ASSAM UNIVERSITY, SILCHAR

SYLLABUS UNDER

CHOICE BASED CREDIT SYSTEM

STATISTICS
(HONOURS & GENERAL)

Course Structure
Details of courses for B.Sc. (Honours) Statistics

Course	*Credits	
	Theory+ Practical	Theory+Tutorial
I. Core Course		
Core Course Theory (14 Papers)	14X4= 56	14X5=70
Core Course Practical / Tutorial* (14 Papers)	14X2=28	14X1=14
II. Elective Course (8 Papers)		
A.1. Discipline Specific Elective (4 Papers)	4X4=16	4X5=20
A.2. Discipline Specific Elective Practical/Tutorial* (4 Papers)	4 X 2=8	4X1=4
B.1. Generic Elective (4 Papers) to be chosen from other discipline	4X4=16	4X5=20
B.2. Generic Elective Practical/ Tutorial* (4 Papers)	4 X 2=8	4X1=4
III. Ability Enhancement Courses		
1. Ability Enhancement Compulsory (2 Papers)		
Environmental Science	1 X 4=4	1 X 4=4
English/MIL Communication	1 X 4=4	1 X 4=4
2. Ability Enhancement Elective (Skill Based) (2 Papers)	2 X 4=8	2 X 4=8
Total credit	148	148

 Each credit is equivalent to 1 hour of activity per week

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN
B. Sc. Honours (Statistics)

	CORE COURSE (14)	Ability Enhancement Compulsory	Ability Enhancement Elective Course (AEEC) (2)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) 4 To be taken from other discipline
I	STATISTICS-C-101	Environmental Science			GE-1
	STATISTICS-C-102				
II	STATISTICS-C-201	(English/MIL/Hindi Communication)			GE-2
	STATISTICS-C-202				
III	STATISTICS-C-301		STATISTICS-SEC-301		GE-3
	STATISTICS-C-302				
	STATISTICS-C-303				
IV	STATISTICS-C-401		STATISTICS-SEC-401		GE-4
	STATISTICS-C-402				
	STATISTICS-C-403				
V	STATISTICS-C-501			STATISTICS-DSE-501	
	STATISTICS-C-502			STATISTICS-DSE-502	
VI	STATISTICS-C-601			STATISTICS-DSE-601	
	STATISTICS-C-602			STATISTICS-DSE-602	

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B. Sc. (General)

Course	*Credits	
	Theory+ Practical	Theory +Tutorial
I. Core Course		
Core Course Theory **(12 Papers)** 04 Courses from each of the 03 disciplines of choice	12X4= 48	12X5=60
Core Course Practical / Tutorial* **(12 Practical/ Tutorials*)** 04 Courses from each of the 03 Disciplines of choice	12X2=24	12X1=12
II. Elective Course		
Elective Course Theory **(6 Papers)** Two papers from each discipline of choice	6x4=24	6X5=30
Elective Course Practical / Tutorials* **(6 Practical / Tutorials*)** Two Papers from each discipline of choice	6 X 2=12	6X1=6
III. Ability Enhancement Courses		
1. Ability Enhancement Compulsory (2 Papers) Environmental Science English/MIL Communication	2 X 4=8	2 X 4=8
2. Skill Enhancement Course (Skill Based) (4 Papers)	4 X 4=16	4 X 4=16
	Total credit= 132	**Total credit= 132**

 Each credit is equivalent to 1 hour of activity per week

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B. Sc. with Statistics

	CORE COURSES (12)	Ability Enhancement Elective Course (AEEC) (2)	Skill Enhancement Course (SEC) (4)	Discipline Specific Elective DSE (6)
I	STATISTICS-DSC-101 DSC-2 A DSC-3 A	Environmental Science		
II	STATISTICS-DSC-201 DSC-2 B DSC-3 B	(English/MIL Communication)		
III	STATISTICS-DSC-301 DSC-2 B DSC-3 B		STATISTICS-SEC-301	
IV	STATISTICS-DSC-401 DSC-2 B DSC-3 B		STATISTICS-SEC-401	
V			STATISTICS-SEC-501	STATISTICS-DSE-501 DSE- 2 A DSE- 3 A
VI			STATISTICS-SEC-601	STATISTICS-DSE-601 DSE- 2 B DSE- 3 B

Semester wise list of Statistics papers to be studied by a Statistics (H) student

Semester	COURSE OPTED	COURSE NAME	CREDITS
I	STATISTICS-C-101	Descriptive Statistics	4
	STATISTICS-C-101 LAB	Descriptive Statistics	2
	STATISTICS- C-102	Calculus	6
II	STATISTICS-C-201	Probability and Probability Distributions	4
	STATISTICS-C-201 LAB	Probability and Probability Distributions	2
	STATISTICS- C-202	Algebra	6
III	STATISTICS-C-301	Sampling Distributions	4
	STATISTICS-C-301 LAB	Sampling Distributions	2
	STATISTICS-C-302	Survey Sampling and Indian Official Statistics	4
	STATISTICS-C-302 LAB	Survey Sampling and Indian Official Statistics	2
	STATISTICS- C-303	Mathematical Analysis	4
	STATISTICS- C-303 LAB	Mathematical Analysis	2
	STATISTICS-SEC-301	Statistical Data Analysis Using R	4
IV	STATISTICS-C-401	Statistical Inference	4
	STATISTICS-C-401 LAB	Statistical Inference	2
	STATISTICS-C-402	Linear Models	4
	STATISTICS-C-402 LAB	Linear Models	2
	STATISTICS-C-403	Statistical Quality Control and Index Number	4
	STATISTICS-C-403 LAB	Statistical Quality Control and Index Number	2
	STATISTICS-SEC-401	Statistical Techniques for Research Methods	4
V	STATISTICS-C-501	Stochastic Processes and Queuing Theory	4
	STATISTICS-C-501 LAB	Stochastic Processes and Queuing Theory	2
	STATISTICS-C-502	Statistical Computing Using C/C++ Programming	4
	STATISTICS-C-502 LAB	Statistical Computing Using C/C++ Programming	2
	STATISTICS-DSE-501	Time Series Analysis	4
	STATISTICS-DSE-501 LAB	Time Series Analysis	2
	STATISTICS-DSE-502:	Demography and Vital Statistics	4
	STATISTICS-DSE-502 LAB	Demography and Vital Statistics	2
VI	STATISTICS-C-601	Design of Experiments	4
	STATISTICS-C-601 LAB	Design of Experiments	2
	STATISTICS-C-602	Multivariate Analysis and Nonparametric Methods	4
	STATISTICS-C-602 LAB	Multivariate Analysis and Nonparametric Methods	2
	STATISTICS-DSE-601	Econometrics	4
	STATISTICS-DSE-601 LAB	Econometrics	2
	STATISTICS-DSE-602(A)	Operations Research	4
	STATISTICS-DSE-602(A) LAB	Operations Research	2
	STATISTICS-DSE-602(B)	Project Work	6

