KURUKSHETRA UNIVERSITY, KURUKSHETRA

(Established by the State Legislature Act XII of 1956)
('A++' Grade, NAAC Accredited)

Syllabus for

Under-Graduate Programme

Subject: Statistics

Vth and VIth Semesters

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2024-25

KURUKSHETRA UNIVERSITY, KURUKSHETRA

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Minor change in the Scheme of Examination for Under-Graduate Programme Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2024-25

Subject: Statistics

SEMESTER-VI

Remarks	Course Type	Course Code	Nomenclature of Paper	Credits	Contact Hours/ Week	Internal marks	End Term Marks	Total Marks	Duration of Exam
Scheme A, B & C	**CC-6 MCC-11 (4 credit)**	B23- STA - 601	Design of Experiments	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**MCC-12 (4 credit)**	B23- STA - 602	Parametric Inference	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**DSE-4 (4 credit)** Select one option	B23- STA - 603	Non-parametric Inference	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
		B23- STA - 604	Bayesian Inference	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**DSE-5 (4 credit)** Select one option	B23- STA - 605	Statistical Data Analysis using Statistical Softwares	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
		B23- STA - 606	Data Analysis using Python	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Fifth		
Name of the Course	Sample Surveys		
Course Code	B23-STA-501		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-5 MCC-9		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Concepts of census, sampling and sample surveys. 2. Simple random sampling techniques, population parameter estimations, and use of random number tables. 3. Stratified random sampling methodologies, comparing and contrasting various allocation strategies. 4. Systematic random sampling, assessing its strengths, weaknesses, and distinguishing it from simple random sampling.		
CLO 5 is related to the practical components of the course	5. Problems based on sampling methods, random numbers, simple random sampling, stratified sampling and systematic sampling.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	
Part B - Contents of the Course			

Instructions for Paper- Setter

There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.

Unit	Topics	Contact Hours
I	**Sample Survey**: Concepts of census and sample survey, basic concepts in sampling, utility of standard error, sampling and non-sampling errors, Principal steps involved in a sample survey, Principles of sample survey, sampling vs complete census, limitations of sampling.	11
II	**Simple Random Sampling**: Simple random sampling (SRS) with and without replacement, use of random number tables, determination of sample size, Random sample from distributions, estimation of mean and variance in case of SRS, Simple random sampling of attributes, Merits and demerits of SRS.	11
III	**Stratified Random Sampling**: Concept and importance of Stratified random sampling, estimation of population mean and its variance in stratified random sampling, allocation of sample size: Proportional and optimum allocations, comparison of Proportion allocation, Neyman allocation and Simple random sampling.	12
IV	**Systematic Random Sampling**: Principle of systematic random sampling, estimation of mean and its variance, comparison of **S**ystematic random sampling with Simple random sampling, systematic sampling in presence of linear and general linear trend, merits and demerits of systematic random sampling.	11
	Practicum	
	1. Determine the non-response rate and calculate the impact of non-sampling error on the survey results for a given mean with standard error. 2. Generate random samples using random number tables, both with and without replacement. 3. Draw a random sample of size 5 from Normal Population with given mean and variance. 4. Draw a random sample from Chi square distribution with given degree of freedom. 5. Determine which sampling method (with or without replacement) would result in a more efficient estimate of the population mean, given a fixed sample size and variability. 6. Estimates population mean, population mean square, and its variance using sample data obtained through SRSWR and SRSWOR. Also compare these estimates. 7. Estimate proportions or percentages of certain characteristics in a population through Simple random	30

	sampling of attributes. 8. Estimates population mean and its variance using data obtained through stratified random sampling, employing proportional and Neyman allocation methods. 9. Compare the precision of estimation using simple random sampling, proportional allocation and Neyman allocation methods. 10. Estimates population mean and its variance using systematic random sampling and compare them with results from simple random sampling.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20marks

Part C- Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Fundamentals of Applied Statistics	Gupta, S.C.& Kapoor, V.K.	Sultan Chand & Sons (2014)
2.	Sampling Techniques	Singh, D. & Chaudhry, F.S	New age International(2020)
3.	Sampling Techniques	Cochran, W.G.	Wiley Publishers (2007)
4.	Sampling Theory	Des Raj and Chandhok P.	Narosa (1998)
5.	Sample Theory of Surveys with Applications	Sukhatme et. al.	Iowa State Uni. Press & IARS (1984)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Fifth		
Name of the Course	Statistical Quality Control and Official Statistics		
Course Code	B23-STA-502		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC-10		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Statistical Quality Control (SQC) basics, including quality variation causes, and learn how to use mean and range charts for quality monitoring. 2. SQC tools like σ chart and control charts ('p', 'd', 'c', 'u'), natural tolerance versus specification limits for quality assurance. 3. Lot acceptance criteria, manage risks for producers and consumers, and apply sampling plans efficiently, alongside key quality assurance concepts like AQL and LTPD. 4. Significance and scope of the Indian official statistics. Learner will be able to describe the structure and functioning of the Indian statistical system.		
CLO 5 is related to the practical components of the course	5. Construction and interpretation of various control charts, determine control limits, and understand sample inspection plans for effective quality control management.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	
Part B – Contents of the Course			
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt			

