ST. JOSEPH'S UNIVERSITY

BENGALURU-27

School of Physical Sciences

DEPARTMENT OF STATISTICS

Syllabus for Bachelor of Science

(With Statistics as one of the three Major subjects with Practical)

Under State Education Policy

For Batch 2024 onwards

Name of the Degree Program: B.Sc.

Discipline Core: Statistics

Total Credits for the Program: 142 (till 6 semesters)

Starting Year of implementation: 2024-25

Pre requisites for the Course:

1. Only those candidates who have passed Pre-University course or an equivalent course with Mathematics/Business Mathematics/Basic Mathematics/Applied Mathematics as one of the optional subjects are eligible to take Statistics as one of the optional subjects in BSc course.
2. Any student taking Statistics as one of the optional subjects in the BSc course shall take Mathematics as another optional subject.
3. The subject of Statistics in this course has to be taught by M.Sc degree holders in Statistics / Applied Statistics.

Program Outcomes

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

1. Acquire fundamental/systematic or coherent understanding of the academic field of Statistics and its different learning areas and applications.
2. Develop and demonstrate an ability to understand major concepts in various disciplines of Statistics.
3. Demonstrate the ability to use skills in Statistics and different practicing areas for formulating and tackling Statistics related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics.
4. Understand procedural knowledge that creates different types of professionals related to subject area of Statistics, including professionals engaged in government/public service and private sectors.
5. Plan and execute Statistical experiments or investigations, analyze and interpret data / information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations.

6. Have a knowledge regarding use of data analytics tools like Excel and R-programming.
7. Developed ability to critically assess a standard report having graphics, probability statements.
8. Analyze, interpret the data and hence help policy makers to take a proper decision.
9. Recognize the importance of statistical modelling and computing, and the role of approximation and mathematical approaches to analyze the real problems using various statistical tools.
10. Demonstrate relevant generic skills and global competencies such as
    i. Problem-solving skills that are required to solve different types of Statistics related problems with well- defined solutions, and tackle open-ended problems, that belong to the disciplinary-area boundaries;
    ii. Investigative skills, including skills of independent thinking of Statistics-related issues and problems;
    iii. Communication skills involving the ability to listen carefully, to read texts and reference material analytically and to present information in a concise manner to different groups / audiences of technical or popular nature;
    iv. Analytical skills involving paying attention to details and ability to construct logical arguments using correct technical language related to Statistics and ability to translate them with popular language when needed;
    v. ICT skills;
    vi. Personal skills such as the ability to work both independently and in a group.
11. Undertake research projects by using research skills –preparation of questionnaire, conducting national sample surveys, research projects using sample surveys, sampling techniques.
12. Understand and apply principles of least squares to fit a model to the given data, study the association between the variables, applications of Probability Theory and Probability Distributions.

Assessment

Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	**40**	**60**
Practical	**15**	**35**
Projects	**30**	**70**
Experiential Learning (Internships, etc.)	**30**	**70**

Summary of Credits of Core Courses			
Semester	**Course Code**	**Title of the Paper**	**Credits**
I	ST 124	Basic Statistics - I	3
	ST 1P24	Practical based on ST 124	2
II	ST 224	Basic Statistics - II	3
	ST 2P24	Practical based on ST 224	2
III	ST 325	Statistical Inference - I	3
	ST 3P25	Practical Based on ST 325	2
IV	ST 425	Statistical Inference- II	3
	ST 4P25	Practical based on ST 425	2
V			
VI			

List of Discipline Specific Electives (DSE)	
• Actuarial Statistics • Advanced Statistical Inference • Analysis of Categorical Data • Analysis of Clinical Trials • Artificial Intelligence with R • Bayesian Inference • Biostatistics • Computational Statistics • Data Analytics with R/Python • Data Science: Multivariate Techniques with R /Python • Data Science with R/Python • Demography • Extreme value Theory • Econometrics	• Financial Statistics • Multivariate Techniques • Nonparametric and Semiparametric Methods • Operations Research • Project Work • Reliability Analysis • Reliability and Statistical Quality Control • Statistical Learning and Data Mining with R/Python • Statistical Quality Control • Stochastic Models in Finance • Survival Analysis • Time Series Analysis • Sampling Theory and Applications

