Savitribai Phule Pune University

(Formerly University of Pune)

Syllabus for M.Phil./ Ph.D. (PET) Entrance Exam : Statistics

Research Methodology

1) **Descriptive Statistics**: Measures of central tendency and dispersion, Three approaches of probability, Conditional probability, Bayes's theorem, Random variables, Moments, Some special discrete probability distributions, Functions of random variables and their distributions, Properties of probability distributions, Relationships among probability distributions such as Binomial, Poisson, etc

2) **Problem Identification & Formulation :** definition and formulating the research problem, Necessity of defining the problem, Importance of literature review in defining a problem, Research Question – Investigation Question – Measurement Issues – Hypothesis- Qualities of a good hypothesis – Null hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & importance

3) **Research Design:** Concept and Importance in Research – Features of good research design- Exploratory Research Design – Concept, Types and uses, Descriptive Research Design- concept, types and uses. Experimental Design- Concept of Independent & Dependent variable.

4) **Data Collection and analysis:** Execution of the research- Observation and Collection of data – Methods of data collection, hypothesis-testing-Generalization and Interpretation.

5) **Sampling:** Concept of Statistical population, Sample, Sampling Frame, Sampling Error, Sample size, Non Response. Characteristics of good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical consideration in sampling and sample size.

6) **Data Analysis :** Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi- square test including testing hypothesis of association.

7) **Interpretation of Data and Paper Writing:** Layout of Research Paper, Journals in Statistics. Impact factor of journals, When and where to publish? Ethical issues related to publishing. Plagiarism and Self- Plagiarism.

8) Use of Encyclopedias, Research Guides, Handbook etc., Academic databases for concerned discipline.

9) **Reasoning and Mentalability :** Analogy, Classification, Series, Coding- Decoding, Direction Sense, Representation Through Venn Diagrams, Mathematical Operations, Arithmetical Reasoning, Inserting the Missing Character, Number, Ranking and Time Sequence Test, Eligibility Test, Representation through Venn- diagrams, Number &symbols ordering, Comprehension questions, Statement & assumptions, Statement & conclusions, Statement & assumptions, Statement & conclusions, Statement & actions

10) Large Sample Tests of Hypothesis such as Z test, t-test, ANOVA, Point estimation, Interval estimation, Non-parametric tests of hypothesis, correlation and regression, Multiple and partial correlation, Designs of experiments, CRD, RBD

Books Recommended

1) Research Methodology – C. R. Kothari
2) Research Methodology : An Introduction – Stuart Melville and Wayne
3) Practical Research Methods – Catherine Dawson
4) Select reference from the Internet
5) Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
6) Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
7) Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
8) Gupta, S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
9) Hogg, R. V. and Craig, A. T., Mckean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.
10) Medhi, J., Statistical Methods, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002.
11) Meyer, P. L., Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.
12) Mood, A. M., Graybill F. A. and Bose, F. A. (1974), Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI), McGraw - Hill Series G A 276
13) MukhopadhyaParimal (1999), Applied Statistics, New Central Book Agency, Pvt. Ltd. Kolkata
14) Ross, S. (2003), A first course in probability (Sixth Edition), Pearson Education publishers, Delhi, India.
15) Walpole R. E., Myers R. H. and Myers S. L. (1985), Probability and Statistics for Engineers and Scientists (Third Edition, Chapters 4, 5, 6, 8, 10), Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022.
16) Weiss N., Introductory Statistics, Pearson education publishers. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York.
17) Agarwal B. L. (2003). Programmed Statistics, second edition, New Age International Publishers, New Delhi.

