St Aloysius College (Autonomous)

Mangaluru

Re-accredited by NAAC "A++" Grade

Course structure and syllabus of

B.Sc.

STATISTICS

Under NEP Regulations, 2020
(2021-2023 Batch)

ಸಂತ ಅಲೋಶಿಯಸ್ ಕಾಲೇಜು
(ಸ್ವಾಯತ್ತ)
ಮಂಗಳೂರು– 575 003, ಕರ್ನಾಟಕ
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ESTD : 1880

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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, 2020.
(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 25-02-2023 vide Agenda No. 12
4. Decision of the Academic Council meeting held on 02-09-2024 vide Agenda No. 3
5. Office Notification dated 21-02-2022
6. Office Notification dated 17-08-2022
7. Office Notification dated 30-03-2023
8. Office Notification dated 26-09-2023

Pursuant to the above, the Syllabus of **B.Sc. Statistics** under NEP Regulations, 2020 which was approved by the Academic Council at its meeting held on 18-12-2021, 09-07-2022, 25-02-2023 & 02-09-2024 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. 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.
5. Have knowledge regarding the use of data analytics tools like Excel and R-programming.
6. Recognize the importance of statistical modeling and computing, and the role of approximation and mathematical approaches to analyze real problems using various statistical tools.
7. 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.

Summary of Discipline Specific Courses (DSC)			
Semester	**Course Code**	**Title of the Paper**	**Credits**
I	DSC B1	Descriptive Statistics	4
		Practicals based on DSC B1	2
II	DSC B2	Probability and Distributions	4
		practical's based on DSC B2	2
III	DSC B3	Calculus and Probability Distributions	4
		Practical's based on DSC B3	2
IV	DSC B4	Statistical Inference-I	4
		Practical's based on DSC B4	2
V	DSC B5	**Matrix Algebra and Regression analysis**	3
		Practical's based on DSC B5	2
	DSC B6	**Analysis of Variance and Design of experiments**	3
		Practical's based on DSC B6	2
		DSE1 (Operation Research)	3
VI	DSC B7	**Statistical Inference-II**	3
		Practical's based on DSC B7	2
	DSC B8	**Sampling Techniques and Statistics for National Development**	3
		Practical's based on DSC B8	2
		DSEE2 (Total Quality Management)	3

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	Practical G 506 DC1.1	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 and Distributions	DSC	04	60	40	100	4
G 506 DC2.2 P	Practical G 506 DC1.2	DSC	04	60	40	100	2
G 506 OE1.2	Applied Statistics	OEC	03	60	40	100	2
SEMESTER III							
G 506 DC1.3	Calculus and Probability Distributions	DSC	04	60	40	100	4
G 506 DC2.3 P	Practical G 506 DC1.3	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						
G 506 DC2.4 P	Practical G 506 DC1.4						
SEMESTER V							
G 506 DC1.5	Matrix algebra and Regression Theory	DSC	04	60	40	100	4
G 506 DC2.5 P	Practical G 506 DC1.5	DSC	04	60	40	100	2
G 506 DC3.5	Analysis of Variance and Designs of Experiment	DSC	04	60	40	100	4
G 506 DC4.5 P	Practical G 506 DC3.5	DSC	04	60	40	100	2
SEMESTER VI							
G 506 DC1.6	Sampling Theory and Development Statistics	DSC	04	60	40	100	4
G 506 DC2.6 P	Practical G 506 DC1.5	DSC	04	60	40	100	2
G 506 DC3.6	Analysis of Variance and	DSC	04	60	40	100	4

	Designs of Experiment						
G 506 DC4.6 P	Practical G 506 DC3.5	DSC	04	60	40	100	2
G 506 DE5.6	Total Quality Management	DSE	03	60	40	100	3
	INTERNSHIP						

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**
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	X	
3. Knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.				X	X	X		X		X	X	
4. Knowledge of types of data reflecting independence and association between two or more attributes				X	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. Chebyshev's inequality, normal data sets.	
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, multiple and partial correlation coefficients. Residual error variance.	

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 Regression.
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 Binomial distribution.
9. Fitting of Poisson distribution.
10. 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), Analysis of Time Series –An Introduction, Chapman

B.Sc. Semester III

Course Title: 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 exponential and 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 tobe 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

1. Robert R Sokal and F. James Rohlf (2009), Introduction to Biostatistics, Dover Publications.Inc.
2. Dutta, N. K. (2004), Fundamentals of Biostatistics, Kanishka Publishers.
3. Gurumani N. (2005), An Introduction to Biostatistics, MJP Publishers.
4. Daniel, W. W. (2007), Biostatistics - A Foundation for Analysis in the Health Sciences, Wiley.
5. Rao, K. V. (2007), Biostatistics - A Manual of Statistical Methods for use in Health Nutrition And Anthropology.
6. Pagano, M. and Gauvreau, K. (2007), Principles of Biostatistics.
7. 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	**56**	**2**	**52**

Content of Theory Course 3	**56 Hrs**
Unit –1: Point Estimation	**18 Hrs**
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 (Applications for Bernoulli, Binomial, Poisson, Normal, Uniform, Exponential, Gamma, Beta and other distributions).	
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. (for Bernoulli, Binomial, Poisson, Geometic, Normal, Uniform, Exponential, Gamma, Beta and other distributions). 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.	

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 Practical

Note: The first practical is on R programming and R packages. Practical 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**

Program Name	**BSc in STATISTICS**	Semester	**V**
Course Title	**Matrix algebra and Regression Analysis (Theory)**		
Course Code:	**STAC9-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Demonstrate and understanding of basic concepts of matrix algebra, including determinants, inverseand properties of various types of matrices.

