St Aloysius College (Autonomous)
Mangaluru

Re-accredited by NAAC "A" Grade

Course structure and syllabus of

B.Sc.

STATISTICS

Under NEP Regulations, 2021

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Re-accredited by NAAC with 'A' Grade with CGPA 3.62/4

Recognised by UGC as "College with Potential for Excellence"

Conferred "College with "STAR STATUS" by DBT, Government of India.

Centre for Research Capacity Building under UGC-STRIDE

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
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8. Ms. K Varsha (Student Representative)

Program Outcomes

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

1. Develop and demonstrate an ability to understand major concepts in various disciplines of Statistics.
2. Solve analytical problems independently and draw logical conclusions.
3. Analyse, interpret the data and hence help policy makers to take a proper decision.
4. Have a knowledge regarding use of data analytics tools like Excel, SPSS, R programming and Python.
5. Use modern statistical techniques and statistical Software to understand the concepts of Statistics.
6. Think, acquire knowledge and skills through logical reasoning and inculcate the culture of self-learning.
7. Create an awareness about the impact of Statistics in real life and development outside the scientific community.

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 and Distributions	DSC	04	60	40	100	4
G 506 DC2.2 P	Probability and Distributions Practical	DSC	04	60	40	100	2
G 506 OE1.2	Applied Statistics	OEC	03	60	40	100	2
III	**Calculus and Probability Distributions (4) +Practical (2)** Discipline B3(4+2)	OE-3 (3)	L1-3 (3), L2-3(3) (3+1+0 each)		SEC-2: Artificial Intelligence (2) (1+0+2)		23
IV	**Statistical Inference-I (4) + Practical (2)** Discipline B4(4+2)	OE-4 (3)	L1-4 (3), L2-4(3) (3+1+0 each)	Constitution of India(2)		Sports /NCC/ NSS etc. (2) (1+0+2)	25
Exit option with Diploma (96 credits)							

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

Summary of Discipline Specific Courses (DSC)			
Semester	**Course Code**	**Title of the Paper**	**Credits**
I	DSC A1	Descriptive Statistics	4
		Practicals based on DSC A1	2
II	DSC A2	Probability and Distributions	4
		Practicals based on DSC A2	2

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 (not more than 3 per course)	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 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.
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

Course Outcomes (COs)

Course Outcomes	
	Semester - I **G 506.1: Descriptive Statistics and Probability Theory**
Course Objectives	● Enable the students to understand the concepts of descriptive statistics. ● Have a broad idea about the fields of application of the topics offered in the course.
Course Outcomes	After completion of this course students should be able to CO-1. Understand the principle of least squares, fitting of various types of curves and the concept of correlation and its applications. CO-2. Explain the theory behind Regression analysis and its applications. CO-3. Have complete knowledge of demand analysis with the law of demand and supply, Engel's curves and Pareto;s law of income distribution. CO-4: Understand probability density function, mean and variance of a random variable and the theorems of probabilities with their applications.
	Semester - I **G 506.1a: Descriptive Statistics & Probability Theory Practical.**
Course Objectives	● Empower the students with the ability to understand and apply the statistical tools. ● Have a broad idea about the fields of application of the topics offered in the course
Course Outcomes	After completion of this course students should be able to CO-1. Analyse the data through correlation and regression analysis. Understand the applications of mathematical expectation. CO-2. Understand the concept of demand analysis with practical examples. CO-3. Find the mean and variance of the given random variable.
	Semester-I **G 506.1E: Applied Statistics (CBCS)**
Course Objectives	• To understand the applications of Statistics through these measures. • To give a broad idea about applications of Statistics in governance.
Course Outcomes	After completion of this course students should be able to CO-1. Understand the applications of Vital events, Life table in government policies and planning.

