KURUKSHETRA UNIVERSITY, KURUKSHETRA

(Established by the State Legislature Act XII of 1956)

('A++' Grade, NAAC Accredited)

Revised Scheme of Examination and Syllabus for

Under-Graduate Programme

Subject: Statistics

Inclusion of CC-M3 (IIIrd Semester) & CC-M6 (VIth Semester), VIIth & VIIIth Semesters

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2025-26

KURUKSHETRA UNIVERSITY, KURUKSHETRA

(Established by the State Legislature Act XII of 1956)

('A+' Grade, NAAC Accredited

Scheme of Examination for Under-Graduate Programme

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020

w.e.f. 2023-24 (in phased manner)

Subject: Statistics

(First Year)

Remarks	Course Type	Course Code	Nomenclature of Paper	Credits	Contact Hours/ Week	Internal marks	End Term Marks	Total Marks	Duration of Exam
SEMESTER-I									
Scheme A & C	**CC-1/ MCC-1 (4 credit)**	B23-STA-101	Descriptive Statistics	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme C only	**MCC-2 (4 credit)**	B23-STA-102	Statistical Methods	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme A, B & D	**CC-M1 (2 credit)**	B23- STA - 103	Introduction to Statistics	1	1	10	20	30	3 hrs.
			Practical	1	2	5	15	20	3 hrs.
Scheme A,B,C & D	**MDC-1 (3 credits)**	B23- STA - 104	Business Statistics	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	3 hrs.
SEMESTER-II									
Scheme A & C	**CC-2/ MCC-3 (4 credit)**	B23- STA - 201	Probability Theory and Distributions	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme C only	**DSEC-1 (4 credit)**	B23- STA - 202	Numerical Analysis	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme A,B & D	**CC-M2 (2 credit)**	B23- STA - 203	Introduction to Operations Research	1	1	10	20	30	3 hrs.
			Practical	1	2	5	15	20	3 hrs.
Scheme A,B,C & D	**MDC-2 (3 credit)**	B23- STA - 204	Vital and Official Statistics	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	3 hrs.
Internship of 4 credits of 4-6 weeks duration after IInd Semester									

(Second Year)

Remarks	Course Type	Course Code	Nomenclature of Paper	Credits	Contact Hours/ Week	Internal marks	End Term Marks	Total Marks	Duration of Exam
SEMESTER-III									
Scheme A,B & C	**CC-3/ MCC-4 (4 credit)**	B23- STA - 301	Applied Statistics	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B and C	**MCC-5 (4 credit)**	B23- STA - 302	Advanced Probability	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme A,B,C & D	**MDC-3 (3 credit)**	B23- STA - 303	Industrial Statistics	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	3 hrs.
Scheme A & D	**CC-M3 (4 credit)**	B23- STA - 304	Theory of Estimation and Testing	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
SEMESTER-IV									
Scheme A, B & C	**CC-4 MCC-6 (4 credit)**	B23- STA - 401	Statistical Inference	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**MCC-7 (4 credit)**	B23- STA - 402	Linear Algebra	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**MCC-8 (4 credit)**	B23- STA - 403	Linear Programming	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**DSE-1 (4 credit)** Select one option	B23- STA - 404 OR B23- STA - 405	Demography	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
			Statistical Methods in Epidemiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Internship of 4 credits of 4-6 weeks duration after 4th Semester (if not done after second semester)									

(Third Year)

Remarks	Course Type	Course Code	Nomenclature of Paper	Credits	Contact Hours/ Week	Internal marks	End Term Marks	Total Marks	Duration of Exam
SEMESTER-V									
Scheme A, B & C	**CC-5 MCC-9 (4 credit)**	B23- STA - 501	Sample Surveys	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**MCC-10 (4 credit)**	B23- STA - 502	Statistical Quality Control and Official Statistics	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**DSE-2 (4 credit)** Select one option	B23- STA - 503	Operations Research	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
		OR	Statistical Simulation	3	3	20	50	70	3 hrs.
		B23- STA - 504	Practical	1	2	10	20	30	3 hrs.
Scheme B & C	**DSE-3 (4 credit)** Select one option	B23- STA - 505	Linear Models	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
		OR	Actuarial Statistics	3	3	20	50	70	3 hrs.
		B23- STA - 506	Practical	1	2	10	20	30	3 hrs.
SEMESTER-VI									
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.
		OR	Bayesian Inference	3	3	20	50	70	3 hrs.
		B23- STA - 604	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.
		OR	Data Analysis using Python	3	3	20	50	70	3 hrs.
		B23- STA - 606	Practical	1	2	10	20	30	3 hrs.

Scheme A & D	**CC-M6 (4 credit)**	B23- STA - 607	Sampling Techniques	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.

(Fourth Year)

Remarks	**Course Type**	**Course Code**	**Nomenclature of Paper**	**Credits**	**Contact Hours/ Week**	**Internal marks**	**End Term Marks**	**Total Marks**	**Duration of Exam**
SEMESTER-VII (FOR HONOURS/HONOURS WITH RESEARCH IN STATISTICS)									
Same for Honours/ Honours with Research	**CC-H1 (4 credit)**	B23- STA -701	Measure and Probability Theory	4	4	30	70	100	3 hrs.
	CC-H2 (4 credit)	B23- STA -702	Statistical Methods and Distribution Theory	4	4	30	70	100	3 hrs.
	CC-H3 (4 credit)	B23- STA -703	Theory of Estimation	4	4	30	70	100	3 hrs.
	DSE-6 (4 credit) Select one option	B23- STA -704 OR B23- STA -705	Industrial Statistics	4	4	30	70	100	3 hrs.
			Financial Statistics	4	4	30	70	100	3 hrs.
	PC-H1 (4 credit)	B23- STA -706	Practicum Course (Calculator and SPSS based)	4	8	30	70	100	3 hrs.
	CC-HM1 (4 credit)	B23- STA -707	Statistical Inference-I	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
SEMESTER-VIII (FOR HONOURS IN STATISTICS)									
For Honours in Statistics	**CC-H4 (4 credit)**	B23- STA -801	Stochastic Processes	4	4	30	70	100	3 hrs.
	CC-H5 (4 credit)	B23- STA -802	Industrial Operations Research	4	4	30	70	100	3 hrs.
	CC-H6 (4 credit)	B23- STA -803	Testing of Hypotheses	4	4	30	70	100	3 hrs.
	DSE-7 (4 credit) Select one option	B23- STA -804 OR B23- STA -805	Programming with C and R	4	4	30	70	100	3 hrs.
			Statistical Ecology	4	4	30	70	100	3 hrs.

	PC-H2 (4 credit)	B23- STA -806	Practicum Course (based on C and R)	4	8	30	70	100	3 hrs.
	CC-HM2 (4 credit)	B23- STA -808	Statistical Inference-II	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.

