Kurukshetra University, Kurukshetra

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

Syllabus of Examination
for
Post Graduate Programme

M.Sc. Statistics

as per NEP 2020

Curriculum and Credit Framework for Postgraduate Programme

With Multiple Entry-Exit, Internship and CBCS-LOCF

With effect from the session 2024-25 (in phased manner)

DEPARTMENT OF STATISTICS AND OPERATIONAL RESEARCH

FACULTY OF SCIENCES

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119

HARYANA, INDIA

Chairperson
Department of Statistics &
Operational Research,
Kurukshetra University,
Kurukshetra-136119.

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**First**		
Name of the Course	**Measure and Probability Theory**		
Course Code	M24-STA-101		
Course Type	CC-1		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 101.1: Understand the concepts of random variables, different measures & their properties. • CLO 101.2: Understand the concept of moment generating function and characteristic function and their properties • CLO 101.3: Apply the results based on various modes of convergence and their interrelationship. • CLO 101.4: Describe the advanced techniques of Probability theory including Laws of large numbers and Central limit theorem.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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 measures, 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

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III	Moments inequalities : Tchebycheff's, Markov, Holder and Jensen. Borel-Contelli Lemma, Borel 0-1 law, Kolmogorov's 0-1 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
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1 Basu, A.K.(2017). : Measure Theory and Probability, PHI Learning (Pvt. Ltd.)
2. Bhat, B.R. (2014) : Modern Probability Theory, Wiley Eastern Limited
3. Taylor, J. C.(1997) : An Introduction to Measure and Probability, Springer.
4. Rohatgi,V.K.(1976) : An Introduction to Probability Theory and Mathematical Statistics, John Wiley & sons.
5. Mayer, P.L (1970) : Introductory probability and Statistical applications, Addison wesley.
6. Feller, W. (1968) : Introduction to probability and its applications, Vol.-I, Wiley

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**First**		
Name of the Course	Statistical Methods and Distribution Theory		
Course Code	M24- STA -102		
Course Type	CC-2		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 102.1: Understand the correlation and regression analysis. • CLO 102.2: Understand the applications of discrete distributions. • CLO 102.3: Understand the applications of continuous distributions. • CLO 102.4: Understand the order statistics and their distribution.		
Credits	Theory	Tutorial	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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 – t distribution, F- distribution, Fisher's z – distribution, 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
	Total Contact Hours	60

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Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Feller, W. (1968) : Introduction to probability and its applications, Vol.I, Wiley
2. Parzen, E. (1992) : Modern Probability Theory and its Applications, Wiley Interscience
3. Meyer, P.L. (1970) : Introductory Probability and Statistical Applications, Addison wesley.
4. Cramer, H.(2004) : Random variable and Probability Distribution, Cambridge University Press.
5. Kapur, J.N. & Sexena, H.C. (2010) : Mathematical Statistics , S. Chand & Co.
6. Herbert A. David & Haikady N. Nagaraja (2004) : Order Statistics, John Wiley & sons.

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Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc. Statistics		
Semester	**First**		
Name of the Course	Theory of Estimation		
Course Code	M24-STA-103		
Course Type	CC-3		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 103.1: Apply various discrete and continuous probability distributions in modeling statistical processes. Familiar with the fundamental concepts of random variables as they apply to statistical inferences. • CLO 103.2: Understand how sampling distributions are used in making statistical inferences and familiar with the fundamental concepts of statistical inference as they apply to problems found in other disciplines. • CLO 103.3: Estimate unknown parameters of a given probability distribution using various estimation techniques. • CLO 103.4: Understand (i) how probability is used to make statistical inferences, (ii) what inferential statistics are used for and (iii) know how to perform point and interval estimation.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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

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II	Sufficient statistic, Neymann factorization theorem sufficiency and minimum variance. Rao- Blackwell theorem. Lehman 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
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Kendall and Stuart (1946) : Advanced Theory of Statistics Vol.-II, Charles Griffin Co .Ltd London.
2. Rohtagi,V.K. (1976) : Introduction to probability Theory and Mathematical Statistics (for Numerical and Theoretical Applications), John Wiley and Sons.
3. Wald, A. (2013) : Sequential Analysis, Dover publications, INC, New York.
4. Rao, C.R. (1970) : Advanced Statistical Methods in Biometric John Wiley &Sons, INC, New York.

