The University of Burdwan

Syllabus for 3-Year Degree/ 4-YearHonours in Statistics under Curriculum and Credit Framework for Under-graduate Program (CCFUP) as per NEP, 2020 with effect from 2023-24

Semester wise & Course Wise Credit Distribution Structure under CCFUP as per NEP, 2020

Semester	Course Type	Name of The Course	Credit	Lecture	Tutorial	Practical/Viva Voce	Full Marks	Distribution of Marks		
								Theory	Practical/ Viva-Voce	Internal Assessment
I	Major/DS Course (Core) Code: STAT1011	Descriptive Statistics and Elementary Probability	4	3		1	75	40	20	15
	Minor Course Code: STAT1021	Descriptive Statistics and Elementary Probability	4	3		1	75	40	20	15
	Multi/ Interdisciplinary Code: STAT1031	Elementary Statistics	3	2	1	0	50	40	0	10
	Ability Enhancement Course (AEC) [L_1-1, MIL] Code: …..1041	Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu orEquvlnt. Course from SWAYAM/ Any other UGC-recognized platform	2	2	0	0	50	40	0	10
	Skill Enhancement Course (SEC) Code: STAT1051	Numerical Analysis	3	2	1	0	50	40	0	10
	Common Value Added (CVA) Course Code: CVA1061	Environmental Science/ Education	4	3	0	1	100	60	20	20

Semester	Course Type	Name of The Course	Credit	Lecture	Tutorial	Practical /Viva Voce	Full Marks	Distribution of Marks		
								Theory	Practical /Viva-Voce	Internal Assessment
II	Major/DS Course (Core) Code: STAT2011	Probability Distribution – I	4	3		1	75	40	20	15
	Minor Course Code: STAT2021	Probability Distribution – I	4	3		1	75	40	20	15
	Multi/ Interdisciplinary Code: STAT2031	Statistics for National Development – An Introduction	3	2	1	0	50	40	0	10
	Ability Enhancement Course (AEC) [L_2-1] Code: ENGC2041	English or Equvlnt. Course from SWAYAM / Any other UGC-recognized platform	2	2	0	0	50	40	0	10
	Skill Enhancement Course (SEC) Code: STAT2051	Research Methodology	3	2	1	0	50	40	0	10
	Common Value Added (CVA) Course Code: CVA2061	Understanding India/ Digital &Technological Solutions/Health & Wellness, Yoga Education, Sports & Fitness	4	3	0	1	100	60	20	20
Skill based vocational course (addl. 4 Cr) during summer term for 8 weeks, who will exit the program after securing 40 Cr.										
For UG certificate 40 cr+ additional 4 cr (work based vocational course) = 44 cr. Students are allowed to reenter within 3 years and complete the program within stipulated max. period of 7 years										
	Total		**20**				**400**			

Semester	Course Type	Name of The Course	Credit	Lecture	Tutorial	Practical/ Viva Voce	Full Marks	Distribution of Marks		
								Theory	Practical/ Viva-Voce	Internal Assessment
III	Major/DS Course (Core) Code: STAT 3011	Linear Algebra and Mathematical Analysis-I	5	4		1	75	40	20	15
	Major/DS Course (Core) Code: STAT 3012	Descriptive Statistics and Probability Distributions – II	5	4		1	75	40	20	15
	Minor Course (Vocational Education And Training) Code: MSR3021 or HRM3021 or RSA3021	Medical Sales Representative or Human Resource Management or Retail Sales Associate	4	3	1	0	75	60	0	15
	Multi/ Interdisciplinary Code: STAT 3031	Research Methodology	3	2	1	0	50	40	0	10
	Ability Enhancement Course (AEC) [L_1-2, MIL] Code: 3041	Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu Or Equvlnt. Course from SWAYAM/ Any other UGC-recognized platform	2	2	0	0	50	40	0	10
	Skill Enhancement Course (SEC) Code: STAT 3051	Statistics for National Development – An Introduction	3	2	1	0	50	40	0	10
	Total		**22**				**375**			

Semester	Course Type	Name of The Course	Credit	Lecture	Tutorial	Practical/Viva Voce	Full Marks	Distribution of Marks		
								Theory	Practical /Viva-Voce	Internal Assessment
IV	Major/DS Course (Core) Code: STAT 4011	Statistical Inference	5	4		1	75	40	20	15
	Major/DS Course (Core) Code: STAT 4012	Sampling Distribution and Mathematical Analysis-II	5	4	1		75	60	0	15
	Major/DS Course (Core) Code: STAT 4013	Numerical Analysis and Statistical Computing using R	5	0	0	5	75	0	60	15
	Minor Course Code: STAT 4021	Basics of Statistical Inference	4	3		1	75	40	20	15
	Minor Course (other than statistics) Code: 4021		4				75			15

	Ability Enhancement Course (AEC) [L$_2$-2] Code: 4041	English or Equvlnt. Course from SWAYAM / Any other UGC-recognized platform	2	2	0	0	50	40	0	10

Skill based vocational course (addl. 4 Cr) during summer term for 8 weeks, who will exit the program after securing 87 Cr.

For UG diploma 87 cr+ additional 4 cr (work based vocational course) = 91 cr. Students are allowed to reenter within 3 years and complete the program within stipulated max. period of 7 years

	Total		**25**				**425**			

Semester	Course Type	Name of The Course	Credit	Lect.	Tuto.	Prac.	Full Marks	Distribution of Marks		
								Th.	Prac./ Viva-Voce	Internal Assessment
V	Major/DS Course (Core) Code: STAT5011	Large Sample Distribution and Nonparametric Methods	5	4		1	75	40	20	15
	Major/DS Course (Core) Code: STAT5012	Linear Models	5	4		1	75	40	20	15
	Major/DS Course (Core) Code: STAT5013	Sample Survey and Indian Official Statistics	5	4		1	75	40	20	15

			Credit	Lect.	Tuto.	Prac.	Full Marks	Th.	Prac./Viva-Voce	Internal Assessment
Minor Course (Vocational Education And Training) Code: MSR5021 or HRM5021 or RSA5021	Medical Sales Representative or Human Resource Management or Retail Sales Associate		4	3	1	0	75	60	0	15
Course Code : INT5081	Internship		2			2	50	0	50 (Project/ Field Diary: 30 + Viva-voce: 20)	0
Total			**21**				**350**			

Semester	Course Type	Name of The Course	Credit	Lect.	Tuto.	Prac.	Full Marks	Distribution of Marks		
								Th.	Prac./ Viva-Voce	Internal Assessment
	Major/DS Course (Core) Code: STAT 6011	Design of Experiments	4	3		1	75	40	20	15
	Major/DS Course (Core) Code: STAT 6012	Time Series Analysis and Index number	4	3		1	75	40	20	15
	Major/DS Course (Core) Code: STAT 6013	Statistical Quality Control and Demography	4	3		1	75	40	20	15

VI	Major/DS Course (Core) Code: STAT 6014	Project/ Social Outreach	4			4	75	0	60 (Project work- 40 and viva-voce-20)	15
	Minor Course (Vocational Education And Training) Code: MSR6021 or HRM6021 or RSA6021	Medical Sales Representative or Human Resource Management or Retail Sales Associate	4	3	1	0	75	60	0	15
	Total		**20**				**375**			
	Grand Total (Sem.- I to VI)		**128**				**2325**			

Detailed Syllabus

Semester – I

(MAJOR)

Course Code: STAT 1011Credit: 4   Full Marks: 75

Descriptive Statistics and Elementary Probability

*Course Objective:*The following are the course objectives of the major course STAT 1011 (Descriptive Statistics and Elementary Probability)

1. It gives the introductions of basic statistics to the students.
2. It focuses the application of basic statistics to the different real situations of daily life and our different activities in the society.