Semester wise list of Statistics Generic Elective papers for students taking honours in other subjects

Semester	COURSE OPTED	COURSE NAME	CREDITS
I	STATISTICS-GE-101	Descriptive Statistics and Probability Theory	4
	STATISTICS-GE-101 LAB	Descriptive Statistics and Probability Theory	2
II	STATISTICS-GE-201	Statistical Methods	4
	STATISTICS-GE-201 LAB	Statistical Methods	2
III	STATISTICS-GE-301	Statistical Inference	4
	STATISTICS-GE-301 LAB	Statistical Inference	2
IV	STATISTICS-GE-401	Sample Surveys and Design of Experiments	4
	STATISTICS-GE-401 LAB	Sample Surveys and Design of Experiments	2

Semester wise list of Statistics papers to be studied by a B.Sc. student with Statistics

Semester	COURSE OPTED	COURSE NAME	CREDITS
I	STATISTICS-DSC-101	Descriptive Statistics and Probability Theory	4
	STATISTICS-DSC-101 LAB	Descriptive Statistics and Probability Theory	2
II	STATISTICS-DSC-201	Statistical Methods	4
	STATISTICS-DSC-201 LAB	Statistical Methods	2
III	STATISTICS-DSC-301	Statistical Inference	4
	STATISTICS-DSC-301 LAB	Statistical Inference	2
	STATISTICS-SEC-301	Statistical Computing using C	4
IV	STATISTICS-DSC-401	Sample Surveys and Design of Experiments	4
	STATISTICS-DSC-401 LAB	Sample Surveys and Design of Experiments	2
	STATISTICS-SEC-401	Statistical Data Analysis using R	4
V	STATISTICS-SEC-501	Statistical Techniques for Research Methods	4
	STATISTICS-DSE-501	Vital Statistics	4
	STATISTICS-DSE-501 LAB	Vital Statistics	2
VI	STATISTICS-SEC-601	Data Analysis using Software(SPSS or Microsoft Excel)	4
	STATISTICS-DSE-601	Index Number and Time Series Analysis	4
	STATISTICS-DSE-601 LAB	Index Number and Time Series Analysis	2

CORE COURSE IN STATISTICS

STATISTICS-C-101: Descriptive Statistics
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The emphasis of course is on descriptive statistics. It gives an idea about the various statistical methods, measures of central tendency, correlation and basis of probability.

UNIT I
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.

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.

UNIT III
Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression

UNIT IV
Principle of least squares and fitting of polynomials and exponential curves. Theory of attributes: Independence and association of attributes, consistency of data, measures of association and contingency, Yule's coefficient of colligation.

UNIT V
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.

SUGGESTED READING:

1. Feller, W. (2014): An Introduction to Probability theory and application, Wiley.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamental of Mathematical Statistics, 11th Edition. (Reprint), Sultan Chand & Sons.
4. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
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.
6. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New D

STATISTICS-C-101 LAB: Descriptive Statistics
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of descriptive statistics.

List of Practicals

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's correlation coefficient.
8. Correlation coefficient for a bivariate frequency distribution.
9. Lines of regression, angle between two lines of regression 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.

STATISTICS-C-102: Calculus
(Credits: 06)

Full marks= 100 [End Semester Exam (70) + CCA (30)]
Pass Marks= 40 [End Semester Exam (28) + CCA (12)]
Contact Hours: 90
(Four questions of 7 marks each will be set from each unit; ten questions need to be answered taking two from each unit)

The emphasis of course is on the theory based on differential calculus, integral calculus, differential equations and formation of solution of a partial differential equation.

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.

UNIT II
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 III
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 IV
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 2, Homogeneous and non-homogeneous linear differential equations of order 2 with constant coefficients.

UNIT V:
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. Charpit's method. Homogeneous linear partial differential equations with constant coefficients.

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.

STATISTICS-C-201: Probability and Probability Distributions
(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper provides a general overview on probability distributions. Discrete and continuous distributions are included in the units.

UNIT I

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 II

Mathematical Expectation and Generating Functions: Expectation of single and bivariate random variables and its properties.

UNIT III

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

Discrete Probability Distributions: Uniform, Binomial, Poisson, Geometric, Negative Binomial and Hyper-geometric distributions along with their characteristic properties.

UNIT V

Continuous Probability Distributions: Normal, Exponential, Uniform, Beta, Gamma, Cauchy, Weibull and Laplace distributions along with their characteristic properties.

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
4. Bhattacharjee D and Das D. (2010) Introduction to Probability Theory, Asian Books, New Delhi

STATISTICS-C-201 LAB: Probability and Probability Distributions
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on theory on practical of probability and probability distributions.

List of Practicals

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.

STATISTICS-C-202: Algebra
(Credits: 04)

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasizes on theory of equations, algebra of matrices, determinants of matrices, rank, characteristic roots and vectors.

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.

UNIT II

Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem.

UNIT III

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, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties.

UNIT IV

Determinants of Matrices: Definition, properties and applications of determinants for 3^{rd} and higher orders, evaluation of determinants of order 3 and more using transformations. Row reduction, echelon forms and normal forms, the matrix equations AX=B, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix. Solution of both homogenous and non-homogenous linear equations.

