Semester: 05**

Course Objectives: To introduce concepts and methodology of Statistical Modeling.

SEMESTER-I

UNIT I **(Lecture-12, Marks- 13)**
Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

UNIT II **(Lecture-12, Marks- 12)**
Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.

UNIT III **(Lecture-14, Marks- 15)**
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

UNIT IV **(Lecture-10, Marks- 10)**
Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity(Detection and consequences only).

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

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. F test for 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

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER-IV
COURSE TITLE Statistical Quality Control
COURSE CODE: STSC-403 **COURSE NO: C- 10**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100
Total Marks- Theory: 65 **End Semester: 50** **In Semester: 15**
Practical: 35 **End Semester: 30** **In Semester: 05**

Objectives: To familiarize with the techniques of Industrial Statistics .

UNIT I **(Lecture-12, Marks- 12)**
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.

UNIT II **(Lecture-16, Marks- 18)**
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.

UNIT III **(Lecture-10, Marks- 10)**
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.

UNIT IV **(Lecture-10, Marks- 10)**
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.

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

Practical

List of Practical

1. Construction and interpretation of statistical control charts
i) X-bar & R-chart
ii) X-bar & s-chart
iii) np-chart
iv) p-chart
v) c-chart
vi) 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.

Detailed Syllabus for Skill Enhancement Course
Sub: Statistics

SEMESTER-IV
COURSE TITLE Statistical Techniques for Research Methods
COURSE CODE: STSS-401 **COURSE NO: SEC- 02**
CREDITS: 02 **NO. OF CLASSES: 48**
TOTAL MARKS: 50 (End Semester-40, Insemester-10)

Course Objectives: To enable students to understand concepts and aspects related to Research, Data Collection, Analysis 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.

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

UNIT III
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.

UNIT IV
Processing, Data Analysis and Interpretation: Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation

Unit I and II: Assignment
Unit III and IV: Practical using knowledge of STSS-301

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

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER- V
COURSE TITLE Stochastic Processes and Queuing Theory
COURSE CODE: STSC-501 **COURSE NO: C- 11**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100

Total Marks-	**Theory: 65**	**End Semester: 50**	**In Semester: 15**
	Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To Develop knowledge of the various aspects of **Stochastic Processes and Queuing Theory**

UNIT I
Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process. **(Marks-8, Lecture-10)**

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. (**Marks-15, Lecture-12)**

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.
(Marks-15, Lecture-14)

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). **(Marks-12, Lecture-12)**

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

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.

Detailed Syllabus for Core Course
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SEMESTER V
COURSE TITLE Statistical Computing Using C Programming

COURSE CODE: STSC-502 **COURSE NO: C- 12**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**

TOTAL MARKS: 100

Total Marks-	**Theory: 65**	**End Semester: 50**	**In Semester: 15**
	Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To introduce C language

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 **(Marks-20, Lecture-20)**

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). **(Marks-10, Lecture-8)**

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. **(Marks-10, Lecture-10)**

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. **(Marks-10, Lecture-10)**

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

Using C Programming Language

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

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER V
COURSE TITLE Demography and Vital Statistics
COURSE CODE: STSD-501 **COURSE NO: DSE-01**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**

TOTAL MARKS: 100

Total Marks-	**Theory: 65**	**End Semester: 50**	**In Semester: 15**
	Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To provide basic knowledge of different techniques of Population science

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. **(Marks-10, Lecture-10)**

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. **(Marks-15, Lecture-14)**

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. **(Marks-10, Lecture-10)**

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). **(Marks-15, Lecture-14)**

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.: Demography through Problems S-Verlag Newyork. 38

Practical

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

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER V
COURSE TITLE Time Series Analysis
COURSE CODE: STSD-502 **COURSE NO: DSE-02**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**

TOTAL MARKS: 100

Total Marks-	**Theory: 65**	**End Semester: 50**	**In Semester: 15**
	Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To impart basic background knowledge of time series and forecasting

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. **(Marks-14, Lecture-14)**

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. **(Marks-14, Lecture-14)**

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. **(Marks-14, Lecture-12)**

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. **(Marks-8, Lecture-8)**

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
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

Detailed Syllabus for Core Course
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SEMESTER VI
COURSE TITLE Design of Experiments
COURSE CODE: STSD-601 **COURSE NO: C-13**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**

TOTAL MARKS: 100

Total Marks-	**Theory: 65**	**End Semester: 50**	**In Semester: 15**
	Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To familiarize with the techniques of field experimentation

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. (**Marks-17, Lecture-16)**

UNIT II
Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties.
(Marks-7, Lecture-8)

UNIT III
Factorial experiments: advantages, notations and concepts, 2^2, $2^3 \ldots 2^n$ and 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$) and 3^2. (Marks**-16, Lecture-14)**

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
(Marks**-10, Lecture-10)**

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

List of Practical

1. Analysis of a CRD
2. Analysis of an RBD
3. Analysis of an LSD
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 2^2 and2^3 factorial in CRD and RBD
8. Analysis of 2^2 and2^3 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 2^n design
13. Analysis of a fraction of 2^n factorial design

Detailed Syllabus for Core Course
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SEMESTER VI
COURSE TITLE Multivariate Analysis and Nonparametric Methods
COURSE CODE: STSD-602 **COURSE NO: C-14**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**

TOTAL MARKS: 100

Total Marks-	**Theory: 65**	**End Semester: 50**	**In Semester: 15**
	Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To introduce multivariate analysis and distribution free concept

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**.** **(Marks-10, Lecture-10)**

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. **(Marks-15, Lecture-14)**

UNIT III
Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis. **(Marks-10, Lecture-10)**

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.
(Marks-15, Lecture-14)

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.

