St Aloysius College (Autonomous)

Mangaluru

Re-accredited by NAAC "A++" Grade

Course structure and syllabus of

B.Sc.

STATISTICS

Under NEP Regulations, 2021

¸À0vÀ C¯ÉÆÃ²AiÀÄ¸ï PÁ¯ÉÃdÄ
(¸ÁéAiÀÄvÀÛ)
ªÀÄ0UÀ¼ÀÆgÀÄ– 575 003, PÀ£ÁðlPÀ
www.staloysius.edu.in

ESTD : 1880

ST ALOYSIUS COLLEGE
(AUTONOMOUS)
P.B. NO. 720, MANGALURU – 575 003,
KARNATAKA, INDIA
Phone: +91- 0824-4117701, 4117702,
4117703, 4117704
Email: principal@staloysius.edu.in
aloysius.principal@gmail.com

Re-accredited by NAAC with '**A++**' Grade with CGPA 3.67/4 (Cycle 4)
Recognised as Centre for Research Capacity Building under UGC-STRIDE Scheme
Recognised under DBT – BUILDER Scheme, Government of India
College with "STAR STATUS" Conferred by DBT, Government of India
Recognised by UGC as "College with Potential for Excellence"

Date: 21-02-2022

NOTIFICATION

Sub: Syllabus of **B.Sc. STATISTICS** under NEP Regulations, 2021.
(As per Mangalore University guidelines)

Ref: 1. Decision of the Academic Council meeting held on 18-12-2021 vide Agenda No.6
2. Decision of the Academic Council meeting held on 09-07-2022 vide Agenda No.14
3. Decision of the Academic Council meeting held on 02-09-2023 vide Agenda No.3
4. Office Notification dated 21-02-2022
5. Office Notification dated 17-08-2022
6. Office Notification dated 26-09-2023

Pursuant to the above, the Syllabus of **B.Sc. STATISTICS** under NEP Regulations, 2021 which was approved by the Academic Council at its meeting held on 18-12-2021, 09-07-2022 & 02-09-2023 is hereby notified for implementation with effect from the academic year **2021-22**.

PRINCIPAL

ST ALOYSIUS COLLEGE MANGALORE 575 003 AUTONOMOUS

REGISTRAR

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

A meeting of the Board of Study in Statistics was held on 19/11/2021

Following members were present for the meeting.

1. Dr. Aruna Kalkur T (Chairperson)
2. Dr. Savitha Kumari (University Nominee), Associate Professor of Statistics, SDM College Ujire.
3. Mr. Umesh Pai (Subject Expert), Associate Professor of Statistics, MGM College, Udupi
4. Dr. Ashwini Kumari (Subject Expert), Asst. Professor of Statistics, Alva's College, Moodbidri
5. Ms. Sonal Caren D'souza, (Member) SAC, Mangaluru
6. Ms. Felicia Roza Martis, (Member) SAC, Mangaluru
7. Ms. Anvitha Jain (Member) SAC, Mangaluru
8. Ms. K Varsha (Student Representative)

Statistics BOS meeting conducted on 27/06/2022

The following members were present for BOS:

1. Dr. Aruna Kalkur T (Chairperson)
2. Dr. Savitha Kumari (University Nominee), Associate Professor of Statistics, SDM College Ujire.
3. Mr. Umesh Pai (Subject Expert), Associate Professor of Statistics, MGM College, Udupi
4. Dr. Ashwini Kumari (Subject Expert), Asst. Professor of Statistics, Alvas College, Moodbidri.
5. Ms. Sonal Caren D'souza, (Member) SAC, Mangaluru
6. Ms. Felicia Roza Martis, (Member) SAC, Mangaluru
7. Ms. Anvitha Jain (Member) SAC, Mangaluru
8. Ms. K Varsha (Student Representative)

BOS Meeting of Statistics (08-02-2023)

Members present:

1. Dr. Aruna Kalkur T. (Chairperson)
2. Mr Umesh Pai (University Nominee), Associate Professor of Statistics, MGM College, Udupi.
3. Dr. Ashwini Kumari (Subject Expert), NMAMIT, NITTE University, Mangalore.
4. Ms. Dhanya K (Subject Expert), Poorna Prajna College, Udupi.
5. Ms. Sonal Caren D'Souza, (Member) SAC, Mangaluru
6. Ms. Sowmya T., (Member) SAC, Mangaluru
7. Ms. Stephil M. P., (Member) SAC, Mangaluru
8. Ms. Anvitha Jain (Special Invitee)
9. Mr. Jesan Dsouza (Industry Nominee), Systems Engineer, TCS Ltd.
10. Ms. Varsha K (Meritorious Alumnus)
11. Mr Larren Peter Pinto (Student Representative)

Program Outcomes

By the end of the program the students will be able to:

1. Acquire a fundamental/systematic or coherent understanding of the academic field of Statistics and its different learning areas and applications.
2. Develop and demonstrate an ability to understand major concepts in various disciplines of Statistics.
3. Demonstrate the ability to use skills in Statistics and different practicing areas for formulating and tackling Statistics related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics.
4. Understand procedural knowledge that creates different types of professionals related to the subject area of Statistics, including professionals engaged in government/public service and private sectors.
5. Plan and execute Statistical experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations.
6. Have knowledge regarding the use of data analytics tools like Excel and R-programming.
7. Developed ability to critically assess a standard report having graphics and probability statements.
8. Analyze and interpret the data and hence help policymakers to take a proper decision.
9. Recognize the importance of statistical modeling and computing, and the role of approximation and mathematical approaches to analyze real problems using various statistical tools.
10. Demonstrate relevant generic skills and global competencies such as (i) Problem-solving skills that are required to solve different types of Statistics related problems with well-defined solutions, and tackle open-ended problems, that belong to the disciplinary-area boundaries.