3. It introduces the chance of different activities in the real life and real society.

Theory   Credit: 3   Full Marks: 40

Statistics: Definition and scope, concepts of statistical population and sample

Data: quantitative and qualitative   (5L)

Scales of measurement: nominal, ordinal, interval and ratio. Frequency distribution

Presentation: textual, tabular and graphical, including histogram and ogives.

Measures of Central Tendency: Mean, Median, Mode.   (5L)

Measures of Dispersion: range, mean deviation, standard deviation, coefficient of variation, Gini's Coefficient, Lorenz Curve. Moments, skewness and kurtosis, Quantiles and measures based on them. Box Plot, Outlier, Detection, Quantile-Quantile Plot.   (15L)

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.(20L)

Reference Books

• Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I& II, 8th Edn. The World Press, Kolkata.

• Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

• 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.

• Tukey, J.W. (1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.

• Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.

• Freedman, D., Pisani, R. and Purves, R.(2014): Statistics, 4th Edition, W. W. Norton & Company.

Descriptive Statistics and Elementary Probability Lab (Prac)

Practical   Credit: 1 Full Marks: 20

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. Box Plot and Q-Q Plot.

7. Application problems based on Classical Definition of Probability.

8. Application problems based on Bayes Theorem.

Course Outcome: The following are the course outcomes of the major course STAT 1011(Descriptive Statistics and Elementary Probability):
   1. Students will be acquainted with the meaning, application and necessary of the subject Statistics based on the topics Statistics, Data, Measurement etc.
   2. They will be able to apply Statistics in the different activities in the real life and in the society based on the topics Central tendency and dispersion.
   3. They can predict the situations of different events through the elementary probability.

(MINOR)

Course Code: STAT 1021   Credit: 4   Full Marks: 75

Descriptive Statistics and Elementary Probability

*Course Objective:*The following are the course objectives of the minor course
STAT 1021 (Descriptive Statistics and Elementary Probability)
1. It gives the introductions of basic statistics to the students.
2. It focuses the application of basic statistics to the different real situations of daily life and our different activities in the society.
3. It introduces the chance of different activities in the real life and real society.

Theory   **Credit: 3   Full Marks: 40**

Statistics: Definition and scope, concepts of statistical population and sample

Data: quantitative and qualitative (5L)

Scales of measurement: nominal, ordinal, interval and ratio. Frequency distribution

Presentation: textual, tabular and graphical, including histogram and ogives.

Measures of Central Tendency: Mean, Median, Mode. (5L)

Measures of Dispersion: range, mean deviation, standard deviation, coefficient of variation, Gini's Coefficient, Lorenz Curve. Moments, skewness and kurtosis, Quantiles and measures based on them. Box Plot, Outlier, Detection, Quantile-Quantile Plot. (15L)

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. (20L)

Reference Books

• Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I& II, 8th Edn. The World Press, Kolkata.

• Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

• 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.

• Tukey, J.W. (1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.

• Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.

• Freedman, D., Pisani, R. and Purves, R. (2014): Statistics, 4th Edition, W. W. Norton & Company.

Descriptive Statistics and Elementary Probability Lab (Prac)

Practical   **Credit: 1   Full Marks: 20**

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. Box Plot and Q-Q Plot.

7. Application problems based on Classical Definition of Probability.

8. Application problems based on Bayes Theorem.

Course Outcome: The following are the course outcomes of the minor course
STAT 1021(Descriptive Statistics and Elementary Probability):
1. Students will be acquainted with the meaning, application and necessary of the subject Statistics based on the topics Statistics, Data, Measurement etc.
2. They will be able to apply Statistics in the different activities in the real life and in the society based on the topics Central tendency and dispersion.
3. They can predict the situations of different events through the elementary probability.

(Multi/Interdisciplinary)

<u>Course Code</u>: STAT 1031   Credit: 3   Full Marks: 50

Elementary Statistics

*Course Objective:*The following are the course objectives of the
Multi/Interdisciplinary course STAT 1031 (Elementary Statistics)

1. It gives the introductions of basic statistics to the students.
2. It focuses the application of basic statistics to the different real situations of daily life and our different activities in the society.
3. It introduces the chance of different activities in the real life and real society.

Theory   **Credit: 2 Full Marks: 40**

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. Frequency distribution, Presentation: tabular and graphic, including histogram and ogives.   (6L)

Measures of Central Tendency: mathematical and positional.

Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis (6L)

Bivariate   data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation (Spearman). Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.   (5L)

Theory of attributes, consistency of data, independence and association of attributes, measures of association and contingency.   (3L)

Reference Books

• Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

• Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

• 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.

• Goon A.M., Gupta M.K. and Dasgupta B.: Basic Statistics. The World Press, Kolkata.

• Chakraborty, Arnab (2016): Probability and Statistics. Sarat Book House.

Course Outcome: The following are the course outcomes of the Multi/Inter disciplinary course STAT 1031(Elementary Statistics):

1. Students will be acquainted with the meaning, application and necessary of the subject Statistics based on the topics Statistics, Data, Measurement etc.
2. They will be able to apply Statistics in the different activities in the real life and in the society based on the topics Central tendency and dispersion.
3. They can predict the situations of different events through the elementary probability.

(SEC)

Course Code: STAT 1051   Credit: 3   Full Marks: 50

Numerical Analysis

*Course Objective:*The following are the course objectives of the SEC course
STAT 1051 (Numerical Analysis):

1. It gives the ideas to compute approximate values in the different real situation where there are no exact equations for computing the interested values.
2. It helps the students to estimate the unknown values in any complex situations based on a derived equation on the basis of the data in hand.

Theory   **Credit: 2 Full Marks: 40**

Approximation of numbers and functions, Absolute and Relative errors.

Interpolation: Polynomial approximation, Difference Table, Newton's Forward and Backward interpolation formulae and Lagrange's general interpolation formula, Error terms.

Numerical differentiation and its applications.   (10L)

Numerical Integration: Trapezoidal and Simpon's 1/3 rules.

Numerical solution of equations: method of false position, method of fixed point iteration and Newton-

Raphson method in one unknown, Conditions of convergence, rates of convergence.   (10L)

Reference Books

- Scarborough J.B. (1958) : Numerical Mathematical Analysis, Oxford Univ. Press

- Atkinson K. (1985) : Elementary Numerical Analysis

- Sastry S.S. (1998) : Introductory Methods of Numerical Analysis

- Hildebrand F.B. (1974) : Introduction to Numerical Analysis, Tata McGraw-Hill

Course Outcome:The following are the course outcomes of the SEC course STAT 1051 (Numerical Analysis):

1. Based on areal data set, students will be acquainted to estimate any value which is not available in the data set.
2. Students can predict the any interested values of the real fact based on the observations in hand.