List of Open Elective (OE) for first four semesters	
• Statistical Methods • Business Statistics • Applied statistics • Biostatistics	• Statistical Methods for Population Studies • Introduction to R Software • An introductory course on Operations Research

Curriculum Structure for the Undergraduate Degree

Program: B.Sc.

Total Credits for the Program: 142
Starting year of implementation: 2024-25
Name of the Degree Program: B. Sc.
Discipline/Subject: Statistics (Major)

Program Articulation Matrix

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc.

Elective courses may be listed separately.

Sem ester	Title / Name of the course	Program outcomes that the course addresses (not more than 3 per course)	Prerequisite course(s)	Pedagogy##	Assessment$
1	**Basic Statistics - I**	PO1,PO2,PO8	Mathematics of 12th level	1. The course is taught using traditional chalk and talk methods 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 test, open book examination, 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	**Basic Statistics - II**	PO7,PO9,PO 10	Mathematics of 12th level	1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises. 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.

2	**Practical**	PO5, PO6	Mathematics of 12^{th} level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/course projects/ problem or project- based learning/ case studies/self-study like seminar, term paper or MOOC course.
$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e., assessment for learning).

Course Prerequisite(s): II PUC with Mathematics

Course Outcomes (CO's):

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

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

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 ability to critically assess a standard report having graphics, probability statements.					X	X	X		X			
6. Knowledge to conceptualize the probabilities of events including frequentist and axiomatic approach. 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 expectation and moments.					X	X			X	X		
8. Knowledge of important discrete and continuous distributions such as Binomial, Poisson, Normal, distributions.					X	X			X	X		
9. Knowledge on R-programming in the 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 particular course outcome addresses that particular program outcome.

Bachelor of Science (Statistics)

First Semester
ST 124: Basic Statistics - I

Semester	**I**
Paper Code	**ST 124**
Paper Title	**Basic Statistics - I**
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03
Formative Assessment Marks	40
Summative Assessment Marks	60

Unit – 1: Introduction to Statistics **11 Hours**

Statistics: Definition and scope. Concepts of statistical population and sample. Census and survey; Types of Sampling (Simple, Stratified and Systematic random sampling- Definitions only). Data: quantitative and qualitative, cross sectional and time-series, discrete and continuous. Scales of measurement: nominal, ordinal, interval and ratio. Classification and Tabulation of data. Frequency distributions: frequency and Cumulative frequency distributions. Diagrammatic and graphical representations of data: Bar diagram, Pie chart, Histogram, frequency Polygon, frequency curve, Ogives and Stem and Leaf.

Unit – 2: Univariate Data Analysis **14 Hours**

Measures of Central Tendency: Arithmetic Mean, Weighted mean, Median, Mode, Geometric and harmonic means, properties, merits and limitations, relation between these measures. Partition values; Quartiles, Deciles, Percentiles. Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation and their relative measures, properties, merits and limitations. Moments, Skewness and Kurtosis. Box Plot - Outliers.

Unit – 3: Bivariate Data Analysis **10 Hours**

Bivariate Data, Scatter plot, Correlation: Karl Pearson's correlation coefficient and its properties, Spearman's Rank correlation. Curve fitting: Concept of errors, Principle of least squares, polynomial and exponential curves. Simple linear regression: fitting and interpretation of coefficients, Coefficient of determination (R-Square).

Unit –4: Introduction to Probability **10 Hours**

Experiment: Deterministic and Random experiment, trial, sample space and events. Classical, empirical and axiomatic approaches to probability – illustrations and applications. Addition rule, Conditional probability, Independence of events and Multiplication rule. Total probability rule, Bayes theorem - applications.