CO2. Apply matrix algebra and linear algebra techniques to solve systems of linear equations, determine the rank of matrix, understanding quadratic forms and their applications in statistics, characteristicroots and vectors.

CO3. Develop and understanding of simple and multiple regression models, including the assumptions underlying these models, techniques for inference and hypothesis testing and diagnostics checks and corrections.

CO4. Apply regression analysis techniques to real world data sets.

Contents	**60 Hrs**
Unit 1: Algebra of matrices and determinants	15 Hrs
A review of matrix algebra, 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, unitary matrices. Adjoint and inverse of a matrix and related properties. Determinants ants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants. Jacobi's Theorem, product of determinants.	
Unit 2: Linear Algebra	15 Hrs

Linear algebra: 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, by Cramer's rule and matrix method (Application for higher order matrices). Applications of linear equations. Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms, nature of quadratic form and properties. Linear orthogonaltransformation.	
Unit 3: Simple linear regression	15 Hrs
Assumptions, inference related to regression parameters, standard error of prediction, tests on intercepts and slopes, extrapolation, diagnostic checks and correction: graphical techniques, tests for normality, uncorrelatedness, homoscedasticity, lack-of-fit testing, transformations on Y or X (Box-Cox, square root, log etc.), method of weighted least squares, inverse regression.	
Unit 4: Multiple linear regression	15 Hrs
Standard Gauss Markov setup, Gauss-Markov theorem (without proof), least squares (LS) estimation, variance-covariance of LS estimators, estimation of error variance, LS estimation with restriction on parameters. Simultaneous estimation of linear parametric functions. Tests of hypotheses for one and more than one linear parametric functions, confidence intervals, Variable Selection problems.	

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

Course Outcomes (COs) / Program Outcomes(POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Demonstrate and understanding of basic concepts of matrix algebra, including determinants, inverse and properties of various types of matrices.	x	x								x		

Apply matrix algebra and linear algebra techniques to solve systems of linear equations, determine the rank of matrix, understanding quadratic forms and their applications in statistics, characteristic roots and vectors.			x							x		
Develop and understanding of simple and multiple regression models, including the assumptions underlying these models, techniques for inference and hypothesis testing and method diagnostics checks and corrections.				x	x					x		
Apply regression analysis techniques to real worddata sets				x	x							

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 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	**Matrix algebra and Regression analysis (Practical)**	Practical Credits	**2**
Course Code	**STAC10-P**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content
1. Calculation of determinant of higher order
2. Calculation of rank of a matrix
3. Calculation of equivalent canonical form by using elementary row and column operations
4. Calculation of inverse of matrices of higher order
5. Calculation of Eigen values and Eigen vectors
6. Solution of simultaneous equations with 4 variables by Cramer's Rule
7. Solution of simultaneous equations with 4 variables by Matrix method
8. Simple Linear Regression
9. Multiple Regression-I
10. Multiple Regression -II.

Pedagogy: Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) andexecuted 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	Ramachandra Rao, A. and Bhimasankaram, P. (2000). Linear Algebra.Hindustan Book Agency
2	Searle, S. R. (1982). Matrix Algebra Useful for Statistics, John Wiley, New York.
3	Kumaresan, S. (2000). Linear Algebra: A Geometric Approach, Prentice Hall
4	Gilbert strang (2016) Linear Algebra and its Applications, 5th edition Cengage Learning.
5	Montgomery, D. C., Peck, E. A. and Vining, G. G. (2020). Introduction to Linear Regression Analysis, Wiley.
6	Weisberg, S. (2005). Applied Liner Regression, Wiley.
7	Yan, X. and Su, X. G. (2009). Linear Regression Analysis: Theory & Computing, World Scientific.

Program Name	**BSc in STATISTICS**	Semester	**V**
Course Title	**Analysis of variance and Design of experiments (Theory)**		
Course Code:	**STAC11-T**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs):

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

CO1. Learn fixed and random effect models and one-way and two-

way classified data.CO2.Understand different designs (CRD, RBD,

LSD) and missing plot techniques.

CO3. Understand the different factorial experiments.

CO4. Develop complete and partial confounding for factorial experiments.

CONTENTS	**60 Hrs**
UNIT 1: ANALYSIS OF VARIANCE	15 Hrs
Meaning and assumptions. Fixed and random effect models. Analysis of One - way and two wayclassified data with and without interaction effects. Multiple comparison tests: Tukey's method, Critical difference.	
UNIT 2: EXPERIMENTAL DESIGNS	15 Hrs
Principles of design of experiments. Completely randomized, randomized block and Latin square designs (CRD, RBD, LSD) – layout formation and the analysis using fixed effect models. Comparison of efficiencies of CRD, RBD and LSD. Estimation of one and two missing observations in RBD and LSD and analysis.	

UNIT 3: FACTORIAL EXPERIMENT	15 Hrs
Basic concepts – main and interaction effects, and orthogonal contrasts in 2^2 and 2^3 factorial experiments. Yates' method of computing factorial effects total. Analysis of 2^2 and 2^3 factorialexperiments in RBD.	
UNIT 4: CONFOUNDING	15 Hrs
Need for confounding. Types of confounding - Complete and partial, Confounding in a 2^3-factorial experiment in RBD and its analysis. Advantages of confounding in factorial experiment.	

