UNIVERSITY OF RAJASTHAN

JAIPUR

SYLLABUS

M.Phil./Pre.Ph.D. (Statistics) Course Work

Examination 2019-2020

University of Rajasthan, Jaipur

Course Work for M.Phil./Ph.D. in STATISTICS
(Faculty of Science)

SCHEME OF EXAMINATION
Time Allowed: 3 hours
Max. Marks: 100
Min. Pass Marks: 40

Semester-I
(Common for M.Phil and Ph.D. Course Work):

There will be Four papers in all:
- Compulsory Papers: 2 Papers
  - Paper-I: PCWC01: Research Methodology and Computer Application
  - Paper-II: PCWC02: Review of Literature and Research Techniques
- Elective Paper: 2 Papers
  - Paper-III : Elective paper-I
  - Paper-IV : Elective paper-II

Semester-II
(For M.Phil Students only)

There will be Four papers in all:
- Compulsory Papers: 2 Papers
  - Paper-I : PCWC03: Non-Parametric and Semi-Pararmetric Methods
  - Paper-II: PCWC04: Dissertation Work.
- Elective Paper: 2 Papers
  - Paper-III : Elective paper-I
  - Paper-IV : Elective paper-II

Syllabus – Semester I
PCWC01: Research Methodology and Computer Application

Introduction, objective, types and significance of research, research methodology, methods and process of research, Quantitative and Qualitative significance of Research. Criteria of Good Research. Research process. Formulation of Problems, Types of Research Design.

Sample Survey Techniques, Variable and Sample design, Data collection, Execution of Survey work. Questionnaire Preparation, Measurement and Scaling Techniques; Scale Classification, Scale Construction Techniques, Importance. Reliability and Validity of Data, Test for Normality and types of transformation under Non-Normality.

Interpretation & Report Writing Techniques: Meaning of Interpretation, Need & Techniques of Interpretation. Precaution in Interpretation. Significance in Report Writing. Steps of Report Writing. Types and Layout of Reports. Oral Presentation.

Mechanics of Preparation & Writing of Report or Thesis, manuscripts, writing for publication, errors in research, criteria of good research problems encountered in research in India

Analysis of data, frequency distribution, descriptive statistics, cross- tabulation analysis, Regression analysis. Hypothesis testing, Significance of test, p-value of test statistic. Parametric Non-Parametric Tests, its characteristics and limitations.

Computer Application - Use of MS word, excel and internet. Software packages: Introduction to SPSS. Data Entry, Descriptive Statistics, Data Analysis, Statistical Tests-Parametric & Non-Parametric Tests. Factor Analysis and Cluster Analysis. Introduction to R and STATA.

Review of Literature of Published Research Work in the relevant field under the supervision of chosen/assigned supervisor.

Paper III & IV : Elective Papers

 (i) PCWST 101: Advanced Design of Experiment
 (ii) PCWST 102: Advanced Theory of Sample Survey
 (iii) PCWST 103: Advanced Operation Research
 (iv) PCWST 104: Applied Regression Analysis.

Note :

1) Student has to select any TWO Elective papers (Elective Paper I and II) from the above list
2) Students may take the advice from the Department about the availability of elective papers, mentioned above.
3) Paper : PCWST 103(Advanced Operation Research) will be provided to only those students who has not opted Paper- MST- C03(Operation Research-II) in MA/MSc. Sem-III (Statistics), University of Rajasthan, Jaipur or similar course from any other PG Department/ University.

PCWST 101: Advanced Design of Experiments

 Finite group and finite field, finite geometry-projective and Euclidean. Construction of complete set of mols, lattice designs and their analyses, construction of BIBDs using mols, finite geometry and difference method of lose, inter and intra-block analyses of a BIBD. Two- associate PBIB designs, association scheme and intra-block analysis, group divisible designs, dual and linked block designs resolvable and affine-resolvable designs, general row-column designs-connectedness and intra-block analysis.