References

1. Balakrishnan, N., Koutras, M. V., & Politis, K. G. (2019), Introduction to probability: models and applications, John Wiley & Sons.
2. Freedman, D., Pisani. R and Purves. R. (2014), Statistics, 4th Edition, W. W. Norton & Company.
3. Gupta, S.C. (2018), Fundamental of Statistics, Himalaya Publishing House, 7thEdition.
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.
9. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.
10. Rao, B. P. (2009), A first course in probability and statistics, World Scientific.

Pedagogy

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

MODEL BLUEPRINT		
Code number:		**ST 124**
Title of the paper:		**Basic Statistics - I**
Unit number	**Number of hrs.**	**Total marks**
1	11	22
2	14	27
3	10	19
4	10	20
Total	45	88
Maximum marks for the paper (Excluding bonus questions)		60

Note: **For the current batch, blueprint of having weightage 35% pre Mid-Sem and 65% post Mid-Sem portions will be followed.**

Course Outcomes: At the end of the Course, the student should be able to

CO1	Apply knowledge of statistical concepts and methods to effectively organize and present data using appropriate tabular and graphical techniques.
CO2	Demonstrate the ability to analyze and apply various measures of central tendency and dispersion, including mean, median, mode, standard deviation, and quantiles, as well as interpret data distributions using box plots etc.
CO3	Analyze the relationship between two variables using bivariate data analysis techniques like scatter plots, correlation coefficients, and linear regression and draw meaning conclusions.
CO4	Explain the fundamental concepts of probability theory, including random experiments, sample spaces, events, different approaches to defining probability (classical, statistical, subjective, axiomatic), and their applications in various scenarios.

Practical I

ST 1P24 – Practical on ST 124

Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	02
Formative Assessment Marks	15
Summative Assessment Marks	35

Note: Computing all the practical's manually and using MS Excel

1. Presentation of data by frequency tables, diagrams and graphs, stem and leaf, partition values.
2. Measures of Central Tendency: Arithmetic Mean (AM), Geometric mean, Harmonic mean, Weighted AM, Corrected mean.
3. Computation of Median, Mode, Partition values.
4. Problems on Absolute and relative measures of dispersion, Box plots.
5. Problems on moments, skewness and kurtosis.
6. Fitting of curves by least squares method.
7. Computation of Product moment correlation coefficient and rank correlation.
8. Fitting Regression line of two variables.
9. Computation of probability using combinatorial methods.
10. Computation of probability using addition and multiplication theorem. Application of conditional probability, Bayes theorem.

Bachelor of Science (Statistics)

Second Semester
ST 224: Basic Statistics – II

Semester	II
Paper Code	**ST 224**
Paper Title	**Basic Statistics - II**
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03
Formative Assessment Marks:	40
Summative Assessment Marks:	60

Unit –1: Random Variables and Mathematical Expectations 12 Hours

Discrete and continuous random variables, Distribution function, probability mass function (p.m.f) and probability density functions (p.d.f) – properties and illustrations, Expectation of a random variable and rules of expectation, variance and related results.

Joint, marginal and conditional distributions, Independence of random variables, Moments, covariance and correlation coefficient, Addition and multiplication rules of expectation, Mean and variance of linear combination of random variables, Conditional expectation. Moments and moment generating function (m.g.f) – properties and uses.

Unit –2: Discrete and Continuous Probability Distributions 16 Hours

Discrete probability distributions:
Discrete Uniform, Bernoulli, Binomial distributions: mean, variance, m.g.f., recurrence relation for probabilities, additive property of Binomial distribution. Poisson, Geometric distributions: mean, variance, and m.g.f. recurrence relations for probabilities, additive property of Poisson and geometric distributions, Lack of memory property of geometric distribution. Negative-Binomial and Hypergeometric distributions: mean, variance.