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

Course Outcomes (COs) / Program Outcomes(POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1.Learn about fixed, random, and mixed effectmodels and one-way and two-way classified data.	x	x		x		x			x	x		
CO2.Understand different designs (CRD, RBD,LSD) and missing plot techniques.	x	x				x			x	x		
CO3. Understand the different factorialexperiments.	x	x				x			x	x		
CO4. Develop complete and partial confoundingfor factorial experiments.	x	x		x		x			x	x		

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 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	**Analysis of variance and Design of experiments (Practical)**	Practical Credits	**2**
Course Code	**STAC12-P**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. ANOVA for one-way classified data.
2. ANOVA for two-way classified data.
3. Analysis of CRD.
4. Analysis of RBD.
5. Analysis of LSD.
6. Missing plot techniques in RBD and LSD.
7. Analysis of 2^2factorial experiment using RBD layout.
8. Analysis of 2^3factorial experiment using RBD layout.
9. Analysis of 2^3factorial experiment using RBD layout (Complete confounding).
10. Analysis of 2^3factorial experiment using RBD layout (Partial confounding).

Pedagogy: Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) andexecuted 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	Goon, A. M., Gupta, M. K., Das Gupta, B (1991). Fundamentals of Statistics, Vol-I, World Press, Calcutta.
2	Montgomery. D. C. (2018): Design and Analysis of Experiments, Wiley. New York.
3	Joshi. D. D. (1987): Linear Estimation and Design of Experiments, New Age International (P) Limited, New Delhi.
4	Cochran. G and G. M. Cox, G. M. (1992): Experimental Designs, John Wiley and Sons, New York.
5	Mukhopadhyay. P (2015): Applied Statistics, Books and Allied (P) Ltd., Kolkata.

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	**Statistical Inference-II (Theory)**		
Course Code:	**STAC14-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):	
Course Outcomes (COs): After the successful completion of the course, the student will be able to: CO1. Understand expected loss, decision rules, decision principles and Bayes and minimax decision rule. CO2. Learn about UMP test, MLR property and Likelihood ratio tests.CO3. Explore about sequential inference. CO4. Learn about one sample and two sample nonparametric tests.	
Contents	**60 Hrs**
Unit-1: Testing of Hypothesis-II	15 Hrs
Monotone likelihood ratio (MLR) property, Examples of distributions having MLR property, Likelihood ratio tests (LRT), LRT for mean with known and unknown variances, LRT for variance with known and unknown mean, of Normal populations. Definition of UMP test, construction of UMP test based on Bernoulli, Binomial, Poisson, Normal and Exponential populations.	
Unit-2: Nonparametric tests	15 Hrs
Nonparametric and distribution-free tests, merits and demerits of nonparametric tests, one sample problems: Sign test, Wilcoxon signed rank test, Kolmogorov-Smirnov test. Test of randomness using run test. General two sample problems: Wolfowitz runs test, Kolmogorov Smirnov two sample test (for sample of equal size), Median test, Wilcoxon-Mann-Whitney U-test. Several sample problems:Friedman's test, Kruskal Wallis test.	

Unit -3: Sequential Inference	15 Hrs
Meaning of sequential testing, Need for sequential test, Strength of sequential tests. Wald's SPRTP. Derivation and applications of SRTP applied to Bernoulli, Binomial, Poisson, Normal and Exponential populations.	
Unit-4: Nonparametric tests	15 Hrs
Chi-square test for variance, test of goodness of fit (Binomial and Poisson population), independence of attributes, Yates correction for continuity, Derivation of Brandt-Snedecor's formula, Chi-square test for 2X2 contingency table and its applications.	

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

Course Outcomes (COs) / Program Outcomes(POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1. Understand expected loss, decision rules, decision principles and Bayes and minimaxdecision rule.	x	x	x	x					x	x		
CO2. Learn about UMP test, MLR property andLikelihood ratio tests.	x	x	x	x					x	x		
CO3. Explore about sequential inference.	x	x	x	x					x	x		
CO4. Learn about one sample and two samplenonparametric tests.	x	x	x	x					x	x		

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 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	**Statistical Inference-II (Practical)**	Practical Credits	**2**
Course Code	**STAC15-P**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. UMP test based on sample from Bernoulli and Poisson distributions.
2. UMP test based on sample from Normal and Exponential distributions.
3. Construction of SPRT for Bernoulli and Poisson distributions.
4. Construction of SPRT for Normal and Exponential distributions.
5. One sample Nonparametric tests: Kolmogorov-Smirnov test, sign test, Wilcoxon signed rank test,
6. Two sample Nonparametric tests: Mann-Whitney (Wilcoxon rank sum test), Wald-Wolfowitz Run test
7. Several sample Nonparametric tests: Kruskal -Wallis test, Friedman's test.
8. Chi-square tests for variance
9. Tests for goodness of fit (Binomial and Poisson populations)
10. Tests for independence of Attributes

References

1	Berger, J.O.(1985): Statistical Decision Theory and Bayesian Analysis, 2nd Edition. SpringerVerlag.
2	Bernando, J.M. and Smith, A.F.M.(1993): Bayesian Theory, John Wiley and Sons.
3	Robert, C.P.(2007): The Bayesian Choice: A Decision Theoretic Motivation, Springer.
4	George Casella, Roger L. Berger (2020): Statistical Inference, 2nd ed., Thomson Learning.
5	Rohatagi, V.K.: (2010): Statistical Inference, Wiley Eastern, New Delhi.
6	Hogg Mckean and Craig (2009): Introduction to Mathematical Statistics, 6th edition ,Pearson PrenticeHall.

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	**Sampling Techniques and Statistics for National development (Theory)**		
Course Code:	**STAC16-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Understand the principles underlying sampling as a means of making inferences about apopulation.

CO2. Understand the difference between probability and nonprobability sampling.

CO3. Understand different sampling techniques.

CO4. To learn to estimate population parameters from a sample.