 Fractional factorial designs, orthogonal and balanced arrays and their connections with confounded and fractional factorials. Response surface designs- orthogonality, rotatability and blocking, construction and analysis, method of steepest ascent. Experiments with mixtures-models: analysis and designs. Optimum designs-various optimality criteria and their interpretations, regression designs-exact and approximate designs, optimal linear and quadratic regression designs over $[-1,1]$, Equivalence Thorern [statement and simple applications only],optimality of BIBD, optimal chemical balance weighing designs, optimality of 2 factor designs. Repeated measurements designs[first order residual effects]-analysis.

Reference Books :

1) Atkinson, A.C. and Donev, A.N.(1992):Optimal Experimental Designs; Oxford University Press.
2) Bose,R.C. and Shimamoto.T.(1952,1973): Classification and Analysis of PBIB Designs with two Associate classes. Jour.Amer.Stat.Assoc.Vol.47,pp 151-184.
3) Chakrabarty, M.C.(1962):Mathematics of Design of Experiments; Asia Pub..House
4) Cornell, M.(1963):Mixture Experiments; Wiley.
5) John,P.W,M,(1971): Statistical Design and Analysis of Experiments. MacMillan.
6) Khuri, A.and Cornell. M.(1991):Response Surface Methodology; Marcel Dekker.
7) Pukelsheim,F.(1993):Optimal Design of Experiments; Wiley
8) Raghavarao,D.(1971):Construction and Combinatorial Problems in Design of Experiments; Wiley
9) Rao,C.R. and Kleffe,J.(1988): Estimation of Variance Components and Applications. North-Holland, Amsterdam
10) Searle,S.R.,Casella,O.and McCulloch,C.E.(1992):Variance Components; John Wiley,New -York
11) Shah,K.R. and Sinha,B.K.(1989):Theory of Optimal Designs; Springer-Verlag.

PCWST 102: Advanced Theory of Sample Survey

Techniques of un-ordering and combined un-ordering. The un-ordering of the most general I class of linear estimators. The combined un-ordering of the classical SRSWR estimator. Some important results in T_1 ,T_2 T_7 classes of linear estimators. Unified theory of Godambe: His general class as a special class T_7 – Class and some other important results. Some Concept of Non-linear estimation.

Theory of univariate successive sampling on ' h occasions & its applications. Stratification problems: Construction of strata, declaration of Strata boundaries & its approximate solutions in different allocations. sufficiency in sampling theory and its applications to improve classical

SRSWR estimator. Sukhatme, Tukey and Robson's main results on symmetric functions and Polyksa. Issues in small area estimation- synthetic and generalized regression estimators. Variance estimation, method of random groups, balanced half samples (IPNSS), Jack-Knife method.

Reference Books:
1) Chaudhuri, A. and J.W.E.Vos.(1988): Unified Theory and Strategies of Survey Sampling. North-Holland, Amsterdam.
2) Chaudhuri, A. and Mukerjee ,R.(1988) : Randomized Response: Theory and Technique New York: Marce Dekker inc.
3) Cochran,W.G.(1984): Sampling Techniques: 3rd Ed. Wiley
4) Des Raj and Chandhok (1998): Sampling Theory; Narosa.
5) Hedayat, A.S.and Sinha,B.K. (1991):Design and Inference in Finite Population Sampling; Wiley.
6) Mukhopadhyay, P (1996) :Inferential Problems in Survey Sampling; New Age International (P).
7) Mukhopadhyay, P. (1998): Small Area Estimation in Survey Sampling; Narosa.
8) Murthy, M.N. (1977): Sampling Theory and Methods; Stat. Publ. Hous, Calcutta.
9) Sukhatme, P.V. et al (1984): Sampling Theory of Surveys with Applications; Iola State University. Press.
10) Wolter, K.M. (1985): Introduction to Variance Estimation; Springer-Verlag.

PCWST 103: Advanced Operation Research

Integer Linear Programming : Gomory's Cutting Plane Method , Branch & Bond method & their Algorithms & Applications. Dynamic Programming : Decision Tree and Bellman's Principle of Optimality.Concept of Dynamic Programming. Minimum Path Problem.Non-Linear Programming – Lagrangian Method, Necessary & Sufficient conditions. Kuhn-Tucker conditions for optimality, Graphical Solution of Non-Linear Programming Problem. Quadratic Programming: Wolfe's and Beale's Algorithms. Simplex Method for Quadratic Programming.