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**First**		
Name of the Course	Industrial Statistics		
Course Code	M24- STA -104		
Course Type	CC-4		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 104.1: Explain the concepts of Statistical Quality Control and Construct appropriate Quality Control Charts useful in monitoring a process. • CLO 104.2: Apply 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. • CLO 104.3: Understand to estimate Trend, Seasonal and Cyclic components of time series. • CLO 104.4: Understand 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
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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

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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
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Kendall, M.G. (1989) : Time Series, Griffin London
2. Gupta, S.C. & Kapoor, V.K. (2014) : Fundamentals of Applied Statistics, Sultan Chand & Sons.
3. Ekambaram, S.K.,(1963) : The Statistical Basis of Acceptance Sampling, Asia Publishing House.
4. Goon, A.M., Gupta, (2016) : Fundamentals of Statistics, Vol. II, ed. VI, Word Press Calcutta M.K. & Dasgupta, B.
5. Montgomery, D.C., (1996) : Introduction to Statistical Quality Control, J.Wiley. 1985
6. Duncan, A.C (1986) : Quality Control and Industrial Statistics, Richard O.Irwin, Homewood.IL

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc. Statistics		
Semester	**First**		
Name of the Course	Practical-1 (Calculator and SPSS based)		
Course Code	M24- STA -105		
Course Type	PC-1		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 105.1: Obtain experience in using SPSS & R and interpret the results of Statistical Analysis. • CLO 105.2: Test the hypothesis using suitable statistical test(s). • CLO 105.3: Understand to identify whether a process in statistical control or not. • CLO 105.4: Understand to estimate Trend, Seasonal and Cyclic components of time series.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B-Contents of the Course

Contact Hours 120

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

Practicals

1. Testes 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.
   (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.

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7. Fitting of the
   (i) Binomial distribution
   (ii) Poisson
   (iii) Normal distribution and their test of goodness of fit using $\chi 2$ 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: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1.Feller, W. (1968) : Introduction to probability and its applications, Vol. I, Wiley

2. Parzen, E. (1992) : Modern Probability Theory and its Applications, Wiley Interscience

3. Meyer, P.L. (1970) : Introductory Probability and Statistical Applications, Addison Wesley.

4. Kapur, J.N. & Sexena, H.C. (2010) : Mathematical Statistics , S. Chand & Co.

5.Gupta, S.C. & Kapoor, V.K. (2014) : Fundamentals of Applied Statistics, Sultan Chand & Sons.

6.Goon, A.M., Gupta, (2016) : Fundamentals of Statistics, Vol. II, ed. VI, Word Press Calcutta M.K. & Dasgupta, B.

7.Montgomery, D.C., (1996) : Introduction to Statistical Quality Control, J.Wiley. 1985

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Session: 2024-25	
Name of the Programme	M.Sc.(Statistics)
Semester	**First**
Name of the Course	Seminar
Course Code	M24- STA -106
Course Type: (CC/DEC/PC/Seminar/CHM/OEC/EEC)	Seminar
Level of the course	400-499
Course Learning Outcomes(CLO) After completing this course, the learner will be able to:	• CLO 106.1: To enhance the critical thinking and communication skills of students, enabling them to effectively evaluate, synthesize, and apply information in academic and professional contexts. • CLO 106.2: To enhance the statistical analytic and interpretation skills of students, enabling them to effectively apply statistical methods, analyze data, and interpret results in academic and professional contexts.
Credits	Seminar
	2
Teaching Hours per week	2
Max. Marks	50
Internal Assessment Marks	0
End Term Exam Marks	50
Examination Time	1 hour
Instructions for Examiner: Evaluation of the seminar will be done by the internal examiner(s) on the parameters as decided by staff council of the department. There will be no external examination/viva-voce examination.	

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