Semester – II

(MAJOR)

Course Code: STAT 2011   Credit: 4   Full Marks: 75

Probability Distribution– I

Course Objective:The following are the course objectives of the major course
STAT 2011 (Probability Distribution – I):

1. It focuses on the random variables, their distributions and properties.
2. It presents many basic probability theories to understand the real events in the society.
3. It gives basic knowledge to undergo the higher courses.

Theory   Credit: 3   Full Marks: 40

Random variables: discrete random variables, p.m.f. and c.d.f., statement of properties of c.d.f, illustrations and properties of random variables.   (8L)

Standard discrete probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform.   (10L)

Continuous random variables, p.d.f. and c.d.f., illustrations and properties, univariate transformations with illustrations.

Mathematical Expectation: One Dimensional random variable and their properties. Probability generating function.Moments.Moment generating function.
Probability Inequalities: Markov &Chebyshev.   (12L)

Standard continuous probability distributions: uniform, normal, exponential, Cauchy, beta, gamma, lognormal, logistic, double exponential and Pareto along with their properties and limiting/approximation cases.   (15L)

Reference Books

- Chung, K.L. (1983): Elementary Probability Theory with Stochastic Process, Springer / Narosa.
- Feller, W. (1968): An Introduction to Probability Theory & its Applications, John Wiley.
- Goon, A.M., Gupta, M.K.&Dasgupta, B. (1994): An Outline of Statistical Theory (Vol-1), World Press.
- Parzen, E. (1972): Modern Probability Theory and its Applications, John Wiley .
- Uspensky, J.V. (1937): Introduction to Mathematical Probability, McGraw Hill.
- Cacoullos, T. (1973): Exercises in Probability. Narosa.
- Rahman, N.A. (1983): Practical Exercises in Probability and Statistics, Griffen.
- Ross, S. (2002): A First Course in Probability, Prentice Hall.

Probability Distribution - I Lab (Prac)

Practical   **Credit: 1 Full Marks: 20**

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 distribution.

7. Application problems based on binomial distribution.

8. Application problems based on Poisson distribution.

9. Application problems based on negative binomial distribution.

10. Problems based on area property of normal distribution.

11. To find the ordinate for a given area for normal distribution.

12. Application based problems using normal distribution.

Course Outcome: The following are the course outcomes of the major course STAT 2011 (Probability Distribution - I):

1. Students will be acquainted about different kind of random variables in the real society based on the topic Random variables.
2. Students will be acquainted with the nature and variability of different random variables based on the topics: Standard discrete and continuous random variables distribution.
3. Student can undergo higher courses through the knowledge of mathematical expectations, probability inequality etc.

(MINOR)

Course Code: STAT 2021   Credit: 4   Full Marks: 75

Probability Distribution– I

Course Objective: The following are the course objectives of the minor course
STAT 2021 (Probability Distribution – I):

1. It focuses on the random variables, their distributions and properties.
2. It presents many basic probability theories to understand the real events in the society.
3. It gives basic knowledge to undergo the higher courses.

Theory   Credit: 3   Full Marks: 40

Random variables: discrete random variables, p.m.f. and c.d.f., statement of properties of c.d.f, illustrations and properties of random variables. (8L)

Standard discrete probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform. (10L)

Continuous random variables, p.d.f. and c.d.f., illustrations and properties, univariate transformations with illustrations.

Mathematical Expectation: One Dimensional random variable and their properties. Probability generating function.Moments.Moment generating function.
Probability Inequalities: Markov &Chebyshev. (12L)

Standard continuous probability distributions: uniform, normal, exponential, Cauchy, beta, gamma, lognormal, logistic, double exponential and Pareto along with their properties and limiting/approximation cases. (15L)

Reference Books

- Chung, K.L. (1983): Elementary Probability Theory with Stochastic Process, Springer / Narosa.
- Feller, W. (1968): An Introduction to Probability Theory & its Applications, John Wiley.
- Goon, A.M., Gupta, M.K.&Dasgupta, B. (1994): An Outline of Statistical Theory (Vol-1), World Press.
- Parzen, E. (1972): Modern Probability Theory and its Applications, John Wiley .

- Uspensky, J.V. (1937): Introduction to Mathematical Probability, McGraw Hill.
- Cacoullos, T. (1973): Exercises in Probability. Narosa.
- Rahman, N.A. (1983): Practical Exercises in Probability and Statistics, Griffen.
- Ross, S. (2002): A First Course in Probability, Prentice Hall.

Probability Distribution - I Lab (Prac)

Practical   **Credit: 1 Full Marks: 20**

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 distribution.

7. Application problems based on binomial distribution.

8. Application problems based on Poisson distribution.

9. Application problems based on negative binomial distribution.

10. Problems based on area property of normal distribution.

11. To find the ordinate for a given area for normal distribution.

12. Application based problems using normal distribution.

*Course Outcome:*The following are the course outcomes of the minor course
STAT 2021 (Probability Distribution - I):

1. Students will be acquainted about different kind of random variables in the real society based on the topic Random variables.
2. Students will be acquainted with the nature and variability of different random variables based on the topics: Standard discrete and continuous random variables distribution.
3. Student can undergo higher courses through the knowledge of mathematical expectations, probability inequality etc.

(Multi/Interdisciplinary)

Course Code: STAT 2031Credit: 3   Full Marks: 50

Statistics for National Development – An Introduction

Course Objective:The following are the course objectives of the Multi/Inter disciplinary course STAT 2031 (Statistics for National Development – An Introduction):
1. It focuses on the different data sources which are used in the society, ruling the government and social researchers.
2. It gives the ideas of different data sources along with their applications in the different field of the society.

Theory   Credit: 2   Full Marks: 40

An outline of 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), Registered General Office and National Statistical Commission. Government of India's Principal publications containing data on the topics such as Agriculture, price, population, industry, finance and employment.   (10L)

Consumer price Index, Wholesale price index number and index of industrial production.

National   Income: Basic   idea   and   a   brief   description of income, expenditure and production approaches.   (10L)

Reference Books

- Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics (Vol.2), World Press.
- Guide to current Indian Official Statistics, Central Statistical Office, GOI, and New Delhi.
- http://mospi.nic.in/

Course Outcome:The following are the course outcomes of the Multi/Inter disciplinary course STAT 2031 (Statistics for National Development – An Introduction):

1. Students will be acquainted with the different sources of the data sets which are related in the different fields in the society based on the topics: different data sources, registers, published books by the government.

2. Students will be able to study about the society based on the data sets obtained from the different registered sources.

(SEC)

Course Code: STAT 2051   Credit: 3   Full Marks: 50

Research Methodology

*Course Objective:*The following are the course objectives of the SEC course
STAT 2051 (Research Methodology):

1. It gives ideas about research, types of research, research problems, research hypothesis, research frame and its limitations.
2. It gives the ideas about research data which may be experimental or environmental.
3. It presents the data collection method, basis analysis and interpretations.

Theory   **Credit: 2   Full Marks: 40**

What is Research? Role of Research in important areas.Characteristics of Scientific Method. Process of research: Stating Hypothesis or Research question, Concepts & Constructs, Units of analysis & characteristics of interest, Independent and Dependent variables, Extraneous or Confounding variables. Measurements and scales of Measurements. Types of research: Qualitative & Quantitative Research, Longitudinal Research, Survey & Experimental Research.   (7L)

Survey Methodology and Data Collection, sampling frames and coverage error, non-response.

Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation.   (5L)

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), questions and answers in surveys, Internal & External validity, interpret the results and draw inferences. Formats and presentations of Reports – an overview.   (12L)

Reference Books

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

Course Outcome: The following are the course outcomes of the SEC course STAT 2051 (Research Methodology):

1. Students will be acquainted with different types of research and they will be interested in the different field of research based on the topics: Research, Research Method and Process, Research Problems and Hypothesis etc.
2. Students will be able to collect data for their own research using the proper questionnaire, suitable sampling method based on the course: Sample Survey.
3. Students will be able to analyze their collected data and interpret their research questions based on this topic.

Semester – III

(MAJOR)

Course Code: STAT 3011   **Credit: 5   Full Marks: 75**

Linear Algebra and Mathematical Analysis-I

Course Objective: The following are the course objectives of the major course
STAT 3011 (Linear Algebra and Mathematical Analysis-I)
1. It gives the basic ideas about Linear Algebra and Mathematical Analysis.
2. The concepts of Linear Algebra are used in Linear Models, Design of Experiments and Analysis of Variance. Again the concepts of basic Mathematical Analysis are used in the Probability Theory.
3. The contents of this course will help the students to digest the other topics such as Linear Models & Estimation, Design of Experiments, ANOVA and Probability theory.

Theory   **Credit: 4   Full Marks: 40**

Linear Algebra : Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem. Algebra of matrices - A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, Adjoint and inverse of a matrix and related properties

Determinants of Matrices: Definition, properties and applications of determinants for 3rdand higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, 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.

Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, Properties of

characteristic roots, Quadratic forms: Classification & canonical reduction. Linear transformation.Applications of Linear Algebra in Statistics.

Mathematical Analysis-I : Representation of real numbers as points on a line. Algebraic, Order and Completeness properties of R (Concepts only).Bounded and unbounded sets, neighbourhood of a point, Supremum and infimum. Functions, Countable, Uncountable sets and Uncountability of R. Sequences and their convergence, monotonic sequences, bounded sequences, squeeze theorem Limits of some special sequences such as n^n,$(1+)^n$, $n^{(1/n)}$ Infinite series, positive termed series and their convergence, Comparison test, ratio test and root test. Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence.

Reference Books

- Lay David C (2000): Linear Algebra and its Applications, Addison Wesley.
- Schaum's Outlines (2006): Linear Algebra, Tata McGraw-Hill Edition, 3rd Edition.
- Krishnamurthy, V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
- Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International.
- Gupta, S.C (2008): An Introduction to Matrices (Reprint). Sultan Chand & Sons.
- Artin, M (1994): Algebra. Prentice Hall of India.
- Datta, K.B (2002): Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd.
- Hadley, G (2002): Linear Algebra. Narosa Publishing House (Reprint).
- Searle, S.R (1982): Matrix Algebra Useful for Statistics. John Wiley &Sons.
- Chakraborty, Arnab (2014): Linear Algebra, first edition. Sarat Book House.

Linear Algebra and Mathematical Analysis-I (Lab)

Practical   **Credit: 1 Full Marks: 20**

List of Practical

1. Vector dependence and independence
2. Vector orthogonalization
3. Rank and/or determinant of a matrix

4. Singularity and non-singularity of a matrix
5. Solution of system of homogeneous equations
6. Solution of system of non-homogeneous equations
7. Finding characteristic roots and vector of a matrix
8. Identification of a quadratic forms (like pd, psd, nd, nnd etc.)

Course Outcomes: Development of basic mathematical tools for understanding the other courses such as Linear Models & Estimation, Design of Experiments, ANOVA and Probability theory, and critical thinking for carrying out scientific investigations.

Course Code: STAT 3012   Credit: 5   Full Marks: 75

Descriptive Statistics and Probability Distributions – II

Course Objective: The following are the course objectives of the major course
STAT 3012 (Descriptive Statistics and Probability Distributions- II)
1. It gives ideas about some higher levels of the basic statistics and Probability Theory to the students.
2. It focuses the applications of basic statistics to the different real situations of daily life and our different activities in the society.
3. It introduces the ideas about the chances of different activities in real life and real society.

Theory   **Credit: 4   Full Marks: 40**

Bivariate data: Definition, scatter diagram, product moment correlation

linear regression, principle of least squares

Correlation Index, Correlation Ratio. Intra-class correlation coefficient.

Spearman's Rank correlation and Kendall's Tau (including tie cases).

Analysis of Categorical Data: Contingency table, association of attributes and

different measures, odds ratio, relative risk, Pearson's measure, Goodman-

Kruskal's Gamma

Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f. and p.d.f. and c.d.f., statement of properties of c.d.f, independence of variables.

Expectations of bivariate random variable and their properties.Correlation coefficient, Conditional expectation and variance, moment generating function (m.g.f.)

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

Reference Books

- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I& II, 8th Edn. The World Press, Kolkata.
- Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
- 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.
- Tukey, J.W. (1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.
- Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.
- Freedman, D., Pisani, R. and Purves, R.(2014): Statistics, 4th Edition, W. W. Norton & Company.
- Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Sevent Ed, Pearson Education, New Delhi.
- Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
- Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi.

Descriptive Statistics and Probability Distribution – II (Lab)

Practical   **Credit: 1 Full Marks: 20**

List of Practical

1. Karl Pearson correlation coefficient.
2. Correlation coefficient for a bivariate frequency distribution.

3. Lines of regression, angle between lines and estimated values of variables.
4. Spearman's rank correlation.
5. Problems related to categorical data

Course Outcome: The following are the course outcomes of the major course
STAT 3012 (Descriptive Statistics and Probability Distributions- II):
1. Students will be acquainted with the meaning, application and necessary of the subject Statistics based on the topics Statistics, Data, Measurement etc.
2. They will be able to apply Statistics in the different activities in real life and in society based on the topics in this course.
3. They can predict the situations of different events through probability distributions and descriptive statistics.

(Multi/Interdisciplinary)

Course Code: STAT 3031   Credit: 3   Full Marks: 50

Research Methodology

Course Objective: The following are the course objectives of the SEC course STAT 3031 (Research Methodology):

1. It gives ideas about research, types of research, research problems, research hypothesis, research frame and its limitations.
2. It gives ideas about research data which may be experimental or environmental.
3. It presents the data collection method, basis analysis and interpretations.

Theory   Credit: 3   Full Marks: 40

What is Research? Role of Research in important areas.Characteristics of Scientific Method. Process of research: Stating Hypothesis or Research question, Concepts & Constructs, Units of analysis & characteristics of interest, Independent and Dependent variables, Extraneous or Confounding variables. Measurements and scales of Measurements. Types of research: Qualitative & Quantitative Research, Longitudinal Research, Survey & Experimental Research.

Survey Methodology and Data Collection, sampling frames and coverage error, non-response.

Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation.

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), questions and answers in surveys, Internal & External validity, interpret the results and draw inferences. Formats and presentations of Reports – an overview.

Reference Books

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

Course Outcome: The following are the course outcomes of the SEC course STAT 3031 (Research Methodology):

1. Students will be acquainted with different types of research and they will be interested in the different fields of research based on the topics: Research, Research Method and Process, Research Problems and Hypothesis etc.
2. Students will be able to collect data for their own research using the proper questionnaire, suitable sampling method based on the course: Sample Survey.
3. Students will be able to analyze their collected data and interpret their research questions based on this topic.

