

**DEPARTMENT OF STATISTICS
UNIVERSITY OF DELHI
DELHI-110007**

May 13, 2016

MINUTES

A meeting of the Departmental Research Committee was held on **Friday, May 13, 2016** at **10.30 A.M.** in Room No. 313, New Academic Block, University of Delhi, Delhi-110007.

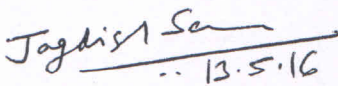
The following members were present:

1. Prof. Jagdish Saran - Chairman
2. Dr. Ranjita Pandey
3. Prof. V. Ravichandran, Deptt. of Mathematics (VC Nominee)

1. The minutes of the last meeting of the D.R.C. held on 11.02.2016 were confirmed.
2. The Committee approved the precise title of Ph.D. thesis as "***Some Contributions to Multiple Imputation for Missing Data in Survival Analysis***" in respect of the thesis to be submitted by **Mr. Vinay Kumar Gupta**.
3. The following papers along with syllabi for Ph.D. course work in Statistics were discussed and approved:

Sl. No.	Course Code	Course Name
(i)	Ph.D. - 01	Research Methodology
(ii)	Ph.D. - 02	Advanced Design of Experiments
(iii)	Ph.D. - 03	Applied Bayesian Statistics
(iv)	Ph.D. - 04	Advanced Theory of Order Statistics
(v)	Ph.D. - 05	Advanced Theory of Bio-Statistics
(vi)	Ph.D. - 06	Advanced Reliability And Life Testing

4. The Ph.D. Course structure was discussed and approved.
5. The meeting ended with a vote of thanks to the chair.


.. 13.5.16
(JAGDISH SARAN)
Professor & Head

Ph.D. COURSE IN STATISTICS

The Ph.D. Programme in Statistics is governed by Ordinance VI-B (amended vide notification dated 17th February, 2016) of Ordinances of the University of Delhi related to Doctorate of Philosophy (Ph.D.).

Course Structure

There will be 3 Courses for the Ph.D. Course work. Each student shall undertake one compulsory course on Research Methodology (Course Code: Ph.D. - 01) and two other courses decided by his/her Supervisor.

Courses (i)-(vi):

Sl. No.	Course Code	Course Name
(i)	Ph.D. - 01	Research Methodology
(ii)	Ph.D. - 02	Advanced Design of Experiments
(iii)	Ph.D. - 03	Applied Bayesian Statistics
(iv)	Ph.D. - 04	Advanced Theory of Order Statistics
(v)	Ph.D. - 05	Advanced Theory of Bio-Statistics
(vi)	Ph.D. - 06	Advanced Reliability And Life Testing

Scheme of Evaluation

A student admitted to Ph.D. course work will be evaluated on the basis of written examination in 3 courses and on the internal continual assessment. Each course will be of 100 marks out of which 75 marks for written paper, and 25 marks for internal assessment. The students will be assessed continuously on the basis of their assignments/seminars.

Ph.D. COURSE WORK SYLLABUS

Ph.D.- 01

Research Methodology

Concept of Research in Statistics-Importance and Need for Research Ethics, Selection of Topic for Research-Research schedules, Review of Literature and its Use in Designing a Research Work-Mode of Literature Survey-Books and Monographs, Journals, Conference Proceedings, Abstracting and Indexing Journals, E-Journals/Books and CDROMS-Reports etc. Thesis Writing – Computer Application in Scientific Research-www- Searching Scientific Articles-Statistical Data Base. History of Statistics. Statistical Heritage of India.

Scientific Word Processing with LaTeX and MS-Word: Article, Thesis Report and Slides Making-Power Point Features, Slide Preparation. Statistical Programming with R: Simple Manipulations Using Numbers and Vectors-Objects & Their Attributes-Arrays and Matrices-Lists and Data Frames-Grouping, Loops and Conditions-User Defined Functions- Probability Distributions and Statistical Models in R.

Simulation: Concepts and Advantages of Simulation-Event Type Simulation-Random Variable Generation-U(0,1), Exponential, Gamma and Normal Random Variables-Monte Carlo Integration. The MCMC Principle, Algorithms and its Variants, Bootstrap Methods.

Computer Oriented Numerical Methods-Algorithms for Solving Algebraic and Transcendental Equations-Numerical Integration-Matrix operations.

