Department of Statistics
Savitribai Phule Pune University
Syllabus for M.Phil. Courses

Paper I: Research Methodology in Statistics

5 credits course: distribution of credits out of 50 is given in brackets against each topic.

1. Importance of research methodology in statistical research: Motivation, objectives and purpose of research. Data collection, information extraction and knowledge discovery as statistical methodology. (2)
2. Types of statistical research: empirical, field experiments, laboratory experiments, and secondary sources of data. Exploratory and confirmatory research. Planned and ad-hoc methods of data collection. Non-response and methods of recovering the missing response. (8)
3. Sampling of non-standard populations: Sampling designs when the population is contiguous or non-stationary or when sampling units are not distinguishable, are not enumerated, are affected by the process of making observation or are evasive. (10)
4. Response surface methodology: Factorial experiments with central and axial points. Optimization of factor levels to maximize the response. (10)
5. Resampling techniques: Bootstrap and Jackknife, bootstrap variance estimation, bootstrap confidence intervals and testing. (5)
6. Simulation methods: Monte Carlo methods, techniques to handle missing data, EM-algorithm, imputation methods. (5)
7. Use of computers in statistical research: Statistical packages like SAS, SYSTAT, MINITAB and other packages like MATLAB, GAUSS, Mathematica, and Maple. R statistical computing environment. (10)

References:
1. Gruijter, J., de Brus, Bierkens, M. F. P. amd Knotters, M. (2006): Sampling for natural resource monitoring. Springer.
2. Thompson, S. K. (2002): Sampling, 2nd Edition. Wiley.
3. Hastie, T., Tibshirani, R. and Friedman, J. (2009): Elements of statistical learning, 2nd Edition. Springer.
4. Myers, R. H., Montgomery, D. C., and Anderson-Cook, C. M. (2009): Response surface methodology, 3rd Edition. Wiley.
5. Venables, W. N. and Ripley, B. D. (2002): Modern applied statistics with S. 4th Edition. Springer.
6. Purohit, S. G., Gore, S. D. and Deshmukh, S. R. (2008): Statistics using R. Narosa Publishing House.
7. MATLAB online manual.
8. MINITAB online manual.
9. Mathematica online manual.
10. SAS online manual.
11. GAUSS online manual.
12. MAPLE online manual.

Paper II. Probability Theory

1. Sequences of random variables, Types of convergences, their interrelationships.   (3)
2. Almost sure convergence, Independence of random variables, Borel-Cantelli Lemma, Kolmogorov's zero-one law, strong law of large numbers.   (12)
3. Convergence in distribution, Feller-Lindeberg CLT, Multivariate CLT, Multivariate and univariate delta methods, Approximate moments, Applications in asymptotic inference, consistency of estimators, asymptotic normality of sample percentiles, extreme value distributions.   (15)
4. Conditional probability and conditional expectation, martingale sequences.   (8)
5. Rates of convergence in weak and strong laws of large numbers, Rates of convergence in CLT, Berry -Essen theorems, introduction to Edgeworth expansions.   (12)

References:

1. Shao Jun (2003) : Mathematical Statistics. second edition, Springer.
2. Athreya, K.B. and Lahiri, S.N.(2006) Measure theory and probability theory, Springer.
3. Billingsley, P. (1995) Probability and measure, third edition, Wiley.
4. Serfling, R.J. (1980) Approximation theorems of mathematical statistics, Wiley.

Paper III. Statistical Inference

1. Approaches to statistical inference, Likelihood, Frequency and Bayes approaches, Sufficiency, Ancillary statistics.   (5)
2. Testing of hypotheses, UMPU tests, locally most powerful and invariant tests, UMPI tests, UMPI property of standard tests. P-value. Combination of P-values.   (7)
3. Elements of decision theory, admissible rules, complete classes, minimax rules. Statistical problems as decision problems, Inadmissibility of some UMVU estimators. (5)
4. Bayesian approach, Construction of priors, Bayes tests, estimators and credibility intervals and sets, Bayesian computations, Empirical Bayes estimation.   (10)
5. Nonparametric estimation: Histogram and Kernel density estimators, Choosing bandwidth, estimation of failure rate and conditional expectation of Y given $X = x$.   (8)
6. Asymptotic efficiency of estimators and tests, ARE, Comparison of parametric and non-parametric tests. U-statistics.   (7)
7. Robustness of estimators and tests, Robust and non-robust estimators. Influence functions. Breaking points.   (3)
8. Computer intensive statistical procedures, EM algorithm and its extensions, MCMC methods, Jackknife and bootstrap, estimation of standard errors, bootstrap confidence intervals, bootstrap in regression analysis.   (5)

References:

1. Berger, James O.(1985): Statistical decision theory and Bayesian analysis, Springer.
2. Bradley P. Carlin, Thomas A. Louis, (2000) Bayes and Empirical Bayes methods for data analysis; theory and methods. Chapman and Hall/CRC.
3. David Roxbee Cox, David Victor Hinkley (1982). Theoretical statistics Chapman and Hall.

4. Davison, A. C. and Hinkley, D. V. (1997) Bootstrap Methods and Their Applications. Cambridge: Cambridge University Press.
5. Efron B. and Tibshirani, R. J. (1993): An Introduction to the Bootstrap. Chapman and Hall.
6. Gelman, Andrew (2004): Bayesian data analysis. CRC Press.
7. Ghosh, J. K., Mohan Delampady, Tapas Samanta (2006): An introduction to Bayesian analysis: theory and methods. Springer.
8. B. W. Silverman (1998). Density estimation for statistics and data analysis. Chapman and Hall/CRC.
9. Ripley, Brian D. (1987). Stochastic simulation. Wiley.
10. Van der Vaart, A. W. (1998) . Asymptotic Statistics. Cambridge: Cambridge University Press.
11. Geoffrey J. McLachlan and 1 Thriyambakam Krishnan. (1997). The EM Algorithm and Extensions. Wiley.
12. Serfling, R.J. (1980) Approximation theorems of mathematical statistics, Wiley.
13. Shao Jun (2003) Mathematical statistics, second edition, Springer

Grading will be based on the following methods: participation in class discussions, seminars, reviews, assignments and tests.