Continuous probability distributions:
Uniform, exponential distributions – definition through p.d.f.s, mean, variance, m.g.f., lack of memory property and additive property of exponential distribution. Gamma, Beta, distributions: definition through p.d.f.s, Normal distribution: definition through p.d.f., standard normal distribution, median, mode, m.g.f, area property, odd order and even order moments and linear combination of normal variates.

Unit –3: Limit Theorems and Random Number Generation 10 Hours

Chebyschev's inequality – proof and its use in approximating probabilities for various discrete and continuous distributions. Convergence of Binomial, Poisson, Gamma distributions to Normal distribution. Statement of Central Limit Theorem and its applications.

Introduction to Simulation, Monte Carlo method. Generation of random observations from uniform, exponential, Normal, Binomial, Poisson distributions, simple illustrations.

Unit –4: Introduction to R software 7 Hours

Introduction to R: Installation, command line environment, overview of capabilities, brief mention of open-source philosophy. 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., 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. Inserting Variables, Creating a vector using c(), seq() and colon operator. Functions to summarize a vector: sum, mean, sd, median etc. Extracting a subset from the vector (by index, by property). 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).

References

1. Balakrishnan, N., Koutras, M. V., & Politis, K. G. (2019), Introduction to probability: models and applications, John Wiley & Sons.
2. Dudewitz. E.J. and Mishra. S. N. (1998), Modern Mathematical Statistics. John Wiley.
3. Goon A.M., Gupta M.K., Das Gupta. B. (1991), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
4. Gupta. S.C and V.K. Kapoor (2020), Fundamentals of Mathematical Statistics, Sultan Chand and Co, 12th Edition.
5. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, Seventh Edition, Pearson Education, New Delhi.
6. 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.
7. Mukhopadhyay, N. (2020). Probability and statistical inference. CRC Press.
8. Ross, S. (2002), A First Course in Probability, Prentice Hall.
9. Ross, S. M. (2014). Introduction to probability models. Academic press.
10. Sudha G. Purohit, Sharad D. Gore, Shailaja R Deshmukh, (2009), Statistics using R, Narosa Publishing House.
11. R for beginners by Emmanuel Paradis (freely available at https://cran.rproject.org/doc/contrib/Paradisrdebuts_en.pdf)
12. Rao, B. P. (2009), A first course in probability and statistics, World Scientific.
13. Dhanavanthan, P and Sakthivel, K.M (2024): Elementary theory of probability distributions, Ane Publishers and distributors LLP, New Delhi.
14. Venables W.N., Smith D.M.,and the R development core team (2008): An Introduction to R. Network publishers.
15. Varzani, J (2014): Using R for Introductory statistics, 2nd edition, CRC Press, Chapman & Hall book.

Pedagogy

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

MODEL BLUEPRINT		
Code number:		**ST 224**
Title of the paper:		**Basic Statistics - II**
Unit number	**Number of hrs.**	**Total marks**
1	12	23
2	16	31
3	10	20
4	07	14
Total	45	88
Maximum marks for the paper (Excluding bonus questions)		60

Note: **For the current batch, blueprint of having weightage 35% pre Mid-Sem and 65% post Mid-Sem portions will be followed.**

Course Outcomes: **At the end of the Course, the student should be able to**

CO1	Analyze the characteristics of random variables (discrete or continuous) using probability distributions, calculate expected values and interpret moments and moment generating functions to understand the central tendency and spread of data.
CO2	Apply their knowledge of common probability distributions (Bernoulli, Binomial, Poisson, Uniform, Exponential, Normal) to real-world scenarios by identifying the appropriate distribution based on data characteristics and fitting the distribution to the data.
CO3	Demonstrate knowledge of the convergence of Binomial, Poisson, and Gamma distributions to the Normal distribution under specific conditions and understand the basic principles and purpose of simulation in statistical analysis.
CO4	Use R programming to perform basic data analysis tasks, including creating and manipulating data structures (vectors), calculating summary statistics, and generating informative visualizations (plots, histograms, scatter plots) to explore and understand data.