	CO-2. Apply the Statistical tools like Index Numbers and Time Series for real life situations.
	Semester- II **G506.2:Probability Distributions**
Course Objectives	● Empower the students with the ability to know the theory behind various Probability Distributions. ● Understand the theoretical nature and properties of various probability distributions. ● Have a broad idea about the fields of application of various probability distributions.
Course Outcomes	After completion of this course students should be able to CO-1: Understand the concept of mathematical expectation and its properties. CO-2: Have complete knowledge about standard discrete distributions and its applications. CO-3. Explain the various continuous probability distributions with mean, variance median, MGF and its applications. CO-4: Understand the theory of distribution functions of random variables using mgf and Jacobian transformation.
	Semester- II **G506.2a: Probability Distributions Practical.**
Course Objectives	● Empower the students with mathematical expectation with properties and theorems of expectation. ● To understand the various discrete and continuous Probability distributions with their properties and applications in real life.
Course Outcomes	After completion of this course students should be able to CO-1: Understand the applications of mathematical expectation. CO-1: Identify, relate and differentiate probability distributions and apply them in day to day life. CO-2: Have the ability to fit a probability distribution to the given data.
	Semester - II **G 506.2E: Data Analysis using Ms Excel (CBCS)**
Course Objectives	• To develop the Data Processing skill in MS Excel. • To develop the Data Analysis and Data Visualization skill.
Course Outcomes	After completion of this course students should be able to CO-1: Analyse the data through MS Excel. CO-2: Acquire Data Visualization skills.

	CO-3. Have knowledge of statistical measures.
	Semester- III **G506.3: Statistical Inference I**
Course Objectives	● Familiarise the students with the importance of sample and population. ● Acquaint the students about the concept of a sampling distribution and order statistics. ● To understand the concept of Estimation theory with point and Interval estimation and make use of these tools in day to day life.
Course Outcomes	After completion of this course students should be able to CO-1. Understand the sampling distributions like Chi-square, Student's t Snedecor's F distributions and the distribution of Order statistic. CO-2. Impart knowledge about probability inequalities and convergence concepts. CO-3. Understand the theory of point estimation, method of maximum likelihood estimation, method of moment and its applications. CO-4. Explain the theory of interval estimation and its applications.
	Semester- III **G506.3a: Statistical Inference I, Practical**
Course Objectives	● This course will help the students to understand theory and applications of various probability inequalities, central limit theorem, point estimation and interval estimation.
Course Outcomes	After completion of this course students should be able to CO-1. Understand the applications of probability inequalities, central theorem and WLLN. CO-2. Understand the applications of methods of point estimation. CO-3. Apply the theory of interval estimation to real life.
	Semester- III **G 506.3E: Probability Distributions (CBCS)**
Course Objectives	● Providing students with the applications of mathematical expectation. ● Equipping students with the knowledge of standard discrete and continuous probability distributions with their applications.
Course Outcomes	After completion of this course students should be able to

	CO-1. Understand the applications of mathematical expectation and its properties. CO-2. Have the knowledge of standard discrete probability distribution and its applications. CO-3. Understand continuous probability distributions its applications in day to day life.
	Semester- IV **G506.4: Statistical Inference II**
Course Objectives	● This course will help in introducing the students to the fundamental knowledge of testing of Hypothesis and its applications in real life. ● Empower the students with the ability to be proficient for applying various Chi-square tests and interpret the result. ● Train the students in the applications of parametric and non-parametric tests.
Course Outcomes	After completion of this course students should be able to CO-1: Understand the basic knowledge about testing of hypotheses and the Statistical basis behind every test. Also to Develop Most Powerful Test and Likelihood Ratio Test. CO-2: Apply various large sample, small sample and Chi-square test to real life situations and interpret the results. CO-3: Explain sequential testing and applications of Wald's test for probability distributions. CO-4: Understand the concept and derive the test statistic for various non-parametric tests. Also the applications of these tests.
	Semester- IV **G506.4a: Statistical Inference II Practical.**
Course Objectives	● This course will help the students to make Statistical analysis of the real life situations and help policy makers to take a right decision.
Course Outcomes	After completion of this course students should be able to CO-1. Measure the probability of two types of errors, power of the Test and the BCR to the given situation and help the policy makers. CO-2. Know the applications of various small sample and large sample tests. Also to apply various Chi-square tests and interpret the result.