SEMESTER-VIII (FOR HONOURS WITH RESEARCH IN STATISTICS)

Remarks	**Course Type**	**Course Code**	**Nomenclature of Paper**	**Credits**	**Contact Hours/ Week**	**Internal marks**	**End Term Marks**	**Total Marks**	**Duration of Exam**
Honours with Research in Statistics	**CC-H4 (4 credit)**	B23- STA -801	Stochastic Processes	4	4	30	70	100	3 hrs.
	CC-H5 (4 credit)	B23- STA -802	Industrial Operations Research	4	4	30	70	100	3 hrs.
	Project/Dissertation (12 credit)	B23- STA -807	Project/Dissertation	12	-	-	-	-	-
	CC-HM2 (4 credit)	B23- STA -808	Statistical Inference-II	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.

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-I**	B23- VOC -121	Working with SPSS	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Semester - IV	**VOC-II**	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-IV**	B23- SEC -401	Basic Statistical Tools	1	1	10	20	30	3 hrs.
			Practical	1	2	05	15	20	3 hrs.

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Third		
Name of the Course	Theory of Estimation and Testing		
Course Code	B23- STA -304		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-M3		
Level of the course	200-299		
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 sampling distributions and estimator properties. 2. Parameter estimation using method of moments and maximum likelihood. 3. Hypothesis testing concepts and tests using the normal distribution. 4. Tests based on *t*-, Chi-square, and *F*-distributions.		
CLO 5 is related to the practical components of the course	5. Problems based on estimation methods and hypothesis testing using standard statistical 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	
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	Fundamental concepts of sampling distributions; distinction between parameter and statistic; point estimation and interval estimation of population parameters; Desirable properties of estimators: definitions and illustrations of unbiasedness, efficiency, consistency, and sufficiency.	12
II	Introduction to estimation techniques: method of moments and method of maximum likelihood along with their key properties (without proof). Estimation of parameters for standard probability distributions including Binomial, Poisson, Uniform, Normal, and Exponential distributions.	11
III	Concept of statistical hypothesis: simple and composite; null and alternative hypotheses, critical region, types of errors, level of significance, size and power, one-tailed and two-tailed tests, *p*-value. Tests based on the normal distribution: single proportion, difference of proportions, single mean, and difference of means.	11
IV	Tests based on the *t*-distribution: test for a single mean, difference between two means, paired *t*-test, and test for the sample correlation coefficient. Tests based on the Chi-square distribution and the *F*-distribution for assessing the equality of two population variances.	11
	Practicum	
	1. Problems based on unbiased estimators. 2. Problems based on consistent and efficient estimators. 3. To apply maximum likelihood estimation (MLE) for parameters of a Binomial distribution. 4. To apply large sample test of significance for single proportion and difference of two proportions. 5. To apply large sample test of significance for single mean and difference between two means. 6. To apply *t*-test for testing single mean and difference between two means. 7. To apply paired *t*-test for difference between two means. 8. To apply test of significance of sample correlation coefficient using *t*-test. 9. To apply Chi-square test for goodness of fit and independence of attributes. 10. To apply *F*-test for testing difference of two variances.	30

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.	A First Course on Parametric Inference	Kale B.K.	Narosa (2005)
2.	Introduction to Theory of Statistics	Mood A.M., Graybill F.A. & Boes D.C.	McGraw Hill (2017)
3.	Mathematical Statistics with Applications	Freund J.E.	Prentice Hall (2013)
4.	Fundamentals of Mathematical Statistics	Gupta S.C. & Kapoor V.K.	Sultan Chand & Sons (2014)
5.	An Introduction to Probability Theory and Mathematical Statistics	Rohatgi V.K.	John Wiley (1988)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Sixth		
Name of the Course	Sampling Techniques		
Course Code	B23- STA -607		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-M6		
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. Fundamental concepts of sample surveys and sampling methods. 2. Techniques and applications of simple random sampling. 3. Implementation and efficiency of stratified sampling methods. 4. Principles, use cases, and evaluation of systematic sampling.		
CLO 5 is related to the practical components of the course	5. Problems based on the Sampling techniques and their comparison.		
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	
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	Concepts of census and sample surveys; fundamental ideas in sampling; importance of standard error; distinction between sampling and non-sampling errors; key steps involved in conducting a sample survey; guiding principles of sample surveys; sampling versus complete enumeration; limitations of sampling.	12
II	Definition and methods of simple random sampling with and without replacement; use of random number tables; determination of appropriate sample size; drawing random samples from given distributions; estimation of population mean and variance under SRS; advantages and limitations of SRS.	11
III	Concept and significance of stratified random sampling; estimation of population mean and variance under stratification; sample allocation methods: proportional and Neyman allocations; comparison among proportional allocation, Neyman allocation, and simple random sampling.	11
IV	Basic principle of systematic random sampling; estimation of population mean and variance; comparison between systematic and simple random sampling; strengths and weaknesses of systematic random sampling.	11
	Practicum	
	1. Generate random samples using random number tables, both with and without replacement. 2. Draw a random sample of size 5 from Normal Population with given mean and variance. 3. Draw a random sample from Chi square distribution with given degree of freedom. 4. 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. 5. Estimates population mean, population mean square, and its variance using sample data obtained through SRSWR and SRSWOR. Also compare these estimates. 6. Estimates population mean and its variance using data obtained through stratified random sampling, employing proportional and Neyman allocation methods.	30

	7. Compare the precision of estimation using simple random sampling, proportional allocation and Neyman allocation methods. 8. 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**: 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.	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 & Chandhok, P.	Narosa (1998)
5.	Sample Theory of Surveys with Applications	Sukhatme et al.	Iowa State University Press & IARS (1984)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Seventh		
Name of the Course	Measure and Probability Theory		
Course Code	B23-STA-701		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H1		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. The concepts of random variables, different measures & their properties. 2. The concept of moment generating function and characteristic function and their properties. 3. The results based on various modes of convergence and their interrelationships. 4. Advanced techniques of probability theory including Laws of Large Numbers and Central Limit Theorem.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Algebra of Sets- Fields; sigma field, sigma-field generated by a class of subsets, Borel fields. Sequence of sets, random variables, measurable functions, measure, probability measure, Concept of outer measure. inner measures, lebesgue measures. Probability defined on finite sample spaces, conditional probability and Baye's theorem.	15
II	Probability density function (pdf), probability mass function (pmf), Distribution Function and its properties. Bivariate random variable, joint, marginal and conditional pmfs and pdfs. Expectation of functions of random variables, moment generating function, characteristic function and their properties. Inversion theorem, Uniqueness theorem of characteristic function.	15
III	Moments inequalities: Tchebycheff's, Markov, Holder and Jensen. Borel-Contelli Lemma, Borel 0-1 law, Kolmogorov's 0-l law, Tchebycheff's and Kolmogorov's inequalities, various modes of convergence: in probability, almost sure, in distribution and in mean square and their interrelationship.	15
IV	Laws of large numbers for i.i.d. Sequences. Characteristic function its uniqueness, continuity and inversion formula. Applications of characteristic functions. Central limit theorems: De-Moivre's Laplace, Liapounov, Lindeberg-Levy and their applications	15

