

**SOLAPUR UNIVERSITY, SOLAPUR.**



**SYLLABUS  
FOR  
M.Phil.  
IN  
STATISTICS**

**To be effective from the academic year 2010-11 (June-2010).**

# **SOLAPUR UNIVERSITY, SOLAPUR.**

## **M.Phil. in STATISTICS SYLLABUS**

**To be effective from the academic year 2010-11 (June-2010).**

The following table gives the scheme of Theory Examination at M.Phil. in the subject Statistics.

| <b>Paper No.</b> | <b>Title of the Paper</b>                         | <b>Marks</b> |
|------------------|---|--------------|
| Paper-I          | Research Methodology and<br>Computer Applications | 100          |
| Paper-II         | Topics in Statistical Inference                   | 100          |
| Paper-III        | Topics in Probability and Statistics              | 100          |

### **Nature of Question Paper for Theory Examination at M.Phil. in Statistics**

- 1). Each paper is divided into two sections. Each section contains *Four* questions each of 20 marks. In each section one question will be of “Short Notes” type. The candidate has to attempt *Five* questions choosing *At Least Two* from each section.
- 2). In Paper-III, Section-I is common in all students and Section-II is based on the topic of dissertation.

## **Syllabus**

### **Statistics Paper-I**

#### **(Research Methodology and Computer Applications)**

##### **Section-I (Research Methodology)**

##### **Unit-1: Introduction of Research Methodology**

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research problem, Selection of Problem, Necessity of Defining the

Problem, Technique involved in Defining the Problem, An Illustration, Meaning of Research Design, Different Research Designs, Basic Principles of Experimental designs.

### **Unit-2: Sampling and Data Analysis**

Census and Sample Survey, Implications of a Sample Design, Steps in Sampling Design, Criteria of Selecting a Sampling Procedure, characteristics of a Good Sample Design, Different Types of Sample Designs, Need of Sampling, Fundamental Definitions, Important Sampling Distributions, Concept of Standard Error, Estimation, Sample Size and its Determination, Determination of Sample Size through the Approach Based on Precision Rate and Confidence Level.

Methods of Data Collection, Types of Data, Descriptive statistics, Graphical Representation of Data, Correlation, Regression, Attributes, Analysis of Variance (ANOVA) Technique, Analysis of Co-variance (ANOCOVA) Technique.

### **Unit-3: Testing of Hypotheses**

Basic Concepts Concerning Testing of Hypotheses, Important Parametric Tests, Hypothesis Testing of Means, Hypothesis Testing for Differences between Means, Hypothesis Testing for Comparing Two Related Samples, Hypothesis Testing of Proportions, Hypothesis Testing for Difference between Proportions, Hypothesis Testing for Comparing a Variance to some Hypothesized Population Variance, Testing the Equality of Variances of Two Normal Populations.

### **Unit-4: Multivariate Analysis Techniques**

Growth of Multivariate Techniques, Characteristics and Applications Techniques, Classification of Multivariate Techniques, Variables in Multivariate Analysis, Important Multivariate Techniques, Important Methods of Factor Analysis, Rotation in Factor Analysis, R-type and Q-type factor Analyses, Path analysis, Conclusion.

## **Section-II (Computer Applications)**

### **Unit-5: Role of Computer in Research**

Introduction, Computer and Computer Technology, The Computer system, Important Characteristics, The Binary Number System, Computer Applications, Computers and Researcher.

### **Unit-6: Simulation**

Concept of Simulation, Concept of Random Number Generator, Congruential Method of Generating Uniform Variates, Generation of Random Variables from Standard Continuous and Discrete Distributions. Development of Algorithms, Flow Charts and Computer Programs in C for Generation of Random Sample from Standard Continuous and Discrete Distributions.

### **Unit-7: R-Software**

Introduction to R, Programming based on R for Statistical Data Analysis as Computation of Descriptive Statistics, Correlation and Regression Analysis, Generation of Random Numbers.

### **Unit-8: MINITAB**

Introduction to MINITAB and Programming based on MINITAB Macros for Statistical Analysis covering Descriptive Statistics, Regression Analysis and Resampling Methods.

