P.G. DEPARTMENT OF STATISTICS

UTKAL UNIVERSITY

REGULATIONS AND SYLLABUS
FOR
M. PHIL. (STATISTICS)
EXAMINATION
(UNDER SEMESTER SYSTEM)

(Effective from 2019-20 Academic Session)

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REGULATIONS

1. M. Phil. in Statistics is a one year full time regular course program consisting of two semesters.
2. The eligibility criteria, application procedure and selection procedure for admission, and number of seats in favour of the course program are decided by the Post-Graduate Council of the University.
1. There are two papers in Semester-I and two papers in Semester-II out of which one is an elective and one is Dissertation. All papers carry 100 marks. Each paper (except dissertation) consists of four units each of which carries 25 marks and two questions shall be set from each unit out of which a candidate has to answer one question.
3. Ordinarily the 1st semester examination shall be held in the month of December and the 2nd semester examination in the month of May.
4. The paper setters, board of moderators, examiners and conducting board of the semester examinations shall be decided by the Board of Studies.
5. For passing a semester examination, a candidate must secure at least 40% of the marks in each paper and 50% of the aggregate marks of that semester. If a candidate passes both the semester examinations, he/she will be declared to have passed the M. Phil. (Statistics) Examination. A candidate who fails or remains absent in the 1st semester examination can automatically go to 2nd semester and can appear for the 2nd semester examination. Candidates shall have to pass both the semester examinations within a period of two years from the date of joining the program.
6. If a candidate fails in any paper(s) in any semester examination, he/she has to appear the semester examination for that paper(s), whenever the said semester examination is held, in order to pass the semester examination as per regulation 5.
7. No hard case rule shall be applicable to the candidates for passing out M. Phil. (Statistics) Examination.
8. Improvement examinations either in semester-I or semester-II are not allowed.
9. Each candidate will be required to prepare a dissertation on any topic of his/her interest under the supervision of a faculty member of his/her choice. The topic and the supervisor of the dissertation shall be allotted by the department. Candidates shall submit two copies of their dissertation in the department through the supervisor before filling up the forms for the second semester examination.

The dissertations shall be evaluated by an internal examiner and one external examiner. A candidate cannot be allowed to resubmit dissertation.

Subjects of Study & Scheme of Examinations
M. Phil. (Statistics) Examination
UTKAL UNIVERSITY
(Effective From 2013-14 Academic Session)

Semester	Paper Code	Subject	Total Marks	Distribution of Marks	Exam. Duration
I	*Core Papers* MPST-11 MPST-12	Probability & Statistical Inference Computational Statistics Lab.	100 100	25 per unit Lab. Expt.=70 Viva-voce+ Record =30	4 Hours 6 Hours
II	*Elective Paper* MPST-21	Any one of the following: (A) Model Assisted Survey Sampling (B) Demographic Modeling & Population Processes (C) Advanced Design & Analysis of Experiments (D) Multi-Objective Optimization & Fuzzy Systems	100	25 per unit	4 Hours
	Dissertation MPST-22	Dissertation	100	Dissertation=50 Viva-Voce=20 Seminar=30	-

M. PHIL. (STATISTICS)
DETAILED SYLLABUS

FIRST SEMESTER

MPST-11 – Probability & Statistical Inference (100 Marks)

UNIT-I

Measure space and Probability space – Properties of measure, different examples of measures, random variable and measurable transformation, discrete sample space, combinatorial aspects of set function. Induced measure and distribution function. Probability generating function and discrete convolution.

UNIT-II

Algebra of measurable functions, almost everywhere convergence, convergence in measures. Slutsky's theorm and inter-relation between different types of convergence.

Independence- Definition, Borel zero-one law Kolmogorov's zero-one law, Levy's inequality and Levy's theorem.

UNIT-III

Theory of point estimation, Factorization criterion for sufficiency. Exponential family and sufficient statistic. Uniformly minimum variance unbiased estimators (UMVUE). Conditions for the existence of UMVUE. Rao-Blackwell theorem. Completeness and Lehman-Scheffe theorem, Frechet-Cramer-Rao inquality, Chapman-Robbin's-Kiefer inequality. Bays and Minimax estimation.

UNIT-IV

Composite hypothesis and similar regions. Construction of most powerful similar regions. Tests for mean and variance of normal distribution. Likelihood ratio test, Asymptotic distribution of LR criterion, consistency of LR test.