Course Structure

Course Code	Title of course	Category of course	Teaching hours per week	SEE	CIE	Total Marks	Credits
SEMESTER I							
G 506 DC1.1	Descriptive Statistics	DSC	04	60	40	100	4
G 506 DC2.1 P	Descriptive Statistics Practical	DSC	04	60	40	100	2
G 506 OE1.1	Statistical Methods	OEC	03	60	40	100	2
SEMESTER II							
G 506 DC1.2	Probability Distributions	DSC	04	60	40	100	4
G 506 DC2.2 P	Probability Distributions Practical	DSC	04	60	40	100	2
G 506 OE1.2	Applied Statistics	OEC	03	60	40	100	2
SEMESTER III							
G 506 DC1.3	Differential Calculus and Probability Distributions	DSC	04	60	40	100	4
G 506 DC2.3 P	Differential Calculus and Probability Distributions Practical	DSC	04	60	40	100	2
G 506 OE1.3	Biostatistics	OEC	03	60	40	100	2
SEMESTER IV							
G 506 DC1.4	Statistical Inference-I	DSC	04	60	40	100	4
G 506 DC2.4 P	Statistical Inference-I Practical	DSC	04	60	40	100	2
G 506 OE1.4	Business Statistics	OEC	03	60	40	100	2

SEMESTER V

Course Code	Title of course	Category of course	Teaching hours per week	SEE	CIE	Total Marks	Credits
G 506 DC1.5	Matrix Algebra and Regression Analysis	DSC	4	60	40	100	4
G 506 DC2.5P	Matrix Algebra and Regression Analysis –Practical	DSC	4	25	25	50	2
G 506 DC3.5	Analysis of Variance and Designs of Experiments	DSC	4	60	40	100	4
G 506 DC4.5P	Analysis of Variance and Designs of Experiments –Practical	DSC	4	25	25	50	2

SEMESTER VI							
G 506 DC1.6	Statistical Inference II	DSC	4	60	40	100	4
G 506 DC2.6P	Statistical Inference II -Practical	DSC	4	25	25	50	2
G 506 DC3.6	Sampling Techniques and Statistics for National for National Development	DSC	4	60	40	100	4
G 506 DC4.6P	Sampling Techniques and Statistics for National for National Development -Practical	DSC	4	25	25	50	2

Assessment

Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	30	70
Practical	15	35 (30+5) (Practical record)
Projects	30	70
Experiential Learning (Internships, etc.)	30	70

Curriculum Structure for the Undergraduate Degree Program B.Sc.

Total Credits for the Program: 176 Starting year of implementation: 2021-22
Name of the Degree Program: B. Sc. Discipline/Subject: Statistics (Major)
Program Articulation Matrix

Sem	Title /Name of the course	Program outcomes that the course addresses	Pre-requisite course(s)	Pedagogy##	Assessment$
1	**Descriptive Statistics**	PO1, PO2, PO 8	Mathematics of 12th level	**1.** The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. **2.** Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written tests, open book examinations, viva-voce, seminars, and group discussions.
1	**Practical**	PO5, PO6	Mathematics of 12th level	The course is taught using Excel software and/or manually to carry out descriptive statistical analysis.	Assessment of learning through experiments
2	**Probability and**	PO7, PO9, PO10	Mathematics	**1.** The course is taught using the traditional chalk	The assessment is done using

	Distributions		of 12th level	and talk method using problem-solving through examples and exercises. **2.** Students are encouraged to use resources available on open sources	continuous assessment through written tests, open book examination, viva-voce, seminars, and group discussions.
2	**Practical**	PO5, PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments
3	Differential Calculus and Probability Distributions	PO7, PO9, PO10	Mathematics of 12th level	**1.** The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. **2.** Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written tests, open book examination, viva-voce, seminars, and group discussions.
3	Practical	PO5, PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments
4	Statistical Inference II	PO7, PO9, PO10	Mathematics of 12th level	**1.** The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. **2.** Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written tests, open book examination, viva-voce, seminars, and group discussions.
4	Practical	PO5, PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments
5	Matrix Algebra and Regression Analysis	PO7, PO9, PO10	Mathematics of 12th level	1. The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written tests, open book examination, viva-voce, seminars, and group discussions.

5	Practical	PO5, PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments
5	Analysis of Variance and Designs of Experiments	PO7, PO9, PO10	Mathematics of 12th level	1. The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written tests, open book examination, viva-voce, seminars, and group discussions.
5	Practical	PO5, PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments
6	Statistical Inference-II	PO7, PO9, PO10	Mathematics of 12th level	1. The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written tests, open book examination, viva-voce, seminars, and group discussions.
6	Practical	PO5, PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments
7	Sampling Techniques and Statistics for National Development		Mathematics of 12th level	1. The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises.	The assessment is done using continuous assessment through written tests, open book examination, viva-voce, seminars and group discussions.
7	Practical	PO5, PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments

Course Outcomes (COs)

At the end of the course the student should be able to:

1. Acquire knowledge of introductory statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences, etc.
2. Get knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion, etc.
3. Perceive knowledge of correlation, regression analysis, regression diagnostics, and partial and multiple correlations.
4. Learn different types of data reflecting independence and association between two or more attributes.
5. Develop an ability to critically assess a standard report having graphics and probability statements.
6. Conceptualize the probabilities of events including frequentist and axiomatic approaches. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem,
7. Get knowledge related to the concept of discrete and continuous random variables and their probability distributions including expectation and moments,
8. Learn knowledge of important discrete and continuous distributions such as Binomial, Poisson and Normal distributions.
9. Acquire knowledge of R-programming in descriptive statistics and probability models.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-10)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10
1. Knowledge of introductory statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences, etc.	X	X			X	X				
2. Knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion, etc.			X	X	X	X				X
3. Knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.				X	X	X		X		X
4. Knowledge of types of data reflecting independence and association between two or more attributes				X	X	X				X
5. Develop an ability to critically assess a standard report having graphics and probability statements.					X	X	X		X	
6. Knowledge to conceptualize the probabilities of events including frequentist and axiomatic approaches. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem.					X	X			X	X
7. Knowledge related to the concept of discrete and continuous random variables and their probability distributions including expectations and moments.					X	X			X	X
8. Knowledge of important discrete and continuous distributions such as Binomial, Poisson and Normal distributions.					X	X			X	X
9. Knowledge of R-programming in Descriptive Statistics and Probability Models.					X	X			X	X

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. 'X' in the intersection cell indicates that a particular course outcome addresses that particular program outcome.

B.Sc. Semester I

Course Title: Descriptive Statistics	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 hours
Model Syllabus Authors: State-level NEP-model curriculum setting committee members-Statistics	Summative Assessment Marks: 70

Title of the Course: Descriptive Statistics **Course Code: G 506 DC1.1**

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	56	2	52

Content of Theory Course 1	56 Hrs
Unit – 1: Introduction to Statistics	**13 Hrs**
Statistics: Definition and scope. Concepts of statistical population and sample (SRS, Stratified, Systematic and Cluster sampling methods Definitions only). Data: quantitative and qualitative, cross-sectional and time-series, discrete and continuous. Scales of measurement: nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical. Frequency distributions, cumulative frequency distributions and their graphical representations. Stem and leaf displays.	
Unit – 2: Univariate Data Analysis	**18 Hrs**
Measures of Central Tendency: Mean, weighted mean, trimmed mean, Median, Mode, Geometric and harmonic means, properties, merits & limitations and relation between these measures. Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation and their relative measures. Gini's Coefficient, Lorenz Curve. Moments, Skewness and Kurtosis. Quantiles and measures based on them. Box Plot. Outliers.	
Unit – 3: Bivariate Data Analysis	**15 Hrs**
Bivariate Data, Scatter plot, Correlation, Karl Pearson's correlation coefficient, the Rank correlation – Spearman's and Kendall's measures. Concept of errors, Principle of least squares, fitting of polynomial and exponential curves. Simple linear regression and its properties. Fitting of the linear regression line and coefficient of determination.	
Unit –4: Multivariate Data Analysis	**10 Hrs**
Analysis of Categorical Data: Contingency table, independence and association of attributes, measures of association - odds ratio, Pearson's and Yule's measure, Multivariate Frequencies, Multivariate Data Visualization, mean vector and dispersion matrix, Multiple linear regression.	