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	➢ **Theory**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Name of Author(s)	Publisher
1.	Measure Theory and Probability	A.K. Basu	PHI Learning (2017)
2.	Modern Probability Theory	B.R. Bhat	Wiley Eastern Limited (2014)
3.	An Introduction to Probability Theory and Mathematical Statistics	V.K. Rohatgi	John Wiley & Sons (1976)
4.	Introductory Probability and Statistical Applications	P.L. Mayer	Addison-Wesley (1970)
5.	Introduction to Probability and Its Applications, Vol. 1	W. Feller	Wiley (1968)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Seventh		
Name of the Course	Statistical Methods and Distribution Theory		
Course Code	B23-STA-702		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H2		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. The correlation and regression analysis 2. The applications of discrete distributions. 3. The applications of continuous distributions. 4. The order statistics and their distribution.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Bivariate data: Concept of correlation and regression, correlation coefficient, Fitting of linear regression and related properties. Multivariate data: Multiple linear regression, partial and multiple correlations. Correlation ratio, rank correlation and intra class correlation.	15

II	Binomial, Poisson, Geometric, Negative binomial, Hypergeometric and Multinomial, Normal and log normal distributions.	15
III	Uniform, Exponential, Laplace, Cauchy, Beta, Gamma distribution, Sampling distributions: Student's t distribution, F-distribution, Fisher's z-distributions, Chi-square distribution and their inter relations. Simple tests based on t, F, chi square and normal variate z.	15
IV	Order statistics, their distribution and properties, Joint and marginal distributions of order statistics, distribution of single order statistic, Distribution of range and mid range, extreme values and their asymptotic distributions (statement only) with applications.	15

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	➢ **Theory**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Name of Author(s)	Publisher
1.	Introduction to Probability and Its Applications, Vol. I	W. Feller	Wiley (1968)
2.	Modern Probability Theory and Its Applications	E. Parzen	Wiley Interscience (1992)
3.	Introductory Probability and Statistical Applications	P.L. Meyer	Addison-Wesley (1970)
4.	Random Variable and Probability Distribution	H. Cramér	Cambridge University Press (2004)
5.	Mathematical Statistics	J.N. Kapur & H.C. Saxena	S. Chand & Co. (2010)
6.	Order Statistics	Herbert A. David & Haikady N. Nagaraja	John Wiley & Sons (2004)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Seventh		
Name of the Course	Theory of Estimation		
Course Code	B23-STA-703		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H3		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Various discrete and continuous probability distributions in modeling statistical processes. Familiar with the fundamental concepts of random variables as they apply to statistical inferences. 2. Sampling distributions in making statistical inferences and familiar with the fundamental concepts of statistical inference as they apply to problems found in other disciplines. 3. Estimating unknown parameters of a given probability distribution using various estimation techniques. 4. Various methods of interval estimation, including classical, fiducial, and Bayesian approaches.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Elements of Statistical Inference. Concept of likelihood function. Point estimation. Concept of consistency, unbiased estimators, correction for bias, minimum variance estimator, Cramer-Rao inequality, Minimum Variance-Bound (M.V.B.) estimator.	15
II	Sufficient statistic, Neyman factorization theorem sufficiency and minimum variance. Rao-Blackwell theorem. Lehmann-Schefe's theorem. Distributions possessing sufficient statistics. The method of Least Squares, The Least Squares estimator in the linear model, Optimum properties, Estimation of variance, the normality assumption.	15
III	Methods of estimation: Method of moments, Method of minimum chi-square and modified minimum chi-square, Method of maximum likelihood estimators and their properties, sufficiency, consistency of ML estimators. Hazurbazar's theorem, unique consistent ML estimators, efficiency and asymptotic normality of ML estimators.	15
IV	Interval estimation: Confidence intervals, confidence statements, central and non-central intervals, confidence intervals, Most selective intervals, Fiducial intervals: Fiducial inference in Student's distribution, Problem of two means and its fiducial solution. Exact confidence intervals based on Student's distribution, Approximate confidence-intervals solutions. Elementary Bayesian inference: Ideas of subjective probability, prior and posterior distribution, Bayesian intervals, Discussion of the methods of interval estimation.	15

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	➢ **Theory**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Name of Author(s)	Publisher
1.	Advanced Theory of Statistics, Vol. II	Kendall and Stuart	Charles Griffin & Co. Ltd, London (1946)

2.	Introduction to Probability Theory and Mathematical Statistics (for Numerical and Theoretical Applications)	V.K. Rohatgi	John Wiley & Sons (1976)
3.	Sequential Analysis	A. Wald	Dover Publications, Inc., New York (2013)
4.	Advanced Statistical Methods in Biometric Research	C.R. Rao	John Wiley & Sons, Inc., New York (1970)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Seventh		
Name of the Course	Industrial Statistics		
Course Code	B23-STA-704		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-6		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. The concepts of Statistical Quality Control and construct appropriate Quality Control Charts useful in monitoring a process. 2. Various sampling inspection plans to real-world problems for both theoretical and applied research and Assess the ability of a particular process to meet customer expectations. 3. Estimating Trend, Seasonal and Cyclic components of time series. 4. Past and future behavior of phenomena under study and understand how a product quality can be improved and elimination of assignable causes of variations.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Objectives of time series analysis, Components of time series, Measurement of secular trend: Method of mathematical curves (use of polynomial, logistic, Gompertz and lognormal functions), Method of moving averages Approximate formula (Spencer's 15-point and 21-point formulae); Method of variate-differencing and its use for estimation of variance of the random component. Measurement of seasonal fluctuations: Ratio-to-moving average method, Ratio-to-trend method, Method of link relatives.	15
II	Measurement of cyclical fluctuations: Periodogram analysis. Different schemes which account for oscillations in a stationary time series, Concept of serial(auto) correlation and correlogram. Autoregressive series, Correlogram of (i) moving average, (ii) an autoregressive series and (iii) Harmonic series.	15
III	Introduction, Different types of quality measures, Rational sub-groups and technique of control charts, 3-sigma control limits and probability limits, control charts for variables (mean and range, mean and standard deviation), Control chart for number defective and fraction defective, Control charts for percent defective, Control chart for number of defects. Two types of control charts. Natural tolerance limits and specification limits; Modified control limits. Sampling inspection by attributes: single, double and multiple sampling plans.	15
IV	Sequential sampling inspection plans, comparison of three types of plans. Sampling inspection by variables: underlying principles, variables inspection with known and unknown standard deviation. Cumulative sum control chart (Cusum chart): Advantage, Two-sided and one-sided decision procedure. The ARL curve: The ARL Curve for a Shewart chart and for a Cusum chart. Design of a Cusum chart and V-Mask.	15
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks		**End Term Examination:** ➢ **Theory**: 70 marks