Suggested Books:

1. Anderson, J., Durston, B.H., Poole, M. (1970) Thesis and Assignment Writing. Wiley Eastern. Ltd., New Delhi.
2. Beveridge, B. (1979) The Art of Scientific Investigation. W.E. Norton & Co., New York.
3. Braun, J., Duncan, W. and Murdock, J. (2008) A First Course in Statistical Programming with R. Cambridge University Press, London.
4. Chambers, J. (2008) Software for Data Analysis: Programming with R. Springer, New York.
5. Crewley, M.J. (2007) The R-Book. John Wiley, New York.
6. Dalgaard, P.(2008) Introductory Statistics with R. Springer Science, New York.
7. Ghosh, J.K., Mitra, S.K. and Parthasarathy, K. R.(1992) Glimpses of India's Statistical Heritage. Wiley Eastern Limited, New Delhi.
8. Hald, A.(1998) A History of Mathematical Statistics from 1750 to 1930. John Wiley & Sons, New York.
9. Kantiswarup, S., Gupta P.K. and Man Mohan (2008) Operations Research. Sultan Chand & Sons, New Delhi.
10. Kothari, C.R. and Garg, G. (2014), Research Methodology: Methods and Techniques, 3rd Edn.,New Age International. Publishers.
11. Lamport, L. (1999) LATEX: A Document Preparation System. Addison, Wesley, 2nd edition, New York
12. Pannerselvan,R. (2006) Research Methodology. Prentice-Hall of India. Pvt., NewDelhi.
13. Robert, C.P. and Casella, G. (2004) Monte Carlo Statistical Methods. Springer Science, New York.

14. Venkataraman, M.K. (1998) Numerical Methods in Science and Engineering. The National Publishing Company, Chennai.

Ph.D.- 02

Advanced Design of Experiments

Finite fields, Quadratic residues, Legendre symbol and Hilbert norm residue, Balancing in Block Designs, Optimality of Block Designs, Tactical Configuration and Doubly Balanced Designs, Block Designs with Factorial structure, Orthogonal arrays and Difference Schemes, Response surface designs, Design criterion involving bias and variance. Mixture experiments involving process variables, Crossover Designs.

Suggested Books:

1. Bose, M. and Dey, A. (2009). Optimal Crossover Designs, World Scientific.
2. Cornell, John A. (2002). Experiments with Mixtures, John Wiley & Sons.
3. Dey, A. (1986). Theory of Block Designs, John Wiley & Sons.
4. Dey, A. and Mukerjee, R. (1999). Fractional Factorial Plans, John Wiley & Sons.
5. Hedayat, A. S., Sloane, N. J.A. and Stufken, J. (1999). Orthogonal Arrays: Theory and Applications, Springer.
6. Hinkelmann, K. and Kempthorne, O. (2005). Design and Analysis of Experiments, Vol. 2: Advanced Experimental Design, John Wiley & Sons.
7. Myers, R. H. and Montgomery, D. C. (2002). Response Surface Methodology: Process and Product Optimization using Designed Experiments, John Wiley & Sons.
8. Raghavarao, D. (1970). Construction and Combinatorial Problems in Design of Experiments, John Wiley & Sons.

Ph.D.- 03

Applied Bayesian Statistics

Some simple consequences of Axioms of probability, Bayes Theorem. Conjugate analysis for count data, waiting times, Normal likelihood, multivariate normal distribution, normal linear regression model. Behrens-Fisher Controversy.

Informative, non-informative, hybrid and nonparametric priors. Loss functions. Bayes factor, Information theoretic measures for model selection, sensitivity and robust analysis. Bayes point estimation: one parameter, Bayes decisions between k simple hypothesis and between two composite hypothesis. Lindley's method.

Hierarchical models - Poisson-gamma, Gaussian, linear mixed, nonlinear mixed.

Empirical Bayes : asymptotic optimality and robustness with respect to prior distribution.

Spatial and spatio-temporal Bayesian models.

Monte Carlo Sampling from the posterior, Comparing Bayesian Inference from Numerical posterior and posterior random samples.

Suggested Books:

1. Applied Bayesian Modelling. (2003). Peter Congdon. Wiley.
2. Applied Bayesian Hierarchical Methods. (2010). Peter Congdon. Chapman & Hall.
3. Bayesian analysis with STATA. (2014). John Thompson State Press.