Replacement Problems : Replacement Theorems. Age (Mortality) Group (Block) Replacement Policies. Decision Making under uncertainty and risk.. Project Management – PERT & CPM, .Network Diagram, Critical Path Determination. Probability of Project completion. Resource Allocation of PERT. Goal Programming- Single Goal & Multiple Goal models. Formulation and Methodology.. Fractional Programming – Formulation and Computational Algorithm .

Reference Books:
1) Hadley G. Non-Linear and Dynamic Programming .Addison Wesley.
2) Kantiswaroop et. al Operation Reseach ,Sultan chand & Sons..
3) Klienrock L. , Queueing System , Vol. I Theory , John Wiley.
4) Mckinsey J.C.C. :Introduction to The Theory of Games; McGraw Hill
5) Phillps D.T. et. at: Operation Research Principles and Practice
6) Taha H.A : Operation Research; McMillan Publishing Co. Inc (6th Edition,1999)

PCWST 104: APPLIED REGRESSION ANALYSIS

Residuals and their analysis, Influential observations, Power transformations for dependent and independent variables. Robust and L-1 regression, estimation of prediction error by cross-validation and boot-strap. non-Linear regression models, Different methods of estimation (Least squares, Maximum Likelihood), Asymptotic properties of estimators.

Generalized linear models, Analysis of binary and grouped data by using logistic models, Log-linear models. Random and mixed effect models, Maximum likelihood, MINQUE and restricted maximum likelihood estimators of variance components, Best linear unbiased predictors (BLUP). Growth curves.

Reference Books:
1) Bates, D.M. and Watts, D.G.(1988). Nonlinear Regression Analysis and its application. Wiley, New York.
2) Cook, R.D. and Weisberg, S(1992). Residuals and inference in Regression ,Chapman and Hall,London.
3) Draper, N.R. and Smith, H.(1988). Applied Regression Analysis, 3rd ed.. Wiley New yark .
4) Efron,B.and Tibsirani,J.R.(1993). An Introduction to the Bootstrap, Chapman and Hal, New York.
5) Kshirsagar, A.M. (1995). Growth Curves, Marcel and Dekker, New York.
6) McCullagh, P. and Nelder, J.A. (1989). Generalized Linear Models,2 nd Chapman and Hall, London
7) Searle, S.R. (1987). Linear Models for Unbalanced data, Wiley, New York.
8) Sober, G.A. and Wild, G.J.(1989)Nonlinear Regression, Wiley, New York.
9) Rao, C.R. (1973): Linear Statistical Inference and its Applications,2/e, Wiley Eastern

④

Syllabus – Semester II
(For M.Phil. Students only)

- Compulsory Papers: 2 Papers
    - Paper I : PCWC03: Non-Parametric and Semi-Pararmetric Methods .
    - Paper II : PCWC04: Dissertation Work.

- Elective Paper III & IV : Elective Papers (Select any TWO papers)
    - (i) PCWST 201: Advanced Distribution Theory.
    - (ii) PCWST 202: Advanced Reliability Analysis.
    - (iii) PCWST 203: Advanced Survival Analysis
    - (iv) PCWST 204: Statistics for Clinical Trials

Note :
1) Student has to select any TWO Elective papers (Elective Paper I and II) from the above list
2) Students may take the advice from the Department about the availability of elective papers, mentioned above.

PCWST C03: Non-Parametric & Semi-Parametric Methods

Empirical distribution function, Glivenko Cantelli Theorem, Kolmogorov Goodness of fit test. One sample U- statistic. Kernel and symmetric kernel, two sample U- statistic, Asymptotic distribution of U-statistic. UMVUE property of U-statistic.Asymptotic distribution of linear function of order statistics.Rank tests, Locally most powerful rank tests, Linear rank statistics and their distributional properties under null hypothesis, Pitman's asymptotic relative efficiency.