(SEC)

Course Code: STAT 3051   Credit: 3   Full Marks: 50

Statistics for National Development – An Introduction

Course Objective: The following are the course objectives of the Multi/Inter disciplinary course STAT 3051 (Statistics for National Development – An Introduction):
  1. It focuses on the different data sources which are used in society, ruling the government and social researchers.
  2. It gives the ideas of different data sources along with their applications in the different fields of the society.

Theory   Credit: 3   Full Marks: 40

An outline of 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), Registered General Office and National Statistical Commission. Government of India's Principal publications containing data on the topics such as Agriculture, price, population, industry, finance and employment.

Consumer price Index, Wholesale price index number and index of industrial production.

National Income: Basic idea and a brief description of income, expenditure and production approaches.

Reference Books

  ➢ Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics (Vol.2), World Press.
  ➢ Guide to current Indian Official Statistics, Central Statistical Office, GOI, and New Delhi.
  ➢ http://mospi.nic.in/

Course Outcome: The following are the course outcomes of the Multi/Inter disciplinary course STAT 3051 (Statistics for National Development – An Introduction):

1. Students will be acquainted with the different sources of the data sets which are related in the different fields in the society based on the topics: different data sources, registers, published books by the government.
2. Students will be able to study about the society based on the data sets obtained from the different registered sources.

Semester – IV

(MAJOR)

Course Code: STAT 4011   Credit: 5   Full Marks: 75

Statistical Inference

Course Objective: The following are the course objectives of the major course STAT 4011 (Statistical Inference):

1. It introduces some statistical estimation and inference concepts to the students.
2. It focuses on theories and applications of statistical estimation and inferences problems to the different real situations of daily life and our different activities in the society.
3. Students can apply these estimation and inference concepts in real life situations.

Theory   Credit: 4   Full Marks: 40

Problems of Statistical Inference: Population & parameter, random sample & statistic, Point and Interval Estimation, Confidence level, Testing of Hypothesis, Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Sampling distribution of a statistic.

Exact tests and confidence intervals: classical and p-value approaches. Binomial proportion(s),Poisson mean(s), Univariate Normal mean (s), standard deviation(s), Standard tests related to Bivariate normal parameters.

Limit laws: Sequence of random variables, convergence in probability, convergence in mean square and convergence in distribution and their interrelations, W.L.L.N. and their applications, De-Moivre Laplace Limit theorem, Statement of Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T.

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 (statement and applications) and MVB estimators. Methods of Estimation: Method of moments, method of

maximum likelihood estimation, method of minimum Chi-square and statements of their properties

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, Most powerful test, uniformly most powerful test, Neyman-Pearson Lemma (statement and proof of sufficiency part only) and its applications to construct uniformly most powerful test, unbiased test (definition only). Likelihood ratio test, properties of likelihood ratio tests (without proof).

Reference Books

- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I,4thEdn. World Press, Kolkata.
- Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics.2ndEdn. (Reprint) John Wiley and Sons.
- Hogg, R.V. And Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. PearsonEducation.
- Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4th Edn.John Wiley and Sons.
- Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics,3rdEdn. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.
- Hogg R.V. & Craig A.T. (1978): Introduction to Mathematical Statistics, Prentice Hall.
- Casella, G. and Berger R.L (2002). : Statistical Inference, 2nd Edn. Thomson Learning

Statistical Inference (Lab)

Practical   **Credit: 1 Full Marks: 20**

List of Practical

1. Testing of significance for single proportion and difference of two proportions
2. Testing of significance for single Poisson mean and difference of two Poisson means.
3. Testing of significance and confidence intervals for single mean and difference of two means.

4. Testing of significance and confidence intervals for single standard deviation and difference of two standard deviations.
5. Testing of parameters under bivariate normal distribution.
6. Unbiased estimators (including unbiased but absurd estimators).
7. Consistent estimators, efficient estimators and relative efficiency of estimators.
8. Maximum Likelihood Estimation.
9. Estimation by the method of moments, minimum Chi-square.
10. Type I and Type II errors.
11. Most powerful critical region.
12. Uniformly most powerful critical region.
13. Power curves.
14. Likelihood ratio tests for simple null hypothesis against simple alternative hypothesis.
15. Likelihood ratio tests for simple null hypothesis against composite alternative hypothesis.

Course Outcome: The following are the course outcomes of the major course STAT 4011 (Statistical Inference):

1. Students will be acquainted with statistical estimation, testing of hypotheses, and their applications in different real fields.
2. They will be able to apply Statistical Inference in the different activities in real life and in society based on the topics covered in this course.
3. They can perform some statistical hypothesis testing in some real field.

Course Code: STAT 4012   Credit: 5   Full Marks: 75

Sampling Distribution and Mathematical Analysis-II

Course Objective: The following are the course objectives of the major course STAT 4012 (Sampling Distribution and Mathematical Analysis – II):

1. It focuses on the distributions of discrete, continuous, and order statistics, and along with some higher levels of Mathematical analysis.
2. It presents sampling distributions of different statistics from different distributions, and along with some higher levels of Mathematical analysis theories.

3. It helps the students to use suitable statistics in estimation and inference problems.

Theory   **Credit: 5   Full Marks: 60**

Sampling Distribution: Discrete Case: Function of discrete random variables and their distributions.

(mainly Binomial and Poission distribution related functions)

Continuous Case: Derivation of the sampling distribution of sample mean and variance for a normal population, standard errors of sample mean, sample variance and sample proportion.

Exact sampling distribution: Definition and derivation of p.d.f. of χ^2 with n degrees of freedom (d.f.), nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., additive property of χ^2 distribution.

Exact sampling distributions: Student's and Fisher's t-distributions, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance and limiting form of t distribution.

Snedecor's F-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance. Distribution of.Relationship between t, F and χ^2 distributions.

Distribution of sample correlation coefficient in the null case.

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.

Mathematical Analysis-II : Review of limit, continuity and differentiability. Indeterminate form, L' Hospital's rule.Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with lagrange's form of remainder (without proof). Taylor's series expansions of sin x, cos x, e^x, $(1 + x)^n$, log (1+x). Maxima and Minima of Functions.Successive Differentiation.

Integral Calculus: definite integral (definition). Statements of properties, Fundamental Theorem of Integral Calculus. Improper Integral, Beta and Gamma functions: properties and relationship between them.

Functions of two variables and Partial Derivatives.Maxima and Minima of such Functions.Constrained Maximization and minimization, use of Lagrange Multiplier. Double Integral (intuitive-graphical approach), change of order of integration, transformation of variables and Jacobians (statement of relevant theorems and their uses)

Reference Books

- ➢ Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I,4thEdn. World Press, Kolkata.
- ➢ Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics.2ndEdn. (Reprint) John Wiley and Sons.
- ➢ Hogg, R.V. And Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. PearsonEducation.
- ➢ Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4th Edn.John Wiley and Sons.
- ➢ Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics,3rdEdn. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.
- ➢ Hogg R.V. & Craig A.T. (1978): Introduction to Mathematical Statistics, Prentice Hall.
- ➢ Casella, G. and Berger R.L (2002). : Statistical Inference, 2nd Edn. Thomson Learning

Course Outcomes: The following are the course outcomes of the major course STAT 4012 (Sampling Distribution and Mathematical Analysis – II):

1. Students can undergo the inference and estimation courses very easily.
2. Students can undergo higher level probability theories very easily.
3. It helps the students to select suitable statistics for real life estimation and inference problems.