Practical II

ST 2P24 – Practical on ST 224

Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	02
Formative Assessment Marks	15
Summative Assessment Marks	35

Note: Computing all the practical's manually and using R Software

1. Descriptive statistics (Presentations, Summarizations, correlations, regression and Graphs) using R.
2. Univariate probability distribution: Expectation, moments, skewness and kurtosis.
3. Bivariate Probability Distribution: Joint, Marginal, Conditional, and correlation coefficient, Conditional Expectation.
4. Applications of discrete probability distributions: Binomial, Poisson and Geometric
5. Fitting of discrete distributions: Binomial, Poisson, Geometric
6. Applications of Continuous probability distributions: Uniform and Exponential
7. Fitting of continuous probability distributions: Uniform and Exponential
8. Fitting and Applications of Normal distribution
9. Generation of random observations: Binomial, Poisson, Geometric, Uniform, Exponential and Normal using Simulation
10. Applications of Chebyschev's inequality and Central Limit Theorem

Bachelor of Science (Statistics)

Third Semester

ST 325: Statistical Inference–I

Semester	**III**
Paper Code	**ST 325**
Paper Title	**Statistical Inference-I**
Number of teaching hours per week	**03**
Total number of teaching hours per semester	**42**
Number of credits	**03**
Formative Assessment Marks:	**40**
Summative Assessment Marks:	**60**

Unit -1: Family of Distributions and Theory of Point Estimation: 15 Hours

Family of distributions: Single parameter exponential family, K - parameter exponential family, Location - Scale family, Pitman family – Definitions and examples.

Point Estimation - Concepts of estimator and estimate, criteria of a good estimator - Unbiasedness, Consistency, sufficient conditions for consistency, Invariance property of consistent estimator, Sufficient Statistic - Statement of Neyman Factorization theorem, Minimum variance unbiased estimator, Efficiency and Relative efficiency, mean square error. Problems on estimation from some Standard distributions (Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Uniform, Normal and Exponential distributions only).

Unit -2: Methods of Point Estimation: 8 Hours

Methods of Point Estimation: Maximum likelihood estimator (MLE) and method of moments: Properties, Illustration for non-uniqueness and invariance property of MLE. Estimation of parameters for Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Normal, Exponential, Continuous Uniform distributions.

Unit - 3: Sampling Distributions and Interval Estimation: 13 Hours

Sampling distributions and Standard error of a statistic and its uses. Sampling distribution of the sample mean, sample variance, and their independence under normality assumption. Chi-square, t, and F distribution and their statistics under normality assumption.

Confidence Interval, Confidence Coefficient, Pivotal quantity method of constructing Confidence Intervals, construction of confidence intervals for: the mean, the difference between two means, variance and ratio of variances, proportion, the difference between proportions, and correlation coefficient (small and large samples) .

Unit - 4: Testing of Hypotheses **6 Hours**

Definition of Statistical hypotheses and its types - Null and Alternative, Simple and Composite hypotheses. Type-I and Type-II Errors, Size of the test, Level of significance, Power of the test and Power function and its computations. Test function - Randomized and non-randomized test (definition only). Critical region, P-value and its interpretation.

References:

1. Freund J.E. (2001): Mathematical Statistics, Prentice Hall of India.
2. Nitis Mukhopadhyay (2000): Probability and Statistical Inference, Marcel Dekker, Inc, New York.
3. Goon A.M., Gupta M.K., Das Gupta.B. (1991): Fundamentals of Statistics, Vol. I, World Press, Calcutta.
4. Hogg R.V. and Tannis E.A. (1988): Probability and Statistical Inference, Collier MacMillan.
5. Hodges J.L and Lehman E.L (1974): Basic Concepts of Probability and Statistics, Holden-Day.
6. Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
7. Gupta. S.C. and V.K.Kapoor (2001): Fundamentals of Mathematical Statistics. Sultan Chand & Co.
8. Bhattacharya and Johnson (1986): Statistical Concepts, Wiley Int. Ed.
9. Rohatgi. V.K. and A.K. Md. Ehsanes Saleh (2002): An Introduction to Probability Theory and Mathematical Statistics. John Wiley (WSE).
10. Ross S.M (1987): Introduction to Probability and Statistics for Engineers & Scientists, John Wiley & Sons.
11. Rajagopalan M & Dhanavanthan P (2012): Statistical Inference, Eastern Economy Edition, PHI Learning Private Limited, New Delhi.