Nonparametric Inference**:** Single sample problems - Kolmogorov-Smirnov test, Wilcoxon signed rank test. Two sample problems - Wald-Wlfowitz run test, Kolmogorov-Smirnov test, U-Statistics, Mann-Whitney U-test, Kruskal-Wallis test

***Books Suggested*:**

1. Basu, A. K. – Measure Theory and Probability: Prentice Hall of India (Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 4.1, 4.2, 4.3, 6.1, 6.2, 7.2, 7.3, 7.4).
2. Chow, Y. S. and Teicher, H. – Probability Theory: Narosa (For reference).
3. Rao, C. R. – Linear Statistical Inference & its Applications: Jhon Wiley & Sons.
4. Rohatgi, V. K. – An Introduction to Probability Theory & Mathematical Statistics: John Wiley & Sons.

MPST-12 – Computational Statistics Lab. (100 marks)

UNIT-I

Introduction to object oriented programming – Concept and design. Programming in C^{++}: Data types, operators and expressions, functions and parameters, classes, constructors, input/output. Control statement: if-else, switch, for, while and do-while, loops, arrays and strings, pointers.

UNIT-II

Modular programming with functions: passing data between functions, libraries, functions with variable number of arguments, recursive functions.

UNIT-III

Uses of (i) MS-Office, (ii) Scientific software packages (SPSS/ CSTAT/ MATLAB).

UNIT-IV

Development of programs on different statistical problems using C^{++}

Marks Distributions:

Lab Experiment - 70 marks

Viva-voce + Record - 30 marks

SECOND SEMESTER

MPST-21 – Any One of the Electives (100 marks)

(A) Model Assisted Survey Sampling

UNIT – I

Basic Idea in Estimation from Probability Samples – Sampling design, inclusion probabilities, sample membership indicators, estimators and their basic statistical properties, π estimator and its properties.

Unbiased Estimation for Element Sampling Design – Bernoulli sampling, simple random sampling, systematic sampling, poisson sampling, probability proportional to size sampling, stratified sampling.

UNIT – II

Unbiased Estimation for Cluster and Multi-stage Sampling – Single stage cluster sampling, two-stage sampling, multi-stage sampling. More Complex Estimation Problems – Effect of bias, consistency and asymptotic unbiasedness, π estimators for several variables, Taylor linearization technique for variance estimation, estimation of ratio, mean, domain mean, variance and covariance.

UNIT – III

Estimation through linear modelling – Auxiliary variables, difference and regression estimators, alternative expression for regression estimator, variance of regression estimator, optimal coefficient for regression estimator. The common ratio model and the ratio estimator, the common mean model, simple regression models and simple regression estimator.

UNIT – IV

Non-sampling Errors – Non response and its characteristics, measuring of non response, sub-sampling of non-respondents, randomized response. Measurement Errors – Nature, the simple measurement model, mean square error decomposition, measurement models taking interviewer effects into account, deterministic assignment of interviewers, random assignment of interviewers to groups.

***Book Suggested*:**

1. Carl-Erik Sarndal, Bengt Swensson and Jan Wretman – Model Assisted Survey Sampling: Springer. [Ch. 2 (2.3, 2.4, 2.6 – 2.8), Ch. 3 (3.2 – 3.7), Ch. 4 (4.2 – 4.4), Ch. 5 (5.2 – 5.9), Ch. 6 (6.2 – 6.6, 6.8), Ch. 7 (7.3, 7.4, 7.8), Ch. 15 (15.2, 15.3, 5.4.3, 15.4.4), Ch. 16 (16.2 – 16.4, 16.7 – 16.9)]

(B) Demographic Modelling & Population Processes

UNIT-I

The Stable population model: A simplified example, Lotka's demonstration of conditions. The equations characterizing a stable population, stable equivalent population, Relation between Intrinsic growth rate & Net reproduction rate, Momentum of population growth, uses of stable population model in demographic estimation.

UNIT-II

Modelling Age patterns of vital events, model age patterns of mortality, Age patterns of Nuptiality, Age patterns of fertility, Model age patterns of Migration.

UNIT-III

Indirect estimation methods, estimation of child mortality from information on child survivorship : Brass method, Estimation of Adult mortality using information on orphan hood, sisterhood method for estimating maternal mortality, estimating mortality and fertility from maternity histories.