Course Code: STAT 4013   Credit: 5   Full Marks: 75

Numerical Analysis and Statistical Computing using R

Course Objective: The following are the course objectives of the major course STAT 4013 (Numerical Analysis and Statistical Computing using R):

1. It focuses on several theories and applications of numerical computations of many real problems.
2. In addition, R programming is used to derive numerical computations very easily.
3. It helps the students to find an approximate value for any real problems under any situation.

Practical   **Credit: 5   Full Marks: 60**

Numerical Analysis: Polynomials and Difference Tables. Approximation of functions and Weierstrass Theorem (statement).Lagrange and Newton formulae for Interpolation. Trapezoidal and Simpson's 1/3 Rules for approximations of definite integrals. Approximate solutions of Numerical Equations by Fixed-point Iteration and Newton-Raphson methods.Conditions of convergence.

Introduction to R: Installation, commandline environment, overview of capabilities, brief mention of open source philosophy.

R as a calculator: The four basic arithmetic operations. Use of parentheses nesting up to arbitrary level.The power operation.Evaluation of simple expressions.Quotient and remainder operations for integers.

Standard functions, e.g., sin, cos, exp, log.

The different types of numbers in R: Division by zero leading to Inf or -Inf. NaN. NA. No need to go into details.

Variables. Creating a vector using c( ), seq( ) and colon operator. How functions map over vectors.

Functions to summarise a vector: sum, mean, sd, median etc. Extracting a subset from the vector (by index, by property).

R as a graphing calculator: Introduction to plotting. Plot ( ), lines( ), abline( ). No details about the graphics parameters except colour and line width. Barplot, Pie chart and Histogram.Box plot.Scatter plot and simple linear regression using lm(y~x).

Matrix operations in R: Creation. Basic operations.Extracting submatrices.

Loading data from a file: read.table ( ) and read.csv ( ). Mention of head=TRUE and head=FALSE. Dataframes. Mention that these are like matrices, except that different columns may be of different types.

Problems on discrete and continuous probability distributions.

Reference Books

- Kernighan, B.W. and Ritchie, D.(1988): C Programming Language,2nd Edition, PrenticeHall.
- Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition Tata McGraw Hill.
- Gottfried, B.S. (1998): Schaum's Outlines: Programming with C, 2nd Edition, TataMcGrawHill.
- Jain, M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.
- Mukherjee, Kr. Kalyan (1990): Numerical Analysis. New Central Book Agency.
- Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Del
- Scarborough, J.B. (1966): Numerical Mathematical Analysis. Oxford and IBH Publishing.
- Gardener, M (2012) Beginning R: The Statistical Programming Language, WileyPublications.
- Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R.Cambridge University Press. New York
- A simple introduction to R by ArnabChakraborty (freely available at http://www.isical.ac.in/~arnabc/)
- R for beginners by Emmanuel Paradis (freely available at ftp://cran.r-project.org/pub/R/doc/contrib/Paradis-rdebuts_en.pdf)

Course Outcomes: The following are the course outcomes of the major course STAT 4013 (Numerical Analysis and Statistical Computing using R):

1. Students can obtain numerical solutions for any problems in real life situations.
2. They can compute these numerical solutions using R- Programming.
3. They will be able to solve any complex real life problems using numerical solutions with the help of R- Programming.

(MINOR)

Course Code: STAT 4021   Credit: 4   Full Marks: 75

Basics of Statistical Inference

Course Objective: The following are the course objectives of the minor course
STAT 4021 (Basic Statistical Inference)
1. It introduces basic statistical inference to the students.
2. It focuses the applications of basic statistical inference to the different real
    situations of daily life and our different activities in the society.

Theory   Credit: 3   Full Marks: 40

Population and Sample, Parameter and Statistic, Population distribution and
Sampling distribution.

Statistical Inference: Point Estimation, Interval Estimation and Testing of
Statistical Hypothesis.

Four useful distributions for statistical Inference; Normal, χ^2, t and F
(Statement of the pdf's& shape of the curves)

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), Binomial and
Poisson Distribution

Categorical data: Tests of proportions, tests of association and goodness-of-fit
using Chi- square test.

Tests for the significance of correlation coefficient. Sign test. Wilcoxon two-
sample test.

Reference Books

➤ Daniel, Wayne W., Bio-statistics (2005): A Foundation for Analysis in the
    Health Sciences. John Wiley .

- Goon, A.M., Gupta M.K. & Das Gupta(2005):Fundamentals of statistics, Vol.-I & II.
- Dass, M. N. &Giri, N. C.: Design and analysis of experiments. John Wiley.
- Dunn, O.J (1977): Basic Statistics: A primer for the Biomedical Sciences. John Wiley.
- Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York
- Goldstein, a Biostatistics-An introductory text (1971). The Macmillion New York.

Basics of Statistical Inference (Lab)

Practical   **Credit: 1   Full Marks: 20**

List of Practical

1. 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. Exact test for Binomial proportion.
5. Exact test for Poisson proportion
6. Chi-square test of proportions.
7. Chi-square tests of association.
8. Chi-square test of goodness-of-fit.
9. Test for correlation coefficient.
10. Sign test for median.
11. Sign test for symmetry.
12. Wilcoxon two-sample test

Course Outcome: The following are the course outcomes of the minor course

STAT 4021 (Basic Statistical Inference):
1. Students will be acquainted with statistical estimation, testing of hypotheses, and their applications in different real fields.
2. They will be able to apply Statistical Inference in the different activities in real life and in society based on the topics covered in this course.
3. They can perform some statistical hypotheses testing in some real field.

Semester – V

(MAJOR)

Course Code: STAT 5011   **Credit: 5   Full Marks: 75**

Large Sample Distribution and Nonparametric Methods

Course Objective: The following are the course objectives of the major course
STAT 5011 (Large Sample Distribution and Nonparametric Methods):
1. It gives the basic ideas about Large Sample Distribution and Nonparametric Methods.
2. The concepts of Large Sample Distribution are used in classical inference problems. The concepts of Nonparametric Methods are used in the inference problems.
3. The contents of this course will help the students to solve the critical inference problems where exact inference tests are inapplicable.

Theory   **Credit: 4   Full Marks: 40   Lecture Hours:60**

Large Sample Distribution: Large Sample Theory: Transformations of Statistics to stabilize variance: derivation and uses of Sin^{-1}, square root, Arctan transformation. Uses of logarithmic and z-transformations.

Large sample tests for binomial proportions, Poisson means (single and two independent samples cases) and correlation coefficients.

Large Sample distribution of Pearsonian χ^2 –statistic and its uses.**LH-45**

Nonparametric Methods: Introduction and Concept, Test for randomness based on total number of runs, Sign test, Signed rank test, Wilcoxon-Mann-Whitney test,Kruskal-Wallis test, Kolmogorov – Smirnov test.**LH-15**

Reference Books

➢ Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I, 8thEdn. The World Press, Kolkata
➢ Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition Marcel Dekker, CRC

➤ Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics.2nd Edn. (Reprint) John Wiley and Sons
➤ Casella, G. and Berger R.L. (2002). : Statistical Inference, 2nd Edn. Thomson Learning.