CO5. Understand official statistical system in India and their functions. CO6. Understand the role statistics in national development.

Contents	**60 Hrs**
Unit 1: Introduction to sampling theory	15 Hrs
Objectives and principles of sampling theory; Concept of population and sample; complete enumeration versus sampling; Planning, execution and analysis of a sample survey; practical problems at each of these stages; basic principle of sample survey; sampling and non-sampling errors; Types of sampling: non-probability and probability sampling, pilot survey.	

Unit 2: Simple random sampling	15 Hrs
Simple random sampling with and without replacement, definition, and procedure of selecting a sample, estimates of population mean, total and proportion, variances and SE of these estimates, estimates of their variances related proofs, sample size determination.	
Unit 3: Stratified sampling and systematic sampling	15 Hrs
Stratification and its benefits; basis of stratification, Technique, estimates of population mean and total, variances of these estimates, proportional, optimum allocations, Neyman's allocation, allocation with cost functions and their comparison with SRS. Practical difficulties in allocation,derivation of the expressions for the standard errors of the above estimators when these allocationsare used, estimation of gain in precision. **Systematic Sampling:** Linear systematic sampling Technique; estimates of population mean andtotal, variances of these estimates (N=n x k). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.	
Unit 4: Statistics for National development	15 Hrs
An outline of present official statistical system in India, Role, function, and activities of Centraland 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.	

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

Course Outcomes (COs) / Program Outcomes(POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1.Understand the principles underlyingsampling as a means of making inferences about a population.	x	x	x	x					x	x		
CO2.Understand the difference betweenprobability 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 parametersfrom a sample.	x	x	x	x					x	x		
CO5. Understand official statistical system inIndia and their functions.	x	x	x	x					x	x		
CO6. Understand the role statistics in nationaldevelopment.	x	x	x	x					x	x		

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 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 nationaldevelopment **(Practical)**	Practical Credits	**2**
Course Code	**STAC17-P**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Drawing of random sample under SRSWOR from a given population and estimation of the meanand total and the standard error of the estimator.
2. Drawing of random sample under SRSWR from a given population and estimation of the mean andtotal 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 sampleunder SRSWR
5. Estimation of the proportion, total and the standard errors of the estimators based on a randomsample under SRSWOR.
6. Estimation of the mean, total and the standard error of the estimator under stratified randomsampling.
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) andexecuted 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 NatureSwitzerland.

References	
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, WileyEastern Ltd., New Delhi.
10	Sukhatme, P.V., Sukhatme, B. V.(1984): Sampling theory of Surveys with Applications, IndianSociety 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/

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	**Econometrics (Theory)**		
Course Code:	**STAC18-T**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):	
Course Outcomes (COs): After the successful completion of the course, the student will be able to:CO1**.** Model economic phenomena and estimate the model. CO2. Understand use of simple and multiple linear regression models. CO3. Know the impact of violations of assumptions of regression models. CO4. Model the economic phenomena with more than equations and their estimation.	
Contents	**60 Hrs**
Unit 1: Introduction	15 Hrs
Origin, definition, methodology, scope and limitations of econometrics. The two – variable linear regression model: Relationships between economic variables, twovariable linear regression model, assumptions, least squares estimators. Multiple linear regression models: Model descriptions and assumptions, least squares estimators, selection of variables in multiple regression model.	
Unit 2: Analysis of residuals	15 Hrs
Presence of outliers omitted variables, nonlinear relationship, correlated disturbances,heteroscedasticity, Generalized Least Squares. Multicollinearity: The plausibility of the assumption of non-multicollinear regressors,consequences of multicollinearity, tests for detecting multicollinearity, solutions for multicollinearity.	

Unit 3: Autocorrelation	15 Hrs
Introduction and plausibility of serial dependence, sources of autocorrelation, tests forautocorrelation, solutions for autocorrelation, methods for estimating the parameters of autocorrelation, serial correlation.	
Autoregressive and Distributed Lag Models: Autoregressive model, distributed lag model, methods of estimation of lagged models.	
Unit 4: Simultaneous equation models	15 Hrs
The problem of identification, Rank and Order Conditions, Examples. Single equation methodsof estimation: reduced form method or indirect least squares (ILS), the method of instrumental variables (IV), two-stage least squares (2SLS).	

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

Course Outcomes (COs) / Program Outcomes(POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1. Model economic phenomena and estimatethe model.	x	x	x	x					x	x	x	x
CO2. Understand use of simple and multiple linear regression models.	x	x	x	x					x	x	x	x
CO3. Know the impact of violations of assumptions of regression models.	x	x	x	x					x	x	x	x
CO4. Model the economic phenomena with morethan equations and their estimation.	x	x	x	x					x	x	x	x

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 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	

References	
1	Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition McGraw Hill
2	Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
3	Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, , Palgrave Macmillan Limited
4	Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, John Wiley &Sons
5	G.M.K. Madanani (1980) : Introduction to Econometrics, second edition, Oxford & IBH Publishingcompany, New Delhi.
6	Baltagi B.H. (2000) Econometrics, Springer.

DSE

Program Name	**BSc in STATISTICS**	Semester	**V**
Course Title	**Operations Research (Theory)**		
Course Code:	**STAE1-T (A)**	No. of Credits	**3**
Contact hours	**45 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:CO1. Formulate a linear programming problem and solve it using graphical, simplex methods. conceptualize the feasible region and to find out feasible solution.

CO2. Solve transportation and assignment problems and give the optimal solution.CO3. Solve game problems using different techniques.

CO4. Describe an inventory system, simple inventory models and obtain mathematical solutions.