References

1) Garg, B. L., Karadia, R., Agarwal, F. and Agarwal, U. K., 2002. An introduction to Research Methodology, RBSA Publishers,
2) Kothati, C.R., 1990. Research Methodology : Methods Techniques. New Age Internation. 418p.
3) Sinha, S.C. and Dhiman, A.K., 2002 Research Methodology, EssEss Publications. 2 columes.
4) Trochim,W.M.K., 2005. Rearch Methods: the concise knowledge base, Atomic Dog Publishing. 270p
5) Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing

Additional reading

1) Antony, M., Graziano, A.M. and Raulin, M.L., 2009. Reserch Methods: A Process of Inquiry, Allyn and Bacon.
2) Carlos,C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3) Coley, S.M. and Scheinberg, C.A., 1990, "Proposal Writing", Sage Publications.

4) Day. R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
5) Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6) Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7) Satarkar, S.V., 2000. Intellectual property rights and Copy right, EssEss Publications.

Subject Concerned Syllabus
Statistics

Analysis:

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum.

Sequences and series, convergence, limsup, liminf.

Bolzano Weierstrass theorem, Heine Borel theorem.

Continuity, uniform countinuity, differentiability, mean value theorem.

Sequences and series of functions, uniform convergence.

Riemann sums and Riemann integral, Improper Integrals.

Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral.

Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation.

Metric spaces, compactness, connectedness.Normed Linear Spaces.Spaces of Continuous Functions as examples.

Linear Algebra:

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations.

Algebra of matrices, rank and determinant of matrices, linear equations.

Eigenvalues and eigenvectors, Cayley-Hamilton theorem.

Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis.

Quadratic forms, reduction and classification of quadratic forms.

Probability :

Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments.Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities (Tchebyshef, Markov, Jensen).Modes of convergence, weak and strong laws of large numbers, Central Limit theorems (independent case).

Stochastic Processes:
Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution. Poisson process, birth process, birth-death process.

Proability Distributions:
Standard discrete and continuous univariate distributions. Sampling distributions.Standard errors and asymptotic distributions, distribution of order statistics and range.

Statistical Inference:
Methods of estimation. Properties of estimators.Confidence intervals.Tests of hypotheses: most powerful and uniformly most powerful tests, Large sample inference, Likelihood ratio tests. Analysis of discrete data and chi-square test of goodness of fit.Large sample tests. Simple nonparametric tests for one and two sample problems, rank correlation and test for independence. Elementary Bayesian inference.

Linear Models/Regression:
Gauss-Markov models, estimability of parameters, Best linear unbiased estimators, tests for linear hypotheses and confidence intervals. Analysis of variance and covariance. Fixed, random and mixed effects models. Simple and multiple linear regression. Elementary regression diagnostics.Logistic regression.

Multivariate Analysis :
Multivariate normal distribution, Wishart distribution and their properties. Distribution of quadratic forms.Inference for parameters, partial and multiple correlation coefficients and related tests. Data reduction techniques: Principle component analysis, Discriminant analysis, Cluster analysis, Canonical correlation.

Sampling:
Simple random sampling, stratified sampling and systematic sampling. Probability proportional to size sampling. Ratio and regression methods.Horwitz Thompson estimation.

Design of Experiments:
Completely randomized, randomized blocks and Latin-square designs. Connected, complete and orthogonal block designs, BIBD. 2 Factorial experiments: confounding and construction.

Reliability:
Series and parallel systems, hazard function and failure rates, censoring and life testing.

Linear Programming :
Linear Programming problem. Simplex methods, duality.Elementary queuing and inventory models. Steady-state solutions of Markovian queuing models:M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1.

References:

1) Apostol, T. M. (1975). Mathematical Analysis: A Modern Approach to Advanced Calculus. (Addison -Wesley)
2) Rudin, W. (1985). Principles of Mathematical Analysis (McGraw - Hill)
3) Goldberg R. R. (1976).Methods of real analysis (John Wiley & Sons, Inc.)
4) Bartle R. G. &Sherbert D. R., (2007), Introduction to real analysis (Wiley Student Edition)
5) Graybill, F.E. (1961). Introduction to Matrices with Applications in Statistics Wadsworth Pub. Co.)
6) Hohn, F. E. (1973). Elements of Matrix Algebra (Macmillan)
7) Rao, C. R. (1995). Linear Statistical Inference and Its Applications. (Wiley Eastern)
8) Searle, S. R. (1982). Matrix Algebra Useful for Statistics. (John Wiley)
9) Hogg, R. V. and Craig, T. T. (1978) Introduction to Mathematical Statistics (Fourth Edition) (Collier-McMillan)
10) Dasgupta, A. (2010) Fundamentals of Probability: A First Course (Springer)
11) Berger, R. and Casella G. (2002) Statistical Inference (Duxbury Resource Center) Second Edition.
12) Bhat, B. R. (1985). Modern Probability Theory (New Age International)
13) Feller, W. (1969). Introduction to Probability and its Applications vol.II (Wiley Eastern Ltd.)
14) AthreyaK. B. and Lahiri S. (2006). Probability Theory vol 41, Trim series, (Hindustan Book Agency).
15) Draper, N. R. and Smith, H. (1998). Applied Regression Analysis (John Wiley) Third Edition.
16) Hosmer, D.W. and Lemeshow, S. (1989). Applied Logistic Regression (Wiley).
17) Montgomery, Douglas C.; Peck, Elizabeth A.; Vining, G. Geoffrey (2003). Introduction to Linear Regression Analysis (Wiley).
18) Weisberg, S. (2005). Applied Liner Regression (Wiley).
19) Kale, B.K. (1999) A First Course on Parametric Inference. (Narosa).
20) Dudewicz, E. J. and Mishra, S.N.(1988) Modern Mathematical Statistics. (John Wiley)
21) Lehmann, E. L. (1986) Testing of Statistical hypothesis (John Wiley)
22) Lehmann, E. L. (1988) Theory of Point Estimation (John Wiley)
23) Rohatgi, V. K. and Saleh, A.K. Md. E. (1976) Introduction to Theory of Probability and Mathematical Statistics. (John Wiley & Sons)
24) Anderson, T. W. (1984). Introduction to Multivariate Analysis (John Wiley)
25) Kshirsagar, A. M. (1983). Multivariate Analysis (Marcel Dekker)
26) Johnson R.A. &Wichern, D.W. (1988). Applied Multivariate Statistical Analysis (Prentice Hall Inc.)
27) Härdle, W. K. & Simar, L. (2012), Applied Multivariate Statistical Analysis Springer, New York)
28) Härdle, W. K., Hlávka, Z. (2007), Multivariate Statistics: Exercises and Solutions (Springer, New York)
29) Ferguson, T.S. (1996), A Course in Large Sample Theory, Chapman & Hall, London,
30) Gupta Anirban Das (2008), Asymptotic Theory of Statistics and Probability, Springer, New York.
31) Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer.
32) Hicks, C.R., Kenneth V. and Turner, Jr. (1999). Fundamental Concepts in the Design of Experiments, Oxford University Press.
33) Kshirsagar A.M. (1983). Linear Models, Marcel Dekker
34) Montgomery, D.C. (2001). Design and Analysis of Experiments, Wiley.
35) Cochran, W.G. (1984). Sampling Techniques, Wiley.
36) Des Raj and Chandhok, P. (1998). Sample Survey Theory, Narosa.

37) Murthy, M.N. (1977). Sampling Theory and Methods, Statistical Publishing Society Sukhatme P.V, Suktatme, B.V.,Sukhatme S. and Asok C. (1984). Sampling Theory of Surveys with Applications, Indian Society for Agricultural Statistics, New Delhi.
38) Bhat B.R. (2000). Stochastic Models: Analysis and Applications, New Age International.
39) Medhi, J. (1982) Stochastic Processes, Wiley Eastern
40) Ross, S. (2007). Introduction to Probability Models, 9th Edn., Academic Press. Additional Books for Reference
41) Karlin, S & Taylor, H.M. (1975). A First Course in Stochastic Processes (Second. Edition), Academic Press.