Pedagogy

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

MODEL BLUEPRINT		
Code Number:		**ST 325**
Title of the paper:		**Statistical Inference-I**
Unit number	**Number of Hrs.**	**Total Marks**
1	15	31
2	8	17
3	13	27
4	6	13
Total	42	88
Maximum marks for the paper (Excluding bonus questions)		60

Note: For the current batch, a blueprint of having weightage 35% pre Mid-Sem and 65% post Mid-Sem portions will be followed.

Course Outcomes: At the end of the Course, the student should be able to

CO1	Describe the family of distributions, including the single-parameter exponential family, location-scale family and explain their applications with examples.
CO2	Learn the concepts of point estimation to standard distributions, such as estimating parameters from Bernoulli, Poisson, Normal, Exponential distributions, etc.
CO3	Acquire the concept of confidence intervals to estimate population parameters based on sample data.
CO4	Apply the concepts of hypothesis testing to formulate and analyze real life datasets and draw meaningful conclusions.

Practical - III
ST 3P25 – Practical on ST 325

Number of teaching hours per week	**03**
Total number of teaching hours per semester	**42**
Number of credits	**02**
Formative Assessment Marks	**15**
Summative Assessment Marks	**35**

Computing all the practical manually and using Excel/R

1. Properties of estimators on unbiasedness, consistency and efficiency.

2. Comparison of estimators by plotting mean square error using MS-Excel and R.

3. Estimation of parameters by Maximum Likelihood method.

4. Estimation of parameters by Method of Moments.

5. Estimation of parameters by Maximum Likelihood method and Method of Moments (Using R).

6. Construction of confidence intervals-I (large samples).

7. Construction of confidence intervals-II (small samples).

8. Construction of confidence intervals using R & MS-Excel.

9. Testing of Hypothesis-I (Formulation of hypotheses, understanding types of hypotheses, understanding types of tests).

10. Testing of Hypothesis-II (Understanding Type I error and Type II Error)

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Fourth Semester

ST 425: Statistical Inference-II

Semester	**IV**
Paper Code	**ST 425**
Paper Title	**Statistical Inference–II**
Number of teaching hours per week	**03**
Total number of teaching hours per semester	**42**
Number of credits	**03**
Formative Assessment Marks:	**40**
Summative Assessment Marks:	**60**

Unit – 1: MP and UMP tests **14 Hours**

Most Powerful (MP) test. Statement of Neyman – Pearson Lemma and its applications. MP test for parameters of Bernoulli, Binomial, Poisson and Normal distributions.

Monotone likelihood ratio (MLR) property. Uniformly most powerful (UMP) test. Statement of the theorem on UMP test for testing one-sided hypothesis for distributions with MLR property. (Only parameter of Bernoulli and mean of Normal Distribution)

Unit – 2: Likelihood Ratio tests **6 Hours**

Likelihood ratio tests (LRT) and its properties. LRT's for mean and variance of normal distribution (one-sample problem), LRT for the mean of Exponential distribution.

Unit - 3: Tests of Significance **12 Hours**

Large and small sample tests of significance with corresponding assumptions: Tests for proportions and differences between proportions, Tests for single mean, equality of two means, single variance, and the ratio of two variances. Tests for correlation coefficient and regression coefficients (only slope and intercept (t-test)). Fisher's Z-transformation and its applications (test for non-zero correlation coefficient).
Analysis of categorical data- contingency table, Chi-square test for independence of attributes in a contingency table, Chi-square test for goodness of fit, and equality of several proportions using Chi-square test.

