JSPM University Pune

Syllabus for Ph.D. Research Program Entrance

Test (RPET) 2023

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 continuity, 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.

Probability 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:
- Apostol, T. M. (1975). Mathematical Analysis: A Modern Approach to Advanced Calculus. (Addison -Wesley)
- Rudin, W. (1985). Principles of Mathematical Analysis (McGraw - Hill)
- Goldberg R. R. (1976).Methods of real analysis (John Wiley & Sons, Inc.)
- Bartle R. G. &Sherbert D. R., (2007), Introduction to real analysis (Wiley Student Edition)
- Graybill, F.E. (1961). Introduction to Matrices with Applications in Statistics Wadsworth Pub. Co.)
- Hohn, F. E. (1973). Elements of Matrix Algebra (Macmillan)
- Rao, C. R. (1995). Linear Statistical Inference and Its Applications. (Wiley Eastern)
- Searle, S. R. (1982). Matrix Algebra Useful for Statistics. (John Wiley)
- Hogg, R. V. and Craig, T. T. (1978) Introduction to Mathematical Statistics (Fourth Edition) (Collier-McMillan)
- Dasgupta, A. (2010) Fundamentals of Probability: A First Course (Springer)
- Berger, R. and Casella G. (2002) Statistical Inference (Duxbury Resource Center) Second Edition.
- Bhat, B. R. (1985). Modern Probability Theory (New Age International)
- Feller, W. (1969). Introduction to Probability and its Applications vol.II (Wiley Eastern Ltd.)
- AthreyaK. B. and Lahiri S. (2006). Probability Theory vol 41, Trim series, (Hindustan Book Agency).
- Draper, N. R. and Smith, H. (1998). Applied Regression Analysis (John Wiley) Third Edition.
- Hosmer, D.W. and Lemeshow, S. (1989). Applied Logistic Regression (Wiley).
- Montgomery, Douglas C.; Peck, Elizabeth A.; Vining, G. Geoffrey (2003). Introduction to Linear Regression Analysis (Wiley).
- Weisberg, S. (2005). Applied Liner Regression (Wiley).
- Kale, B.K. (1999) A First Course on Parametric Inference. (Narosa).

- Dudewicz, E. J. and Mishra, S.N. (1988) Modern Mathematical Statistics. (John Wiley)
- Lehmann, E. L. (1986) Testing of Statistical hypothesis (John Wiley)
- Lehmann, E. L. (1988) Theory of Point Estimation (John Wiley)
- Rohatgi, V. K. and Saleh, A.K. Md. E. (1976) Introduction to Theory of Probability and Mathematical Statistics. (John Wiley & Sons)
- Anderson, T. W. (1984). Introduction to Multivariate Analysis (John Wiley)
- Kshirsagar, A. M. (1983). Multivariate Analysis (Marcel Dekker)
- Johnson R.A. &Wichern, D.W. (1988). Applied Multivariate Statistical Analysis (Prentice Hall Inc.)
- Härdle, W. K. & Simar, L. (2012), Applied Multivariate Statistical Analysis Springer, New York)
- Härdle, W. K., Hlávka, Z. (2007), Multivariate Statistics: Exercises and Solutions (Springer, New York)
- Ferguson, T.S. (1996), A Course in Large Sample Theory, Chapman & Hall, London,
- Gupta Anirban Das (2008), Asymptotic Theory of Statistics and Probability, Springer, New York.
- Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer.
- Hicks, C.R., Kenneth V. and Turner, Jr. (1999). Fundamental Concepts in the Design of Experiments, Oxford University Press.
- Kshirsagar A.M. (1983). Linear Models, Marcel Dekker
- Montgomery, D.C. (2001). Design and Analysis of Experiments, Wiley.
- Cochran, W.G. (1984). Sampling Techniques, Wiley.
- Des Raj and Chandhok, P. (1998). Sample Survey Theory, Narosa.
- 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.
- Bhat B.R. (2000). Stochastic Models: Analysis and Applications, New Age International.
- Medhi, J. (1982) Stochastic Processes, Wiley Eastern
- Ross, S. (2007). Introduction to Probability Models, 9th Edn., Academic Press. Additional Books for Reference
- Karlin, S & Taylor, H.M. (1975). A First Course in Stochastic Processes (Second. Edition), Academic Press.