PRACTICAL

List of Practical

1. Multiple Correlations
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

Detailed Syllabus for Core Course
B.Sc. (Honours) Statistics

SEMESTER VI
COURSE TITLE Econometrics

COURSE CODE: STSD-601 **COURSE NO: DSE-03**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**

TOTAL MARKS: 100

Total Marks- Theory: 65	**End Semester: 50**	**In Semester: 15**
Practical: 35	**End Semester: 30**	**In Semester: 05**

Course Objectives: To introduce mathematical and statistical techniques in Economics

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

(Marks-14, Lecture-14)

UNIT II
Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences, detection and remedies of multicollinearity, specification errors.

(Marks-14, Lecture-14)

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

(Marks-14, Lecture-12)

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.

(Marks-8, Lecture-8)

SUGGESTED READING:

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw HillCompanies.
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

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 36
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.

Detailed Syllabus for Core Course
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SEMESTER VI
COURSE TITLE Project Work
COURSE CODE: STSD-602 **COURSE NO: DSE-04**
CREDITS: 06
Total Marks-100 (Data Collection and Report Writing-50, Presentation & Viva-30; IA-20)

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

B.Sc. (Generic Elective) Statistics

Objectives:

- **To provide an understanding on Descriptive, Inferential and Applied Statistics.**
- **To improve statistical thinking.**

Outcomes

After completing this programme the learners will be enabled to

- **Apply various Statistical Methods in their respective field of studies**
- **Analyse data and interpret the results.**

Name of the Programme : B.Sc.(Generic Elective) Statistics

Sem	Course No.	Course Code	Course Title	Course Type	Marks Distribution					Remark
					TH	TH-IA	PR	PR-IA	Total	
1st	C-01	STSG-101	Statistical Methods	Theory+ Practical	50	15	30	05	100	
2nd	C-02	STSG-201	Introductory Probability	Theory+ Practical	50	15	30	05	100	
3rd	C-03	STSG-301	Applied Statistics	Theory+ Practical	50	15	30	05	100	
4th	C-04	STSG-401	Basics of Statistical Inference	Theory+ Practical	50	15	30	05	100	

Detailed Syllabus for Generic Elective Course
Sub: Statistics

SEMESTER-I
COURSE TITLE: ***STATISTICAL METHODS***
COURSE CODE: STSG-101 **COURSE NO: C- 01**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100
Total Marks- Theory: 65 **End Semester: 50** **In Semester: 15**
Practical : 35 **End Semester: 30** **In Semester: 05**

Course Objectives: To Develop knowledge of various Statistical Methods

UNIT I **(Lecture- 12, Marks-12)**
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.
UNIT II **(Lecture- 14, Marks-15)**
Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.
UNIT III **(Lecture- 14, Marks-15)**
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.
UNIT IV **(Lecture- 8, Marks-8)**
Theory of attributes, consistency of data, independence and association of attributes, measures of association and contingency.

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

Practical
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.

Detailed Syllabus for Generic Elective Course
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SEMESTER-II
COURSE TITLE: ***INTRODUCTORY PROBABILITY***
COURSE CODE: STSG-201 **COURSE NO: C- 02**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**

TOTAL MARKS: 100
Total Marks- Theory: 65 **End Semester: 50** **In Semester: 15**
Practical :35 **End Semester: 30** **In Semester: 05**

Course Objectives :To provide basic knowledge of Probability and different discrete and continuous probability distributions.

UNIT I **(Lecture=12,Marks-12)**
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.

UNIT II **(Lecture=12,Marks-12)**
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.

UNIT III **(Lecture=12,Marks-12)**
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.).

UNIT IV **(Lecture=12,Marks-14)**
Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, beta, gamma.

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:

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

Detailed Syllabus for Generic Elective Course
Sub: Statistics

SEMESTER-III
COURSE TITLE: Applied Statistics
COURSE CODE: STSG-301 **COURSE NO: C- 03**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**

TOTAL MARKS: 100

Total Marks- Theory: 65	**End Semester: 50**	**In Semester: 15**
Practical :35	**End Semester: 30**	**In Semester: 05**

Course Objectives: The objective of this course is to familiarize students with Applied Statistics

UNIT I **(Lecture=14,Marks-14)**
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.

UNIT II **(Lecture=12,Marks-12)**
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.

UNIT III **(Lecture=12,Marks-12)**
Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. 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

UNIT IV **(Lecture=10,Marks-12)**
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.

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, 4thEdition(Reprint), Sultan Chand & Sons
4. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition,Wiley India Pvt. Ltd.

Practical

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. 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

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Detailed Syllabus for Generic Elective Course
Sub: Statistics

SEMESTER-IV
COURSE TITLE: Basics of Statistical Inference
COURSE CODE: STSG-401 **COURSE NO: C- 04**
CREDITS: 06 (Theory-4, Practical-02) **NO. OF CLASSES: 96 (48+48)**
TOTAL MARKS: 100
Total Marks- Theory: 65 **End Semester: 50** **In Semester: 15**
Practical :35 **End Semester: 30** **In Semester: 05**

Course Objectives: To impart basic knowledge of Parametric and Non Parametric techniques of
Testing of Hypothesis

UNIT I **(Lecture=14,Marks-15)**
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 hypothesis. 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).

UNIT II **(Lecture=12,Marks-12)**
Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chi square test, Yates' correction.

UNIT III **(Lecture=8,Marks-6)**
Tests for the significance of correlation coefficient. Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.

UNIT IV **(Lecture=14,Marks-17)**
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. Bioassay.

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) byJ ohn Wiley.
5. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
6. Goldstein, A Biostatistics-An introductory text (1971). The Mac million New York.

Practical

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.