Part C-Learning Resources			
S. No.	**Title of Book**	**Author(s)**	**Publisher**
1.	Time Series	M.G. Kendall	Griffin, London (1989)
2.	Fundamentals of Applied Statistics	S.C. Gupta & V.K. Kapoor	Sultan Chand & Sons (2014)
3.	The Statistical Basis of Acceptance Sampling	S.K. Ekambaram	Asia Publishing House (1963)
4.	Fundamentals of Statistics, Vol. II, Ed. VI	A.M. Goon, M.K. Gupta, B. Dasgupta	World Press, Calcutta (2016)
5.	Introduction to Statistical Quality Control	D.C. Montgomery	John Wiley (1996)
6.	Quality Control and Industrial Statistics	A.C. Duncan	Richard D. Irwin, Homewood, IL (1986)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Seventh		
Name of the Course	Financial Statistics		
Course Code	B23-STA-705		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-6		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Basics of probability and discrete stochastic processes. 2. Stochastic tools and introduction to financial derivatives. 3. Derivative pricing using arbitrage and discrete models. 4. Black-Scholes model, hedging, and binomial option pricing.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Probability review: Real valued random variables, expectation and variance, skewness and kurtosis, conditional probabilities and expectations. Discrete Stochastic Processes, Binomial processes, General random walks, Geometric random walks, Binomial models with state dependent increments.	15

II	Tools Needed For Option Pricing: Wiener process, stochastic integration, and stochastic differential equations. Introduction to derivatives: Forward contracts, spot price, forward price, future price. Call and put options, zero-coupon bonds and discount bonds.	15
III	Pricing Derivatives: Arbitrage relations and perfect financial markets, pricing futures, put-call parity for European options, relationship between strike price and option price. Stochastic Models in Finance: Discrete time process- binomial model with period one.	15
IV	Stochastic Models in Finance: Continuous time process-geometric Brownian motion. Ito's lemma, Black-Scholes differential equation, Black-Scholes formula for European options, Hedging portfolios: Delta, Gamma and Theta hedging. Binomial Model for European options: Cox-Ross-Rubinstein approach to option pricing. Discrete dividends.	15

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	➢ **Theory**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Author(s)	Publisher
1.	Statistics of Financial Markets: An Introduction	J. Franke, W.K. Hardle, C.M. Hafner	Springer Publications (2011)
2.	A Course on Statistics for Finance	Stanley L. S.	Chapman and Hall/CRC (2012)
3.	Introduction to Financial Econometrics	Chris Brooks	Wiley (2008)
4.	Financial Risk Modelling and Portfolio Optimization with R	Bernhard Pfaff	Wiley (2013)
5.	Financial Econometrics: Models and Methods	Christian Gourieroux, Joann Jasiak	Princeton University Press (2001)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Seventh		
Name of the Course	Practicum Course (Calculator and SPSS based)		
Course Code	B23-STA-706		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	PC-H1		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Using SPSS & R interpret the results of Statistical Analysis. 2. Testing the hypothesis using suitable statistical test(s). 3. Identifying whether a process in statistical control or not. 4. Estimating Trend, Seasonal and Cyclic components of time series.		
Credits	Theory	Practical	Total
	0	4	4
Contact Hours	0	8	8
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 4 Hours	

Part B- Contents of the Course

Instructions for Paper- Setter

Note: There will be 4 questions, the candidate will be required to attempt any 3 questions.

Practicals	**Contact Hours**
1. Tests of significance based on t-distribution (i) Testing the significance of the mean of a random sample from a normal population. (ii) Testing the significance of difference between two sample means. (iii) Testing the significance of an observed correlation coefficient.	120

(iv) Testing the significance of an observed partial correlation coefficient.
(v) Testing the significance of an observed regression coefficient.

2. Tests based on F-distribution
   (i) Testing the significance of the ratio of two independent estimates of the population variance.
   (ii) Testing the homogeneity of means (Analysis of variance).
3. Testing the significance of the difference between two independent correlation coefficients.
4. Testing the significance for
   (i) A single proportion
   (ii) Difference of proportions for large samples.
5. Testing the significance of the difference between means of two large samples.
6. Testing the significance of difference between standard deviations of two large samples.
7. Fitting of the
   (i) Binomial distribution
   (ii) Poisson
   (iii) Normal distribution and their test of goodness of fit using χ^2 test.
8. Correlation and regression
   (i) Pearson's coefficient of correlation
   (ii) Spearman's rank correlation coefficient (with ties and without ties)
   (iii) Fitting of the lines of regression.
9. Multiple and partial correlations
   (i) Multiple correlation coefficients
   (ii) Partial correlation coefficients
   (iii) Fitting of regression plane for three variates
10. Time series and SQC
    (a) To obtain trends by using
       (i) Method of Semi-Averages
       (ii) Method of curve fitting
       (iii) Method of moving average.
       (iv) Spencer's 15-point and 21 point -formulas.
    (b) To obtain seasonal variation indices by using
       (i) Ratio to trend method
       (ii) Ratio to moving average method
       (iii) Link relative method
    (c) To construct:
       (i) X and R-chart
       (ii) p-chart
       (iii) c-chart and u-chart and comment on the state of control of the process.