UNIT-IV

Simple birth & death population processes, Kendall's birth, death & migration model, Stochastic models of M.S. Bartleh & D.G. Kendall, The two sex problem, Deterministic model of A.H. pollard, Some simple marriage models.

***Books Suggested*:**

1. Pollard, J. H. – Mathematical Models for the Growth of Human Populations: Cambridge University Press, Cambridge, 1975.
2. Samuel H-Prestor, Patrick Heuveline, Michel Guillat – Demography: Measuring & Modeling Population Processes: Blackwell Publisher, 2003.
3. Guy L. Cuvery & Richard M. Feildman – Mathematical Foundations of Population Dynamics: Texas A & M University Press, 1987.
4. Multidimensional Mathematical Demography, Edited by Kenneth C. Land & Andrei Rogers, 1982.

(C)Advanced Design and Analysis of Experiments

UNIT – I

Incomplete Block Designs – Balance incomplete block design (BIBD), construction of BIBD with parameters, intra-block and inter-block analysis, recovery of inter-block information. Partially Balanced Incomplete Block Designs (PBIBD) – Parametric relations, some methods of construction, analysis.

UNIT – II

The General Factorial Experiments – Main effects and interactions, analysis of variance, blocking in factorial designs, analysis of 2^n and 3^n factorial experiments in randomized blocks, confounding and partial confounding.

UNIT – III

Nested Design – Concept, analysis of two-stage nested design, general m-stage design, nested-factorial design. Split-Plot Design – Concept, analysis, split-plot designs with more than two factors, split-split-plot design, strip-split-plot design.

UNIT – IV

Response Surface Designs – Concept, first and second order response surface designs, analysis of second order response surface design, variance of estimated response. Rotatable Designs – Analysis, uses and construction.

***Books Suggested*:**

1. Das, M. N. and Giri, N. C. – Design and Analysis of Experiments (Second Edition): New Age International (P) Limited, Publishers, New Delhi. [Ch. 4 (4.6, 4.7), Ch. 5 (5.1 – 5.3, 5.4.1, 5.4.2, 5.6, 5.9.2, 5.9.4, 5.10), Ch.7 (7.7.1 – 7.7.8)]
2. Joshi, D. D. – Linear Estimation and Design of Experiments: New Age International (P) Limited, Publishers, New Delhi. [Ch. 12 (12.1 – 12.3, 12.8), Ch. 13 (13.1 – 13.4), Ch. 14 (14.1 – 14.4), Ch. 15, Ch. 16, Ch. 17 (17.4 – 17.8)]
3. Montgomery, D. C. – Design and Analysis of Experiments (Fifth Edition): Wiley-India Edition. [Ch. 5 (5.4, 5.6), Ch. 6 (6.4, 6.5) Ch. 7 (7.4 – 7.7), Ch. 9 (9.1 – 9.3), Ch.11 (11.1, 11.3), Ch. 13 (13.1 – 13.4, 13.5.1 – 13.5.3)]

(D) Multi-Objective Optimization & Fuzzy Systems

UNIT-I

Advanced linear programming, Revised Simplex Algorithm, Karmakar interior point algorithm, Dynamic programming, Non-linear programming, Kuhn-Tucker theory, Quadratic Programming, Separable programming, Duality in Non-linear programming, Search Techniques, Unimodal function, Dichotomous search, steps Descent, Geometric and constrained Programming, Unconstrained Posynomial Optimization Goal Programming, standard form & Partitioning Algorithm, Groupings Algorithm.

UNIT-II

Multi Objective optimization problem, Linear & Non-linear, Convex & Non Convex, Principles of Multi-objective Optimization, Difference with single objective optimation, Dominance & Pareto-Optimality, Classical methods: Weighted Sum, E-constraint, weighted metric, Goal Programming methods, Interactive methods, Evolutionary Algorithms, Genetic Programming.

UNIT-III

Fuzzy sets, characteristics of crisp set, Definition, Concepts and standard operation of fuzzy set. Fuzzy Complement, Union, interactions, Fuzzy relation & composition: crisp relation, properties, Extension of fuzzy set, Fuzzy graphs, characteristics & classification of fuzzy relation, Concept of fuzzy number, Triangular fuzzy number, other types of fuzzy number, Fuzzy function: Kinds of Fuzzy function, Fuzzy extrema of function , Integration & Differentiation of Fuzzy function, Probability & Possibility, Fuzzy event, Uncertainty, Measure of fuzzyness.

