DEPARTMENT OF STATISTICS

Scheme and Syllabus
Ph.D. (Statistics)
w.e.f. 2017-18

CENTRALUNIVERSITY OF HARYANA
JANT-PALI, MAHENDERGARH

COURSE WORK: Ph.D. PROGRAMME IN STATISTICS

Course Type

➢ Core Course

➢ Elective Course

Total Credits: 12

S. No.	Course Title	Course Code	Credits	Course Type
1.	Research Methodology	SPMS STAT 02 01 01 C 4004	4	Core
2.	Advanced Inference	SPMS STAT 02 01 01 E 4004	4	Elective
3.	Bayesian Inference	SPMS STAT 02 01 02 E 4004	4	Elective
4.	Order Statistics	SPMS STAT 02 01 03 E 4004	4	Elective
5.	Reliability and Life Testing	SPMS STAT 02 01 04 E 4004	4	Elective

Note: Students will be required to choose any two subjects from the elective courses.

RESEARCH METHODOLOGY

(SPMS STAT 02 01 01 C 4004)

UNIT I

Research Problems: Meaning, Motivation, Objectives and types of research, Significance of research, Research proposals and aspects, Criteria of good research, Research formulation and hypotheses, Selection and necessity of defining the problem, Literature review, Primary and secondary sources, Reviews, Treatise, Monographs, Patents.

UNIT II

Research Design: Need, Problem Definition, Variables, Research design concepts, Research design process, Research Modeling: Types of models, Model building and stages, Data collection, processing and analysis, Simulation techniques using computer software(s).

UNIT III

Design and Planning of Experiments: Aims and objectives, expected outcome, methodology to be adopted, importance of reproducibility of research work, Interpolation, Extrapolation, Types of errors (rounding, truncation, machine and random), Error analysis and least square curve fitting. Analysis of Variance components (ANOVA) for fixed effect model, Objectives and basic principles of designs of experiments. Complete randomized design (CRD), Randomized block design (RBD) and Latin square design (LSD).

UNIT IV

Data mining and Report Writing: Library resources, Internet, Scientific search engines, Introduction to Latex/Google docs, Structure and component of research paper, Presenting the research paper/thesis, Journal impact factor, Citation index, References and bibliography, Copyright, Plagiarism and ethics in research, Communication and presentation.

Suggested Readings:
1. Kothari, C.R & Garg, G. (2014). Research Methodology: Methods and Techniques, 3rdEdition. New Age International Publishers, New Delhi.
2. Pannerselvan, R. (2009). Research Methodology. Prentice Hall of India, New Delhi.
3. Singh, Y.K. (2008). Fundamental of Research Methodology and Statistics. New Age International Publishers, New Delhi.
4. Montgomery, D.C. (2013). Design and Analysis of Experiments, 8th Edition. Wiley India.
5. Prathapan, K. (2014). Research Methodology for Scientific Research. IK International, New Delhi.

ADVANCED INFERENCE

(SPMS STAT 02 01 01 E 4004)

Objectives: The objective of the course is to apprise the students about various nonparametric techniques of hypothesis testing, multiple comparisons and ranking and selection.

UNIT I

Kernel, symmetric kernel. One-sample and two-sample U-statistics, asymptotic distribution of U-statistics. Rank order statistics: sign and signed rank tests. Linear Rank Statistics: linear rank statistics. Two-sample location problem: Wilcoxon Rank Sum test, Mann-Whitney U-test **and related research articles.**

UNIT II

Tests for scale problem: Mood test, , Sukhatme test. Tests for the c-sample problem: Kruskal-Wallis test, Jonckheere-Terpstra test. Asymptotic Relative Efficiency: Theoretical basis for calculating the ARE, Examples of the Calculation of Efficacy and ARE. Concept of Jackknifing **and related research articles.**

UNIT III

Introduction to simultaneous inference,error rates. Bonferroni inequality. Studentized range, Scheffe's F-projections, Bonferroni t-statistics, many-one t-statistics. Many-one sign statistics,many-one rank statistics **and related research articles.**

UNIT IV

Bechhofer's indifference zone, Gupta's subset selection approach,Bechhofer-Sobel approach and other selection procedures. Multiple comparisons with a control, multiple comparisons with the best **and related research articles.**

Suggested Readings:
1. Gibbons, J.D. & Chakraborti, S. (2010). Nonparametric Statistical Inference, 5th Edition. CRC Press.
2. Hollander, M., Wolfe, D. & Chicken, E. (2013). Nonparametric Statistical Methods, 3rd Edition. Wiley.
3. Miller, R.G. (2013). Simultaneous Statistical Inference, 2nd Edition reprint. Springer.
4. Gupta, S. & Panchapakesan, S. (2002). Multiple Decision Procedures: Theory and Methodology of Selecting and Ranking Populations. Society for Industrial and Applied Mathematics.