Suggested Evaluation Methods	
Internal Assessment: ➢ **Practicum (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	**End Term Examination:** ➢ **Practicum**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Author(s)	Publisher
1.	Introduction to Probability and Its Applications, Vol. I	W. Feller	Wiley (1968)
2.	Modern Probability Theory and Its Applications	E. Parzen	Wiley Interscience (1992)
3.	Introductory Probability and Statistical Applications	P.L. Meyer	Addison Wesley (1970)
4.	Mathematical Statistics	J.N. Kapur & H.C. Saxena	S. Chand & Co. (2010)
5.	Fundamentals of Applied Statistics	S.C. Gupta & V.K. Kapoor	Sultan Chand & Sons (2014)
6.	Fundamentals of Statistics, Vol. II, Ed. VI	A.M. Goon, M.K. Gupta, B. Dasgupta	World Press, Calcutta (2016)
7.	Introduction to Statistical Quality Control	D.C. Montgomery	John Wiley (1996)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Seventh		
Name of the Course	Statistical Inference-I		
Course Code	B23-STA-707		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-HM1		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Basic concepts of estimation and properties of estimators. 2. M.V.B. estimators and sufficiency using Neyman's theorem. 3. Moment and likelihood methods to estimate distribution parameters. 4. Completeness, Rao-Blackwell theorem, and confidence intervals.		
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	

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 Estimation: Basic concept of sampling distribution, Elements of Statistical Inference, Point estimation. Concepts of	12

	Unbiased estimators, consistency, Efficiency, bias, Minimum variance unbiased estimator.	
II	Cramer-Rao Inequality (without proof), Minimum Variance-Bound (M.V.B.) estimator, Sufficient statistic, Neyman factorization theorem sufficiency.	11
III	Methods of Estimation: Method of moments, method of maximum likelihood estimators and their properties (without proof). Estimation of parameters of standard distributions.	11
IV	Elementary ideas of complete statistics, Completeness of sufficient statistics, Rao-Blackwell theorem, Interval estimation, Confidence intervals: concept and interpretation, Confidence intervals for mean, variance and proportions.	11
	Practicum	
	1. Problems based on unbiased estimators 2. Problems based on consistent estimators and efficient estimators. 3. Problems on identification of minimum variance unbiased estimators 4. Problems based on Cramer-Rao inequality and M.V.B. estimators. 5. Applications of Neyman factorization theorem for finding sufficient statistics. 6. Estimation using the method of moments. 7. Estimation using the method of maximum likelihood. 8. Problems on complete statistics and checking completeness. 9. Construction and interpretation of confidence intervals for mean and variance. 10. Construction of confidence intervals for population proportions.	30
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**	**Author(s)**	**Publisher**
1.	Fundamentals of Mathematical Statistics	S.C. Gupta & V.K. Kapoor	Sultan Chand & Sons (2018)
2.	Fundamentals of Statistics, Vol. I	A.M. Goon, M.K. Gupta & B. Dasgupta	World Press, Calcutta (2016)
3.	Basic Statistics, Seventh Edition	B.L. Agarwal	New Age Publication (2022)
4.	Introduction to Probability Theory and Mathematical Statistics (for Numerical and Theoretical Applications)	V.K. Rohatgi	John Wiley & Sons (1976)
5.	Advanced Theory of Statistics, Vol. II	Kendall and Stuart	Charles Griffin & Co. Ltd, London (1946)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Eighth		
Name of the Course	Stochastic Processes		
Course Code	B23-STA-801		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H4		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. The concept of stochastic processes and their classifications. 2. Recurrent events, recurrence time, and random walk models with applications. 3. Classifying states and Markov chains according to their long-term behavior. 4. Deriving the probabilities for the birth, death and Polya processes.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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 to Stochastic processes, Classification of Stochastic processes according to state, space and time domain.	15

	Generating function, Convolutions, Compound distribution, Partial fraction expansion of generating functions.	
II	Recurrent events, recurrence time distribution: necessary and sufficient condition for persistent and transient recurrent events & its illustrations and Notion of delayed recurrent event. Random walk models: absorbing, reflecting and elastic barriers, Gambler's ruin problem, probability distribution of ruin at nth trial.	15
III	Markov chains: transition probabilities, classification of states and chains, evaluation of the n^{th} power of its transition probability matrix. Discrete branching processes, chance of extinction, means and variance of the n^{th} generation.	15
IV	Notions of Markov processes in continuous time and Chapman-Kolmogorov equations. The Poisson process: The simple birth process, the simple death processes. The simple birth and death process: The effect of immigration on birth and death process. The Polya Processes: Simple non-homogeneous birth and death processes.	15

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	➢ **Theory**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1	The Elements of Stochastic Processes	N.T. Bailey	John Wiley & Sons (1966)
2	Stochastic Processes	J. Medhi	New Age International (P) Limited (2010)
3	Introduction to Stochastic Processing, Vol. I	S. Karlin	Academic Press (1997)
4	Introduction to Stochastic Process	A.K. Basu	Narosa Publishing House (2017)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Eighth		
Name of the Course	Industrial Operations Research		
Course Code	B23-STA-802		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H5		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Formulating Linear Programming problems and obtain optimum solution. 2. Systematic approaches to solve transportation and assignment problems, and analyse decision making. 3. Game Theory, CPM and PERT. 4. The Inventory and Queuing models.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Convex sets, Linear Programming problems (LPP): Formulation, examples and forms, Hyperplane, Open and Closed half spaces. Feasible, basic feasible and optimal	15

	solutions. Solution of LPP by Graphical and Simplex method. Duality in linear programming.	
II	Transportation Problems- Initial Basic Feasible Solution by North-West Corner Rule, Row minima method, Column minima method, Lowest Cost Entry Method, Vogel's Approximation Method, Optimum Solution of Transportation Problems. Assignment problem and its solution. Decision Theory: Algorithm for decision based problems, Types of decision making, Decision making under uncertainty: Criterion of optimism, Criterion of pessimism and Hurwicz criterion. Decision making under risks: EMV and EOL.	15
III	Game Theory: Terminology, two person zero sum game; game of pure strategy, reducing game by dominance, solution of game of mixed strategy without saddle point using linear programming method. Replacement models: replacement of items whose efficiency deteriorates with time and (i) The value of the money remains same during the period (ii) The value of the money also changes with time. Criterion of present value for comparing replacement alternatives. CPM (Critical path method) to solve the network problems and PERT.	15
IV	Inventory models: Deterministic inventory models (D.I.M) without shortages: EOQ model with constant rate of Demand, EOQ model with different rate of Demand, EOQ with finite rate of replenishment. D.I.M. with shortages: E O Q model with constant rate of Demand and scheduling time constant, E O Q model with constant rate of Demand and scheduling time variable. Queuing models: Introduction of queuing models, steady state solution of M/M/1, M/M/1/N, M/M/C and M/M/C/N and their measures of effectiveness.	15
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks		**End Term Examination:** ➢ **Theory**: 70 marks
Part C-Learning Resources		