CO5.Understand Need for replacement. Replacement policy for items which deteriorate with time. Groupreplacement policy

CO6.Understand a queueing system and its different components; derive the characteristics of a single server queue.

Contents	**45 Hrs**
Unit 1: Introduction to OR and LPP	15 Hrs
Definition and scope of operations research (OR). Linear programming problem (LPP): Definition, standard and canonical forms. Formulation of LPP. Basic feasible solutions, degenerate and non-degenerate solutions. Graphical solution and simplex algorithm for solving an LPP. Criteria for unbounded, multiple, and infeasible solutions. Big-M method.	
Unit 2: Transportation, assignment problems and game theory	15

	Hrs
Mathematical formulation of transportation problem. Existence of feasible solution. Findinginitial basic feasible solution: North - West corner rule and Vogel's method. Test for optimality. Transportation algorithm. Problem of degenerate solution. Unbalanced transportation problem.	
Mathematical formulation of assignment problem and Hungarian algorithm. Unbalanced assignment problems. **Game Theory**: Basic concepts of game theory. Two-person zero sum game. Pure and mixed strategies. Maximin–Minimax principles, Games with saddle point. Principle of dominance. Games without saddle point. Mixed strategies. Determination of optimum solution for a 2x2 game.	
Unit 3: Inventory, replacement and Queuing theory:	15 Hrs
Description of an inventory system. Inventory costs. Demand, lead time, and reorder level. Inventory models. EOQ model with and without shortages. Need for replacement. Replacement policy for items which deteriorate with time. Optimum policy with discrete and continuous time. Group replacement policy. **Queuing theory:** Characteristics of a queuing system. Steady state system size distribution in M/M/1 queuing system (only statement). Waiting time distributions. Little's formula, measures of effectiveness, derivation of expressions for expected queue length, and expected system size(length) and expected waiting times.	

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

Course Outcomes (COs) / Program Outcomes(POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1. Formulate a linear programming problem and solve it using graphical, simplex methods, conceptualize the feasible region and to find out feasible solution.	x	x	x	x					x	x		

CO2. Solve transportation and assignmentproblems and give the optimal solution.	x	x	x	x					x	x		
CO3. Solve game problems using differenttechniques.	x	x	x	x					x	x		
CO4. Describe an inventory system, simple inventory models and obtain mathematical solutions.	x	x	x	x					x	x		
CO5.Understand Need for replacement. Replacement policy for items which deteriorate with time. Group replacement policy	x	x	x	x					x	x		
CO6.Understand a queueing system and its different components; derive the characteristics ofa single server queue.	x	x	x	x					x	x		

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 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	

References	
1	Churchman, C.W, Ackoff, R.L., and Arnoff, E.L. (1957). Introduction to Operations Research, JohnWiley and Sons, New York.
2	Kanthi Swaroop, Manmohan, and P.K. Gupta (2012). Operations Research, Sultan Chand, NewDelhi.
3	Kalavathy, S. (2004). Operations Research, Vikas Publishing House Pvt. Ltd. New Delhi.
4	Shenoy, G.V., Srivastava, U. K., and Sharma, S.C. (2009). Operations Research for Management,2/e, New Age International, New Delhi.
5	Mustafi, C.K. (2006). Operations Research: Methods and Practice, 3/e, New Age International, NewDelhi.
6	Mital, K.V. and Mohan, C. (2004). Optimization Methods, 3/e, New Age International, New Delhi.
7	Narag, A. S. (1970). Linear Programming and Decision Making, S. Chand, New Delhi.
8	Hillier, F.S. and Leiberman, G. J. (1962). Introduction to Operations Research, Holden Day,NewYork.
9	Taha, H.A. (2010). Operational Research: An Introduction, Macmillan, New York.

DSE

Program Name	**BSc in STATISTICS**	Semester	**V**
Course Title	**Demography and Vital statistics (Theory)**		
Course Code:	**STAE1-T (B)**	No. of Credits	**3**
Contact hours	**45 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. acquire knowledge about the size, composition, organization and distribution of the population.CO2. perform basic demographic analysis using various techniques.

CO3. study the trend of population growth which describes the past evolution, present distribution andfuture changes in the population of an area.

CO4. acquire knowledge about the construction of life table and its applications in demographic analysis.

Contents	**45 Hrs**
Unit 1: Introduction and Sources of Demographic Data	15 Hrs
Demography**:** Its definition, nature, and scope. Sources of demographic data – salient features of Census, Civil Registration System, Demographic Surveys, their limitations and uses. Coverage and content errors. Vital Statistics: Introduction, definition, and uses of Vital statistics. Sources of data on Vital statistics. Measurement of population, rates, and ratios of vital events.	
Unit 2: Fertility and Population Growth	15 Hrs

Basic concepts and terms used in the study of fertility. Measures of fertility- Crude Birth Rate (CBR), General fertility rate (GFR), Age-Specific Fertility Rate (ASFR), Total Fertility Rate (TFR), use of Birth order statistics, Child Women ratio. Measures of reproduction- Gross Reproduction rate and Net Reproduction rate. Measurement of population growth rate- simple growth rate and compound growth rate. Pearl's Vital Index. Population Estimation, Projection and Forecasting: Use of A.P. and G.P. methods for population estimates, Fitting of Logistic curve for population forecasting using Rhode's method.	
Unit 3: Mortality and Life Tables	15 Hrs
Basic concepts and definitions of mortality. Measures of mortality- Crude Death Rate (CDR),Age Specific Death Rate(ASDR), Standardized death rates, Neonatal, Perinatal and Postnatal mortality rates, Maternal and Infant mortality rates. Cause Specific Death Rate.	
Life tables : Components of a life table, force of mortality and expectation of life table, types of life tables. Construction of life tables using Reed-Merrell's method , Greville's method. Uses oflife tables.	