five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Statistical Quality Control:** Meaning and uses of SQC, causes of variations in quality, product and process control, control charts, 3-σ control limits, control chart for variables- $\bar{X}$ and R chart, criteria for detection of lack of control in $\bar{X}$& R Charts, Interpretation of $\bar{X}$& R charts.	11
II	**Control Charts:** Control chart for standard deviation (σ chart), control charts for attributes: 'p' chart, 'd' chart, 'c' chart and "u" chart, natural tolerance and specification limits.	12
III	**Acceptance Sampling**: Problem of lot acceptance, stipulation of good and bad lots, producer's and consumer's risks, single and double sampling plans, their OC functions, concepts of AQL, LTPD, AOQL, average amount of total inspection and ASN function.	11
IV	**Indian Official Statistics:** Introduction, Indian statistical system, Statistical system at the centre, Statistical offices in the states, Population statistics, Agricultural statistics, Industrial statistics, Trade statistics, Price statistics, Statistics of labour and employment, Statistics of transport and communication, Financial and banking statistics.	11
	Practicum	
	1. Determine the control limits for the $\bar{X}$ and R control charts assuming 3-σ control limits for a given set of sample measurements from a manufacturing process. 2. Construct $\bar{X}$ and R- chart, and comment on the state of control of the process. 3. Determine the control limits for $\bar{X}$ and R- charts for future use, eliminating all the out-of-control points. Also find the natural tolerance limits. 4. Construct an σ chart with 3-σ control limits. Interpret the chart to assess process variability and identify any out-of-control signals. 5. Construct p-chart and d-chart, and comment on the state of control of the process. 6. Construct control chart for fraction defective for given data set with varying sample size. 7. Obtain control limits for number of defects and comment on the state of control plotting the appropriate chart. 8. Obtain control limits for number of defects per unit and comment on the state of control.	30

	9. Single sample inspection plan: Construction and interpretation of OC, ASN, ATI, AOQ, AOQL curves. 10. Double sample inspection plan: Construction and interpretation of OC, ASN, ATI, AOQ and AOQL curves. 11. Calculation of process capability and comparison of 3-sigma control limits with specification limits.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Fundamentals of Applied Statistics	Gupta S.C. & Kapoor V.K.	Sultan Chand & Sons (2018)
2.	Fundamentals of Statistics, Vol. II	Goon A.M., Gupta M.K. & Dasgupta B.	World Press Calcutta (2016)
3.	Statistical Quality Control	Grant E.L.	McGraw Hill (2017)
4.	Statistical Methods in Quality Control	Cowden D.J.	Asia Pub. Society (1957)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Fifth		
Name of the Course	Operations Research		
Course Code	B23-STA-503		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-2		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Operations Research (O.R.) and understand its interdisciplinary, quantitative approach to problem-solving, decision-making, and optimization in various fields. 2. Optimize job processing, solve routing problems and find shortest paths in networks. 3. Decision-making processes using different strategies, employing techniques like optimism, pessimism, and EMV to make informed choices effectively. 4. Analyzing games using various strategies, mastering various solution methods and real-world applications like bidding problems.		
CLO 5 is related to the practical components of the course	5. Problems based on sequence jobs, identify the route with the least cost in network problems, decision-making concepts like EMV and EOL, and game theory for strategic decision-making.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	
Part B – Contents of the Course			
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set			

from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Introduction to Operations Research (O.R.):** Definition, characteristics and scope of O.R., Scientific method in O.R., different phases of O.R., objectives and applications of O.R., Role of O.R. in decision-making processes, classification of O.R. models, Advantages & disadvantages of O.R. models, Steps in model formulation, Characteristics of a good model.	11
II	**Sequencing Models**: Sequencing problems, assumptions, processing of *n* jobs through one, two and three machines, routing problems in networks, travelling salesman problem, minimal path problem.	11
III	**Decision Theory**: Steps in decision theory approach, types of decision making, Decision making under certainty, Decision making under uncertainty: criterion of optimism, criterion of pessimism, Savage criterion, and Hurwicz criterion, Decision making under risks: EMV and EOL.	11
IV	**Game Theory**: Characteristics of games, terminology, rules for game theory: two-person zero sum game; game of pure strategy, reducing game by dominance, solution of game of mixed strategy without saddle point using arithmetic method; Algebraic method; method of subgame; graphical method; method of matrices and method of linear programming, limitations of game theory, Bidding problems.	12
	Practicum	
	1. Find the optimal sequence to minimize the total processing time when processing of *n* jobs through one machine. Also find total processing and mean flow time. 2. Find the order in which jobs should be processed in order to minimize total time when processing of n jobs through two machines. Also find idle time. 3. Determine the order in which then jobs should be processed to minimize the total time required to turn out all the jobs thorough three machines. Also find the idle times for the three machines. 4. In network problems, find the route that involves least cost. 5. Find the optimal route for a delivery person/salesman covering multiple destinations. 6. Indicate the decision taken under the different approaches: (i) Optimistic (ii) Pessimistic, (iii) Savage criterion and (iv)	30

	Hurwicz criterion. 7. Calculate the Expected Monetary Value (EMV) for given options and recommend the optimal choice based on the EMV criterion. 8. Calculate Expected Opportunity Loss (EOL) for each given option, make a recommendation on which option is the most favorable choice according to the EOL criterion. 9. Using the dominance method, reduce the game to its essential form and determine the optimal strategy for each player. 10. Find the optimal mixed strategy for each player and the value of the game using arithmetic method and Algebraic method.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S.No.	Title of Book	Name of author	Publisher
1.	Operations Research	Gupta P.K. and Hira D.S.	Sultan Chand & Sons (2018)
2.	Operations Research: An Introduction	Taha H.A.	Macmillan Pub. Co. (2019)
3.	Operations Research	Goel, B.S. & Mittal S.K.(2014)	Pragati Prakashan
4.	Operations Research	Sharma S.D.	Kedar Nath & Co. (2017)
5.	Operations Research	Sharma J.K.	Macmillan Pub. (2017)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Fifth		
Name of the Course	Statistical Simulation		
Course Code	B23-STA-504		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-2		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Simulation basics like its definition, types, and the Monte Carlo method. They will differentiate physical from digital simulations using examples like Buffen's needle problem. 2. Importance of random numbers and methods for their generation. They will also understand statistical tests for assessing pseudo-random numbers. 3. Methods for generating random variates. They will enhance their ability to simulate random variables efficiently in various applications. 4. Generating random variates from various continuous distributions. They will also understand Monte Carlo integration techniques.		
CLO 5 is related to the practical components of the course	5. Problems based on simulating estimation via needle dropping, generating pseudo-random numbers, and assessing their uniformity with goodness of fit tests. They will also masterin random variate generation as well as Monte Carlo integration techniques.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	