#### **Books:**

- 1) Kothari C.R.: **Research Methodology** Methods and Techniques, New Age International Publisher.
- 2) Purohit, Gore, Deshmukh: **Statistics Using R**, Narosa Publishing House.
- 3) Ghosh, B.N.(1982): **Scientific Methods And Social Research**, Sterling Publishers, New Delhi.
- 4) Kothari C.R.(1984): **Quantitative Techniques**, Vikas Publishing House, New Delhi.

- 5) Karson, Marvin(1982): **Multivariate Statistical Methods**, Ames, Iowa:Iowa State University Press.
- 6) Ryan and Joiner (2001): **MINITAB Handbook**, Duxbury.
- 7) Kanetkar, Y : **Let us C**, BFB Publishers, New Delhi.
- 8) Balguruswamy E. : **Programming in ANSI 'C'**.

## **Statistics Paper-II**

### **(Topics in Statistical Inference)**

The following topics from the book by Dudewicz and Mishra (1988): “**Modern Mathematical Statistics**”.

#### **Section-I**

##### **Unit-1: Point Estimation**

Unbiasedness and Consistency, Maximum Likelihood Estimation, Method of Moment Estimation

**Unit-2:** Goodness Properties of Estimators, Cramer-Rao Inequality and Efficiency of Estimation.

##### **Unit-3: Data Reduction and Best Estimation.**

Sufficiency, Minimal Sufficiency, Completeness, Ancillary Statistic, Basu's Theorem, UMVUE, Rao-Blackwell Theorem.

**Unit-4:** Bias Reduction Methods, Jack-Knife Estimator, its properties and limitations, Boot-strap Method and its simple properties.

#### **Section-II**

##### **Unit-5: Tests of Hypotheses-I**

Simple and Composite Null and Alternative Hypotheses, Tests, Errors of Type I and Type II , Power, The Neyman Pearson Lemma, its Generalizations and Uses, A Decision Theoretic View of the Hypotheses Testing Problem.

### **Unit-6: Tests of Hypotheses-II**

Testing Normal Means (One population), Testing Normal Variances (One Population and Two Populations), Testing Normal Means (Two Populations with Equal Variances), Testing Normal Means (Two Populations with Unequal Variances), Likelihood Ratio Test (LRT) and Sequential LR Test (SPRT), The Chi-Square Test of Goodness of fit.

### **Unit-7: Interval Estimation**

Confidence sets and Tests of Hypotheses, Confidence Intervals for one normal mean, Confidence Intervals for one normal variance, Confidence Intervals for a success probability, Confidence Intervals for the difference of two normal means, Confidence Intervals for the ratio of two normal variances, Large Sample Confidence Intervals for difference of two probabilities of success.

### **Unit-8: Nonparametric Statistical Inference**

Nonparametric Confidence Intervals, Nonparametric Testing of Quintiles  $\xi_p$ , Nonparametric Tests for ordinal data, Tests for distribution function, tests for normality.

#### **Books:**

- 1) Dudewicz and Mishra (1988): “**Modern Mathematical Statistics**”.
- 2) Rohatgi and Saleh: **An Introduction to Probability and Statistics**, John Wiley and Sons.

### **Statistics Paper-III**

#### **Topics in Probability and Statistics**

##### **Section-I**

The following topics from the book by T. Cacoullos (1987): “**Exercises in Probability**”, (Narosa Publishing House).

**Unit-1:** Basic Probabilities, Discrete Spaces.

**Unit-2:** Distributions, Random Variables.

**Unit-3:** Expectation, Variance, Moments.

**Unit-4: Multivariate Distributions.**

**Section-II**

Section-II is based on the topic of dissertation; **ANY ONE** of the following topics is to be chosen related to the topic of dissertation.

- ( i ). Statistical Quality Control
- ( ii ). Applied Regression Analysis
- ( iii ). Topics in Discrete Multivariate Analysis
- ( iv ). Topics in Distribution Theory
- ( v ). Reliability Theory and Survival Analysis
- ( vi ). Topics in Asymptotic Inference
- ( vii). Advanced Inference
- ( viii). Decision Theory

**(Paper-III Section-II )**

**( i ) Statistical Quality Control**

**Unit-1.** Statistical Quality Control: Meaning and scope of SQC, Shewhart Control charts for  $\bar{X}$ , R, np, p, c etc. and their uses, (A review), OC and ARL of control charts, use of runs and related pattern of points.