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

Course Outcomes (COs) / Program Outcomes(POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1. acquire knowledge about the size, composition, organization and distribution of the population.	x	x	x	x					x	x		
CO2. perform basic demographic analysisusing various techniques.	x	x	x	x					x	x		
CO3. study the trend of population growth which describes the past evolution, present distribution and future changes in the population of an area.	x	x	x	x					x	x		
CO4. acquire knowledge about the construction of life table and its applications indemographic analysis.	x	x	x	x					x	x		

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 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	

References	
1	Bhende, Asha and Tara Kanitkar, (2004): Principles of Population Studies, 5th Ed. HimalayaPublishers, New Delhi.
2	Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
3	Keyfitz, N and Caswell. H (2005): Applied Mathematical Demography, Springer.
4	Mishra, B. D, (1981): An Introduction to the Study of Population, South Asian Publishers, Pvt. Ltd.
5	Ramakumar, R, (1986): Technical Demography, Wiley Eastern Ltd, New Delhi.
6	Pathak, K. B and F. Ram, (1998): Techniques of Demographic Analysis, Himalaya Publishing House,Mumbai.
7	Pressat, R, (1972): Demographic Analysis, Edward Arnold, London.
8	Shryock, H. S. et al (1979): The Methods & Materials of Demography, Condensed Edition byStockwell, E. G, Academic Press, New York.
9	Srinivasan K. (1998): Basic Demographic Techniques & Applications, Sage Publications, New Delhi

DSE

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	**Statistical Quality Control (Theory)**		
Course Code:	**STAE2 (A)**	No. of Credits	**3**
Contact hours	**45 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):	
Course Outcomes (COs): After the successful completion of the course, the student will be able to:CO1: Learn about process control and product control, different limits and causes of variation. CO2: Understand control chart for variables and process capability. CO3: Understand lot acceptance sampling and sampling plans.	
Contents	**45 Hrs**
Unit 1: Introduction	15 Hrs
Introduction – Statistical Quality Control (SQC) - Aims and objectives, Chance and assignable causes of variation, Process control and product control. Control charts and basis for its construction, Action, andwarning limits. Various tools of SQC.	
Unit 2: Process Control and Process Capability	15 Hrs
Control charts for variables: Derivation of control limits, basis, construction and interpretation of mean,range and standard deviation charts, np-chart, p-chart, stabilized p-chart c-chart and u-chart. Rational subgroups, Criteria for detecting lack of control. Process capability study: Natural tolerance limitsand specification limits, process capability, PCR and interpretation.	
Unit 3: Acceptance Sampling (Product Control)	15 Hrs

Lot Acceptance Sampling – Sampling Inspection,100 % inspection and rectifying inspection AQL, LTPD, Producer's Risk and Consumer's Risk. Acceptance sampling plans – single and double sampling plans byattributes.	

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

Course Outcomes (COs) / Program Outcomes(POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1: Learn about process control and product control, different limits and causes of variation.	x	x	x	x					x	x		
CO2: Understand control chart for variables andprocess capability.	x	x	x	x					x	x		
CO3: Understand lot acceptance sampling andsampling plans.	x	x	x	x					x	x		

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 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	

References	
1	Goon, A. M., Gupta, M. K., Das Gupta, B. (1991). Fundamentals Of Statistics, Vol. II (World Press,Calcutta).
2	Grant, E. L. and Leavenworth, R. S. (1996): Statistical Quality Control. 7th Edition, McGraw hill,New York.
3	Mahajan, M. (2001): Statistical Quality Control, Dhanpat Rai & Co. (P) Ltd. New Delhi.
4	Gupta, R. C: Statistical Quality Control (Khanna Pub, Co.)
5	Montgomery, D .C (2013): Introduction to Statistical Quality Control, (Wiley Int.Edn)
6	Gupta, R. C and V. K. Kapoor (): Fundamentals of Applied Statistics, (Sultan Chand and Co.)
7	Alwan, L. C. (2000). Statistical Process Analysis, McGraw Hill, New York.
8	John, S. Oakland and Follwell, R. F. (1990): Statistical Process Control. (East West Press, India)
9	Mukhopadhyay. P. (1996): Applied Statistics, Calcutta Publishing House.
10	Wetherill, G. B. and D. W.B (): Statistical Process Control Theory and Practice. (Chapman and Hall).

DSE

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	**Reliability Analysis (Theory)**		
Course Code:	**STAE2 (B)**	No. of Credits	**3**
Contact hours	**45 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Find reliabilities of various models of mechanical units (industry), biological science, health science,finance.

CO2.Understand impact of age on functioning of systems.

CO3. Know impact of configuration of sub-assemblies on performanceCO4. Evaluate and analyse reliabilities of models.

Contents	**45 Hrs**
Unit 1: Reliability	15 Hrs
Introduction to Reliability Theory, Definitions and interrelationships of reliability function, failure rate (hazard rate), cumulative failure rate, conditional reliability, residual life, mean residual life for both continuous and discrete distributions. Distributions useful in modeling the life length: Binomial, Poisson, Geometric, Exponential, Weibull, Gamma, Pareto, Normal, Truncated Normal and Log Normal (derivation of failure reliability functions).	
Unit 2: Notion of Ageing	15 Hrs
Definitions of Monotone failure rates, mean residual function, checking for monotonicity of failure rates of above life distributions. Classes of life Distributions: IFR, IFRA, NBU, NBUE, DMRL and their inter-relationships. Characterization properties above classes of life distributions. Dual classes of	

IFR, IFRA, NBU, NBUE, DMRL.	
Unit 3: System Reliability and life testing:	15 Hrs
Series System, Parallel System, k-out-of-n system and Standby Redundant System. Reliabilities and their inter-relationships for these systems. Examples based on exponential and uniform distributions. **Life testing experiments:** Complete sample, Type I and Type II censorings (with replacement and without replacement). Distribution of observed observations in all these cases for exponentialdistribution.	