UNIT V

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 and Quadratic forms.

SUGGESTED READINGS:

1. Lay David C.: Linear Algebra and its Applications, Addison Wesley, 2000.
2. Krishnamurthy V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
3. Jain P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1973
4. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International, 1997.
5. Gupta S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.
6. Artin M.: Algebra. Prentice Hall of India, 1994.
7. Hadley G.: Linear Algrbra. Narosa Publishing House (Reprint), 2002.
8. Searle S.R.: Matrix Algebra Useful for Statistics. John Wiley & Sons, 1982.
9. Sharme and Vasistha: Matrices, Krishna Prakashan, 2014.

10. Sharma and Vasistha Linear Algebra, Krishna Prakashan, 2010.
11. Sharma and Vasistha Modern Algebra, Krishna Prakashan, 2014.

STATISTICS-C-202 LAB: Algebra
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of theory of equations, determinants of matrices, rank, characteristic roots and vectors.

List of Practicals

1. Computation of adjoint and inverse of a matrix
2. Reducing a Quadratic Form to its canonical form and finding its rank and index
3. Proving that a quadratic form is positive or negative definite
4. Finding the product of two matrices by considering partitioned matrices
5. Finding inverse of a matrix by using Cayley Hamilton theorem
6. To find whether a given set of vectors is linearly dependent or linearly independent

STATISTICS-C-301: Sampling Distributions
(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasizes on limit laws, testing of hypothesis and sampling distributions.

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).

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. Order Statistics: Introduction, distribution of the rth order statistic, smallest and largest order statistics. Joint distribution of r^{th} and s^{th} order statistics, distribution of sample median and sample range.

UNIT III

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. Concept of p-value.

UNIT IV

Exact sampling distribution: Definition and derivation of p.d.f. of χ^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 χ^2 distribution. Tests of significance and confidence intervals based on χ^2 distribution.

UNIT V

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 $1/F(n_1,n_2)$. Relationship between t, F and χ^2 distributions. Test of significance and confidence Intervals based on t and F distributions.

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.

STATISTICS-C-301 LAB: Sampling Distributions
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is a practical paper on Testing of significance and confidence intervals.

List of Practicals

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 of significance and confidence intervals of an observed sample correlation coefficient.
9. Testing and confidence intervals of equality of two population variances

STATISTICS-C-302: Survey Sampling and Indian Official Statistics
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper introduces the various sampling techniques and concept on official statistics.

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 and total, variances of these estimates, estimates of their variances.

UNIT II
Sample size determination, Concept of pilot survey.
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.

UNIT III
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. Concept of cluster sampling and double sampling

UNIT IV
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. Concept of multistage, multiphase and PPS sampling.

UNIT V
Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), concept of 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. Website of the Ministry of Statistics and Program Implementation (http://mospi.nic.in/)

STATISTICS-C-302 LAB: Survey Sampling and Indian Official Statistics

(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is on practical based on random sampling.

List of Practicals

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.

STATISTICS-C-303: Mathematical Analysis
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The emphasis of course is on real analysis, numerical analysis and numerical integration.

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 $r^n\left(1+\frac{1}{n}\right)^n$ and $n^{\frac{1}{n}}$ 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
Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Raabe's test (statements and examples only). Absolute convergence of series, Leibnitz's test for the convergence of alternating series.

UNIT III
Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with Lagrange's form of remainder (without proof). Taylor's and Maclaurin's series expansions
of sinx, cosx, $(1+x)^n$, log (1+x).

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.

UNIT-V
Central differences: Gauss and Stirling's interpolation formulae. Numerical integration: Trapezoidal rule, Simpson's one-third rule, three-eighth rule, Weddle's rule. 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. Appostol T.M.: Mathematical Analysis, Second Edition, Narosa Publishing House, NewDelhi, 1987.
4. Shanti Narayan: A course of Mathematical Analysis, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi, 1987.
5. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.

6. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis,Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
7. Jain,M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.
8. Mukherjee, Kr. Kalyan (1990): Numerical Analysis. New Central Book Agency.
9. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.

STATISTICS-C-303 LAB: Mathematical Analysis
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is a practical based paper on numerical integration.

List of Practicals

1. Formation of difference table, fitting of polynomial and missing terms for equal interval of differencing
2. Based on Newton's Gregory forward difference interpolation formula
3. Based on Newton's backward difference interpolation formula.
4. Based on Newton's divided difference and Lagrange's interpolation formula
5. Based on Gauss forward, Gauss backward central difference interpolation formula
6. Based on Stirling's central difference interpolation formula
7. Based on Lagrange's Inverse interpolation formula
8. Based on Trapezoidal Rule, Simpson's one-third rule, Simpson's three-eighth rule, Weddle's rule

STATISTICS-C-401: Statistical Inference
(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The emphasis of course is on methods of estimation and test of significance.

UNIT I

Estimation: Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE) and Rao-Blackwell theorem with applications. Cramer-Rao inequality and MVB estimators (statement and applications).

UNIT II

Methods of Estimation: Method of moments, method of maximum likelihood estimation.

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,

UNIT IV

Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test and relevant problems, properties of likelihood ratio tests (without proof).

UNIT V

Interval estimation - Confidence interval for the parameters of various distributions, Confidence interval for Binomial proportion, Confidence interval for population correlation coefficient for Bivariate Normal distribution, Pivotal quantity method of constructing confidence interval, Large sample confidence intervals.

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 (6^{th} 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. lowa State University Press.
8. Bhattacharjee, D. & Das, K. K.(2008) A Treatise on Statistical Inference and Distributions, Asian Books, New Delhi.

STATISTICS-C-401 LAB: Statistical Inference
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is a practical paper on methods of estimation and power curves.

List of Practicals

1. Unbiased estimators
2. Maximum Likelihood Estimation
3. Estimation by the method of moments
4. Type I and Type II errors
5. Power curves

STATISTICS-C-402: Linear Models
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper is based on methods of least squares, regression analysis, analysis of variance and model checking.