Large Sample Distribution and Nonparametric Methods (Lab)

Practical   **Credit: 1 Full Marks: 20 Lecture Hours: 30**

List of Practical

1. Large sample tests for proportions, rates and correlation coefficient.
2. Test for randomness based on total number of runs.
3. Kolmogorov -Smirnov test (one and two sample).
4. Sign test.
5. Signed rank test.
6. Wilcoxon-Mann-Whitney test.
7. Kruskal-Wallis test.

*Course Outcomes:*The following are the course outcomes of the major course
STAT 5011 (Large Sample Distribution and Nonparametric Methods):
1. Development of basic knowledge of large sample distribution and Nonparametric methods. It will help the students to solve some inference problems, where exact distributions of the test statistics are complicated.
2. Students will be able to solve inference problems for non-normal set-up encountered in real life situations.

Course Code: STAT 5012   Credit: 5   Full Marks: 75

Linear Models

Course Objective: The following are the course objectives of the major course STAT 5012 (Linear Models)
1. It imparts knowledge about the basic theories of linear models.
2. Linear models are used in diverse topics such as ANOVA, Design of Experiments, Regression Analysis etc. Students will be able to understand these topics based on the knowledge of linear models theories.
3. The contents of this course will help the students to solve the practical problems on several areas like agricultural and industrial statistics and bio-statistics.

Theory   **Credit: 4   Full Marks: 40 Lecture Hours:60**

Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance. Fundamental Theorems on least squares (statements only).

Regression analysis: Simple and Multiple linear regression- Estimation and hypothesis testing. Tests for parallelism, identity and linearity of regression.

Analysis of variance(ANOVA): 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 (with one concomitant variable) in two-way classified data with equal number of observations per cell, for fixed effect models. ANOVA of one-way classified data for random effect models.

Regression Diagnostics:Violation of assumptions concerning normality, Homoscedasticity and collinearity, Quantile-Quantile plots.

Reference Books

- ➢ Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
- ➢ Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
- ➢ Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.
- ➢ Scheffe, H. (1959): The Analysis of Variance, John Wiley.
- ➢ Goon, A.M., Gupta, M.K.: Das Gupta, B. (2005), Outline of Statistics, Vol.II, World Press, Calcutta.

Linear Models(Lab)

Practical   **Credit: 1 Full Marks: 20 Lecture Hours:30**

List of Practical

1. Simple Linear Regression.
2. Multiple Regression.

3. Tests for Linear Hypothesis.
4. Lack of fit.
5. Analysis of Variance of a oneway classified data.
6. Analysis of Variance of a twoway classified data with one and m (>1) observation per cell.
7. Analysis of Covariance of a one way classified data with one concomitant variable.
8. Analysis of Covariance of a two way classified data with one concomitant variable.
9. Analysis of Variance of a one way classified data for random effect model.

Course Outcome: The following are the course outcomes of the major course STAT 5012 (Linear Models):
1. Development of basic theoretical knowledge on Linear Models and its applications.
2. Students will be able to solve practical problems on different topics such as Design of Experiments, Regression Analysis, ANOVA and analysis of covariance (ANCOVA).

Course Code: STAT 5013   **Credit: 5   Full Marks: 75**

Sample Survey and Indian Official Statistics

Course Objective: The following are the course objectives of the major course STAT 5013 (Sample Survey and Indian Official Statistics):
1. It develops knowledge about the basic techniques of survey sampling and contents on Indian Official Statistics.
2. It imparts about the knowledge of basic sampling techniques used in surveys and overview of Indian official statistics systems.
3. The contents of this course will help the students to conduct sample surveys and to gain knowledge about the official statistics data and their uses.

Theory   **Credit: 4   Full Marks: 40 Lecture Hours:60**

Sample Survey: Concept of population and sample, complete enumeration versus survey sampling, sampling frame, sampling and non-sampling errors.

Types of sampling: probability and non-probability sampling, basic principle of sample surveys.

Simple random sampling (SRS): With and without replacement, estimating population mean, total and proportion, variances and their estimates; sample size determination.

Stratified random sampling: Estimating population mean and total, variances and their estimates, proportional and optimum allocations and their comparison with SRS, estimation of gain in precision due to stratification.

Systematic Sampling: Estimating population mean and total, variances and their estimates (N=n x k). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend.

Estimating population mean using Ratio and Regression methods of estimations and associated results. Concepts of cluster and two stage sampling including variance estimation.**LH-45**

Indian Official Statistics: An outline of present official statistical system in India, Methods of collection of officialstatistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), Registered General Office and National Statistical Commission. Government of India's Principal publications containing data on the topics such as Agriculture, price, population, industry, finance and employment.

National Income: Basic idea and a brief description of income, expenditure and production approaches.**LH-15**

Reference Books

- ➢ Cochran, W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
- ➢ Levy, P.S. and Stanley, L. (2008): Sampling of populations: Methods and Applications (4th edition)
- ➢ 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
- ➢ Murthy, M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.

- Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
- Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics (Vol.2), WorldPress.
- Guide to current Indian Official Statistics, Central Statistical Office, GOI, and New Delhi.
- http://mospi.nic.in/

Sample Survey and Indian Official Statistics (Lab)

Practical   Credit: 1 Full Marks: 20 Lecture Hours:30

List of Practical

1. Enumerate all possible samples of size n by WR and WOR and establish all properties relative to SRS.
2. Selecting SRS with and without replacement.
3. Estimating population mean and its variance using the drawn samples for SRSWR and SRSWOR.
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman'smethods. 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.
9. Two-stage Sampling.
10. Tabular and graphical exercises based on available official statistics.

Course Outcome: The following are the course outcomes of the major course
STAT 5013 (Sample Survey and Indian Official Statistics):

1. Development of basic theoretical and practical knowledge of survey sampling techniques.This course develops the ideas of Indian official data structures.
2. Students will be able to conduct a sample survey based on these courses. They will be able to develop a report of the survey sampling.
3. Students will be acquainted with the different sources of Indian official data structures.

Semester – VI

(MAJOR)

Course Code: STAT 6011   Credit: 4   Full Marks: 75

Design of Experiments

Course Objective: The following are the course objectives of the major course
STAT 6011 (Design of Experiments):
1. It gives the basic ideas about the data generating process by using random controlled experimental techniques.
2. This course is intended for planning and conducting experiments in an effective and efficient manner.
3. The contents of this course will help the students to develop knowledge for data generating and their proper analysis.

Theory   Credit: 3   Full Marks: 40 Lecture Hours: 45

Experimental designs: Role, historical perspective, terminology: Treatments, Experimental units& Blocks, Experimental error, Basic principles of Design of Experiments (R.A. Fisher).

Uniformity trials, fertility contour maps, choice of size and shape of plots and blocks in Agricultural experiments. Uses in Industrial Experiments.

Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency. Analysis with one missing observation in RBD and LSD.

Factorial experiments: advantages, notations and concepts. 2^n experiments: design and analysis. Total and Partial confounding for 2^n ($n \leq 3$). Factorial experiments in a single replicate.