4. Bayesian Computation with R. (2007). Jim Albert. Springer.
5. Bayesian Data Analysis. (2004). Gelman et. al., Chapman & Hall 2nd ed.
6. Bayesian Statistics and its applications. (2007) eds. S.K. Upadaya, U. Singh, D.K Dey Anamaya, Delhi.
7. Doing Bayesian Data Analysis. (2015). John K Kruschke. Elsevier AP
8. Introduction to Bayesian Statistics, 2nd ed. . (2010). K. R. Koch. Springer.
9. The Practice of Bayesian analysis (1997) eds. S French & J.Q Smith. Arnold Publisher.

Ph.D.- 04

Advanced Theory of Order Statistics

Basic distribution theory; Discrete order statistics, Joint probability mass function, Dependence structure; Expected values and moments; Order statistics from some specific distributions; Recurrence relations, bounds and approximations for moments of order statistics; Order statistics in statistical inference; Order statistics from a sample containing a single outlier; Asymptotic theory; Record values; Generalized order statistics

Suggested Books:

1. Arnold, B.C. and Balakrishnan, N.(1989): Relations, Bounds and Approximations for Order Statistics. Lecture Notes in Statistics, Vol.53, Springer-Verlag.
2. Arnold, B.C., Balakrishnan, N. and Nagaraja, H.N.(1992): A first course in Order Statistics, John Wiley.
3. Arnold, B.C., Balakrishnan, N. and Nagaraja, H.N.(1998): Records, John Wiley.
4. David, H.A. and Nagaraja, H.N.(2003) : Order Statistics, Third Edition, John Wiley.
5. Galambos, J.(1987) : The Asymptotic Theory of Extreme Order Statistics, Second Edition, Krieger, F.L.
6. Kamps, U. (1995) : A Concept of Generalized Order Statistics, B.G. Teubner Stuttgart.

Ph.D.- 05

Advanced Theory of Bio-statistics

Illustrations and Applications of Accelerated Failure Time Model , Frailty Models, Mixture/Non-Mixture Cure Models, Markov models, Bayesian Survival Analysis, Recurrent Event Analysis selected from research studies.

Suggested Books:

1. Lee, E.T. and Wang, J.: *Statistical methods for survival data analysis*. John Wiley & Sons, 2003.
2. Collett, D.: *Modelling survival data in medical research*. CRC press, 2015.
3. Klein, J.P. and Moeschberger, M.L.: *Survival analysis techniques for censored and truncated data*. Springer, 2005.
4. Chiang, C.L.: *Introduction to Stochastic Processes in Biostatistics*. John Wiley & Sons, New York, 1968.
5. Maller, R.A. and Zhou, S.: *Survival Analysis with long-term survivors*. Wiley, New York, 1996.

6. Cook, R. J. and Lawless, J.: *The statistical analysis of recurrent events*. Springer Science & Business Media, 2007.
7. Lesaffre, E. and Lawson, A.B.: *Bayesian Biostatistics*. John Wiley & Sons, 2012.

Ph.D.- 06

Advanced Reliability And Life Testing

Statistical failure models, Point and interval estimation procedures for lifetime distributions, Testing reliability hypotheses, Goodness of fit, Monte Carlo and distribution-free methods, Bayes methods in reliability, Accelerated life testing, System reliability, The stress-strength models, Estimation and testing under stress-strength set up, Nonparametric models, Progressive censoring, Recursive computation and algorithms, Linear inference, Likelihood inference, Linear prediction, Conditional inference, Optimal censoring schemes.

Suggested Books:

1. Mann, N. R., Schafer, R. E. and Singpurwalla (1974): *Methods for Statistical Analysis of Reliability and Life Data*. John Wiley and Sons, New York.
2. Barlow, R. E. and Proschan, F. (1965): *Mathematical Theory of Reliability*. John Wiley and Sons, New York.
3. Lloyd, D. K. and Lipow, M. (1962): *Reliability: Management, Methods and Mathematics*. Prentice-Hall, New Jersey.
4. Hoyland, A. and Rausand, M. (1994): *System reliability Theory*. John Wiley and Sons, New York.
5. Kalbfleisch, J. D. and Prentice, R. L. (1980): *The Statistical Analysis of Failure Time Data*. John Wiley and Sons, New York.
6. Kotz, S., Lumelskii, Y. and Pensky, M. (2003): *The Stress-Strength Model and its Generalizations*. World Scientific, London.
7. Balakrishnan, N. and Aggarwala, R. (2000): *Progressive Censoring*. Birkhauser, Boston.