	CO-3. Apply SPRTP for various probability distributions and take a Decision about sampling. CO-4. Know the applications of various non-parametric tests.
	Semester- IV **G 506.4E: Statistical Data Analysis using SPSS (CBCS)**
Course Objectives	● Expose the students to the analysis of statistical data. ● Train the students SPSS software.
Course Outcomes	After completion of this course students should be able to CO-1. Understand the measures of averages, variation, correlation and regression. CO-2. Train the students in data analysis using SPSS software. CO-3. Acquire knowledge in data handling and visualization.
	Semester- V **G506.5a.: Designs of Experiments**
Course Objectives	● Acquaint students with the basics and some advanced concepts of Analysis of Variance (ANOVA). ● Imparting knowledge on planning the design of experiments and the design of experiments and methodologies used to obtain the maximum result. ● Enable to conduct experiments efficiently and effectively for missing data in the design. ● Analyzing the factorial data to obtain objective meaningful conclusions.
Course Outcomes	After completion of this course students should be able to CO-1. Impart knowledge on applying the technique of ANOVA to design studies, perform analyses, interpret the results appropriately, and make generalizations. CO-2. Understanding the advantages & disadvantages of various designs and also learning to apply various designs for agricultural data/agricultural fields. CO-3. Describe the analysis of the data from the experiment should be carried out for missing data/ missing plots in the agricultural field. CO-4. Familiarize with 2^2 & 2^3 factorial experiments and analyze the data for agriculture data and draw meaningful conclusions.
	Semester- V **G506.5b.: Elective (1) – Total Quality Management**

Course Objectives	● Give an awareness of applications of statistical tools in industry. ● Train the students in the analysis of various control charts. ● Expose the students for various methods of acceptance sampling plan.
Course Outcomes	After completion of this course students should be able to CO-1. Understand the concept of Total Quality Management in the production process and tools of TQM, CO-2. Explain the various tools and techniques of TQM and general theory of control charts. CO-3. Derive the control limits of various variable and attribute control charts and interpret the same. CO-4. Design acceptance sampling methods for attributes and variables
	Semester- V **G506.5a: Practical based on G506.5 and G506.5a Elective (1)**
Course Objectives	● Apply the various control charts for the problems related to production industry. ● Train the students to identify the best acceptance sampling method. ● Train the students for real applications of designs of experiment.
Course Outcomes	After completion of this course students should be able to CO-1. Explain the applications of various models of designs of experiment. CO-2. Analyse factorial experiments for real life. CO-3. Understand the applications of control charts in industry and analyse the given data. CO-4. Understand how to design a proper Acceptance Sampling Plan.
	Semester- V **G506.5b. Elective (2) – Regression Analysis**
Course Objectives	● Train the students for the applications of regression tools. ● Familiarize the students for multiple regression analysis.
Course Outcomes	After completion of this course students should be able to CO-1. Explain the meaning of Regression models, point and interval estimation using the regression equation, prediction and residual analysis.

	CO-2. Understand Multiple regression model, estimation of parameters testing and confidence intervals and prediction. CO-3. Build a regression model and analyse the given data. CO-4. Understand how to use various variable selection procedure and multiple regression approach to analysis of variance and experimental design.
	Semester- V **G506.5a: Practical based on G506.5 and G506.5a Elective (2)**
Course Objectives	● Apply the various control charts for the problems related to production industry. ● Train the students to identify the best acceptance sampling method. ● Train the students for real applications of designs of experiment.
Course Outcomes	After completion of this course students should be able to CO-1. Explain the applications of various models of designs of experiment. CO-2. Analyse factorial experiments for real life. CO-3. Apply the regression analysis to analyse real life data. CO-4. Understand how to use multiple regression and variable selection procedure.
	Semester- VI **G506.6a: Sampling Theory**
Course Objectives	● Empower students to understand the importance of sample survey to make a decision about the population. ● Familiarise students with various sampling techniques and its applications. ● Train the students to take proper decision regarding the sampling method.
Course Outcomes	After completion of this course students should be able to CO-1. Understand the importance of sampling in analysing data and the methods of determining size of the sample. CO-2. Understand the difference between simple random sampling with replacement and without replacement, estimation of various population parameters and precision of these estimates. CO-3. Have complete knowledge of Stratified random sampling and its application. Also to identify the efficiency of various sampling methods with Stratified sampling.