References

1. Agresti, A. (2010), Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.
2. Anderson T.W. and Jeremy D. Finn (1996), The New Statistical Analysis of Data, Springer.
3. Gupta, S.C. (2018), Fundamental of Statistics, Himalaya Publishing House, 7th Edition.
4. Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
5. Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
6. Joao Mendes Moreira, Andre C P L F de Carvalho, Tomas Horvath (2018), General Introduction to Data Analytics, Wiley.
7. Johnson, R.A. and Bhattacharyya, G.K. (2006), Statistics: Principles and methods. 5th Edition, John Wiley & Sons, New York.
8. Medhi, J. (2005), Statistical Methods, New Age International.

Pedagogy

1. The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total of 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7marks) + Attendance(3marks)	1/3
Total	**01**

Content of Practical Course 1 G 506 DC1.1P
(Computing all the practicals manually (2 hrs) and using Excel (2 hrs))

1. Presentation of data by frequency tables, diagrams & graphs, stem & leaf and partition values.
2. Arithmetic Mean (AM), geometric mean, harmonic mean, weighted AM, trimmed mean, corrected mean.
3. Mode, median and partition values.

4. Absolute and relative measures of dispersion, Box plots.
5. Problems on moments, skewness and kurtosis.
6. Fitting of curves by least squares method.
7. Product moment correlation coefficient and rank correlation.
8. Regression of two variables.
9. Multivariate Descriptive statistics, mean Vector, dispersion matrix correlation matrix
10. Problems on the Association of attributes.

Statistical Methods (Open Elective) G 506 OE1.1

Course Objectives

1. This is an open elective course for other than statistics students.
2. The students will learn the elements of descriptive statistics, probability, and statistical methods such as tests of hypotheses, correlation and regression.

Course Outcomes

Students will be able to

CO1. Acquire knowledge of statistical methods.

CO2. Identify types of data and visualization, analysis and interpretation.

CO3. Know about elementary probability and probability models.

CO4. Employ suitable test procedures for the given data set.

Pedagogy

The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. Students are encouraged to use resources available on open sources.

Statistical Methods **G 506 OE1.1**	**42 Hrs**
Unit –1: Introduction	**10 Hrs**
Definition and scope of Statistics. Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio. Presentation: tabular and graphic, including histogram and ogives. Concepts of statistical population and sample. Sampling from finite population - Simple random sampling, Stratified and systematic random sampling procedures	

(definitions and methods only). Concepts of sampling and non-sampling errors.	
Unit –2: Univariate and Bivariate Data Analysis	**16 Hrs**
Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis. Bivariate data, scatter diagram, Correlation, Karl Pearson's correlation coefficient, Rank correlation. Simple linear regression, the principle of least squares and fitting of polynomials and exponential curves.	
Unit –3: Probability and Distributions	**16 Hrs**
Probability: Random experiment, trial, sample space, events-mutually exclusive and exhaustive events. Classical, statistical and axiomatic definitions of probability, addition and multiplication theorems. Discrete and continuous random variables, probability mass and density functions, distribution functions, and expectation of a random variable. Standard univariate distributions: Binomial, Poisson and Normal distributions (Elementary properties and applications only).	

References

1. Daniel, W. W. (2007), Biostatistics - A Foundation for Analysis in the Health Sciences, Wiley.
2. Anderson T.W. and Jeremy D. Finn (1996), The New Statistical Analysis of Data, Springer.
3. Mukhyopadyaya P (1999), Applied Statistics, New Central Book Agency, Calcutta.
4. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers and Scientists.
5. Cochran, W G (1984), Sampling Techniques, Wiley Eastern, New Delhi.

B.Sc. Semester II

Course Title: Probability and Distributions	
Total Contact Hours: 56	Total Contact Hours: 56
Formative Assessment Marks: 30	Formative Assessment Marks: 30
Model Syllabus Authors: State-level NEP-model curriculum setting committee members-Statistics	Model Syllabus Authors: State-level NEP-model curriculum setting committee members-Statistics

Course Pre-requisite(s): II PUC with Mathematics

Title of the Course: Probability and Distributions **G506 DC1.2**

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	56	2	52

Content of Theory Course 2	**56 Hrs**
Unit –1: Probability	**15 Hrs**
Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability–classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.	
Unit –2: Random Variables and Mathematical Expectation	**12 Hrs**
Definitions of discrete and continuous random variables, Distribution function, probability mass and density functions – properties and illustrations, Expectation of a random variable and rules of expectation and related results, Moments and moment generating function – properties and uses.	
Unit –3: Standard Distributions	**15 Hrs**
Bernoulli, Binomial, Poisson - mean, variance, moments and m. g. f. recursive relations for probabilities. Discrete Uniform, Negative Binomial, Geometric, Hyper-Geometric distributions – mean and variance. Applications of all these distributions.	
Unit –4: Data Analysis Using R	**14 Hrs**
Introduction to R: Installation, command line environment, an 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 summarize a vector: sum, mean, sd, median, etc. Extracting a subset from the vector (by index, by the 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). Problems on discrete and continuous probability distributions.	