S. No.	Title of Book	Name of Author(s)	Publisher
1.	Linear Programming	G. Hadley	Narosa Publishing House (1997)
2.	Introduction to Operations Research	C.W. Churchman	John Wiley & Sons, New York (1965)
3.	Operations Research: Theory, Methods & Applications	S.D. Sharma	KNRN (2012)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Eighth		
Name of the Course	Testing of Hypotheses		
Course Code	B23-STA-803		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H6		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. The elements of Statistical decision theory. 2. The Likelihood ratio test and its applications. 3. Identifying applications where nonparametric approaches are appropriate. 4. Performing and interpret various nonparametric tests.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Elements of Statistical decision theory. Neyman - Pearson lemma (with emphasis on the motivation of theory of testing of hypothesis) BCR and sufficient statistics. Testing a simple hypothesis against a class of alternatives. Most powerful test,	15

	uniformly most powerful test and sufficient statistics, power function. One and two sided tests. Bhattacharya Bounds, Uniqueness of minimum variance estimators, efficiency, Minimum mean- square estimation.	
II	Composite hypotheses, An optimum property of sufficient statistics. Similar regions, Elementary ideas of complete statistics, Completeness of sufficient statistics. Likelihood ratio test and its applications, asymptotic distribution of LR statistic and asymptotic power of LR tests. Sequential Analysis. Concept of ASN and OC functions. Wald's sequential probability ratio test and its OC and ASN functions.	15
III	Non - parametric tests and their applications: Empirical distribution function and its properties (without Proof), Test of randomness (Test based on the total number of runs). One-sample and paired-sample techniques: The Ordinary Sign test and Wilcoxon Signed-rank test. Tests of Goodness of Fit: Chi-square Goodness of Fit, The Empirical distribution function, Kolmogrov-Smirnov tests, Independence in Bivariate sample: Kendall's Tau coefficient and Spearman's rank correlation.	15
IV	Generalized two-sample problem: The Wald-Wolfowitz Runs test, Kolmogrov-Smirnov two sample Test, Median Test, Mann-Whitney U Test, Linear Ranked tests for the Location and Scale problem: Wilcoxon Test, Mood Test, Siegel-Tukey Test, Klotz Normal-scores Test, Sukhatme Test. Kruskal Wallis ANOVA test, Concept of Jackknife, Bootstrap methods.	15

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	➢ **Theory**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Name of Author(s)	Publisher
1.	Advanced Theory of Statistics, Vol. II	Kendall and Stuart	Charles Griffin & Co. Ltd, London (1967)
2.	An Introduction to Probability and Statistics	V.K. Rohtagi, Md. Ehsanes A.K. Saleh	John Wiley & Sons (2015)
3.	Sequential Analysis	A. Wald	Dover Publications, Inc., New York (2013)
4.	Nonparametric Statistical Inference	Jean Dickinson Gibbons, Subhabrata Chakraborti	CRC Press (2010)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Eighth		
Name of the Course	Programming with C and R		
Course Code	B23-STA-804		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-7		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. The basics of C programming. 2. The pointers, arrays, structures and unions of C programming. 3. The basics of R programming. 4. Handling data manipulations and various statistical models with R programming.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Overview of C: Introduction and Importance of C, Structure of a C Program. Elements of C: Character set, identifiers and keywords, Data types, Constants and Variables. Operators and their hierarchy & associativity. Input/output in C.	15

	Control statements: Sequencing, Selection: if and switch statement; alternation, Repetition: for, while, and do-while loop; break, continue, go to statement. Functions: Definition, prototype, passing parameters, recursion.	
II	Storage classes in C: auto, extern, register and static storage class, their scope, storage and lifetime. Arrays: Definition, types, initialization, processing an array, passing arrays to functions. Pointers: Declaration, operations on pointers, use of pointers. String handling functions Structure & Union: Definition, processing, Structure and pointers, passing structures to functions. Data files: Opening and closing a file, I/O operations on files.	15
III	Introduction to R: Overview of R programming, Evolution of R, Applications of R programming, Basic syntax; Basic Concepts of R: Reserved Words, Variables & Constants, Operators, Operator Precedence, Data Types, Input and Output; Data structures in R: Vectors, Matrix, List in R programming, Data Frame, Factor. Control flow: If...else, If else() Function, For loop, While Loop, Break & next, Repeat Loop; Functions: R Functions, Function Return Value, Environment & Scope, R Recursive Function, R Infix Operator, R Switch function; Strings: String construction rules, String Manipulation functions.	15
IV	R packages: Study of different packages in R; R Data Reshaping: Joining Columns and Rows in a Data Frame, Concept of List, Merging Data Frames, Melting and Casting; Working with files: Read and writing into different types of files. R object and Class Object and Class: R S3 Class, R S4 Class, R Reference Class, R Inheritance; Data visualization in R and Data Management: Bar Chart, Dot Plot, Scatter Plot (3D), Spinning Scatter Plots, Pie Chart, Histogram, Box plot, Plotting with Base and Lattice Graphics, Sorting Datasets, Merging Datasets; Statistical modelling and Databases in R: Mean, median, mode, Linear regression, Decision tree, K-means Clustering.	15
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks		**End Term Examination:** ➢ **Theory**: 70 marks

Part C-Learning Resources			
S. No.	**Title of Book**	**Name of Author(s)**	**Publisher**
1.	Programming with C	B.S. Gottfried	Tata McGraw Hill (1996)
2.	Programming in ANSI C	E. Balagurusamy	McGraw-Hill (2004)
3.	Let Us C	Yashwant Kanetkar	BPB (2002)
4.	R for Beginners	E. Paradis	Institute of Evolutionary Sciences, University of Montpellier. (2005)
5.	Statistics Using R with Biological Examples	Kim Seefeld & Ernst Linder	Department of Mathematics & Statistics, University of New Hampshire (2007)
6.	Problem Solving and Program Design in C	Jeri R. Hanly & Elliot P. Koffman	Addison-Wesley (2013)
7.	Practical Data Science with R	Nina Zumel, John Mount & Jim Porzak	Manning (2014)
8.	Learning R: A Step-by-Step Function Guide to Data Analysis	Richard Cotton	O'Reilly Media, Inc. (2013)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Eighth		
Name of the Course	Statistical Ecology		
Course Code	B23-STA-805		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-7		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Basic models of population growth and species interaction. 2. Methods to estimate population size in the wild. 3. Survival patterns using data and mathematical models. 4. Species diversity and sustainable resource use.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Population Dynamics: Single species -exponential logistic and Gompertz models, two species competition and competitive exclusion, Predator-pray interaction, Lotka-Volteria equations.	15

II	Estimation of Abundance: Capture-recapture method, Line transect methods, nearest neighbor and nearest individual distance methods.	15
III	Analysis of bird ring recovery data, open and closed populations. Survivorship Models: Discrete case-life table, Leslie matrix. Continuous case survivorship curve, hazard rate, life distribution with monotone and non-monotone hazard rates.	15
IV	Ecological community: Species abundance curve, broken stick model. Diversity and its measures. Renewable Resources: Maximum sustainable yield, maximum economic yield, optimal harvesting strategy.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	**End Term Examination:** ➢ **Theory**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Name of Author(s)	Publisher
1.	Population Ecology	M. Begin and M. Mortiner	Blackwell Science (2000)
2.	Mathematical Ecology	T.G. Hallan and S.A. Levin	Springer (1986)
3.	Mathematical Models in Biology and Medicine	J.N. Kapur	Affiliated East-West Press (1985)
4.	Mathematical Ecology	E.C. Pielou	John Wiley & Sons Inc.(1977)
5.	Mathematical Bioeconomics: The Optimal Management of Renewable Resources	C.W. Clark	Wiley-Interscience (1990)
6.	The Estimation of Animal Abundance	G.A.F. Seber	The Blackburn Press (2002)