Part B – Contents of the Course		
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Introduction to Simulation:** Definition, Systems, Models, types of models, need of simulation, Monte Carlo method, physical versus digital simulation: Buffen's needle problem.	11
II	**Random Number Generation:** Importance of random numbers, Mid square method, Congruential generators, Statistical tests for assessing pseudo random numbers: Chi square goodness of fit test; Kolmogorov-Smirnov goodness of fit test; Cramer-von Mises Goodness of fit test.	11
III	**Random Variate Generation methods:** Introduction**,** Inverse transformation method, Composition method, Acceptance-Rejection method for single variate case, Von Neumann's method.	11
IV	**Generating Random Variates:** Generate random variates from continuous distributions: Exponential; Normal; Lognormal;Cauchy; Weibull; Chi-Square; Student's t and F distributions. **Monte Carlo Integration:** Introduction**,** Hit or miss Monte Carlo method, Sample Mean Monte Carlo method, Efficiency of Monte Carlo method.	12
	Practicum	
	1. Simulate the dropping of the needle n times and use the results to estimate the value of π. 2. Using the Mid Square method, generate pseudo-random numbers with a given initial seed. 3. Using a congruential generator with given parameters, generate ten pseudo-random numbers. 4. Generate pseudo-random numbers using a congruential generator and perform a Chi-square goodness of fit test to assess their uniformity. 5. Generate pseudo-random numbers using Mid Square method and perform Kolmogorov-Smirnov goodness of fit test to assess their uniformity. 6. Generate pseudo-random numbers using Mid Square method and congruential generator. Perform a Cramer-von Mises	30

	Goodness of fit test to assess their uniformity. 7. Generate random variates from an Exponential distribution with given parameter using the Inverse transformation method. 8. Generate random variates from a normal distribution with given parameter using the Acceptance-Rejection method. 9. Estimate the value of the integral using the Hit or Miss Monte Carlo method. 10. Estimate the value of the integral using the Sample Mean Monte Carlo method with given number of samples.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Simulation and the Monte Carlo Method	Rubinstein, R.Y. (1981)	John Wiley & Sons
2.	System Simulation (2001)	Gorden, G.	Prentice Hall of India
3.	Monte Carlo Statistical Methods	Robert, C. P., & Casella, G.	Springer (2004)
4.	Simulation	Ross, S. M.	Academic Press. (2011)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Fifth		
Name of the Course	Linear Models		
Course Code	B23-STA-505		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-3		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Linear estimation, quadratic forms, central and non-central distributions for statistical analysis. 2. Regression analysis, including simple and multiple linear regression, with a strong grasp of key concepts like best linear unbiased estimator. 3. Fixed, random, and mixed effect models, Analysis of variance for one-way and two-way classified data, and effectively test main effects. 4. Use ANCOVA techniques, conduct hypothesis testing for main effects and interactions, and understand linear mixed models for advanced analysis.		
CLO 5 is related to the practical components of the course	5. Problems based on linear regression, conduct hypothesis tests, and interpret results for various analyses including regression, ANOVA, and ANCOVA enabling informed decision-making in data-driven contexts.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	
Part B – Contents of the Course			
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set			

from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Linear Estimation**: Importance and applications of linear estimation, least distribution of quadratic forms, mean and variance of quadratic forms, central and non-central chi square, t and F distributions.	11
II	**Regression analysis**: Simple regression model, least square estimation of parameters and its properties, best linear unbiased estimator, Gauss Markov theorem, estimation and hypothesis testing of parameters in case of simple and multiple linear regression.	11
III	**Analysis of Variance**: Definition of fixed, random and mixed effect models, Fisher-Cochran theorem (without derivation), analysis of variance in one-way classified data for fixed effect models, analysis of variance in two-way classified data with single observation per cell for fixed effect models, testing of main effects, expectations of sum of squares and variance of estimates of one-way and two-way classified data.	11
IV	**Analysis of Covariance**: One-way ANCOVA model with one covariate, two-way ANCOVA model with one covariate, estimation and testing of hypothesis in ANCOVA, testing of main effects, slopes, interactions and estimation of variance components, Linear mixed models (without derivation).	12
	Practicum	
	1. Calculate the distribution of the quadratic form and compute the mean and variance of the quadratic form. 2. Perform a simple linear regression analysis and interpret the coefficients. 3. Perform a hypothesis test to determine if there is a significant linear relationship between two variables using the t-distribution. 4. Conduct hypothesis tests to determine if the slope coefficient is significant and calculate its 95% confidence interval. 5. Perform multiple linear regression analysis and interpret the coefficient. 6. Assess the overall significance of the multiple linear regression model using hypothesis testing. 7. Test for differences in means between the levels of the factor	30