References

1. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.
2. Ross, S. (2002), A First Course in Probability, Prentice Hall.
3. Tukey, J.W. (1977), Exploratory Data Analysis, Addison-Wesley Publishing Co.
4. Dudewitz. E.J. and Mishra. S. N. (1998), Modern Mathematical Statistics, John Wiley.
5. Goon A.M., Gupta M.K., Das Gupta. B. (1991), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
6. Gupta. S.C and V.K. Kapoor (2020), Fundamentals of Mathematical Statistics, Sultan Chand and Co, 12th Edition.
7. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, Seventh Edition, Pearson Education, New Delhi.
8. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007), Introduction to the Theory of Statistics, 3rd Edition. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
9. Sudha G. Purohit, Sharad D. Gore, Shailaja R Deshmukh (2009), Statistics Using R, Narosa Publishing House.
10. R for beginners by Emmanuel Paradis (freely available at **https://cran.r project.org/doc/contrib/Paradisrdebuts_en.pd**

Pedagogy

1. The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar(7marks) +Attendance(3marks)	1/3
Total	**01**

Content of Practical Course 2:

List of Experiments to be conducted (Computing all the practicals manually and using Excel/R)

1. Computing probability: using addition and multiplication theorems.
2. Conditional probability and Bayes' theorem.
3. Two exercises on Descriptive statistics (Presentations, Summarizations, correlations, regression and Graphs using R)
4. Problems on pmf, expectation, variance, quantiles, skewness, kurtosis (Discrete Case).
5. Problems on pdf, expectation, variance, quantiles, skewness, kurtosis (Continuous case).
6. Problems on discrete probability distributions (Binomial, Poisson, Negative – Binomial, Geometric, and discrete uniform.
7. Computation of moments and Moment generating functions (Discrete and Continuous Case).
8. Fitting of distributions Binomial and Poisson distributions.
9. Generation of random samples. (Binomial, Poisson, Geometric Distributions)

Applied Statistics (Open Elective) G 506 OE1.2

Course Objectives

1. To enable the students to use statistical tools in finance, industries, population studies and health sciences.
2. To acquire knowledge about sampling methods for surveys.

Course Outcomes (CO)

Upon successful completion of this course, the student will be able to:

CO1. Understand the Price and Quantity Index numbers and their different measures and understand the applicability of the cost-of-living Index number.

CO2. Know the components & need for Time series and understand the different methods of studying trends and Seasonal Index.

CO3. Study the concept of vital statistics, sources of data and different measures of Fertility and Mortality and understand the Growth rates- GRR and NRR and

interpretations.

CO4. Know the concept of Population, Sample, Sampling unit, sampling design, sampling frame, sampling scheme, need for sampling, apply the different sampling methods for designing and selecting a sample from a population, explain sampling and non-sampling errors.

CO5. Describe the philosophy of statistical quality control tools as well as their usefulness In industry and hence develop quality control tools in a given situation.

Pedagogy

The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. Students are encouraged to use resources available on open sources.

Contents

Applied Statistics **G 506 OE1.2**	**42Hrs**
Unit –1: Index numbers	**16 Hrs**
Definition, Criteria for a good index number and different types of index numbers. Construction of index numbers of prices and quantities, consumer price index number. Uses and limitations of index numbers. Consumer price index number: Construction of consumer price index numbers. Applications of consumer price index numbers.	
Unit-2: Time Series Analysis	**16 Hrs**
Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of the trend by method of the free-hand curve, method of semi-averages and method of least squares (linear). Measurement of seasonal variations by the method of ratio to trend.	
Unit –3: Vital Statistics	**16 Hrs**
Sources of demographic data, errors in data. **Measurement of mortality:** crude death rate, specific death rates and standardized death rates, infant mortality rate, maternal mortality rate, neonatal mortality rates, merits and demerits and comparisons of various mortality rates. **Measurement of Fertility and Reproduction:** Fecundity, fertility, measurement of fertility, crude birth rate, general fertility rate, age-specific fertility rate and total fertility rates, merits and demerits of each measure of fertility, comparative study of these measures of fertility, Growth rates: Gross reproduction rate and Net reproduction rates.	

References

1. J. Medhi (1992), Statistical Methods, New Age International (P) Ltd. New Delhi.
2. 2. M.N. Das (1993), Statistical Methods and Concepts, Wiley Eastern Ltd.
3. Irwin Miller, John E Freund and Richard A Johnson (1992), Probability and Statistics for Engineers, Prentice Hall of India New Delhi.
4. Mukhopadhaya P (1998), Theory and Methods of Survey Sampling, Prentice Hall of India.
5. Mukhopadhyay P. (2011), Applied Statistics, 2nd ed. Revised reprint, Books and Allied.
6. Kendall M.G. (1976), Time Series, Charles Griffin.
7. Chatfield C. (1980), The Analysis of Time Series –An Introduction, Chapman & Hall.

B.Sc. Semester III

Course Title: Differential Calculus and Probability Distributions	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2 hours
Model Syllabus Authors: State-level NEP-model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Number of Theory Credits	**Number of lecture hours/semester**	**Number of practical Credits**	**Number of practical hours/semester**
4	**56**	**2**	**52**

Content of Theory Course 3	**56 Hrs**
Unit –1: Calculus and limit theorem	**10 Hrs**
Differential Calculus: Limits of function, continuous functions, and properties of continuous functions, partial differentiation, and total differentiation. Maxima and minima of functions. **Integral Calculus**: Review of integration and the definite integral. Differentiation under the integral sign. Beta and Gamma integrals: properties and relationship between them.	
Unit –2: Continuous Probability Distributions	**16 Hrs**
Uniform, Gamma (one and two parameters), Exponential, Beta (type 1 and type 2), distributions –definition through probability density function, mean, variance, moments; the additive property of exponentialand gamma variates, lack of memory property of exponential distribution. Cauchy and Weibull distribution - definition through p.d.f, properties, and uses. Bivariate normal distribution- definition through p.d.f.	
Unit –3: Sampling Distributions	**15 Hrs**
Definitions of a random sample, parameter and statistic, sampling distribution of the sample mean, standard error of the sample mean, sampling distribution of sample variance, and standard error of sample variance. Exact sampling distributions: Chi-Square distribution, mean, variance, moments, mode, additive property. Definition of Student's and Fishers t-distribution, mean, variance, moments, and limiting form of the t distribution. Snedecor's F-distribution: mean, variance and mode. Distribution of 1/F (n_1, n_2). Relationship between t, F, and χ^2 distributions (no proof).	
Unit –4: Simulation	**15 Hrs**
Introduction to simulation. Monte Carlo method. Generation of random observations from Uniform, Exponential, Cauchy distributions. Simple illustrations.	

Limit theorems: Chebychev's inequality- proof and its use in approximating probabilities; Convergence in probability; Statements of Weak Law of Large Numbers; Convergence in law and Central Limit theorems – De-Moivre, Laplace and some applications.	