**Unit-2.** Control charts based on C.V., extreme values, moving averages, Modified control charts, CUSUM procedures, use of V-mask, derivation of ARL.

**Unit-3.** Process Capability, Tolerance limits, Beta content and beta expectation, normal theory and nonparametric approaches.

**Unit-4.** Sampling Inspection Plans: Classification and general properties, Sampling plans by variables, estimation of lot defective and plan parameter determination in known and unknown cases.

**Unit-5.** Continuous sampling plans: CSP-1 and its modifications, Derivation of AOQL for CSP-1. Operations of MLP's and Wald-Wolfowitz plans, MTL STD 105D and ISI plans.

- Books:** 1). Montgomery D.C. (1996): Introduction to Statistical Quality Control.  
2). Mitag H. and Rinne H. (1993): Statistical Methods in Quality Assurance.  
3). Guenther W. 91981). Sampling inspection in Statistical Quality Control

**( ii ) Applied Regression Analysis**

**Unit-1.** Regression and Outliers: Introduction and review of basic results on regression. Drawing conclusions, interpreting estimates, case analysis, residuals and influences, symptoms and remedies.

**Unit-2.** Data analysis approach to residual analysis including Box-Cox transformation, Identification of outliers, identification of leverage points, Cook's method.

**Unit-3.** Regression and Collinearity: Tools for handling Multicollinearity, methods based on singular value decomposition and ridge regression, Properties of ridge estimator.

**Unit-4.** Introduction to general nonlinear regression: Least squares in non-linear case, estimating the parameters of a non-linear system, Reparametrisation of the model.

- Books:** 1). Draper N. and Smith H. (1998): Applied Regression Analysis.  
2). Gunst R. F. and Mason R. L. (1980): Regression Analysis and its Applications-A data oriented approach.  
3). Montgomery D., Peck E. and Vining G. (2001): Introduction to Linear Regression Analysis.

**( iii ) Topics in Discrete Multivariate Analysis**

**Unit-1.** Log-linear models for multivariate discrete data arising under random sampling scheme, Saturated and unsaturated models, Concept of interaction.

**Unit-2.** Models exhibiting partial association, conditional independence, absence of higher order interaction and hierarchy principle, effect of collapsing, collapsibility theorem.

**Unit-3.** Different sampling Schemes, sufficient configurations and method of finding ML.

**Unit-4.** Goodness of fit statistics: Chi-squared and likelihood ratio tests, brief discussion of incomplete tables.

**Unit-5.** Logistic Regression: estimation of parameters and related topics.

**Books:** 1). Bishop, Fienberg, Holland (19975): Multivariate Analysis: Theory and Practice.

2). Christensen R. (1997): Log-linear Models and Logistic Regression.

#### ( iv ) Topics in Distribution Theory

**Unit-1.** Standard families of distributions: Characterization of some standard families, classes of distributions based on failure rate, Proportional Hazards Models.

**Unit-2.** Bivariate distributions: Standard discrete and Continuous bivariate distributions, Bivariate Exponential, Bivariate Cauchy, Bivariate Gamma, Shock models yielding Bivariate distributions. Dirichlet and Lioville distributions.

**Unit-3.** Methods of generation of families of distributions: Transformation of variables, Truncation, Conditioning, Compounding. Other Methods: epsilon-Skew normal, Binomial, use of composite functions, Exponentiated Distributions.

**Unit-4.** Dispersion Models: Natural and General Exponential Models, Exponential dispersion models.

**Unit-5.** Generalized Lambda distribution: GLD approximation to Standard distributions, Bivariate GLD.

- Books:** 1). Kotz and Balakrishanan: Continuous Multivariate Distributions.  
2). Karlin and Dudewicz: Fitting Statistical Distributions.  
3). Barlow and Proschan: Statistical Theory of Reliability and Life Testing.

( v ) **Reliability Theory and Survival Analysis**

**Unit-1.** Parametric Inference for various life distributions, moments and maximum likelihood estimation, likelihood ratio tests, test based on MLE (Rao and Wald techniques). Type-1, Type-2 and random censoring sampling schemes, estimation and testing based on these schemes for various parametric models.

**Unit-2.** Analysis of randomly censored data in grouped form, competing risks, model for grouped data and its analysis.