UNIT-IV

Fuzzy logic: Classical logic & Fuzzy logic, linguistic variable, fuzzy truth qualifier, Representation of fuzzy rule, Fuzzy inference: Composition of rules, Fuzzy rules & implication, inference mechanism, Fuzzy control & Fuzzy expert systems. Defuzzification.

***Books Suggested*:**

1. Kwang, H. Lee – First Course on Fuzzy Theory & Application: Springer International Edition, 2005.
2. Kalyanmoy, Deb – Multi-Objective Optimization Using Evolutionary Algorithms: John Wiley & Son, 2001.
3. Kasama, H. S. & Kumar, K. D. – Introductory Operations Research Theory & Applications: Springer International Edition, 2007.
4. Klir, G. J. & Folger, T. A. – Fuzzy Sets, Uncertainty & Information: Eastern Economy Edition, New Delhi, 2003.

(E) Econometrics

UNIT-I

R-variable Linear Regression models – OLS estimators and their properties, analysis of variance, prediction.

Multicolinearity – detection, consequences and remedial measures.

UNIT-II

Heteroscedasticity – Nature, OLS estimation in the presence of heteroscedasticity, detection, consequences and remedial measures.

Autocorrelation – Nature, OLS estimation in the presence of autocorrelation, detection, consequences and remedial measures.

UNIT-III

Generalized least squares – GLS estimators, prediction Stochastic regressors, instrumental variables and errors in variables.

UNIT-IV

Regression on Dummy Variables – The nature of dummy variables, Regression in one quantitative variable, comparing two regressions.

Regression on Dummy Dependent variables – The linear probability model, logit model, probit model and tobit model.

***Books Suggested*:**

1. Johnston, J. – Econometric Methods: MC-Graw Hill.
2. Gujarati, D. – Basic Econometrics: MC-Graw Hill.
3. Maddala, G. S. – Econometrics: MC-Graw Hill.

(F)Applied Survival Analysis

UNIT-I

Concepts of time, Censoring mechanisms, Survival and hazards functions, Survival distributions-Exponential, Gamma, Weibull, Lognormal, Parametric inference (point estimation, confidence intervals, scores, LR, MLE tests), Life table analysis, failure rate, mean residual life and their properties, Ageing classes-IFR, IFRA, NBU, NBUE, HNBUE, Bathtub failure rate.

UNIT-II

Estimation of survival function-Actuarial estimator, Kaplan-Meier estimator, Estimation under IFR/DFR, Hazards function estimator, Tests of exponentiality against non-parametric classes-Total time on test, Despande test, Two sample problem-Gehan test, Log-rank test, Mantel-Haenszel test, Tarone-Ware tests, Rank tests with censored data.

UNIT-III

Notion of truncated, left censored and interval censored data, Semi parametric regression models-Proportional hazards (fitting, estimating survivorship function, interpretation, model development, model assessment, proportionality checking), stratified proportional hazards, time-varying covariates, concept of unobserved heterogeneity.

UNIT-IV

Parametric regression models-Exponential, log-logistic, Weibull; Concept of frailty and shared frailty models-gamma, inverse Gaussian frailties, Discrete time proportional hazards, Competing risk models.

***Books Suggested*:**

1. Cox, D. R. & Oakes, D. – Analysis of Survival Data: Chapman & Hall, New York.
2. Miller, R. G. – Survival Analysis: Wiley, NY.
3. Kalbfleisch, J. D. & Prentice, R. L. – The Statistical Analysis of Failure Time Data: John Wiley, NY.
4. Klein, J. P. – Survival Analysis Techniques for Censored and Truncated Data: Springer, Germany.
5. Lawless, J. F. – Statistical Models and Methods for Lifetime Data: Wiley, NY.
6. Duchateau, L. & Janssen, P. – The Frailty Model: Springer, Germany.
7. Hosmer, D. W. & Lameshaw, S. – Applied Survival Analysis: Regression Modelling of Time to Event Data: John Wiley, NY.

MPST-22 – Dissertation (100 marks)

- The dissertation on an approved topic is to be prepared under the guidance of a supervisor assigned by the department.
- The candidate is required to present one seminar relating to the dissertation during the academic year.

***Marks Distribution*:**

Dissertation	- 50 marks
Viva-Voce	- 20 marks
Seminar Presentation	- 30 marks