References

1. Anderson T.W. and Jeremy D. Finn (1996), The New Statistical Analysis of Data, Springer.
2. Andre I Khuri (2003), Advanced Calculus with Applications in Statistics, SecondEdition, John Wiley & Sons.
3. Freedman, D., Pisani, R. and Purves, R. (2014), Statistics, 4th Edition, W. W. Norton & Company.
4. Gupta, S.C. (2018), Fundamental of Statistics, Himalaya Publishing House, 7th Edition.
5. Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
6. Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
7. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference,10th Edition, Pearson Education, New Delhi.
8. Joao Mendes Moreira, Andre C P L F de Carvalho and Tomas Horvath (2018), General Introduction to Data Analytics, Wiley.
9. Johnson, R.A. and Bhattacharyya, G.K. (2006), Statistics: Principles and methods. 5th Edition, John Wiley & Sons, New York.
10. Medhi, J. (2005), Statistical Methods, New Age International.
11. Rohatgi, V.K. and A.K. Md. Ehsanes Saleh. (2002), An Introduction to Probability Theory and Mathematical Statistics, New York, John Wiley.
12. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers andScientists, 5th Edition, Academic Press.
13. Shanthi Narayana (2000), Integral Calculus, S. Chand & Co. Ltd.
14. Shanti Narayana (2000), Differential Calculus, S. Chand & Co. Ltd

III Semester practicals:

Note: The first 2 practicals are on R-programming and R packages. Practicals 3 to 10 have to be first solved manually then results should be verified using R-programming.

1. Demonstration of R-packages required for calculus, distribution of random variables, standard probability distributions, sampling distribution, and simulation.
2. Demonstration of R functions required for calculus, distribution of random variables, standard probability distributions, sampling distribution, and simulation.
3. Practical in numerical differentiation and integration.
4. Bivariate Probability Distribution - Marginal and Conditional distributions, Conditional Mean,Conditional Variance, Correlation.
5. Applications problems of Chebyschev's inequality.
6. Applications of continuous probability distributions- Normal, Exponential, Gamma, Cauchy and Weibull distributions.
7. Fitting of discrete and continuous distributions.
8. Generating random samples from discrete distributions.
9. Generating random samples from continuous distributions.

Pedagogy

1. The course is taught using the traditional chalk and talk method using problem-solving throughexamples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	10
Internal Test 2	15
Assignment/Seminar (7 marks) + Attendance(3marks)	15
Total	**40**

Biostatistics (Open Elective) G 506 OE1.3

Course Objectives

1. To enable the students to identify the variables of biological studies and explore the tools of classification and presentation.
2. To study the probability notion, models and their applications in the study of biological phenomenon.
3. To acquire knowledge on sampling distribution and testing of hypotheses.

Course Learning Outcomes

After studying the course, the student will be able to apply statistical tools and techniques in data analysis of biological sciences.

Pedagogy

The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises. Students are encouraged to use resources available on open sources.

Contents

Biostatistics G 506 OE1.3	**42 Hrs**
Unit –1: Introduction to Bio-Statistics	**10 Hrs**
Definition and scope of Bio-Statistics, types of Data in Bio-Statistics. Difference between Statistics and Bio-Statistics. Scales of Measurement: nominal, ordinal, interval and ratio. Techniques of data collection. Classification and tabulation of data, construction of frequency table for grouped and ungrouped data.	
Unit–2: Sampling Distributions and Statistical Inference	**16 Hrs**
Concepts of random sample and statistic, Chi-square, t and F distributions (No derivations) and their applications. Estimation of population mean, population standard deviation. Testing of Hypothesis: Tests for variance, independence of attributes and goodness of fit. Two samples Mann- Whitney's U test and Kruskal Wallis H test.	
Unit –3: Introduction to design of experiments	**16 Hrs**
Gauss-Markov Theorem (meaning and statement only), testing of linear hypotheses, Basic principles of experimental design, uniformity trails, analysis of variance (One-way, two- way and three-way analysis).	

References

- Robert R Sokal and F. James Rohlf (2009), Introduction to Biostatistics, Dover Publications.Inc.
- Dutta, N. K. (2004), Fundamentals of Biostatistics, Kanishka Publishers.
- Gurumani N. (2005), An Introduction to Biostatistics, MJP Publishers.
- Daniel, W. W. (2007), Biostatistics - A Foundation for Analysis in the Health Sciences, Wiley.
- Rao, K. V. (2007), Biostatistics - A Manual of Statistical Methods for use in Health Nutrition And Anthropology.
- Pagano, M. and Gauvreau, K. (2007), Principles of Biostatistics.
- Rosner Bernard (2010), Fundamentals of Biostatistics, 6thEdition, Duxbury.

B.Sc. SEMESTER IV

Course Title: Statistical Inference-I	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2 hours
Model Syllabus Authors: State-level NEP-model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Number of Theory Credits	**Number of lecture hours/semester**	**Number of practical Credits**	**Number of practical hours/semester**
4	**60**	**2**	**52**

Content of Theory - Statistical Inference-I	**56 Hrs**
Unit –1: Point Estimation	**18 Hrs**
Families of distributions- location and scale families. Single parameter exponential family. Concept of ordered statistics (For maximum and minimum with proof and for r^{th} order without proof). Concepts of estimator and estimate. Criteria for estimators: Unbiasedness, Consistency. Invariance property of consistent estimators. Efficiency and relative efficiency. Mean squared error as a criterion for comparing estimators. Sufficient statistics. Statement of Neyman-Factorization theorem. Fisher information function. Statement of Cramer–Rao inequality and its applications.	
Unit –2: Methods of Estimation and Basics of Testing of Hypothesis	**12 Hrs**
Maximum likelihood and method of moment estimation; Properties of MLE and moment estimators and examples. Statistical hypotheses - null and alternative, Simple and composite hypotheses. Type-I and Type-II errors, test functions. Randomized and non-randomized tests. Size, level of significance, Power function, power of tests. The critical region, p-value, and its interpretation.	
Unit –3: Testing of Hypothesis	**14 Hrs**
Large and small sample tests of significance. Tests for single mean, equality of two means, single variance, and equality of two variances for normal populations. Tests for proportions. Most Powerful (MP) and UMP test. Statement of Neyman-Pearson Lemma and its applications.	
Unit –4: Interval Estimation	**12 Hrs**
Confidence interval, confidence coefficient, shortest confidence interval. Methods of constructing confidence intervals using pivotal quantities. Construction of confidence intervals for mean, a difference of two means, variance and ratio of variances, proportions, a difference of two proportions, and correlation coefficient.	

References:

1. Anderson T.W. and Jeremy D. Finn (1996), The New Statistical Analysis of Data, Springer
2. Freedman, D., Pisani, R. and Purves, R. (2014), Statistics, 4th Edition, W. W. Norton& Company.
3. Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
4. Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
5. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, 10th Edition, Pearson Education, New Delhi.
6. Joao Mendes Moreira, Andre C P L F de Carvalho, Tomas Horvath (2018), General Introduction to Data Analytics, Wiley.
7. Johnson, R.A. and Bhattacharyya, G.K. (2006), Statistics: Principles and methods. 5th Edition, John Wiley & Sons, New York.
8. Kale. B. K. (1999), *A First Course on Parametric Inference*, New Delhi, Narosa Publishing House.
9. Kendall, M.G., et. al., (1996), *An Introduction to the Theory of Statistics*, Universal Book Stall.
10. Medhi, J. (2005), Statistical Methods, New Age International.
11. Rohatgi, V.K. and A.K. Md. Ehsanes Saleh. (2002), An Introduction to Probability Theory and Mathematical Statistics, New York, John Wiley.
12. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.