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Eighth		
Name of the Course	Practicum Course (based on C and R)		
Course Code	B23-STA-806		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	PC-H2		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Measures of location, dispersion, Skewness and Kurtosis. 2. Ploting graphs: Bar Chart, Dot Plot, Scatter Plot, Pie Chart, Histogram and Box plot. 3. Correlation and regression, and test of significance. 4. Fitting and evaluate probability distributions (Binomial, Poisson, and Normal).		
Credits	Theory	Practical	Total
	0	4	4
Contact Hours	0	8	8
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		Time: 4 Hours	
Part B- Contents of the Course			
Instructions for Paper- Setter Note: There will be 4 questions, the candidate will be required to attempt any 3 questions.			
Practicals			**Contact Hours**

1. Finding the mean and standard deviation for discrete and continuous data. 2. Computation of Moments, Skewness and Kurtosis of given data. 3. Computation of Karl Pearson's, Partial & Multiple correlation coefficient and Spearman's rank correlation coefficient. 4. Curve fitting, fitting of lines of regression. 5. Fitting of distribution: Binomial, Poisson and Normal. 6. Testing the significance of the mean of a random sample from a normal population. 7. Testing the significance of difference between two sample means, 8. Testing the significance of an observed correlation coefficient. 9. Testing the significance of an observed partial correlation coefficient. 10. Testing the significance of an observed multiple correlation coefficient. 11. Testing the significance of an observed regression coefficient. 12. Testing the significance of the ratio of two independent population variances. 13. To test the goodness of fit. 14. To test if the hypothetical value of the population variance is $\sigma^2 = \sigma_0^2$ (say).	120
Suggested Evaluation Methods	
Internal Assessment: ➢ **Practicum (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	**End Term Examination:** ➢ **Practicum**: 70 marks
Part C-Learning Resources	

Session: 2025-26			
Part A - Introduction			
Subject	Statistics		
Semester	Eighth		
Name of the Course	Statistical Inference-II		
Course Code	B23-STA-808		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-HM2		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Hypothesis testing for large samples using normal distribution-based tests. 2. Small sample tests using t, chi-square, and F distributions to analyze means, variances, and associations. 3. Non-parametric inference and conduct basic one-sample non-parametric tests. 4. Two-sample non-parametric tests and rank correlations.		
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	

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 hypothesis including simple and composite hypotheses; null and alternative hypotheses; critical region;	12

	types of errors; level of significance; size and power of a test; one-tailed and two-tailed tests; large sample tests based on the normal distribution, including tests for a single proportion, difference of two proportions, a single mean, and difference of two means.	
II	t-distribution based tests including test for a single mean, difference of two means, paired t-test, and test for sample correlation coefficient; chi-square tests for a single variance, goodness-of-fit, and independence of attributes; F-distribution-based test for equality of two population variances.	11
III	Definition of non-parametric inference, advantages and disadvantages of non-parametric inference over parametric inference, Empirical distribution function and its properties (without derivation). One-sample non-parametric tests: Sign test and Wilcoxon signed rank test; Test for randomness and Kolmogorov-Smirnov test along with the assumptions of these tests.	11
IV	Two-sample non-parametric tests: Sign test for paired samples and Wilcoxon paired sample signed-rank test; Mann-Whitney U-test; Kolmogorov- Smirnov two-sample test; along with the assumptions of these tests. Chi-square goodness of fit test and Spearman's rank correlation.	11
	Practicum	
	1. Apply large sample test of significance for single proportion and difference between two proportions. 2. Apply large sample test of significance for single and difference between two means. 3. Apply the t-test for testing a single mean and difference between two means. 4. Test the significance of sample correlation coefficient. 5. Analyze a sequence to test for randomness using the Run test. 6. Test the difference between median of pairs using Sign test and Wilcoxon signed-rank test. 7. Apply the Mann-Whitney U-test to check if the medians of two samples differ significantly. 8. Perform a Kolmogorov-Smirnov test to determine whether the two samples come from the same distribution. 9. Calculate Spearman's rank correlation for the dataset and interpret. 10. Apply the Chi-square goodness of fit test.	30

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	Author(s)	Publisher
1.	Fundamentals of Mathematical Statistics	S.C. Gupta & V.K. Kapoor	Sultan Chand & Sons (2018)
2.	Fundamentals of Statistics, Vol. I	A.M. Goon, M.K. Gupta & B. Dasgupta	World Press, Calcutta (2016)
3.	Nonparametric Statistical Inference	J.D. Gibbons	Marcel Dekker, Inc. (1985)
4.	Applied Nonparametric Statistics	W.W. Daniel	Wiley Eastern (2000)
5.	Basic Statistics, Seventh Edition	B.L. Agarwal	New Age Publication (2022)

Session: 2025-26			
Part A - Introduction			
Subject	Honours with Research in Statistics		
Semester	Eighth		
Name of the Course	Stochastic Processes		
Course Code	B23-STA-801		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H4		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. The concept of stochastic processes and their classifications. 2. Recurrent events, recurrence time, and random walk models with applications. 3. Classifying states and Markov chains according to their long-term behavior. 4. Deriving the probabilities for the birth, death and Polya processes.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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 to Stochastic processes, Classification of Stochastic processes according to state, space and time domain. Generating	15

	function, Convolutions, Compound distribution, Partial fraction expansion of generating functions.	
II	Recurrent events, recurrence time distribution: necessary and sufficient condition for persistent and transient recurrent events & its illustrations and Notion of delayed recurrent event. Random walk models: absorbing, reflecting and elastic barriers, Gambler's ruin problem, probability distribution of ruin at nth trial.	15
III	Markov chains: transition probabilities, classification of states and chains, evaluation of the n^{th} power of its transition probability matrix. Discrete branching processes, chance of extinction, means and variance of the n^{th} generation.	15
IV	Notions of Markov processes in continuous time and Chapman-Kolmogorov equations. The Poisson process: The simple birth process, the simple death processes. The simple birth and death process: The effect of immigration on birth and death process. The Polya Processes: Simple non-homogeneous birth and death processes.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks	**End Term Examination:** ➢ **Theory**: 70 marks