	using one-way ANOVA. Interpret the results. 8. Perform a two-way ANOVA analysis on a dataset with two factors and a continuous dependent variable. 9. Conduct a one-way ANCOVA analysis on a given dataset with one covariate. 10. Conduct a two-way ANCOVA analysis on a given dataset with one covariate.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Linear Statistical Inference	Rao, C.R.	Wiley Eastern (1973)
2.	Introduction to Linear Regression Analysis	Montgomery, D. C., Peck, E. A. and Vining, G. G.	John Wiley and Sons (2004)
3.	Linear Models in Statistics	Rencher, A. C. and Schaalje, G. B.	John Wiley and Sons (2008)
4.	Applied Linear Regression(2005)	Weisberg, S.	John Wiley and Sons
5.	Applied Regression Analysis	Draper, N. R. and Smith, H.	John Wiley and Sons (1998)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Fifth		
Name of the Course	Actuarial Statistics		
Course Code	B23-STA-506		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-3		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Various probability distributions in insurance for risk assessment and premium calculation and comprehensive insurance modeling. 2. Analyzing utility functions and also learn premium principles for accurate premium calculation in insurance contexts. 3. Modelling for individual and aggregated claims in insurance, alongside survival distribution concepts crucial for predicting lifetimes and assessing risk. 4. Life table and mortality laws, alongside understanding life insurance models for payout timing, and their correlations.		
CLO 5 is related to the practical components of the course	5. Problems based on various statistical tools for insurance analysis, understand utility functions, survival analysis, and life insurance models for informed decision-making in insurance.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	
Part B – Contents of the Course			
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt			

five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Introductory Statistics and Insurance Applications:** Probability distributions: discrete, continuous, and mixed distributions utilized in insurance contexts for risk assessment and premium calculation, insurance applications, sum of random variables in insurance modeling.	11
II	**Utility Theory:** Examining utility functions, the expected utility criterion, and various types of utility functions, their significance in decision-making under uncertainty within insurance contexts. **Principles of Premium Calculation:** Properties of premium principles, examples of premium principles.	11
III	**Risk Models:** Models designed to assess individual claims within insurance contexts, models for both individual claims and the aggregation of independent claims along with exploring approximation techniques and their practical applications. **Survival Distribution:** Uncertainty of age at death, survival function, time until-death for a person, curate future lifetime, force of mortality,	12
IV	**Life Tables:** Examples, deterministic survivorship group, life table characteristics, assumptions for fractional age, some analytical laws of mortality. **Life Insurance:** Models for insurance payable at the moment of death, insurance payable at the end of the year of death and their relationships.	11
	Practicum	
	1. Utilize Poisson distribution to calculate accident claim probabilities, pivotal for risk assessment in insurance. 2. Analyse utility functions across wealth levels, offering insights into decision-making behaviours under financial uncertainty. 3. Employ the expected utility criterion to guide optimal decisions amidst uncertainty within insurance settings. 4. Apply the equivalence principle to determine life insurance premiums, ensuring fairness and accuracy in pricing. 5. Develop a risk model for auto insurance, integrating driver factors to assess individual claim probabilities.	30

	6. Utilize normal approximation to estimate aggregate health insurance claims efficiently. 7. Explore age-at-death uncertainty's impact on insurance premiums, illuminating mortality's role in pricing. 8. Derive survival functions for life insurance policyholders to predict future lifetimes and inform policy design. 9. Calculate force of mortality across age groups, vital for risk assessment and pricing strategies. 10. Interpret life tables to understand survival probabilities and life expectancy, guiding insurance product development. 11. Compare life insurance models based on payout timing, assessing their implications for policyholder benefits.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Statistical and Probabilistic Methods in Actuarial Science	Boland, P.	Chapman and Hall/CRC (2007)
2.	Actuarial Mathematics	Bowers, N. L. Gerber, H. U., Hickman, J. C., Jones, D.A and Nesbill, C. J.	Society of Actuaries (1997)
3.	Financial and Actuarial Statistics: An Introduction	Borowaik, D.S. and Shapiro, A. F.	Marcel Dekker Inc., New York (2013)
4.	Fundamentals of Actuarial Mathematics	Promislow, S. D.	Wiley (2014)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Sixth		
Name of the Course	Design of Experiments		
Course Code	B23-STA-601		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-6 MCC-11		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Fixed, random, and mixed effect models, perform ANOVA on one-way and two-way data, and test main effects and find expectations of sum of squares. 2. Experiment terminologies, concepts like blocks and replication, and design efficiency. They will grasp the need for experimental design and principles. 3. Layout and statistical analysis of Completely Randomized Design (CRD) and Randomized Block Design (RBD). They will learn applications, advantages, disadvantages, and the efficiency of RBD relative to CRD. 4. Layout and statistical analysis of Latin Square Design. They will explore applications, advantages, disadvantages, and the efficiency of LSD compared to CRD and RBD.		
CLO 5 is related to the practical components of the course	5. Problems based on analyzing data using ANOVA, CRD, RBD, and LSD, and assess efficiencies. Equipping them with comprehensive skills for experimental design and analysis across various methods.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	

Part B – Contents of the Course		
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Analysis of Variance**: Definition of fixed, random and mixed effect models, analysis of variance in one-way and two-way classified data with single observation per cell for fixed effect models, testing of main effects and expectations of sum of squares for one-way and two-way classified data.	11
II	**Introduction to Design of Experiments:** Definitions of experiment, treatment, experimental unit and experimental error; need for design of experiments; concepts of blocks, replication, efficiency of a design and precision; significance of factors like size and shape of plots and blocks; Fundamental principles of design: randomization, replication and local control.	11
III	**Completely Randomized Design (CRD) and Randomized Block Design (RBD)**: Layout, applications and statistical analysis of CRD and RBD for one observation per cell, least square estimates of effects, expectation of sum of squares, critical differences, advantages and disadvantages of CRD and RBD, efficiency of RBD relative to CRD.	12
IV	**Latin Square Design (LSD):**Layout, applications and statistical analysis of LSD, least square estimates of effects, expectation of sum of squares, critical differences, advantages and disadvantages of LSD, efficiency of LSD relative to CRD and RBD.	11
	Practicum	
	1. Analysis of Variance of a one-way classified data. 2. Analysis of Variance of a two-way classified data with one observation per cell. 3. Calculate the total number of experimental units in an experiment. 4. Analyze the data using completely randomized design. 5. Compare the differences between treatments using critical difference in completely randomized design. 6. Analyze the data using randomized block design. 7. Determine the critical difference between means of any	30