IV Semester practicals

Note: The first practical is on R programming and R packages. Practicals 2 to 10 have to be first solved manually then results should be verified using R-programming.

1. Demonstration of R-packages and R-functions required for estimation and testing of hypothesis.
2. Point estimation of parameters and obtaining an estimate of standard errors.
3. Comparison of estimators by plotting mean square error.
4. Computing maximum likelihood estimates.
5. Computing moment estimates.
6. Interval estimation – I: Construction of confidence interval (large sample)
7. Interval estimation – II: Construction of confidence interval (small sample)
8. Evaluation of Probabilities of Type – I and Type – II errors and power of tests.
9. Large Sample tests.
10. Small Sample tests.

Pedagogy

1. The course is taught using the traditional chalk and talk method using problem-solving throughexamples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total of 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	10
Internal Test 2	15
Assignment/Seminar (7 marks) +Attendance (3marks)	15
Total	**40**

Business Statistics (Open Elective) G 506 OE1.4

Course Objectives

1. Provide an introduction to the basics of statistics within a financial context.
2. To enable students to use statistical techniques for the analysis and interpretation of business data.

Course Outcomes (CO)

Upon the completion of this course students should be able to:

CO1. Frame and formulate management decision problems.

CO2. Understand the basic concepts underlying quantitative analysis.

CO3. Use sound judgment in the applications of quantitative methods to management decisions.

Pedagogy

1. The course is taught using the traditional chalk and talk method using problem-solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Contents

Business Statistics (Open Elective) G 506 OE1.4	**42 Hrs**
Unit –1: Ratios and Proportions, Percentages, Interests and Discounts	**16 Hrs**
Ratios & Proportions- Direct proportion, Inverse proportion, Compound proportions & problems. Percentages. Trade discount & cash discount - Problems. Concept of Simple interest & compound interest- nominal & effective rate of interest- Problems on all these. Compound interest for fraction of year, Compound interest when rate changes year by year - Problems and Depreciation-problems.	
Unit –2: Bill discounting and Bankers Gain	**10 Hrs**
Bill discounting. Concept of true discount & bankers' discount - Problems. Banker's gain, Banker's present value, True present value, equated due date-Problems.	
Unit –3: Annuities	**16 Hrs**
Concept of the annuity. Different types of annuities - Annuity immediate, annuity due & Problems. Concept of perpetuity & Problems. Deferred annuity - Problems. Deferred perpetuity problems.	

References

1. Dr. B. H.Suresh, Quantitative Techniques, Chetana Book House.

2. Dr. Padmalochan Hazarika (2016), A Textbook of Business Mathematics, S. Chand, New Delhi, No. 4.

3. A. P. Verma (2007), Business Mathematics, Asian Books Private Limited, New Delhi, No. 3, January.

4. D. C. Sancheti & V. K. Kapoor (2014), Business Mathematics, S. Chand, New Delhi.

5. A Lenin Jothi (2009), Financial Mathematics, Himalaya Publications, Mumbai, No. 1.

6. B. M. Aggarwal (2015), Business Mathematics, Ane Books Pvt. Ltd., No. 5.

7. Bragg, S. M. (2012), *Business ratios and formulas: A comprehensive guide* (3rd ed.), Hoboken, N.J.: Wiley.

V Semester

Course Title: **Matrix Algebra and Regression Analysis**	
Total Contact Hours: 42	Course Credits: 04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2 hours
Model Syllabus Authors: State level NEP-model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
3	**56**	**2**	**32**

B.Sc. Semester V

DSC B5 'Matrix Algebra and Regression Analysis'

Content of Theory Paper 5	**56 Hrs**
UNIT 1: Matrix Algebra	**14 Hrs**
Matrix Operations, The Inverse of a Matrix, Characterization of invertible matrices, Linear Equations in Linear Algebra, System of Linear equations, Row reduction and Echelon forms, Vector equations, The matrix equation Ax=b, Solution sets of linear systems.	
UNIT 2: Regression Models	**14 Hrs**
Simple linear regression model, least squares method, coefficient of determination, model assumptions, testing for significance of model parameters, point and interval estimation using the estimation regression equation, prediction, residual analysis.	
UNIT 3: Multiple Regression Models and Regression Analysis	**14 Hrs**
Estimation of model parameters, hypothesis testing and confidence intervals, prediction, regression diagnosis. Model building, general linear model, addition or deletion of variables.	
UNIT 4: Variable Selection Procedures:	**14 Hrs**
Stepwise regression, forward and backward elimination procedures, best-subsets regression, Mallow's ${}^{2}C_{p}$, residual analysis. Multiple regression approach to analysis of variance and experimental design.	

References:

1. John P. Hoffmann (2021), Linear Regression Models: Applications in R, Chapman & Hall/CRC
2. Jordan Archie (2021), Introduction in to Logistic Regression
3. Gilbert Strang (2020), Linear Algebra for Everyone, Wellesley-Cambridge-Press.
4. Suddhendu Biswas (2012), Matrix Algebra, ISBN-13:978-8120346239, ISBN-10:8120346238
5. Douglas G. Montgomery (2001), Design and Analysis of experiments, John Wiley & sons.
6. Fred L. Ramsey and Daniel W. Schafer (1997), The statistical Sleuth: a course in methods of Data Analysis, Duxbury Press.
7. D. C. Montgomery, E. A. Peck, G. G. Vining (2003), Introduction to Linear Regression Analysis, John Wiley & sons.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	40

Contents of Practical DSC B5

Note: The first practical assignment is on R-programming. Practical assignments 2 to 8 have to be first solved manually (using scientific calculators) and executed using R-programming.

1. Exercise on Solving simultaneous equations
2. Exercise on Simple Linear Regression.
3. Regression Diagnostics for Simple Linear Regression.