Split Plot Design and Strip arrangements.

Reference Books

- Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
- Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II,8thEdn. World Press, Kolkata.
- Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
- Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.
- Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter DesignOptimization (Second edition), John Wiley.
- Dean, A.M. and Voss, D. (1999): Design and Analysis of Experiments. Springer Texts inStatistics.

Design of Experiments(Lab)

Practical   **Credit: 1 Full Marks: 20 Lecture Hours:30**

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. Analysis of 2^2 and 2^3 factorial in CRD and 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.
10. Analysis of a single replicate of a 2^n design.
11. Analysis of Split Plot and Strip Plot designs.

Course Outcome: The following are the course outcomes of the major course STAT 6011 (Design of Experiments):

1. Students will be acquainted with the process of generating random observations from an experimental design.
2. They can formulate different experimental designs under different scenarios along with corresponding analyses.
3. They can interpret many unknown problems and select the optimal levels based on the experimental data analysis. Students will be able to apply many critical techniques in the complex experimental situations.

Course Code: STAT 6012   Credit: 4   Full Marks: 75

Time Series Analysis and Index number

Course Objective: The following are the course objectives of the major course STAT 6012 (Time Series Analysis and Index number):

1. It gives the basic concepts about the time series data, analyses, predictions and index number for economic data.
2. Time series analysis helps to identify patterns and trends, and develops relevant models for forecasting. Index numbers measures "by how much a variable changes over time".
3. The contents of this course will help the students to understand the different components of a time series data and their implications in the real situations. In addition, students will be able to compare many real situations based on the knowledge of index numbers.

Theory   Credit: 3 Full Marks: 40 Lecture Hours: 45

Time Series Analysis: Introduction to time series data with examples from various fields.

Deterministic modelling of time series data- Components of a time series (trend, cyclical and seasonal patterns, random error), Decomposition of time series.

Estimation of trend- method of moving averages and fitting of various mathematical curves and growth curves.

Effect of elimination of trend on other components of the time series.

Estimation of seasonal component by Method of simple averages,

Notions of multiplicative models.

Introduction to stochastic modelling- Concept of stationarity. Illustration of how a stationary time series may show temporal patterns. Stationarity in mean.

Box-Jenkins modelling- Moving-average (MA) process and Autoregressive (AR) process of orders one and two. ACF, PACF and their graphical use in guessing the order of AR and MA processes. Estimation of the parameters of AR (1) and AR (2) using Yule-Walker equations.

Forecasting- Exponential smoothing and ARIMA methods.**LH-30**

Index Number: Review Price, Quantity and Value indices. Price Index Numbers: Construction, Formulae, Uses – base shifting and chain indices, limitations, Tests for index numbers, Variousformulae and their comparisons.**LH-15**

Reference Books

- Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
- Kendall M.G. (1976): Time Series, Charles Griffin.
- Brockwell and Davis (2010): Introduction to Time Series and Forecasting (Springer Texts in Statistics), 2nd Edition.
- Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics (Vol.2), WorldPress.
- Enders, W. (2013): Applied economic time series, third edition, Wiley

Time Series Analysis and Index number (Lab)

Practical   **Credit: 1 Full Marks: 20 Lecture Hours:30**

List of Practical

1. Plotting a real-life time series, and detecting various features (trend, periodic behaviours etc).

2. Fitting and plotting of mathematical trend curves:a. modified exponential curve; b. Gompertz curve
3. Estimating trend by Moving Average Method.
4. Plotting detrended series.
5. Measurement of Seasonal indices Ratio-to-Moving Average method
6. Plotting ACF and PACF of a given time series
7. Using Yule-Walker equation to fit AR (1) and AR (2) models to real life data.
8. Forecasting by simple exponential smoothing.
9. Construction of Consumer and wholesale price index numbers.

Course Outcomes: The following are the course outcomes of the major course STAT 6012 (Time Series Analysis and Index number):

1. Students will be acquainted with the time series data, their analysis, predictions and index number.
2. This course will help the students to understand the different components of a time series data and their implications in real life situations. In addition, student will also be able to compare real situations pertaining to economic changes over time based on knowledge of index numbers.

3. Students can interpret any real time series data. They will be able to apply many critical time series data analysis techniques in the complex real-life situations.

Course Code: STAT 6013   **Credit: 4   Full Marks: 75**

Statistical Quality Control and Demography

Course Objective: The following are the course objectives of the major course STAT 6013 (Statistical Quality Control and Demography):

1. It gives the basic ideas about statistical product and lot quality controland human population related studies.
2. It will impart the concepts of process and product quality techniques, and their measures.
3. Students will also be acquainted with different vital events and their measures.

Theory   Credit: 3   Full Marks: 40 Lecture Hours:45

Statistical Quality Control: Quality- Definition, dimensions of quality, historical perspective of quality control. Quality system and standards.

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.

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, estimation of process capability.

Acceptance sampling plan: Principle of acceptance sampling plans. Single 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.

Introduction to Six-Sigma: Overview of Six Sigma. Lean Manufacturing and Total Quality Management (TQM).

ISO quality standards and quality registration.**LH-21**

Demography: 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 (STDR).

Population Theories- Source and content errors in demographic data, use of balancing equations and Chandrasekaran-Deming formula to check completeness of registration data.Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

Stationary and Stable population, Central Mortality Rates and Force of Mortality.

LifeTables- Assumption, description, construction of Life Tables and Uses of Life Tables. 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, GrossReproduction Rate (GRR) and NetReproduction Rate (NRR). Population estimation.

Projection and Forecasting- Uses of A.P. andG.P. methods for population estimates,Logistic curve (Rhode's method)andGompertz curve.**LH-24**

Reference Books

- Mukhopadhyay, P. (1999): Applied Statistics, Books and Allied (P) Ltd.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9thEdition, World Press
- Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
- Keyfitz, N and Caswell. H (2005): Applied Mathematical Demography (3rd edition), Springer
- Chattopadhyay, A.K. and Saha, A.K. (2012): Demography: Techniques and Analysis, VivaBooks.
- Ramakuar, R. and Gopal, Y.S. (1986): Technical Demography. Wiley Eastern Ltd.
- Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
- Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
- Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition St. Lucie Press.
- Hoyle, David (1995): ISO Quality Systems Handbook, Heinemann Publication. 2nd Edition, Butterworth

Statistical Quality Control and Demography(Lab)

Practical   **Credit: 1 Full Marks: 20 Lecture Hours: 30**

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, and e. c-chart.
2. Single sample inspection plan- Construction and interpretation of OC curve.
3. To calculate CDR and Age Specific death rate for a given set of data.
4. To find STDR by direct and indirect methods.
5. To construct a complete life table.
6. To calculate CBR, GFR, SFR, TFR for a given set of data.
7. Calculate GRR and NRR.
8. Population Estimation.

Course Outcomes: The following are the course outcomes of the major course STAT 6013 (Statistical Quality Control and Demography):

1. Students will be acquainted with the product and lot quality control.
2. Students canmeasure, interpret vital events and growth of a population.
3. Students will be able to study human population and their vital events. In addition, students will be able to examine quality of a product and production processes.

Course Code: STAT 6014   Credit: 4   Full Marks: 75
Project/ Social Outreach

The project work should be done within thousand words based on the topics covered with in the syllabus.