	two treatments/blocks in randomized block design. 8. Obtain the efficiency of RBD relative to CRD. 9. Analyze the data using Latin square design. 10. Calculate the critical difference for treatment mean yield in Latin square design. 11. Calculate the efficiency of LSD over CRD and RBD.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Fundamentals of Applied Statistics	Gupta S.C.& Kapoor V.K.	Sultan Chand & Sons (2014)
2.	Design and Analysis of Experiment	Montgomery, D. C.	Wiley Publishers (2004)
3.	Design and Analysis of Experiment	Kempthorne, O. (2007)	Wiley Publishers
4.	Design and Analysis of Experiment	Dass, M.N. & Giri, N.C.	Wiley Eastern ltd. (1979)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Sixth		
Name of the Course	Parametric Inference		
Course Code	B23-STA-602		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC-12		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. The chi-square distribution for statistical inference, mastering its properties, applications like Bartlett's test, and conditions for valid usage. 2. Student's 't' and Snedecor's 'F' distributions, understanding their roles in statistical inference, including hypothesis testing and analysis of variance. 3. Complete statistics, sufficiency, critical regions, and techniques like MP and UMP tests for robust hypothesis testing. 4. Likelihood Ratio (LR) tests to assess means and variances of normal populations, alongside Sequential analysis techniques, understanding associated functions for decision-making.		
CLO 5 is related to the practical components of the course	5. Problems based on a range of statistical tests for various hypothesis testing scenarios. They will also master techniques for informed decision-making in statistical analysis.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	
Part B – Contents of the Course			
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set			

from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Chi-square distribution**: Definition, derivation, moment generating function, cumulant generating function, mean, mode, skewness, and additive property of chi-square distribution; conditions for the validity of chi-square test;Applications of chi-square distribution; Independence of sample mean and variance in random sampling from a normal distribution; Bartlett's test.	11
II	**Student's 't' and Snedecor's 'F' distributions:** Definition and derivation of Student's 't'; moments, skewness and kurtosis of t-distribution; limiting form of t-distribution. Definition & derivation of Snedcor's F-distribution, moments and mode of F-distribution. Relationship between t, F and chi-square distribution; applications of t and F distributions; Fisher's Z transformation.	12
III	Elementary ideas of complete statistics, Completeness of sufficient statistics, Rao-Blackwell theorem, Concepts of critical regions, test functions, two kinds of errors, size function, power function, level of significance, MP and UMP tests, Neyman - Pearson Lemma, unbiased test, unbiased critical region, UMP critical region.	11
IV	Likelihood ratio (LR) tests, test for mean, equality of two means and equality of several means of normal populations using LR test, testing of variance and equality of variances of several normal populations, Sequential Analysis, concept of ASN and OC functions, Wald's sequential probability ratio test and its OC and ASN functions.	11
	Practicum	
	1. Apply Chi square test for testing the population variance. 2. Apply Chi square test for goodness of fit and test the independence of attributes using Chi square test with Yates' correction. 3. Test the homogeneity of several independent population variances using Bartlett's test. 4. Determine the 95% confidence interval of mean using t distribution. Also test the population mean, and difference of population means using t test. 5. Determine the confidence interval for the ratio of variances from two independent samples using the F-distribution.	30

	6. Test the significance of multiple correlation and linearity of regression. 7. Test the hypothetical value of population correlation and difference between correlations using Fishers' Z transformation. 8. Find the complete estimators in case of Uniform, Binomial and Normal population. 9. Determine the size of Type I and Type II errors, Power function of given testing of null against simple alternative hypothesis. 10. Test the equality of three means of normal populations using LR tests. 11. Obtain the sequential probability ratio test for given hypothesis of Binomial distribution parameter. Also obtain its OC and ASN functions.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C- Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	An Introduction to Probability and Mathematical Statistics	Rohatgi, V. and Saleh, A.K.M.E.	Wiley Eastern Ltd. (2010)
2.	Linear Statistical Inference	Rao, C.R.	Wiley Eastern (1973)
3.	Fundamentals of Mathematical Statistics	Gupta S.C. & Kapoor V.K.	Sultan Chand & Sons (2018)
4.	Fundamentals of Statistics, Vol. I	Goon A.M., Gupta M.K. & Dasgupta B.	World Press Calcutta (2016)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Sixth		
Name of the Course	Non-parametric Inference		
Course Code	B23-STA-603		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-4		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Non-parametric methods, their advantages, and the properties of empirical distribution functions. Additionally, they will gain insight into order statistics. 2. One-sample non-parametric tests with an understanding of their assumptions and distributions. 3. Two-sample non-parametric tests with an understanding of their assumptions and distributions. 4. Spearman's rank and Kendall's Tau coefficient for assessing bivariate sample relationships. They will also gain insight of K-sample non-parametric tests with an understanding of their assumptions and distributions.		
CLO 5 is related to the practical components of the course	5. Problems based on a range of non-parametric tests for various hypothesis testing based on one-sample, two-sample and k-sample scenarios. They will also calculate coefficients for assessing bivariate relationship.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	
Part B- Contents of the Course			
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set			