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

Course Outcomes (COs) / Program Outcomes(POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1.Find reliabilities of various models of mechanical units (industry), biological science,health science, finance.	x	x	x	x					x	x		
CO2.Understand impact of age on functioning ofsystems.	x	x	x	x					x	x		
CO3. Know impact of configuration of sub-assemblies on performance	x	x	x	x					x	x		
CO4. Evaluate and analyse reliabilities of models.	x	x	x	x					x	x		

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 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	

References	
1	Barlow R.E. and Proschan F (1975): Statistical Theory of Reliability and Life Testing. Holt-Rinhartand Winston, New York.
2	Sinha S.K. and Kale B.K. (1990): Life Testing and Reliability Estimation. Wiley Eastern, New Delhi.
3	Mann N.R, Schaffer R.F and Singpurwalla N.D. (1974): Methods for Statistical Analysis of Reliability and Life Data. Wiley New York.
4	Zacks S (1992): Introduction to Reliability Analysis. Springer - Verlag, New York.
5	J.V. Deshpande and Sudha G. Purohit (2005): Lifetime data: Statistical Models and Methods. WorldScientific.

Vocational courses

1. STAV1-T: A course on Statistical software. (Excel/advanced Excel/R/Python/ and any other)
2. STAV2-T: Data analysis using primary data /Secondary data with R/Excel/ any software.

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INTERNSHIPS under UGC regulation, 2023.

INTERNSHIP GUIDELINES

NEP 2020 has devised transformative initiatives in the field of higher education. The skills required for developing employability ingenuities are fostered by introducing internship as an important component in the curriculum.

Internship is provided in two modes-

i. Internship for enhancing the employability
ii. Internship for developing the research aptitude

As per the UGC Guidelines for **"Implementation of Internship/Research Internship for Undergraduate Students**" our institution has structured the internship course under the following categories-

i. Internship for enhancing the employability

The interns may pursue their internships in varied industries perse and go beyond the clusters prescribed by the central, state, micro and local governments. An indicative list is provided by UGC which comprises of –

1. Trade and Agriculture Area
2. Economy & Banking Financial Services and Insurance Area
3. Logistics, Automotive & Capital Goods Area
4. Fast Moving Consumer Goods & Retail Area
5. Information Technology/Information Technology enabled Services & Electronics Area
6. Handcraft, Art, Design & Music Area
7. Healthcare & Life Science Area
8. Sports, Wellness and Physical Education Area
9. Tourism & Hospitality Area
10. Digitisation & Emerging Technologies (Internet of Things/Artificial Intelligence/Machine Learning/Deep Learning/Augmented Reality/Virtual Reality, etc.) Area
11. Humanitarian, Public Policy and Legal Service Area
12. Communication Area
13. Education Area
14. Sustainable development Area

15. Environment Area
16. Commerce, Medium and Small-Scale Industries Area and other areas approved by the statutory bodies of the institution from time to time.

ii. Internship for developing the research aptitude

Building of the research aptitude is a formative way to uncover facts and present the outcomes in an organised manner. Research internship aims at providing hands-on training to work on research tools, techniques, methodologies, equipment, policy framework and various other aspects in pursuing quality research.

The research interns can apply in research institute, research lab, national or internationally reputed organizations, research labs, working with faculty, mentors from distinguished fields.

INTERNSHIP STRUCTURE

- Internship is organised, executed and monitored by the Research & Development Cell (RDC) of the institution.
- Since the internship is time bound, a research supervisor is assigned to the interns for sharing expertise and follow up of their Internship Progress.
- Orientation sessions and interaction faculty-wise was initiated.
- A Nodal Officer was appointed along with four block-wise coordinators to harness the possibilities and effectively implement internship at department level.
- Internship Report Format is drafted for maintaining the uniformity in reporting ethos.
- The Nodal Officer is in charge of corresponding with the Internship Providing Organization (IPO) is any organization, HEI, philanthropy, farmer, government organization, R&D institutions, research labs, artisans, enterprises, institution/person of eminence, cooperatives, corporates providing an opportunity to the student for Internship during the programme.
- The Nodal Officers along with the block coordinators must be approached in case of any issues and will be responsible for any official registration, enrollment and upkeep of the internship programme and the students.
- Internship Supervisors/ Mentors are appointed and a lot of students are assigned to them who inturn are responsible to ensure the authenticity of the internship certificate provided and monitor the hours of the work undertaken by the interns.

- Students may apply for Internship Programme through the Nodal Officer or Online Internship Apps such as Internshala, Go Intern and so on to avail the Internship Offers.
- It is preferred to undertake internship in physical mode. Digital Mode or Group Internships are an option.
- Internship Reports must be endorsed by the Internship Supervisor/ Mentor.

ACADEMIC CREDENTIALS

- The internship as a course is mandatory for the under-graduate level fetching 2 credits each.
- For an internship, one credit of Internship means two-hour engagement per week.
- 60 – 90 Hours is mandatory to be undertaken by every student who is interning in any of the modes mentioned above.
- Hands-on training/ Orientation is mandatory before commencement of the internship/research internship programme.