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.

UNIT II
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
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

UNIT IV
Analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models

UNIT V
Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity

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.

STATISTICS-C-402 LAB: Linear Models
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is a practical paper on simple and multiple regression, tests for linear hypothesis, analysis of a one way and two way classified data.

List of Practicals

1. Simple Linear Regression
2. Multiple Regression
3. Tests for Linear Hypothesis
4. Analysis of Variance of a one way classified data
5. Analysis of Variance of a two way classified data with one observation per cell

STATISTICS-C-403: Statistical Quality Control and Index Number
(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasis on control charts, sampling plan and index numbers

UNIT I

Quality: Definition Its concept, application and importance. Introuction to Process and Product Controls,. 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

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

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.

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.

UNIT V

Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers. Usage and limitations of index numbers.

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 a.& 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. Gupta S.C., Kapoor V.K.(2007): Fundamentals of Applied Statistics. 4th Edition, Sultan Chand and Sons., New Delhi.

STATISTICS-C-403 LAB: Statistical Quality Control and Index Number
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is a practical paper on statistical control charts, calculation of index numbers.

List of Practical

1. Construction and interpretation of statistical control charts
    a. X-bar & R-chart
    b. X-bar & s-chart
    c. np-chart
    d. p-chart
    e. c-chart
2. Calculation of process capability and comparison of 3-sigma control limits with specification limits.
3. Calculate price and quantity index numbers using simple and weighted average of price relatives.
4. To calculate the Chain Base index numbers.
5. To calculate consumer price index number.

STATISTICS-C-501: Stochastic Processes and Queuing Theory
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasizes on generating functions and stochastic process.

UNIT I
Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.

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.

UNIT III
Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, Second order Poisson Process, relevant problems. Branching process (Overview)

UNIT IV
Queuing System: General concept, steady state distribution, queuing model, M/M/1 with finite system capacity, waiting time distribution (without proof) and relevant problems.

UNIT V
Gambler's Ruin Problem: Classical ruin problem, expected duration of the game. Simple birth and death process.

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.

STATISTICS-C-501 LAB: Stochastic Processes and Queuing Theory
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is a practical paper on stochastic process.

List of Practicals

1. Calculation of transition probability matrix
2. Identification of characteristics of reducible and irreducible chains.
3. Identification of types of classes
4. Stationarity of Markov chain and graphical representation of Markov chain
5. Computation of probabilities in case of generalizations of independent Bernoulli trials
6. Calculation of probabilities for given birth and death rates and vice versa
7. Computation of inter-arrival time for a Poisson process.
8. Calculation of Probability and parameters for (M/M/1: ∞/FIFO).
9. Calculation of generating function and expected duration for different amounts of stake.
10. Computation of probabilities and expected duration of ruin between players.

STATISTICS-C-502: Statistical Computing Using C/C++ Programming
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasizes on theory and concept of C programming language.

UNIT I
History and importance of C/C++. Components, basic structure programming, character set, C/C++ tokens, Keywords and Identifiers and execution of a C/C++ program. Data types: Basic data types, Enumerated data types, derived data types. Constants and variables: declaration and assignment of variables, Symbolic Constants.

UNIT II
Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression. Library functions. Managing input and output operations: reading and printing formatted and unformatted data.

UNIT III
Decision making and branching - if…else, nesting of if…else, else if ladder, switch, conditional (?) operator. Looping in C/C++: for, nested for, while, do…while, jumps in and out of loops.

UNIT IV
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).

UNIT V
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.

SUGGESTED READING:

1. Kernighan, B.W. and Ritchie, D. (1988): C Programming Language, 2nd Edition,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.
4. Kanetkar Y. P. (2008) Let us C, 8th Edition, Infinity Science Press

STATISTICS-C-502 LAB: Statistical Computing Using C/C++ Programming
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is a practical paper on C programming language.

List of Practicals

1. Plot of a graph y = f(x)
2. Roots of a quadratic equation
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. Value of n! using recursion
7. Random number generation from uniform distribution
8. Matrix addition, subtraction, multiplication
9. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit
10. t-test for difference of means
11. Paired t-test
12. F-test
13. Karl-Pearson correlation coefficient
14. Fitting of lines of regression

STATISTICS-C-601: Design of Experiments
(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasis on design of experiments.

UNIT I

Experimental designs: Terminology, experimental error, basic principles, uniformity trials, choice of size and shape of plots and blocks, Completely Randomized Design (CRD)

UNIT II

Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, missing plot analysis, relative efficiency.

UNIT III

Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties. Definitions of Symmetric BIBD, Resolvable BIBD, Affine Resolvable BIBD, complimentary BIBD, Residual BIBD, Dual BIBD, and Derived BIBD.

UNIT IV

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 ($n \leq 4$).

UNIT V

Missing plot technique and Fractional factorial experiments: Concept of RBD with one and two missing observations, LSD with one missing observation. Concept of fractional factorial experiment

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 Easter -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.

STATISTICS-C-601 LAB: Design of Experiments
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of design of experiments.

List of Practicals

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. Analysis of 2^2 and 2^3 factorial in RBD
7. Analysis of a completely confounded two level factorial design in 2 blocks
8. Analysis of a completely confounded two level factorial design in 4 blocks
9. Analysis of a partially confounded two level factorial design

STATISTICS-C-602: Multivariate Analysis and Nonparametric Methods
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasizes on bivariate and multivariate normal distributions, sequential analysis and nonparametric tests.

UNIT I
Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN.

UNIT II
Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions. Multinomial distribution

UNIT III
Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance-covariance matrix. Multiple and partial correlation coefficient and their properties.

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 and the derivation of operating characteristics (OC) and average sample number (ASN) functions.

UNIT V
Nonparametric Tests: Introduction and Concept, Test for randomness based on total number of runs, Kolmogrov Smirnov test for one sample, Sign tests- one sample and two samples, Wilcoxon signed rank test- one sample and two samples, Mann-Whitney U test.