BAYESIAN INFERENCE

(SPMS STAT 02 01 02 E 4004)

Objectives: The objective of this course is to provide the sound knowledge of Bayesian estimation and the lifetime distribution methodology to students for the estimation regarding reliability characteristics of systems.

UNIT I

Prior distribution, subjective determination of prior distribution. Improper priors, non-informative (default) priors, invariant priors **and related research articles.**

UNIT II

Conjugate prior families, construction of conjugate families using sufficient statistics of fixed dimension, mixtures of conjugate priors **and related research articles.**

UNIT III

Parametric Empirical Bayes. Bayesian inference: Bayes sufficiency, summary through posterior, predictive inference. Bayesian decision theory: Bayes solutions for practical decision problems. Point estimation, credible sets. Comparison with classical procedures **and related research articles.**

UNIT IV

Bayesian calculation, Monte-Carlo Integration and Markov chain Monte Carlo techniques (without proof) **and related research articles.**

Suggested Readings:
1. Berger, J. O. (2013). Statistical Decision Theory and Bayesian Analysis. Springer.
2. Robert, C.P. & Casella, G. (2013). Monte Carlo Statistical Methods. Springer.
3. Kelly, D. & Smith, C. (2011). Bayesian Inference for Probabilistic Risk Assessment: A Practitioner's Guidebook. Springer.
4. Jeliazkov, I. & Yang, X.S. (2014). Bayesian Inference in the Social Sciences. Wiley.

ORDER STATISTICS

(SPMS STAT 02 01 03 E 4004)

Objectives: The objective of the course is to learn general strategies for problems about order statistics and how to learn to find the median (or k-th largest) in linear average-case number of comparisons (and time).

UNIT I

Order statistics and their distributions and properties. Discrete & continuous joint, marginal and conditional distributions of order statistics. Censoring and progressive censoring, order statistics for independent and non-identically distributed variates. Example based on continuous distributions **and related research articles.**

UNIT II

Moments of order statistics, Large sample approximations to mean and variance of order statistics. Asymptotic distributions of order statistics, Recurrence relations and identities for moments of order statistics **and related research articles.**

UNIT III

Confidence intervals for distribution quantiles, tolerance limits for distributions. Asymptotic distribution of function of sample moments, U-Statistics, Transformation and Variance stabilizing results **and related research articles.**

UNIT IV

Generalized order statistics: distribution of generalized order statistics. Joint, marginal and conditional distribution of generalized order statistics. Moments and recurrence relations. Characterization of continuous distributions through conditional moments and recurrence relations of generalized order statistics. Review of latest literatures **and related research articles.**

Suggested Readings:

1. Shahbaz, M.Q., Ahsanullah, M., Shahbaz, S.H. & Al-Zahrani, B.M. (2016). Ordered Random Variables: Theory and Applications. Springer.
2. David, H.A. & Nagaraja, H.N. (2005). Order Statistics, 3rd Edition. Wiley.
3. Ahsanullah, M., Nevzorov, V.B. & Shakil, M. (2013). An Introduction to Order Statistics, Atlantis Studies in Probability and Statistics, Vol. III. Atlantis Press.
4. Arnold, B.C., Balakrishnan, N. & Nagaraja, H.N. (2008). A First Course in Order Statistics. SIAM Publishers.

RELIABILITY AND LIFE TESTING

(SPMS STAT 02 01 04 E 4004)

Objectives: The objective of this course is to provide lifetime distribution methodology to students for the estimation and testing of hypotheses regarding reliability characteristics of systems.

UNIT I

Definition of reliability function, hazard function, mean time to system failure and their relationship. Life testing plans or censoring methods, right and left censoring, Type I and II censoring schemes **and related research articles.**

UNIT II

Exponential, Gamma, Weibull and normal probability models as used in the analysis of life time data and in problems related to the modeling of aging or failure processes. Estimation of parameters and reliability function associated with various life time distributions and life testing plans, Various properties of these estimators **and related research articles.**

UNIT III

Test of hypothesis and confidence intervals for the parameters and reliability function of exponential, gamma, Weibull and normal distributions **and related research articles.**

UNIT IV

Bayes estimators of the parameters and reliability function under different loss functions associated with various life time distributions. Their properties and comparison with classical estimators **and related research articles.**

Suggested Readings:

1. Deshpande, J.V. & Purohit, S.G. (2016). Life Time Data: Statistical Models and Methods, 2nd Edition. Word Scientific.
2. Lawless, J.F. (2011). Statistical Models and Methods for Lifetime Data, 2nd Edition reprint. Wiley.
3. Zacks, S. (2011). Introduction to Reliability Analysis - Probability Models and Statistical Methods. Springer.
4. Lee, E.T. & Wang, J.W. (2015). Statistical Methods for Survival Data Analysis, 4th Edition. Wiley.