UNIVERSITY OF RAJASTHAN
JAIPUR

SYLLABUS

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

Examination 2018-2019
Department of Statistics
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-Parametric Methods
- **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.
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.
PCWC02: Review of Literature:
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 have 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 Theorem (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:

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 $T_1$, $T_2$, $T_3$ classes of linear estimators. Unified theory of Godambe: His general class as a special class $T_1$ - 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
Polyaksa. 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:
Amsterdam.
Dekker inc.

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. Quadratic

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 Reseac,h, Sultan chand & Sons.
5) Phillips D T et. at: Operation Research Principles and Practice

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

- **Compulsory Papers:** 2 Papers
  1. PCWC03: Non-Parametric and Semi-Parametric Methods
  2. PCWC04: Dissertation Work

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

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**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.

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**PCWST C03: Non-Parametric & Semi-Parametric Methods**


**Reference Books:**


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**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.

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**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 laws. Limit laws for sums of i.i.d random...
variables; stable laws and canonical representation of their characteristic functions (statement 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 Gaussian (Wald) & Logistic distributions-definition, genesis, generating functions & Moments. Pearson's types-I, IV, VI, I, V, II.

Reference Books:

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-Proshan and Deshpande tests for exponentially; tests for HPP vs. NHPP with repairable systems. Basic ideas of accelerated life testing.

Reference Books:
2) Lawless J.F. (1982), Statistical Models and Methods of Life Time Data; John Wiley.
5) Zacks S. Reliability Theory, Springer.

PCWST 203: Advanced Survival Analysis


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 decrement life table.
Reference Books:

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.


Reference Books:
1) C. Jennison and B.W. Turnbull (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.