SUGGESTED READINGS:

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. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005)*: An Outline Of statistical Theory, Volume II,* World Press.
6. Rao, C. R. (2000): Linear Statistical Inference, Wiley.
7. Mukhopadhyay, P.: Mathematical Statistics, Books and Allied, Kolkata
8. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference.4th Edition. Marcel Dekker, CRC.

STATISTICS-C-602 LAB: Multivariate Analysis and Nonparametric Methods
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on the practical on bivariate and multivariate normal distributions, sequential analysis and nonparametric tests.

List of Practicals

1. Multiple Correlation.
2. Partial Correlation.
3. Bivariate Normal Distribution.
4. Multivariate Normal Distribution.
5. Test for randomness based on total number of runs,
6. Kolmogrov Smirnov test for one sample.
7. Sign test: one sample, two samples, large samples.
8. Mann-Whitney U-test
9. Wilcoxon signed rank test-one sample and two samples.

GENERIC ELECTIVE COURSE IN STATISTICS/DISCIPLINE SPECIFIC CORE COURSE IN STATISTICS

STATISTICS-GE-101: Descriptive Statistics and Probability /STATISTICS-DSC-101: Descriptive Statistics and Probability Theory
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The emphasis of course is on descriptive statistics. It gives an idea about the various statistical methods, measures of central tendency, correlation and basis of probability.

Unit I
Concepts of a statistical population and sample from a population, quantitative and qualitative data, nominal, ordinal and time-series data, discrete and continuous data. Presentation of data by tables and by diagrams, frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

Unit II
Measures of location (or central tendency) and dispersion, moments, measures of skewness and kurtosis, cumulants.

Unit III
Bivariate data: Scatter diagram, principle of least-square and fitting of polynomials and exponential curves. Correlation and regression. Karl Pearson coefficient of correlation, Lines of regression, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only and without derivation).

Unit IV
Random experiment, sample point and sample space, event, algebra of events, Definition of Probability - classical, relative frequency and axiomatic approaches to probability, merits and demerits of these approaches (only general ideas to be given).

Unit V
Theorems on probability, conditional probability, independent events. Bayes' theorem and its applications.

SUGGESTED READINGS:

1. J.E. Freund (2009): *Mathematical Statistics with Applications*, 7th Ed., Pearson Education.

2. A.M. Goon, M.K. Gupta and B. Dasgupta (2005): *Fundamentals of Statistics*, Vol. I, 8th Ed., World Press, Kolkatta.
3. S.C. Gupta and V.K. Kapoor (2007): *Fundamentals of Mathematical Statistics*, 11th Ed., Sultan Chand and Sons.
4. R.V. Hogg, A.T. Craig and J.W. Mckean (2005): *Introduction to Mathematical Statistics*, 6th Ed., Pearson Education.
5. A.M. Mood, F.A. Graybill and D.C. Boes (2007): *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw Hill Publication.

STATISTICS-GE-101 LAB: Descriptive Statistics and Probability /STATISTICS-DSC-101 LAB: Descriptive Statistics and Probability Theory
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of descriptive statistics.

List of Practicals

1. Problems based on graphical representation of data: Histograms (equal class intervals and unequal class intervals), Frequency polygon, Ogive curve.
2. Problems based on measures of central tendency using raw data, grouped data and for change of origin and scale.
3. Problems based on measures of dispersion using raw data, grouped data and for change of origin and scale.
4. Problems based on combined mean and variance and coefficient of variation
5. Problems based on Moments using raw data, grouped data and for change of origin and scale.
6. Relationships between moments about origin and central moments
7. Problems based on Skewness and kurtosis
8. Karl Pearson correlation coefficient (with/ without change of scale and origin).
9. Lines of regression, angle between lines and estimated values of variables
10. Lines of regression and regression coefficients
11. Spearman rank correlation with /without ties
12. Fitting of polynomials and exponential curves

STATISTICS-GE-201: Statistical Methods /STATISTICS-DSC-201: Statistical Methods
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The course emphasizes on random variables, moments, and cumulant generating functions, bivariate probability distributions and limit theorems.

Unit I
Random variables: Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations of random variables and its properties, expectation of random variable and its properties.

Unit II
Moments and cumulants, moment generating function, cumulants generating function and characteristic function.

Unit III
Bivariate probability distributions, marginal and conditional distributions; independence of variates (only general idea to be given). Transformation in univariate and bivariate distributions.

Unit IV
Probability Distributions: Binomial, Poisson, Normal, Exponential.

Unit V
Chebychev's inequality, WLLN, Bernoulli's law of large number, Central limit theorem (CLT) (statements only).

SUGGESTED READINGS:

1. A.M. Goon, M.K. Gupta and B. Dasgupta (2003): *An outline of Statistical Theory* (Vol. I), 4th Ed., World Press, Kolkata.
2. S.C. Gupta and V.K. Kapoor (2007): *Fundamentals of Mathematical Statistics*, 11th Ed., Sultan Chand and Sons.
3. R.V. Hogg, A.T. Craig, and J.W. Mckean (2005): *Introduction to Mathematical Statistics*, 6th Ed. Pearson Education.
4. V.K. Rohtagi and A.K. Md. E. Saleh (2009): *An Introduction to Probablity and Statistics*, 2nd Edition, John Wiley and Sons.
5. S.A. Ross (2007): *Introduction to Probability Models*, 9th Ed., Academic Press.

STATISTICS-GE-201 LAB: Statistical Methods /STATISTICS-DSC-201 LAB: Statistical Methods
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of probability distributions.

List of Practicals

1. Fitting of binomial distributions for n and p = q = ½ and for n and p given.
2. Fitting of binomial distributions computing mean and variance
3. Fitting of Poisson distributions for give n and λ and after estimating mean.
4. Fitting of Suitable distribution
5. Application Problems based on Binomial distribution
6. Application problems based on Poisson distribution
7. Problems based on Area property of normal distribution
8. Application based problems based on normal distribution
9. Fitting of normal distribution when parameters are given/ not given.