One sample location problem, sign test and signed rank test, two sample Kolmogorov Smirnov tests. Two sample location and scale problems. Wilcoxon-mann-Whitney test, normal score test, ARE of various tests based on linear rank statistics. Kurskal-Wallis K sample test. Cox's Proportional Hazards Model, rank test (partial likelihood) for regression coefficients. Concepts of Jackknifing method of Quenouille for reducing bias, Bootstrap methods, Confidence intervals.

Reference Books:
1) Cox, D.R. Oakes,D.(1983):Survival analysis, Chapman and Hall.
2) Davison, A.C. and Hinkley, D.V.(1997): Bootstrap methods and their application, Cambridge University Press.
3) Fraser ,D.S.A.(1957) nonparametric methods in statistics, John wiley & sons, Inc.
4) Gibbons, J.D.(1985): Nonparametric statistical inference, 2nd ed. Marcel Dekker. Inc.
5) Fraser ,D.S.A.(1957) nonparametric methods in statistics, John wiley & sons, Inc.
6) Hajek,J. and Sidak,Z (1967): Theory of rank tests, Academic Press.
7) Purl, M.L. and Sen, P.K.(1971): Nonparametric methods in multivariate analysis, John Wiley & Sons Inc.
8) Randles, R.H. and wolfe, D.A. (1979) : Introduction to the theory of nonparametric statistics, John Wiley & Sons, Inc.
9) Seigal,Sidney(1988): Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill Humanities/Social Sciences/Languages.

PCWST C04: Dissertation Work

- The candidate will offer to do the dissertation work on any pure/applied statistical problem. It is a compulsory paper. Total number of pages, in the dissertation, will not exceed 200.
- The candidate is required to submit the dissertation work before the end of examination of semester-II.
- Three copies of dissertation work will be submitted to the university out of which one copy will be returned to the department and one to the supervisor.

PCWST 201: Advanced Distribution Theory
Infinitely divisible distributions; basic properties, canonical representation of the characteristic function due to Levy-Khintchine (statement only). Limit theorems for sums of independent random variables. Characterization of less I Limit laws for sums of i.i.d. random

variables; stable laws and canonical representation of their characteristic functions (state ment only).

Discrete order statistics and their joint probability mass function. Limit distribution of k-th order statistics. Extreme value laws and their properties; asymptotic joint distribution of extreme order statistics, asymptotic distribution of central order statistic. Inverse Gaussion (Wald) & Logistic distributions-definition, genesis, generating functions & Moments. Pearsons types-I, IV, VI, II,V,II.

Reference Books:
1) Arnold, B.C., Balakrishnan, N and Nagraraja, H.N. (1992): A first Course in Order Statistics, Wiley.
2) Feller, W.(1971): An Introduction to Probability Theory and Its Applications. Vol.II; Wiley.
3) Galambos, J.(1978): The Asympotic Theory of Extreme Order Statistics, Wiley.
4) Gnedenko B.V. and Kolomogorov, A.N.(1954): Limit Distributions for Sums of Independent random Variables, Addison-Wesley Publishing Company.
5) Laha, R.G. and Rohatgi, V.K.(1979): ProbabilityTheory, Wiley.
6) Resnick, S.I.(1987):Extreme Values, Regular Variation and Point Processes, Springer Verlag.

PCWST 202: Advanced Reliability Theory

Reliability concepts and measures; components and systems; coherent systems; reliability of coherent systems; cuts and paths; modular decomposition; bounds on system reliability; structural and reliability importance of components.

Life distributions; reliability function; hazard rate; common life distributions-exponential, Weibull, gamma etc. Estimation of parameters and tests in these models. Notions of ageing; IFR, IFRA,NBU,DMRL and NBUE Classes and their duals; loss of memory property of the exponential distribution; closures of these classes under formation of coherent systems, convolutions and mixtures.

Univariate shock models and life distributions arising out of them; bivariate shock models; common bivariate exponential distributions and their properties.