4. Exercise on Multiple Linear Regression.
5. Regression Diagnostics for Multiple Linear Regressions.
6. Exercise on Residual Analysis.
7. Variable selection procedure.
8. ANOVA using Multiple Regression approach

Course Title: **Analysis of Variance and Designs of Experiments**	
Total Contact Hours: 42	Course Credits: 04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2 hours
Model Syllabus Authors: State level NEP-model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Number of TheoryCredits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
3	56	2	32

DSC B6 'Analysis of Variance and Designs of Experiments'

Content of Theory Paper 6	**56Hrs**
UNIT 1: Analysis of variance	**15 Hrs**
Meaning, basic assumptions Gauss Markov model and Gauss Markov and Cochran's Theorem (Statement only), fixed effect model. Analysis of one way, two way and three way classified data with one observation per cell, mathematical model, least square estimates, splitting of total sum of squares, expectation of sums of squares and mean sums of squares (under appropriate hypothesis) and ANOVA table. Critical difference and comparison of treatment means.	
UNIT 2: Designs of experiments	**20 Hrs**
Meaning and terminology - experiment, treatment, experimental unit, experimental error and precision, uniformity trials. Principles of experimental design, choice of size of plot, shape of blocks and plot.	

CRD, RBD and LSD: Layout, model, splitting of total sums of squares, least square estimates of effects, ANOVA tables, comparison of treatment means. Advantages and limitations of each design. Efficiency of a design, efficiency of RBD over CRD and LSD over RBD.	
UNIT 3: Missing plot technique	**06 Hrs**
Estimation of one and two missing observations in RBD and LSD (least square estimates). ANOVA in case of missing observations.	
UNIT 4: Factorial experiments	**15 Hrs**
Meaning and advantages. 2^2 and 2^3 factorial experiments in RBD and LSD, main and interaction effects. Yates's method of computing factorial effect totals, ANOVA table and inferences. Contrasts and orthogonal contrasts, advantages of factorial experiment. Meaning of confounding, partial and multiple confounding and complete confounding in 2^2 factorial experiments in RBD.	

References:

1. Douglas C. Montgomery (2020), Design and Analysis of experiments, Wiley 10th Edition.
2. S.C. Gupta and V.K. Kapoor (2019), Applied Statistics, Sultan Chand & Co.
3. Das M.N. (2019), Design and Analysis of experiments, New Age International (P) Ltd.
4. Angela Dean, Danel Draguljic & Daniel Voss (2017), Design and Analysis of Experiments, 2nd Edition, Springer.
5. M.N. Das and N.C. Giri (1997), Design and analysis of experiments, New Age International (P) Ltd. Publishers.
6. B. L. Agarwal, (2011), Theory and Analysis of Experimental Designs, CBS Publishers and Distributors.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving throughexamples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar/Project	10
Total	40

Contents of Practical DSC B6

Note: The first practical assignment is on R-programming. Practical assignments 2 to 8 have to be first solved manually (using scientific calculators) and executed using R-programming.

1. Analysis of variance.
2. Analysis of CRD.
3. Analysis of RBD.
4. Analysis of LSD.
5. Missing plot technique - RBD & LSD Single value missing.
6. Missing plot technique-RBD & LSD-two values missing.
7. Analysis of 2^2 factorial experiments.
8. Analysis of 2^3 factorial experiments.

B.Sc. VI Semester

Course Title: **Statistical Inference II**	
Total Contact Hours: 42	Course Credits:04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2 hours
Model Syllabus Authors: State level NEP-modelcurriculum setting committee members-Statistics	Summative Assessment Marks: 56

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
3	56	2	2

DSC B7 'Statistical Inference II'

Content of Theory Paper 7	Hrs
UNIT 1: Non – Parametric Tests-I	**16 Hrs**
Advantages and limitations, applications of non-parametric test, Sign test for one sample and for pairs of observations. Two sample median test. Run test for randomness. Two sample run test. Null distribution of test statistic to be derived in each case. Large sample approximation to these tests.	
UNIT 2: Non – Parametric Tests-II	**12 Hrs**
Mann Whitney U test, Wilcoxon Signed-Rank test, Kruskal Wallis test, Kolmogrov Smirnov test for one sample, comparison of parametric and non-parametric tests.	
UNIT 3: Sequential testing	**14 Hrs**
Need for sequential test, Strength of sequential tests. Wald's SPRTP applied to Bernoulli, Poisson, Exonential and Normal distributions with the proof of expressions for constants.	
UNIT 4: Chi-square tests	**14 Hrs**
Test of goodness of fit and independence of attributes in contingency tables, Derivation of Brandt-Snedecor's formula, Chi-square test for 2X2 contingency table. Yates correction for continuity.	

References:

1. S.C.Gupta and V.K. Kapoor (2021), Fundamentals of Mathematical Statistics, Sultan Chand and Co. New Delhi.
2. Hogg R.V and Craig (2014), AT Introduction to Mathematical Statistics Mac Milan, New York.
3. Parimal Mukhopadhyay P (2014), Mathematical Statistics, Books and Applied (P) Ltd. Kolkata.
4. D.W.Wackerly, L.Mendenhall, R.L. Scheafres (2002), Mathematical Statistics with Applications, Duxbury Advance Series.
5. R.V. Hogg and E.A. Tanis (2001), Probability and Statistics, Pearson Education Asia.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar/Project	10
Total	40

Contents of Practical Paper VII-'Statistical Inference II'

Note: The first practical assignment is on R-programming. Practical assignments 2 to 8 have tobe first solved manually (using scientific calculators) and executed using R-programming.

1. Non-parametric test-(1) Sign test and Median test. (Small and Large samples).
2. Non-parametric test-(2) Run test. (Small and Large samples)
3. Non-parametric test-(3) Kruskal Wallis test, Kolmogrov Smirnov test
4. Non-parametric test-(4) Mann Whitney U test, Wilcoxon Signed-Rank test
5. SPRTP-(1) Bernoulli and Poisson distribution
6. SPRTP-(2) Exponential distribution
7. SPRTP-(3) Normal distribution (Mean and Variance)
8. Test for goodness of fit.
9. Test for Independence of Attributes in contingency tables.