	CO-4. Understand theoretical concept of Systematic and Cluster sampling with applications in real life.
	Semester- VI **G506.6:Elective (1) – Operation Research**
Course Objectives	● To impart knowledge in concepts and tools of Operations Research. ● To apply these techniques constructively to make effective business decisions. ● Ability to formulate mathematical models, understand and analyze managerial problems in industry so that they are able to use resources more effectively. ● Analyzing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.
Course Outcomes	After completion of this course students should be able to: CO-1. Understand the concept of OR, Linear programming problem, various methods of solving linear programming problem and its applications in industry. CO-2. Gain knowledge about transportation problems, applying various methods to real life situations and obtaining optimum solutions. CO-3. Understand the concepts of Assignment problem and Game Theory with their applications. CO-4. Familiarize the concepts of inventory problems and apply various types of EOQ models to solve the problems of industry.
	Semester- VI **G506.6a.: Practical based on G506.6 and G506.6a Elective (1)**
Course Objectives	● Train the students for the applications of sampling theory in real life. ● Analyze the efficiency of various methods of sampling. ● Train the students for the applications of various optimisation tools.
Course Outcomes	After completion of this course students should be able to: CO-1. Understand how to draw a simple random sample with replacement and without replacement and find best estimates for the population. CO-2. Find out the efficiency of various methods of sampling and decide the best method for the situations under consideration. CO-3. Understand the applications of various optimal tools in industry. CO-4. Take a proper decision about the selection of one of the tools of optimization.
	Semester- VI

	G506.6a:Elective (2) Simulation
Course Objectives	● Expose the students to the concept of Simulation, areas of applications, systems and models of simulation. ● Familiarise students with the methods of Random number generation, random variate generation and variance reduction technique and their applications.
Course Outcomes	After completion of this course students should be able to: CO-1. Understand the technique of Simulation and its areas of applications. CO-2. Explain the method of random number generation and applications of various tests for random numbers. CO-3. Understand various random variate generation methods and how to apply these methods for different continuous probability distributions. CO-4. Apply Variance Reduction technique.
	Semester- VI **G506.6a.: Practical based on G506.6 and G506.6a Elective (2)**
Course Objectives	● Train the students for the applications of sampling theory in real life. ● Analyze the efficiency of various methods of sampling. ● Familiarise the students for the applications of various techniques of simulation and generation of random numbers from continuous distributions.
Course Outcomes	After completion of this course students should be able to: CO-1. Understand how to draw a simple random sample with replacement and without replacement and find best estimates for the population. CO-2. Find out the efficiency of various methods of sampling and decide the best method for the situations under consideration. CO-3. Understand the applications of various simulation techniques.

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 1

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 Descriptive statistics, mean Vector, dispersion matrix correlation matrix, Partial and Multiple correlation.
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 2

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: 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, Second Edition, 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 and Scientists, 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 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	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**
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. Minimum Variance Unbiased Estimator and Minimum Variance Bound Estimator.	
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 through examples 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.

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Theory: End Semester Examination Question Paper pattern

End Semester theory Examination will be common for all science departments. The duration of the examination is 2 hours carrying 60 marks.

The question paper is divided into Part –A, Part – B and Part-C.

Part - A: Objective-type questions from each unit 10 marks.

Part – B: Analytical questions from each unit 20 marks and

Part – C: Descriptive answer for 30 marks.

Question Paper Pattern Sample

Part - A: Any 5 out of 7 (2 x 5=10 marks.)

Part - B: Answer any one question from A or B (5x4=20 marks)

Unit-I.Q.2A OR 2B =5 marks.

Unit-2. Q.3A OR 3B =5 marks.

Unit-3. Q.4A OR 4B= 5 marks.

Unit-4. Q.5A OR 5B= 5 marks.

Part – C: Answer any TWO (15 X2=30 marks)

Theory: 60:40

1. Ratio of weightage (marks) between Internal & End Semester Examinations for THEORY: 60:40

THEORY INTERNAL COMPONENT: 40

- Two internal tests: 10×2=20
- Assignment: 05
- Attendance: 05
- Continuous Unit wise tests (objective/MCQ): 05
- Group/ teams of two projects:05

Practical:

Total Maximum Marks: 50: (IA 25 + End Semester Practical Exam 25 Marks)

Practicum component marks: 50

Internal component of practicum: 50 (converted to 25)

Internal:

- Continuous Assessment of all practical experiments: 15
- Attendance: 05
- Model practical Test: 20
- Maintenance of Records: 05
- Viva: 05

End semester Practicum: 50 (converted to 25)

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