STATISTICS-GE-301: Statistical Inference / STATISTICS-DSC-301: Statistical Inference
(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The emphasis of course is on sampling distributions, large sample tests and method of estimation.

Unit I

Definitions of random sample, parameter and statistic, null and alternative hypotheses, simple and composite hypotheses, level of significance and probabilities of Type I and Type II errors, power of a test and critical region (definition only).

Unit II

Sampling distribution of a statistic, sampling distribution of sample mean, standard error of sample mean. Large sample tests for single mean, difference of means**,** standard deviation and difference of standard deviations.

Unit III

Sampling distributions of chi-square, t and F: definitions, properties and relationships between them. Tests of Significance based on Chi-square (goodness of fit and independence of attributes), t- distribution and F- distribution.

Unit IV

Estimation: Parameter space, sample space, point estimation, requirement of a good estimator, consistency, unbiasedness, efficiency, sufficiency, Minimum variance unbiased estimators.

Unit V

Cramer-Rao inequality: statement only, Methods of estimation: maximum likelihood. Concept of confidence interval. Neyman-Pearson lemma: statement and proof.

SUGGESTED READINGS:

1. G. Casella and R.L. Berger (2002): *Statistical Inference*, 2nd Ed., Thomson Duxbury.
2. E.J. Dudewicz and S.N. Mishra (1988):*Modern Mathematical Statistics*, John Wiley and Sons.
3. A.M. Goon, M.K. Gupta and B. Dasgupta (2003): *An Outline of Statistical Theory* (Vol. I), 4th Ed., World Press, Kolkata.
4. S.C. Gupta and V.K. Kapoor (2007): *Fundamentals of Mathematical Statistics*, 11th Ed., Sultan Chand and Sons.
5. R.V. Hogg, A.T. Craig and J.W. Mckean (2005): *Introduction to Mathematical Statistics*, 6th Ed. Pearson Education.
6. V.K. Rohtagi and A.K. Md. E. Saleh (2009): *An Introduction to Probablity and Statistics*, 2nd Ed., John Wiley and Sons.

STATISTICS-GE-301 LAB: Statistical Inference / STATISTICS-DSC-301 LAB: Statistical Inference
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of large sample tests, testing goodness of fit and method of estimation.

List of Practicals

1. Large Sample Tests (Based on normal distribution)
2. Testing of goodness of fit
3. Testing of independence of attributes based on 2 X 2 contingency table
4. Testing of equality of two populations variances
5. Applying the paired t-test for difference of means
6. Maximum Likelihood Estimation
7. Confidence interval for difference of population means
8. Type I and Type II errors

STATISTICS-GE-401: Sample Surveys and Design of Experiments / STATISTICS-DSC-401: Sample Surveys and Design of Experiments
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The emphasis of course is based on the concept of sample survey and design of experiments.

Unit I
Sample Surveys: Basic concepts of sample survey: concept of sampling, need for sampling, complete enumeration v/s. sampling, principles of sampling theory, principal steps in a sample surveys, planning and organization of a sample survey, sampling and non-sampling errors.

Unit II
Simple random sampling (srswr and srswor): definition and procedures of selecting a sample, properties of simple random sample, estimation of mean and sampling variance of sample mean.
Stratified random sampling: introduction, estimation of population mean and its variance, choice of sample sizes in different strata, comparison of stratified sampling under proportional and Neyman allocation with SRSWOR in terms of precision.

Unit III
Systematic sampling: introduction to linear systematic sampling, estimation of sample mean and its variance (N=nk).
Analysis of variance: one-way and two-way classified data with one observation per cell only.

Unit IV
Design of experiments: Principles of Design of experiments, uniformity trails, completely randomized, Randomized block and Latin square designs. Missing plot technique (for one missing observation in RBD and LSD), 2^2 and 2^3 Factorial experiments: construction and analysis.

Unit V
Indian Official Statistics: Present Official Statistical System in India relating to census of population; methods of collection of official statistics, major publications. Agencies responsible for the data collection- C.S.O., N.S.S.O.

REFERENCES:

1. A.M. Goon, M.K. Gupta, and B. Dasgupta (2005): *Fundamentals of Statistics* (Vol. II), 8th Ed., World Press, Kolkata.
2. A.M. Goon, M.K. Gupta and B. Dasgupta (2005): *An Outline of Statistical Theory* (Vol. II), 3rd Ed., World Press, Kolkata.

3. S.C. Gupta and V.K. Kapoor, *Fundamentals of Applied Statistics*, 4th Ed., Sultan Chand and Sons, 2008.
4. D.C. Montgomery (2001): *Designs and Analysis of Experiments*, John Wiley and Sons, New York.
5. P. Mukhopadhyay (1998): *Theory and Methods of Surveys Sampling*, Prentice Hall of India.
6. P.V. Sukhatme, B.V. Sukhatme, S. Sukhatme and C. Ashok (1984): *Sampling Theory of Surveys with Applications*, Lowa State University Press, Lowa, USA.
7. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi. http://mospi.nic.in/

STATISTICS-GE-401 LAB: Sample Surveys and Design of Experiments / STATISTICS-DSC-401 LAB: Sample Surveys and Design of Experiments
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of survey sampling and design of experiments.

List of Practicals

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. Analysis of an one way/ two way ANOVA
7. Analysis of CRD, RBD.
8. Analysis of an LSD.
9. Analysis of an RBD with one missing observation
10. Analysis of an LSD with one missing observation
11. Analysis of 2^2 and2^3 factorial in RBD

DISCIPLINE SPECIFIC ELECTIVE COURSE IN STATISTICS

STATISTICS - DSE-501: Time Series Analysis
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasis on time series analysis

UNIT I
Introduction to times 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 (Method of least square)

UNIT II
Trend Cont.: 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.

UNIT III
Seasonal Component cont: Ratio to Moving Averages and Link Relative method, Deseasonalization. Cyclic Component: Harmonic Analysis

UNIT IV
Some Special Processes: Moving average (MA) process and Autoregressive (AR) process of orders one and two. Fitting of Growth Curves.