from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Introduction**: Definition of Non-parametric inference, advantages and disadvantages of non-parametric inference over parametric inference, Empirical distribution function and its properties (without derivation). **Order Statistics**: Definition and distribution of the r^{th}order statistic, smallest and largest order statistics, Joint distribution of r^{th} and s^{th} order statistics, distribution of sample median and range.	12
II	**One sample Non-parametric tests**: Sign test and Wilcoxon signed-rank test; Run test and Test for randomness (Test based on the total number of runs); One-sample Kolmogorov-Smirnov and Chi-square goodness of fit test; along with the assumptions and distribution of these tests.	11
III	**Two-sample Non-parametric tests**: Sign test for paired samples and Wilcoxon paired sample signed-rank test; Median test and Mann-Whitney U-test; Wald-Walfowitz runs test; Kolmogorov-Smirnov two-sample test;along with the assumptions and distribution of these tests.	11
IV	**Independence in Bivariate sample**: Spearman's rank correlation and Kendall's Tau coefficient along with the interpretations and the applicability of these coefficients. **K-sample Non-parametric tests**: Median test for three samples, Kruskal-Wallis ANOVA test, Friedman's testalong with the assumptions and distribution of these tests.	11
	Practicum	
	1. Determine the distribution of smallest, largest, and range in case of sample of size 3 follows exponential distribution. 2. Compute the empirical distribution function of a given data set. 3. Analyze a sequence to test for randomness using the Run test. 4. Apply the Kolmogorov-Smirnov and Chi-square tests to check if observed frequencies fit the hypothesized distribution. 5. Test the difference between median of pairs using sign test and Wilcoxon signed-rank test. 6. Apply the median test and Mann-Whitney U-test to check if the medians of two samples differ significantly. 7. Perform a Kolmogorov-Smirnov test to determine whether the two samples come from the same distribution. 8. Calculate Spearman's rank correlation and Kendall's Tau for the	30

	dataset, interpret, and compare the results. 9. Apply the Median test and Kruskal-Wallis ANOVA to check for significant differences in the medians of three samples. 10. Apply Friedman's test on paired samples to check for significant differences among groups.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Nonparametric Statistical Inference	Gibbons, J.D.	Marcel Dekker, Inc. (1985)
2.	Applied Nonparametric Statistics	Daniel, W.W.	Wiley Eastern (2000)
3.	Fundamentals of Mathematical Statistics	Gupta S.C. & Kapoor V.K.	Sultan Chand& Sons (2018)
4.	Basic Statistics	Agarwal B.L.	New Age Publication; Seventh Edition(2022)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Sixth		
Name of the Course	Bayesian Inference		
Course Code	B23-STA-604		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-4		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Bayesian statistics, mastering probability interpretation, Bayes' theorem, and prior/posterior distributions, enabling informed decision-making using loss functions and Bayes' risk assessments. 2. Bayes estimators for a range of distributions. They will also apply these methods to acceptance sampling, addressing misclassification scenarios effectively. 3.Bayesian Predictive Distribution, Interval and reliability estimation of various distributions. 4. Bayesian interval estimates, including credible and Highest Posterior Density (HPD) intervals for parameters of various distributions.		
CLO 5 is related to the practical components of the course	5. Solve problems based on Bayesian inference techniques, computing posterior distributions with specified priors, alongside proficiency in Bayesian point estimation, computing estimators, Bayesian predictive distribution, Interval estimation and credible intervals for various distributions.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	

Part B- Contents of the Course		
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Elements of Bayesian**: Definition and interpretation of probability, laws of probability, Bayes' theorem, Prior and Posterior distributions, Uniform prior, non-informative, conjugate, Minimal information, Dirichlet's and Jeffery's prior distributions,loss function, Bayes' risk function, Bayesian vs Classic.	11
II	**Bayesian Point Estimation**: Bayes estimator of parameters of Normal, Log-Normal, Multinormal, Binomial, Multinominal, Poisson, Exponential, Weibull and Rayleigh distributions; Acceptance sampling in the presence of misclassification.	12
III	**Bayesian Predictive Distributions:** Introduction, Bayesian predictive distribution for Exponential, Normal, Weibull and Rayleigh distributions including their predictive interval and reliability estimation.	11
IV	**Bayesian Interval Estimation**: Credible and Highest Posterior density intervals, Credible and HPD intervals for parameters of Exponential, Normal, Weibull and Rayleigh distributions.	11
	Practicum	
	1. Compute posterior distribution using Bayes' theorem for Exponential lifetimes with unknown λ and given prior. 2. Compute posterior distribution for Normal distribution parameters with given dataset and prior. 3. Determine Bayes' decision rule minimizing expected loss in two-action problem with given loss function. 4. Compute Bayes estimator and 90% credible interval for unknown mean of Normal distribution with known variance and Normal prior. 5. Compute Bayes estimator and 95% credible interval for rate parameter of Exponential/Poisson data with given prior. 6. Compute probability of defective item given its classification, using Bayesian point estimation with provided data. 7. Compute Bayes estimator for Log-Normal scale parameter of electronic component lifetimes with Gamma (2,2) prior. 8. Compute Bayes estimator for success probability of new drug trial with Binomial distribution and Beta (2,2) prior.	30

	9. Compute Bayesian predictive distribution and predictive Interval for Exponential and Normal distributions. 10. Compute 99% credible interval for scale parameter of Weibull/Rayleigh data with Gamma (2,2) prior.	