Formative Assessment: Total 25 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	5
Total	25

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar/	10
Total	40

Course Title: **Sampling Techniques and Statistics for National Development**	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2 hours
Model Syllabus Authors: State level NEP-modelcurriculum setting committee members-Statistics	Summative Assessment Marks: 56

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
3	56	2	2

DSC B8- Sampling Techniques and Statistics for National Development

Content of Theory Paper 8	56 Hrs
UNIT 1: Introduction to Sampling theory	**15 Hrs**
Objectives and principles of sampling theory, concept of population and sample, Complete enumeration or Census survey v/s sample surveys – merits and demerits, framing of the questionnaire. Probability sampling and Judgment sampling, Principles of sample surveys. Principal steps in sample survey, Errors in sampling. Various methods of sampling, Concepts of parameters, estimators, Bias, mean square error, accuracy and precision of estimators. Selection of samples using random numbers. Drawing samples from finite populations with and without replacement. Sampling from frequency distributions and contingency Tables.	
UNIT 2: Simple Random Sampling with and without replacement	**12 Hrs**
Meaning of SRSWR and SRSWOR. Unbiased estimators of mean, variance, mean square deviation and population total with respect to SRSWR and SRSWOR. Sampling variances, standard errors and their estimation, Comparison of SRSWR with SRSWOR. Methods of sample size estimation. Applications of simple random sampling.	
UNIT 3: Stratified Sampling and Systematic Sampling	**15 Hrs**
Need for stratification, Stratified sampling under SRSWOR, Unbiased estimators of mean and total. Variances of these estimators and their estimation. Allocation of sample size – proportional and optimum allocation (SRSWOR stratification only), Neyman's allocation, allocation with cost functions. Comparison of SRSWOR and stratified sampling. Gain in efficiency due to stratification. **Systematic sampling:** Estimation of mean. Variance of the estimator of mean in terms of S^2_{wsy} and intra class correlation. Comparison of SRSWOR and systematic sampling.	
UNIT 4: National Development	**14 Hrs**
An outline of present official statistical system in India, Role, function, and activities of Central and State Statistical organizations. Methods of collection of official statistics, their reliability and limitations. Central Statistical Office (CSO), National Sample Survey Office (NSO), Registrar General Office and National Statistical Commission. Scope and content of Population census of India. Population census methods, economic	

census. Methods of national income estimation, problems in the estimation of national income. System of collection of Agricultural Statistics. Crop yield, Production Statistics, Crop estimation and forecasting. Statistics related to industries, foreign trade, balance of payment, cost of living, inflation, educational and other social statistics	

References:

1. S. C. Gupta & V. K. Kapoor (2021) Fundamentals of Applied Statistics, Sultan Chand & Co.
2. Changbao Wu, Mary E. Thompson (2020), Sampling Theory and Practice, Springer.
3. Sampath (2001), Sampling theory and methods, Narosa Publishing House.
4. Cochran W. G. (1984), Sampling Techniques – 3rd edition, Wiley Eastern.
5. Singh D. Chaudhary F. S. (1986), Theory and Analysis of Sampling Survey Design – Wiley Eastern.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving throughexamples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	10
Internal Test 2	10
Assignment/Seminar/Project)	20
Total	40

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
CO1.Understand the principles underlying sampling as a means of making inferences about a population.	X	X	X	X					X	X		
CO2.Understand the difference between probability and nonprobability sampling.	X	X	X	X					X	X		
CO3. Understand different sampling techniques.	X	X	X	X					X	X		
CO4. To learn to estimate population parameters from a sample.	X	X	X	X					X	X		
CO5. Understand official statistical system in India and their functions.	X	X	X	X					X	X		
CO6. Understand the role statistics in national development.	X	X	X	X					X	X		

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per NEP guidelines are compulsory	

Course Title	Sampling techniques and Statistics for national development **(Practical)**	Practical Credits	**2**
Course Code	**STAC17-P**	Contact Hours	**56 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Pedagogy: Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

1. Drawing of random sample under SRSWOR from a given population and estimation of the mean and total and the standard error of the estimator.
2. Drawing of random sample under SRSWR from a given population and estimation of the mean and total and the standard error of the estimator.
3. Construction of Confidence Intervals for mean and total for SRSWR and SRSWOR.
4. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWR
5. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWOR.
6. Estimation of the mean, total and the standard error of the estimator under stratified random sampling.
7. Exercise on allocation of samples in Stratified sampling. (Proportional Allocation)
8. Exercise on allocation of samples in Stratified sampling. (Neyman Allocation)
9. Systematic sampling
10. Estimation techniques in official statistics.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	5
Total	**25 Marks**
Formative Assessment as per NEP guidelines are compulsory	

References

1 Cochran, W. G. (2007): Sampling Techniques, Third Edition, Wiley India Pvt. Ltd., New Delhi.

2 Changbao Wu and Mary E. Thompson (2020): Sampling Theory and Practice, Springer Nature Switzerland.

3 Raghunath Arnab (2017): Survey Sampling Theory and applications (2017), Elsevier

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 Murthy, M. N. (1967): Sampling Theory and Methods, Statistical Publishing Society, Kolkata.

7 Mukhopadhyay P (2008): Theory and methods of survey sampling. Prentice-Hall of India, New Delhi

8 Mukhopadhyay, P. (1998): Theory and Methods of Survey Sampling. Prentice Hall

9 Singh, D. and Chaudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi.

10 Sukhatme, P.V., Sukhatme, B. V.(1984): Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi.

11 Sampath S. (2005): Sampling Theory and Methods, Second edition, Narosa, New Delhi.

12 Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi. http://mospi.nic.in/

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per NEP guidelines are compulsory	

Course Title	Sampling techniques and Statistics for national development **(Practical)**	Practical Credits	**2**
Course Code	**STAC17-P**	Contact Hours	**56 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

1. Drawing of random sample under SRSWOR from a given population and estimation of the mean and total and the standard error of the estimator.
2. Drawing of random sample under SRSWR from a given population and estimation of the mean and total and the standard error of the estimator.
3. Construction of Confidence Intervals for mean and total for SRSWR and SRSWOR.
4. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWR
5. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWOR.
6. Estimation of the mean, total and the standard error of the estimator under stratified random sampling.
7. Exercise on allocation of samples in Stratified sampling. (Proportional Allocation)
8. Exercise on allocation of samples in Stratified sampling. (Neyman Allocation)
9. Systematic sampling
10. Estimation techniques in official statistics.

Pedagogy: Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	5
Total	**25 Marks**
Formative Assessment as per NEP guidelines are compulsory	

References

1 Cochran, W. G. (2007): Sampling Techniques, Third Edition, Wiley India Pvt. Ltd., New Delhi.

2 Changbao Wu and Mary E. Thompson (2020): Sampling Theory and Practice, Springer Nature Switzerland.

3 Raghunath Arnab (2017): Survey Sampling Theory and applications (2017), Elsevier

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 Murthy, M. N. (1967): Sampling Theory and Methods, Statistical Publishing Society, Kolkata.

7 Mukhopadhyay P (2008): Theory and methods of survey sampling. Prentice-Hall of India, New Delhi

8 Mukhopadhyay, P. (1998): Theory and Methods of Survey Sampling. Prentice Hall

9 Singh, D. and Chaudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi.

10 Sukhatme, P.V., Sukhatme, B. V.(1984): Sampling theory of Surveys with Applications, Indian
Society of Agricultural Statistics, New Delhi.

11 Sampath S. (2005): Sampling Theory and Methods, Second edition, Narosa, New Delhi.

12 Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi. http://mospi.nic.in/

****