UNIT V
Random Component: Variate component method. Forecasting: Exponential smoothing methods. Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average.

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

STATISTICS- DSE-501 LAB: Time Series Analysis
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of time series analysis.

List of Practicals

1. Fitting and plotting of modified exponential curve
2. Fitting and plotting of logistic curve
3. Fitting of trend by Moving Average Method
4. Measurement of Seasonal indices Ratio-to-Trend method
5. Measurement of Seasonal indices Ratio-to-Moving Average method
6. Measurement of seasonal indices Link Relative method

STATISTICS- DSE-502: Demography and Vital Statistics
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasizes on sources of collecting data on vital statistics and measurements of Fertility.

UNIT I
Population Theories: Coverage and content errors in demographic data, use of balancing equations. Population composition, dependency ratio, Sex ratio and its implication on a population.

UNIT II
Introduction and 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 Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

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.

UNIT IV
Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method.
Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).

UNIT V
Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

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 New York.

STATISTICS-DSE-502 LAB: Demography and Vital Statistics
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical on vital statistics.

List of Practicals

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 Reed-Merrell 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

STATISTICS- DSE-601: Econometrics
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The emphasis of course is on concept of econometrics.

UNIT I
Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, structural and reduced forms. General linear model (GLM).

UNIT II
Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences, tests and solutions of multicollinearity.

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

UNIT IV
Heteroscedastic disturbances: Concepts and efficiency of Aitken estimator with OLS estimator under heteroscedasticity. Consequences of heteroscedasticity.

UNIT V
Tests and solutions of heteroscedasticity. Autoregressive and moving average models, Dummy variables.

SUGGESTED READING:

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

STATISTICS-DSE-601 LAB: Econometrics
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of econometrics.

List of Practicals

1. Testing of parameters of General linear model
2. Forecasting of General linear model
3. Problems related to consequences of Multicollinearity
4. Problems related to consequences of Autocorrelation (AR(I))
5. Estimation of problems of General linear model under Autocorrelation
6. Problems related to consequences Heteroscedasticity
7. Diagnostics of Heteroscedasticity
8. Estimation of problems of General linear model under Heteroscedastic distance terms
9. Problems related to General linear model under (Aitken Estimation)

STATISTICS- DSE-602(A): Operations Research
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper is based on Introduction to Operations Research, Transportation Problem, game theory and inventory management.

UNIT I
Introduction to Operations Research, phases of O.R. Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P. Simplex method for solving L.P.P.

UNIT II
Charne's M-technique for solving L.P.P. involving artificial variables. Concept of Duality in L.P.P: Dual simplex method.

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.

UNIT IV
Game theory: Rectangular game, minimax-maximin principle, solution to rectangular game using graphical method, dominance and modified dominance property to reduce the game matrix
Networking: CPM and PERT.

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

SUGGESTED READING:

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Hall of India. Edition, Prentice
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

STATISTICS- DSE-602(A) LAB: Operations Research
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical of Operations Research, Transportation Problem, game theory and inventory management.

List of Practicals

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. Allocation problem using Transportation model
3. Allocation problem using Assignment model
4. Networking problem using CPM and PERT
5. Problems based on game matrix using Graphical solution to rectangular game

STATISTICS- DSE-602(B): Project Work
(Credits: 06)

Full marks= 100 [End Semester Exam (70) + CCA (30)]
Pass Marks= 40 [End Semester Exam (28) + CCA (12)]
Contact Hours: 90

The emphasis of the paper is on project work.

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.

SKILL ENHANCEMENT COURSE IN STATISTICS

STATISTICS- SEC-301: Statistical Data Analysis Using Software Packages/using R

(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Two questions of one mark each and two questions of two marks each from each unit to be answered without any alternative. Two questions of four marks each will be set from each unit and one question needs to be answered from each unit.)

This course will review and expand upon core topics in statistics and probability, particularly by initiating the beneficiaries of the course to R for statistical computing.

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 and data cleaning.

UNIT V

Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.

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

STATISTICS- SEC-401: Statistical Techniques for Research Methods
(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Two questions of one mark each and two questions of two marks each from each unit to be answered without any alternative. Two questions of four marks each will be set from each unit and one question needs to be answered from each unit.)

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, objective and motivation in research, types of research, research approach, significance of research. Research problems: definition, selection and necessity of research problems.

UNIT II

Review of literature, identifying research gaps, framing of objectives of the survey, research questions and research hypothesis, framing of questionnaire, need of Pilot survey and its implications of its result

UNIT III

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.

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 V

Develop a questionnaire, collect survey data pertaining to a research problem (such as (not limited to) 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.

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.

DISCIPLINE SPECIFIC ELECTIVE COURSE IN STATISTICS

STATISTICS-DSE-501: Vital Statistics
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]
(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

This paper emphasis on population theories, source of data collection on vital statistics and measurements of Fertility.

Unit I
Population Theories: Coverage and content errors in demographic data, use of balancing equations, Population composition, dependency ratio.

Unit II
Introduction and 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 Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

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.

Unit IV
Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).

Unit V
Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

SUGGESTED READINGS:

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

STATISTICS-DSE-501 LAB: Vital Statistics
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical on vital statistics.

List of Practicals

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 CBR, GFR, SFR, TFR for a given set of data
6. To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data
7. Calculate GRR and NRR for a given set of data and compare them

STATISTICS-DSE-601: Index Number and Time Series Analysis

(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Four questions of 5 marks each will be set from each unit, two questions need to be answered from each unit)

The course emphasizes on definition and construction of index numbers. The paper also introduces the concept of time series analysis.

Unit I

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.

Unit II

Factor reversal and time reversal tests. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers.

Unit III

Introduction to times series data, application of time series from various fields. Components of a times series, Decomposition of time series.

Unit IV

Trend: Estimation of trend by free hand curve method, method of semi averages, fitting a various mathematical curve. Method of moving averages.

Unit V

Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend. Ratio to Moving Averages and Link Relative method.