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

PartC-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Bayesian Estimation Limited. (1988)	Sinha, S. K.	New Age International
2.	Bayesian Parametric Inference	Bansal, A.K.	Alpha Science International Ltd.(2007)
3.	Bayesian Data Analysis	Gelman, A., Carlin J.B., Stern, H.S. & Rubin, D.B.	CRC Press (2004)
4.	Introduction to Bayesian Statistics	Bolstad, W. M. and Curran, J. M.	John Wiley & Sons (2017)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Sixth		
Name of the Course	Statistical Data Analysis using Statistical Softwares		
Course Code	B23-STA-605		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/ AEC/VAC)	DSE-5		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Excel basics and Excel Solver for linear programming, transportation and assignment problems. 2. Creating visualizations using Excel, effectively summarizing data. They will also generate automated reports for central tendency and dispersion measures. 3. Analyzing correlations, regression lines, and evaluating model accuracy using R. They will also fit complex data and generate random number. 4 Statistical projects, import data, and preprocess datasets. They will grasp statistical inference basics using R.		
CLO 5 is related to the practical components of the course	5. Problems based on Excel Solver for Linear programming problems, statistical analysis with Excel and R, generate reports, analyze correlations, fit regression models, handle data importation and perform hypothesis testing.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	

Part B-Contents of the Course		
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	Introduction to Excel and utilizing Excel Solver for linear programming problems, as well as for both unconstrained and constrained optimization tasks, Linear programming problems using graphical methods within spreadsheets and through the simplex method via Excel Solver. Solve transportation and assignment problems using Excel Solver.	11
II	Visualizations including histogram, box plots, pie chart and bar charts using Excel for effectively summarizing data through graphical representation methods. Utilizing Excel to generate automated reports of measures of central tendency and measures of dispersion.	11
III	Analysis of correlation, lines of regression and techniques for model evaluation to assess the accuracy using R. Fitting of polynomials and exponential curves to model complex relationships within data and utilize R for Random number generation.	11
IV	Create and manage statistical analysis projects, data importation techniques, code editing to preprocess datasets effectively. Basics of statistical inference including hypothesis testing of mean and difference of means, compute test statistic, p-value, and confidence interval estimation along with their interpretation using R.	12
	Practicum	
	1. Solve resource allocation LP problem in Excel to maximize profit within resource constraints graphically. 2. Use Excel Solver's simplex method for production planning LP problem, maximizing profit. 3. Minimize transportation costs in a distribution network and completion time in task assignment problem using Excel Solver with constraints. 4. Utilize Excel for calculating mean, median, mode, standard deviation, and inter quartile range of data for central tendency and dispersion assessment.	30

	5. Generate automated report with graphical visualizations and statistical summaries for decision-making using Excel. 6. Calculate Pearson correlation coefficient between variables in a dataset using R, interpreting its strength and direction. 7. Fit simple linear regression and polynomial curves to model dataset relationships, assessing model performance with R. 8. Generate random sample numbers from specified distributions with given mean and standard deviation using R. 9. Import data from various file formats into R, handle missing values, transform data, and remove outliers with code. 10. Calculate test statistic and p-value with R to assess group difference significance, interpret results. 11. Estimate mean difference with 95% confidence interval using R, interpret contextually.	

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Data Analysis with Microsoft Excel	Berk, K. and Carey, P.	Duxbury Press (2003)
2.	The R Book	Crawley, M.J.	John Wiley and Sons (2013)
3.	Introduction to R	Dhwani, R, Durgesh, S., &Dushyant, T.	Lambert Academic Publishing (2015)
4.	Introduction to the Practice of Statistics	Moore, D.S., McCabe, G.P. and Craig, B.A.	W.H. Freeman (2014)

Session: 2023-24			
Part A - Introduction			
Subject	Statistics		
Semester	Sixth		
Name of the Course	Data Analysis using Python		
Course Code	B23-STA-606		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-5		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Python fundamentals, Python data structures, interpret datasets, formatting data, harnessing Python libraries for data science tasks, visualizing data effectively, and managing data import/export processes. 2. Analyzing univariate and multivariate data, grasp discrete, continuous distributions and sampling distributions using Python tools. 3. Hypothesis Testing with Python, testing means, applying chi-square tests, and utilizing one-way and two-way ANOVA, all within the Python environment. 4. Correlation and regression analysis in Python. Conduct simple and multiple regression analyses, evaluate model accuracy, and test using Python tools.		
CLO 5 is related to the practical components of the course	5. Create and analyze student grades dictionaries, format data, visualize distributions, and perform statistical analyses like t-tests, chi-square tests, ANOVA, and regression modeling using Python.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 3 Hours (Theory) : 3 Hours (Practical)	

Part B – Contents of the Course

Instructions for Paper- Setter

There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.

Unit	Topics	Contact Hours
I	Overview of Python, covering key topics such as Python data structures, understanding datasets, data formatting, Python libraries for data science, data visualization and importing/exporting data in Python.	11
II	Explore Statistical Data with Python, analyze both univariate and multivariate data, various discrete and continuous distributions including Binomial, Poisson, and Normal distributions, as well as sampling distributions such as chi-square, t and F distributions in Python.	11
III	Hypothesis Testing with Python including testing of means using t-tests, chi-square tests for both goodness of fit and independence of attributes, one-way and two-way ANOVA for testing means across different groups.	11
IV	Correlation and regression coefficients to find relationships between variables in Python, simple and multiple regression analyses using Python, evaluate models using statistical techniques like R square, testing correlation and regression using Python.	12
	Practicum	
	1. Create a student grades dictionary with names as keys and scores as values. Calculate basic statistics in Python. 2. Convert a date string into a date time object. Format a numeric value for currency display using Python. 3. Use Sea born in Python to create a histogram visualizing the distribution of a numerical variable. 4. Load a dataset with multiple numerical variables in Python. Calculate the correlation matrix and export it. 5. Simulate 1000 trials of a Normal distribution in Python and plot the histogram. 6. Generate 1000 random numbers from a t-distribution in Python. Calculate the mean and standard deviation. 7. Conduct an independent t-test on two samples to assess mean differences using Python.	30