EVALUATION

Report writing (15-20 pages)- Format will be sent to the Internship Mentors/ Project Guides	20 Marks
Powerpoint Presentation	10 Marks
Viva Voce (One to One)	10 marks
External Assessment (Internship)/ External Evaluation (Project Report)	10 Marks
Total	**50 Marks**
Number of Hours	**60 hours (Internship)**

EVALUATION AND ASSESSMENT COMPRISES OF-

i. Activity logbook and evaluation report of Internship Supervisor
ii. Format of presentation and the quality of the intern's report
iii. Acquisition of skill sets by the intern
iv. Originality and any innovative contribution
v. Significance of research outcomes
vi. Attendance

ANNEXURE

FORMAT OF THE INTERNSHIP REPORT

ESTD : 1880

ST ALOYSIUS COLLEGE

(AUTONOMOUS) MANGALURU

INTERNSHIP REPORT FORMAT

1. Title Page (1 page)

- Student Name, Class, Register Number, Name of the College
- Name of the Company
- Internship Dates (Duration – Date of commencement –Date of completion)
- Certificate from Dean/Head of Department **(1 page)**
- Declaration by the Student **(1 page)**
- Certificate from the Internship Mentor **(1 page)**
- Company Certificate with Official Logo and Authorized Signature **(1 page)**

REFER SAMPLE 1 to SAMPLE 6 ANNEXED TO THIS FORMAT (Page No. 3 - Page No. 6)

2. Table of Contents (1 page)

- Keep it in Tabular Form
- Serial Number, Particulars and Page Number (three columns)

3. Acknowledgements *(*1 page)

(Mention how they helped you and what you learnt from each person)

4. Brief Profile of the Company/entity (2 pages)

- History- Vision- Mission of the Company
- Regular Business Activities (Broad/Specific)
- Intern's role in Overall Work Scheme

5. Tasks Assigned (1 page)

- Mention in points the various tasks assigned

6. Learning Objectives (1 page)

(Example: three objectives are mentioned- any other objective kindly mention)

- Mention the following learning objectives-

- ✓ To pursue internship in a company or an institution which gives opportunity to explore and nurture our skills.
- ✓ To undertake experiential learning to improvise the technical and social skills.
- ✓ To build curriculum vitae and strengthen the work experiences.
- ✓ Any other (kindly specify)

7. Responsibilities including Job Description (7 pages)

- Internship Position in the Company (Example: Database Management Assist as Designation)
- Day Wise Report (Mention- Date, Time, Venue, Staff In-charge Name and Designation, Detailed report on daily basis)
- Mention Specific Tasks, Skills you learnt and experiences that developed you professionally.
- Mention even the talks, seminars attended, training sessions attended.
- Attach the relevant documents and certificates and evidential documents.

8. Skills and Experiences (Learning Outcomes) (1 page)

- Specific skills developed relate it to educational experiences and your career goal.
- Professional traits acquired.

9. Conclusion (1 page)

- Potentialities for future internships
- Helping the organization in better understanding of the need and interest of interns.

10. Annexure

- Attach relevant documents, certificates and photographs

Principal 22-01-2023 **Registrar**

SAMPLE 1

Title page

ST ALOYSIUS COLLEGE (AUTONOMOUS) MANGALURU

Internship Report on ---------- (area of work)

at ---------- (name of the company, place)

Submitted to St Aloysius College (Autonomous), Mangaluru in partial fulfillment of the requirements for the award of the

Degree of Bachelor of ……jh ……

B. ……..

By

(Name of the Student)

(Class and Register No)

Under the guidance of

Name and address of Internal Guide

2023 – 2024

SAMPLE 2

Certificate from the Dean/HOD

FACULTY OF ……..

ST ALOYSIUS COLLEGE (AUTONOMOUS)

LIGHT HOUSE HILL ROAD, MANGALORE – 575 003

CERTIFICATE

This is to certify that Mr./Ms …….. bearing Register number…….. has successfully completed his/her internship on ……..…….. (area of work) at ……..(name of the company and place).

This internship report is prepared after having undergone internship for the period as stipulated by the College and is submitted to St Aloysius College (Autonomous) Mangaluru, in partial fulfilment of the requirements for the award of the Degree of Bachelor of …….. during the year 2023-24.

Date: Signature with name and Designation

Place: Seal

SAMPLE 3

Declaration by the student

DECLARATION

This is to certify that this internship report has been prepared by me after undergoing internship from……..to……..(duration) at ……..…..(name of the company and place). This report is my original work and is being submitted for the partial fulfilment of the requirements of the award of the Degree of ……..…..

This report has not been submitted earlier to this College or any other Universities/Institutions for the fulfilment of the requirements of the course of the study.

Date: Signature

Name of the student

Place: Register No

SAMPLE 4

Certificate from Internship Mentor

CERTIFICATE

This is to certify that …….. (Name of the student), Register Number……..., of ……..., has successfully completed his/her internship on…… (area of work) at …… (name of the company and place), in partial fulfilment of the requirements for the Degree of ……. The internship report has been prepared by him/her under my guidance and supervision. I further certify that no part of this report has been submitted for the award of any degree, diploma, fellowship or such other similar title.

Name and Designation of the Internship Mentor:

Date:

Place: Signature

(Internship Mentor)

SAMPLE 5

Certificate of Performance from the company in its letter head

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr/Ms …….. (name of the student), …….. (Reg No), student of B.Com at St Aloysius College (Autonomous) Mangaluru, has done his / her internship in our company on …….. ……., (area of work), for the purpose of partial requirements for the award of the Degree of Bachelor of Commerce. He /She has completed the internship from our company for the period from …….. to ……. (date of internship).

During his/her tenure of the internship his/her conduct and character was good.

Signature

Name and Designation

Company seal

Date:

Place:

****