Unit – 4: Non-Parametric tests **10 Hours**

Need for distribution-free tests - non-parametric tests. one sample and two samples sign tests, Wilcoxon signed- rank test, Median test, Wald Wolfowitz run test, Mann Whitney Wilcoxon test, run

test for randomness, test for independence based on Spearman's rank correlation coefficient (small and large samples), Kolmogorov-Smirnov one-sample test and two-sample test, test for more than two samples (Kruskal Wallis test and Friedman test), Normal probability plot and QQ Plot.

References:

1. Rohatgi.V.K.and A.K.Md. Ehsanes Saleh (2002): An Introduction to Probability theory and Mathematical Statistics, John Wiley(WSE).
2. Hogg R.V and Tannis, E.A.(1988): Probability and Statistical Inference, Collier MacMillan.
3. Mukhopadhyay. P (1996): Applied Statistics, Calcutta Publishing House.
4. Gupta S. C and V.K.Kapoor (2001): Fundamentals of Mathematical Statistics, Sultan Chand & Co.
5. Gopal K.Kanji (2006): 100 Statistical tests,3rd Edition, Sage Publications
6. Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
7. Nitis Mukhopadhyay (2000): Probability and Statistical Inference, Marcel Dekker, Inc, New York.
8. Sheldon M Ross (2017): Introductory Statistics, 4th Edition, Academic Press Publishers.
9. Dudewicz. E.J.and Mishra.S.N.(1980): Modern Mathematical Statistics, John Wiley.
10. Kale B.K (2005): A First Course on Parametric Inference,2nd Edition, Narosa Publishers.
11. Randles R.H and Wolfe DA(1979):Introduction to the Theory of Nonparametric Statistics, John Wiley
12. Rajagopalan M & Dhanavanthan P (2012): Statistical Inference, Eastern Economy Edition, PHI Learning Private Limited, New Delhi.

Pedagogy

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

MODEL BLUEPRINT		
Code number:		**ST 425**
Title of the paper:		**Statistical Inference–II**
Unit Number	**Number of Hrs.**	**Total Marks**
1	14	29
2	06	13
3	12	25

4	10	21
Total	42	88
Maximum marks for the paper (Excluding bonus questions)		60

Note: For the current batch, a blueprint of having weightage 35% pre Mid-Sem and 65% post Mid-Sem portions will be followed.

Course Outcomes: At the end of the Course, the student should be able to

CO1	Understand and apply the concepts of MP and UMP tests for standard distributions.
CO2	Explain the concept of likelihood ratio test and its importance.
CO3	Apply the statistical inference tools in real data analysis.
CO4	Understand and apply the concept of nonparametric tests to analyze data when the assumptions of normality for parametric tests are not met.

Practical - IV
ST 4P25 – Practical on ST 425

Number of teaching hours per week	**03**
Total number of teaching hours per semester	**42**
Number of credits	**02**
Formative Assessment Marks	**15**
Summative Assessment Marks	**35**

Computing all the practical manually and using Excel/R

1. MP test, UMP test and LR test for parameters of Bernoulli distribution & Normal Distributions.

2. Tests concerning means and proportions (small and large sample)

3. Tests concerning variances (small and large sample)

4. Tests for correlation coefficients and Regression coefficient (slope and intercept)

5. Tests for Independence of attributes and test for homogeneity (Chi-square test)

6. Tests for goodness of fit.(Uniform, Binomial, Poisson and Normal)

7. Small and Large sample test using MS Excel and R

8. Nonparametric tests–1 (for single and related samples)
(Sign test and Wilcoxon signed rank test, Kolmogorov Smirnov test and one sample Run test)

9. Nonparametric tests–2 (for two independent samples)
(Median test, Wilcoxon Mann Whitney –U test, Wald-Wolfowitz's Run test and Kruskal Wallis test)

10. Tests for Normality, Histogram, QQ Plot using R.