	8. Perform a chi-square test in Python for independence to evaluate association between categorical variables. 9. Analyse categorical variable effects on continuous outcomes with one-way ANOVA. Conduct post-hoc tests for pair wise differences using Python. 10. Calculate Pearson correlation coefficient in Python. Test for its statistical significance. 11. Build a multiple linear regression model in Python for predicting outcomes using multiple predictors. Assess model significance.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:05 marks • Mid-Term Exam: 10 marks ➢ **Practicum (10 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:10 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 50 marks ➢ **Practicum**: 20 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Python for Data Analysis	McKinney W.	O'Reilly Media, Inc. (2013)
2.	An Introduction to Statistics with Python: with Applications in the Life Sciences	Haslwanter, T.	Springer (2016)
3.	Introduction to Python for Econometrics, Statistics and Data analysis	Sheppard, K.	Oxford University Press (2018)
4.	Python Programming for Data Analysis	Unpingco, J.	Springer International Publishing (2021)

Session: 2024-25			
Part A - Introduction			
Subject	Statistics		
Semester	Sixth		
Name of the Course	**Basic Statistical Tools**		
Course Code	B23-SEC-401		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC-4		
Level of the course	300-399		
Pre-requisite for the course (if any)	Mathematics as a Subject at 4.0 Level (Class XII)		
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Basics of statistics, types of data, measurement scales, and different data presentation methods like bar charts and histograms. 2. Measuring central tendency like mean, median, mode and will understand their properties, applications, merits, and demerits. 3. Concepts of dispersion, including characteristics of an ideal measure, and explore various methods to measure dispersion. 4. Moments and will also understand skewness and kurtosis, including coefficients and interpretations.		
CLO 5 is related to the practical components of the course	5. Problems based on classifying data, construct frequency tables, draw graphs, compute central tendency and dispersion, obtain moments and coefficients of skewness and kurtosis.		
Credits	Theory	Practical	Total
	1	1	2
Contact Hours	1	2	3
Max. Marks: 50 Internal Assessment Marks: 15 End Term Exam Marks: 35		Time: 3 Hours	
Part B – Contents of the Course			
Instructions for Paper- Setter There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising 4 to 5 short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions			

in all selecting one question from each unit and the compulsory one. All the questions will carry equal marks except the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Introduction of Statistics**: Origin, definition, scope, uses and limitations. **Types of Data:** Primary and secondary data, discrete and continuous data, qualitative and quantitative data, measurement scales: nominal, ordinal, interval and ratio. **Presentation of Data**: Frequency distribution and cumulative frequency distribution, diagrammatic and graphical presentation of data, construction of bar chart, pie diagrams, histograms, frequency polygon, frequency curve and ogives.	4
II	**Measures of Central Tendency**: Characteristics of an ideal measure of central tendency, Arithmetic mean, median, mode along with their properties, applications, merits and demerits.	3
III	**Measures of Dispersion**: Concept of dispersion, characteristics of an ideal measure of dispersion, range, interquartile range, quartile deviation, mean deviation, variance, standard deviation (σ) and coefficient of variation.	4
IV	**Moments:** Moments about mean and about any point, Sheppard's correction for moments (without derivation), Pearson's β and γ coefficients. **Skewness and Kurtosis:** Coefficients of Skewness and Kurtosis with their interpretations.	4
	Practicum	
	1. Classify the give data sets based on measurement scales. 2. Construct a cumulative frequency distribution table for the given dataset and draw ogives. 3. Draw a pie diagram and bar chart for qualitative data. 4. Represent the data using Histogram, Frequency Polygon, Frequency Curve. 5. Calculate the arithmetic mean of the given dataset. 6. Calculate the median and mode of given data set for measurement of central tendency. 7. Calculate the range, interquartile range, quartile deviation and mean deviation of the given dataset for dispersion. 8. Calculate the variance and standard deviation of given data set. 9. Calculate the coefficient of variation for two datasets and compare them. 10. Obtain first four moments for the given grouped frequency distribution. 11. Obtain coefficients of Skewness and Kurtosis.	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory(10 marks)** • Class Participation: 4 marks • Seminar/presentation/assignment/quiz/class test etc. Nil • Mid-Term Exam: 6 marks ➢ **Practicum (5 marks)** • Class Participation: Nil • Seminar/Demonstration/Viva-voce/Lab records etc.:05 marks • Mid-Term Exam: Nil	**End Term Examination:** ➢ **Theory**: 20 marks ➢ **Practicum**: 15 marks

PartC-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1.	Fundamental of Statistics Vol. I	Goon A.M., Gupta M.K.,& Dasgupta B.	World Press, Calcutta (2016)
2.	Basic Statistics	Aggarwal B.L.	New Age International (2020)
3.	Fundamentals of Mathematical Statistics	Gupta S.C.& Kapoor V.K.	Sultan Chand & Sons (2020)
4.	Programmed Statistics	Aggarwal B.L.	New Age International (2017)

LIST OF VOC COURSES

Remarks	Course Type	Course Code	Nomenclature of Paper	Credits	Contact Hours/ Week	Internal marks	End Term Marks	Total Marks	Duration of Exam
Semester - III	**VOC-1**	B23- VOC -121	Working with SPSS	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Semester - IV	**VOC-2**	B23- VOC -221	Data Handling	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.

LIST OF SEC COURSE

Remarks	Course Type	Course Code	Nomenclature of Paper	Credits	Contact Hours/ Week	Internal marks	End Term Marks	Total Marks	Duration of Exam
Semester - VI	**SEC-4**	B23- SEC -401	Basic Statistical Tools	1	1	10	20	30	3 hrs.
			Practical	1	2	05	15	20	3 hrs.