REFERENCES:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Gupta, S.C. and Kapoor, V. K. (2008): Fundamentals of Applied Statistics, 4th Ed. (reprint), Sultan Chand and Sons.
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.
4. Kendall M.G. (1976): Time Series, Charles Griffin.
5. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
6. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied.

STATISTICS-DSE-601 LAB: Index Number and Time Series Analysis
(Credits: 02)

Full marks= 30 [End Semester (30)]
Pass Marks= 12 [End Semester (12)]
Contact Hours: 30

This paper is based on practical on index numbers and time series.

LIST OF PRACTICALS:

1. Calculate price and quantity index numbers using Laspeyre's, Paasche's, Marshall-Edgeworth and Fisher's formulae
2. To calculate the Chain Base index numbers for a given series of Fixed Base index numbers and show that the two are same
3. To compute Chain Base index numbers for a given set of data
4. To convert the Chain Base index numbers to Fixed Base index numbers
5. Fitting of trend by Moving Average Method (for n even and n odd)
6. Measurement of Seasonal indices Ratio-to-Trend method
7. Measurement of Seasonal indices Ratio-to-Moving Average method
8. Measurement of seasonal indices Link Relative method

SKILL ENHANCEMENT COURSE IN STATISTICS

STATISTICS-SEC-301: Statistical Computing using C
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Two questions of one mark each and two questions of two marks each from each unit to be answered without any alternative. Two questions of four marks each will be set from each unit and one question needs to be answered from each unit.)

This course will review and expand upon core topics in statistics and probability, particularly by initiating the beneficiaries of the course to C programming for statistical computing.

Unit I
C language: Structure of C program. Data type: Basic data types, Enumerated data types, Derived data types. Variable Declaration, Assignment of variables. Numeric, Character, real and string constants.

Unit II
Different type of operators and expressions, Basic input/output. Standard header files, Library functions. String functions.

Unit III
Conditional statements, if...else, Nesting of if....else, elseif ladder, switch statements, Loops in C: for, while, do... while loops. break, continue, exit( ), goto and label declarations.

Unit IV
Arrays, Functions, classification of functions, functions definition and declaration, assessing a function, return statement. Parameter Passing in functions, recursion in Functions.

Unit V
Programs in C should be based on computational techniques in Statistics.

REFERENCES:

1. Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition, Tata McGraw Hill.
2. Forouzan, B.A. and Gilberg, R.F. (2007): Computer Science – A Structured Programming Approach Using C. (3rd Edition). Thompson Course Technology
3. Gottfried, B.S. (1996): Schaum's Outline of Programming with C, 2nd Edition, McGraw Hill.
4. Kanetakar, Y. (2008): Let us C, BPB Publications.

STATISTICS-SEC-401: Statistical Data Analysis using R
(Credits: 04)

Contact Hours: 60

Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]

Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Two questions of one mark each and two questions of two marks each from each unit to be answered without any alternative. Two questions of four marks each will be set from each unit and one question needs to be answered from each unit.)

This course will review and expand upon core topics in statistics and probability, particularly by initiating the beneficiaries of the course to R for statistical computing.

This course will review topics in probability and statistics studied in core for data analysis. Introduction to R for statistical computing, analysis and graphical interpretation would be done using software skills. The following problems can be done using the statistical software to enhance data analysis skills using software.

Unit I
Graphical representation of data by histograms, frequency polygon, Pie chart, ogives, boxplot and stem-leaf.

Unit II
Measures of central tendency, dispersion, measures of skewness and kurtosis.

Unit III
Fitting of polynomials, exponential curves and plotting of probability distributions.

Unit IV
Correlation and regression. Test of significance (t and F tests).

Unit V
Random number generation, ANOVA both one way and two way.

REFERENCES:

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.

STATISTICS-SEC-501: Statistical Techniques for Research Methods
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Two questions of one mark each and two questions of two marks each from each unit to be answered without any alternative. Two questions of four marks each will be set from each unit and one question needs to be answered from each unit.)

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, techniques in defining a research problem.

Unit II
Survey methodology and data collection: introduction, inference and error in surveys, the target populations, sampling frames and coverage error,

Unit III
Methods of data collection, nonresponse, questions and answers in surveys, sample size determination.

Unit IV
Data analysis and interpretation: review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation,

Unit V
Data presentation and data cleaning
Report writing: layout of a research report, characteristics of a good research report.

REFERENCES:

1. Kothari, C.R. (2004): Research Methodology: Methods and Techniques, 2nd Revised Edition, New Age International Publishers.
2. Kumar, R (2011): Research Methodology: A Step - by - Step Guide for Beginners, SAGE publications.

STATISTICS-SEC-601: Data Analysis using Software (SPSS or Microsoft Excel)
(Credits: 04)

Contact Hours: 60
Full Marks = 70 **[**End Semester Exam (50) + CCA (20)]
Pass Marks = 28 **[**End Semester Exam (20) + CCA (8)]

(Two questions of one mark each and two questions of two marks each from each unit to be answered without any alternative. Two questions of four marks each will be set from each unit and one question needs to be answered from each unit.)

This course will review topics in probability and statistics studied in core for data analysis. Introduction to SPSS/Excel for statistical computing, analysis and graphical interpretation would be done using software skills. The following problems can be done on the statistical software to enhance data analysis skills using software.

Unit I
Data view, variable view, data coding, data manipulation, graphical representation of data by histograms, frequency polygon, Pie chart, ogives, boxplot and line diagram.

Unit II
Measures of central tendency, dispersion, Measures of location, Measures of skewness and kurtosis

Unit III
Fitting of polynomials, exponential curves and plotting of probability distributions.

Unit IV
Correlation and regression. Test of significance (t and F tests)

Unit V
Chi square test, Analysis of variance (both one and two way)

REFERENCES:

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. Levine D M, Berenson M L, and Krehbiel T C (2008) Statistics for Managers Using Microsoft Excel, Fifth Edition, Published by Prentice Hall.
4. Bhattacharjee D. (2010) Practical Statistics Using Microsoft Excel, Asian Books, New Delhi