Reliability estimation based on failure times in various censored life tests and in tests with replacement of failed items; stress- strength reliability and its estimation. Maintenance and replacement policies; availability of repairable systems; modeling of a repairable system by a non-homogeneous Poisson process. Reliability growth models; probability plotting techniques; Hollander-Proschan and Deshpande tests for exponentially; tests for HPP vs. NHPP with repairable systems. Basic ideas of accelerated life testing.

Reference Books:
1) Barlow R.E. and Proschan F.(1985) statistical theory of Reliability and Life Testing; Holt, Renehart and Winston.
2) Lawless J.F. (1982). Statistical Models and Methods of Life Time Data; John Wiley.
3) Bain L.J. and Engelhrdt (1991)Statistical Analysis of reliability and Life Testing Models; Marcel Dekker.
4) Nelson. W (1982). Applied Life data analysis; John Wiley.
5) Zacks S. Reliability Theory, Springer.

PCWST 203: Advanced Survival Analysis

Concepts of time, order and random censoring, likelihood in these cases. Life distribution-Exponential Gamma,Weibull, Lognormal,Pareto,Linear Failure rate. Parametric inference: Point estimation, Confidence intervals, Scores, LR, MLE tests (Rao: Willks-Wald) for these distributions. Life tables, failure rate, mean residual life and their elementary properties. Ageing classes-and their properties, Bathtub failure rate. Estimation of survival function- Acturial Estimator, Kaplan-Meier Estimator, Estimation under the assumption of IFR/DFR.Tests of exponentiality against non-Parametric classes. Total time on test, Deshpande test.

Two sample problem-Gehan test, log rank test, Mantel -Haenszel test, Tarone-Ware tests. Semi parametric regression for failure rate-Cox's proportional hazards model with one and several covariates. Rank test for the regression coefficients, Competing risks model: Parametric and non parametric inference for this model. Multiple decrementlife table.

Reference Books:
1) Cox,D.R. and Oakes,D.(1984):Analysis of Survival: Data;Chapman and Hall,New York
2) Elandt-Johnson,R.E. Johnson N.L.:Survival Models and Data Analysis; John Wiley and Sons.
3) Gross A.J. and Clark,V.A.(1975):Sruvival Distribution:Reliability applications in the Biomedical Sciences ;John Wiley and Sons.
4) Kalbfleisch, J.D. and Prentice, R.L.(1980): The Statistical Analysis of Failure Time Data; John Wiley.
5) Miller,R.G.(1981):Survival Analysis; John Wiley.

PCWST 204: Statistics for Clinical Trials

Introduction to clinical trials: the need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, Phase I-IV trials, multi-center trials. Data management: data definitions, case report forms, database design, data collection systems for good clinical practice.

Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, review of factorial designs, objectives and endpoints of clinical trials.Design of Phase I trials, design of single-stage and multi-stage Phase II trials, design and monitoring of Phase III trials with sequential stopping, design of bioequivalence trials.

Reporting and analysis: analysis of categorical outcomes from Phase I-III trials, analysis of survival data from clinical trials. Surrogate endpoints: selection and design of trials with surrogate endpoints, analysis of surrogate endpoint data. Meta analysis of clinical trials.

Reference Books:
1) C. Jennison and B.W.Turnbul (1999). Group Sequential Methods with Applications to Clinical Trials, CRC Press
2) E. Marubeni and M.G. Valsecchi (1994). Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley and Sons.
3) J.L. Fleiss (1989). The Design and Analysis of Clinical Experiments. Wiley and Sons.
4) L.M.Friedman,C.Furburg,D.L.Demets(1998). Fundamentals of Clinical Trials. Springer Verlag.
5) S. Piantadosi (1997). Clinical Trials: A Methodologic Perspective. Wiley and Sons.
6) Friedman,L.M.,Furberg,,C.D,DeMets,,D.L.,(2010): Fundamentals of Clinical Trials, Springer Science & Business Media..
7) Finney,D.J.(1978): Statistical Methods for Biological Assay, alibris Pub..

Dy. Registrar
(Academic)
University of Rajasthan
JAIPUR