Part C-Learning Resources

S. No.	Title of Book	Name of author	Publisher
1	The Elements of Stochastic Processes	N.T.Bailey	John Wiley & Sons (1966)
2	Stochastic Processes	J. Medhi	New Age International (P) Limited(2010)
3	Introduction to Stochastic Processing, Vol. I	S. Karlin	Academic Press (1997)
4	Introduction to Stochastic Process	A.K. Basu	Narosa Publishing House (2017)

Session: 2025-26			
Part A - Introduction			
Subject	Honours with Research in Statistics		
Semester	Eighth		
Name of the Course	Industrial Operations Research		
Course Code	B23-STA-802		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H5		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Formulating Linear Programming problems and obtain optimum solution. 2. Systematic approaches to solve transportation and assignment problems, and analyse decision making. 3. Game Theory, CPM and PERT. 4. The Inventory and Queuing models.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	4	0	4
Max. Marks: 100 Internal Assessment Marks: 30 End Term Exam Marks: 70		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	Convex sets, Linear Programming problems (LPP): Formulation, examples and forms, Hyperplane, Open and Closed half spaces. Feasible, basic feasible and optimal	15

	solutions. Solution of LPP by Graphical and Simplex method. Duality in linear programming.	
II	Transportation Problems- Initial Basic Feasible Solution by North-West Corner Rule, Row minima method, Column minima method, Lowest Cost Entry Method, Vogel's Approximation Method, Optimum Solution of Transportation Problems. Assignment problem and its solution. Decision Theory: Algorithm for decision based problems, Types of decision making, Decision making under uncertainty: Criterion of optimism, Criterion of pessimism and Hurwicz criterion. Decision making under risks: EMV and EOL.	15
III	Game Theory: Terminology, two person zero sum game; game of pure strategy, reducing game by dominance, solution of game of mixed strategy without saddle point using linear programming method. Replacement models: replacement of items whose efficiency deteriorates with time and (i) The value of the money remains same during the period (ii) The value of the money also changes with time. Criterion of present value for comparing replacement alternatives.CPM (Critical path method) to solve the network problems and PERT.	15
IV	Inventory models: Deterministic inventory models (D.I.M) without shortages: EOQ model with constant rate of Demand, EOQ model with different rate of Demand, EOQ with finite rate of replenishment. D.I.M. with shortages: E O Q model with constant rate of Demand and scheduling time constant, E O Q model with constant rate of Demand and scheduling time variable. Queuing models: Introduction of queuing models, steady state solution of M/M/1, M/M/1/N, M/M/C and M/M/C/N and their measures of effectiveness.	15
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (30 marks)** • Class Participation: 05 marks • Seminar/presentation/assignment/quiz/class test etc.:10 marks • Mid-Term Exam: 15 marks		**End Term Examination:** ➢ **Theory**: 70 marks
Part C-Learning Resources		

S. No.	Title of Book	Name of Author(s)	Publisher
1.	Linear Programming	G. Hadley	Narosa Publishing House (1997)
2.	Introduction to Operations Research	C.W. Churchman	John Wiley & Sons, New York (1965)
3.	Operations Research: Theory, Methods & Applications	S.D. Sharma	KNRN (2012)

Session: 2025-26			
Part A - Introduction			
Subject	Honours with Research in Statistics		
Semester	Eighth		
Name of the Course	Project/Dissertation		
Course Code	B23-STA-807		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	Project/Dissertation		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of:		
Credits	Theory	Practical	Total
	12	0	12
Part B-Contents of the Course The student will undertake independent research on a chosen topic in the field of Statistics under faculty supervision. The student will write a well-structured dissertation that would reflect critical thinking and Data analytical depth.			
Suggested Evaluation Methods The Dissertation will be evaluated by an external examiner out of 300 Marks			
Evaluation of Dissertation: 200	**Viva-Voce: 100**		
Total: 200 +100 = 300			
Part C-Learning Resources			

Session: 2025-26			
Part A - Introduction			
Subject	Honours with Research in Statistics		
Semester	Eighth		
Name of the Course	Statistical Inference-II		
Course Code	B23-STA-808		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-HM2		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will demonstrate knowledge of: 1. Hypothesis testing for large samples using normal distribution-based tests. 2. Small sample tests using t, chi-square, and F distributions to analyze means, variances, and associations. 3. Non-parametric inference and conduct basic one-sample non-parametric tests. 4. Two-sample non-parametric tests and rank correlations.		
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	

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 hypothesis including simple and composite hypotheses; null and alternative hypotheses; critical region;	12

	types of errors; level of significance; size and power of a test; one-tailed and two-tailed tests; large sample tests based on the normal distribution, including tests for a single proportion, difference of two proportions, a single mean, and difference of two means.	
II	t-distribution based tests including test for a single mean, difference of two means, paired t-test, and test for sample correlation coefficient; chi-square tests for a single variance, goodness-of-fit, and independence of attributes; F-distribution-based test for equality of two population variances.	11
III	Definition of non-parametric inference, advantages and disadvantages of non-parametric inference over parametric inference, Empirical distribution function and its properties (without derivation). One-sample non-parametric tests: Sign test and Wilcoxon signed rank test; Test for randomness and Kolmogorov-Smirnov test along with the assumptions of these tests.	11
IV	Two-sample non-parametric tests: Sign test for paired samples and Wilcoxon paired sample signed-rank test; Mann-Whitney U-test; Kolmogorov-Smirnov two-sample test; along with the assumptions of these tests. Chi-square goodness of fit test and Spearman's rank correlation.	11
	Practicum	
	1. Apply large sample test of significance for single proportion and difference between two proportions. 2. Apply large sample test of significance for single and difference between two means. 3. Apply the t-test for testing a single mean and difference between two means. 4. Test the significance of sample correlation coefficient. 5. Analyze a sequence to test for randomness using the Run test. 6. Test the difference between median of pairs using Sign test and Wilcoxon signed-rank test. 7. Apply the Mann-Whitney U-test to check if the medians of two samples differ significantly. 8. Perform a Kolmogorov-Smirnov test to determine whether the two samples come from the same distribution. 9. Calculate Spearman's rank correlation for the dataset and interpret. 10. Apply the Chi-square goodness of fit test.	30

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

PartC-Learning Resources

S. No.	Title of Book	Author(s)	Publisher
1.	Fundamentals of Mathematical Statistics	S.C. Gupta & V.K. Kapoor	Sultan Chand & Sons (2018)
2.	Fundamentals of Statistics, Vol. I	A.M. Goon, M.K. Gupta & B. Dasgupta	World Press, Calcutta (2016)
3.	Nonparametric Statistical Inference	J.D. Gibbons	Marcel Dekker, Inc. (1985)
4.	Applied Nonparametric Statistics	W.W. Daniel	Wiley Eastern (2000)
5.	Basic Statistics, Seventh Edition	B.L. Agarwal	New Age Publication (2022)