**Unit-3.** Tests for exponentiality against positive aging based on total time on test statistics, Hollander-Proschan statistics, Deshpande (IFRA) statistics, unbiasedness, consistency and asymptotic relative efficiency (ARE) of these tests.

**Unit-4.** Kaplan-Meier estimator of the distribution function, Gehan-Mantel-Haenszel, Efron tests for two sample censored data problem, versions of the tests for exponentiality for the censored data problem, ranks test for the competing risks model.

**Unit-5.** Accelerated life testing, reliability estimation based on failure times, on-of failures stress-strength analysis, reliability demonstration plan.

- Books:** 1). Barlow and Proschan (1975): Statistical Theory of Reliability and Life Testing.  
2). Lawless (1982). Statistical Models and Life Time Data.  
3). Miller (1981). Survival Analysis.  
4). Sain (1978). Statistical Analysis of Reliability and Life Testing Models.

### ( vi ) Topics in Asymptotic Inference

**Unit-1:** Review of modes of convergence and central limit theorems; Slutsky's theorem; delta method; Fisher Consistency, Weak consistency, functions; Linearization; asymptotic normality, asymptotic point and interval estimation.

**Unit-2:** Nonparametric method of estimation based on U-statistics, sign, rank and signed-rank tests.

**Unit-3:** Nonparametric density estimation, Kernel density estimation, Graphical techniques.

**Unit-4:** Bayesian Point and Interval Estimation.

**Unit-5:** Computer oriented statistical techniques for estimation, interval estimation and testing including resampling techniques-Bootstrap and Jack-Knife.

**Books:** 1) B.K.Kale (1999), Parametric Inference, Narosa Publication.

2) George Casella and Roger L. Berger (1990), Statistical Inference, Cole Publishing Company.

3) Rao C.R. (1995) Linear Statistical Inference and its Applications (Wiley Estem Ltd.)

4) H. Crammer (1946), Mathematical Methods of Statistics (Princeton).

5) Efron B., and Tibshirani R.J. (1993), An Introduction to the Bootstrap, Chapman and Hall.

6) Sileveman, B.N. (1986), Density Estimation for statistics and Data Analysis, Chapman and Hall.

7) Ferguson, T (1967), Mathematical Statistics, A Decision Theoretic Approach, Academic Press.

### ( vii ) Advanced Inference

**Unit-1:** Asymptotic distribution for likelihood ratio and Wald test criteria for composite null hypothesis, super efficiency of estimators, recent results on the optimal property of maximum likelihood estimates(R.R. Bahadur: AMS.1964).

**Unit-2:** Fisher-Behren's Problem, Welch approach, Scheffe's approach and its multivariate extension. Stein's two step sequential test for normal means. General linear hypothesis. (Ref. Scheffe, (1943) AMS and Stein (1945)).

**Unit-3:** Invariance tests and applications to general linear hypotheses, concept of max-min power and stringency with applications.

**Unit-4:** Weak compactness theorems for critical functions and its applications. (Neyman Pearson's generalized lemma-necessity part, closure from below of risk set for the two decision problems).

**Unit-4:** Invariant decision problems and equivariant decision rules, Mini-maxity and admissibility, Applications to location and Scale family (Pitman's estimator).

**Unit-5:** Multiple decision problems, problems on Classification and ranking.

**Books:** 1) Lehman E.L. (1986), Testing of Statistical Hypotheses.

2) Box and Tiao (1973), Bayesian inference in Statistical Analysis.

3) Ferguson T.S. (1967), Mathematical Statistics-A Decision Theoretic Approach.

### ( vii) Decision Theory

**Unit-1:** Description of a decision problem, estimation, testing and confidence region procedures as special cases.

**Unit-2:** The concept of prior information, the posterior distribution, various kinds of priors, the families of conjugate priors.

**Unit-3:** Testing and confidence region problems for various kinds of loss functions.

**Unit-4:** Admissibility, and Minimax procedures.

**Unit-5:** Sequential decision procedures, estimation and test of hypothesis.

**Books:** 1) De-Creet M.H. (1970), Optimal Statistical Decisions, Mac. Grew Hill.

2) Berger V.B. (1990), Statistical Decision Theory, Springer.

3) Ferguson T.S. (1967), Mathematics Statistics, Academic Press.

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