

**Indira Gandhi National Open University
School of Sciences**

**Minutes of the Expert Committee Meeting of Ph.D. (Statistics) Programme
December 5-6, 2016**

An Expert Committee meeting of the Ph.D.(Statistics) Programme was held on 5th and 6th December 2016, at 10.30 A.M. in the Conference Room of School of Sciences, Raman Bhawan, Block-D. New Academic Complex, IGNOU, New Delhi.

The following members were present:

Prof. M.S. Nathawat, Director, SOS, IGNOU	-Chairperson
Prof. U.C. Sud, IASRI, New Delhi	-External Expert
Prof. Girja Kant Shukla, Retd. Prof. from IIT Kanpur	-External Expert
Prof. Diwakar Shukla, Dr. H.S. Gaur Central University, Sagar	-External Expert
Prof. Rakesh Srivastava, M.S. University of Baroda, Vadodara	-External Expert
Prof. H.P. Singh, Vikram University, Ujjain	-External Expert
Prof. Meenakshi Srivastava, Ambedkar University, Agra	-External Expert
Dr. Gurpreet Grover, University of Delhi, Delhi	-External Expert
Dr. Manish Trivedi, SOS IGNOU	-Member
Dr. Neha Garg, SOS IGNOU	-Member
Mr. Prabhat Kr. Sangal, SOS IGNOU	-Member

At the outset, the Chair welcomed the members of the Doctoral Committee. Thereafter, the discipline members presented agenda of the meeting. The following agenda items are discussed.

EC. 1.1: To design the syllabi and evaluation methodology of per-Ph.D. course work of Ph.D. programme in Statistics.

The Chair requested the members to design the syllabi and evaluation methodology of pre-Ph.D. course work of Ph.D. programme in Statistics in light of the UGC (Minimum Standards and Procedure for Award of M.Phil/Ph.D. Degrees) Regulations, 2016. The committee deliberated upon the draft syllabi and evaluation methodology and finalised after some modifications. The final syllabi and evaluation methodology of the pre-Ph.D. course work are enclosed as **Annexures 1 and 2**, respectively.

EC 1.2: To design the syllabi and evaluation methodology of entrance examination for Ph.D. programme in Statistics.

The Chair requested the members to design the syllabi and evaluation methodology for the entrance examination of Ph.D. programme in Statistics in light of the UGC Regulations, 2016. The committee deliberated upon the draft syllabi and evaluation methodology and agreed unanimously after some modifications. The final syllabi and evaluation methodology of the entrance examination are enclosed as **Annexures 3 and 4**, respectively.

EC 1.3: To review the eligibility criteria for Ph.D. programme in Statistics.

The Committee deliberated upon the eligibility criteria for Ph.D. programme in Statistics and recommended it to be as **“Postgraduate in Statistics/Applied Statistics”** from any recognised university with minimum 55% [50% in case of reserved categories (SC, ST, OBC (Non-Creamy)

/Differently abled and PWD) with or without M.Phil]”. It was also recommended that scope of research work may be within the research interests of the supervisor or co-supervisor.

The meeting ended with a vote of thanks to the Chair.

**Indira Gandhi National Open University
School of Sciences**

Syllabus of Course work for Ph.D. Programme in Statistics
For research Students admitted in 2017 Batch Onwards

The doctoral committee may recommend course work of specific number of credits in a given subject in order to update the candidates with the recent advances in the field and fill-up the knowledge gap.

Pre-Ph.D. Courses

S. No.	Title	Credits	Compulsory/ Elective
1	Research Methodology in Statistics	4	Compulsory
2	Computer Applications in Research	4	Elective
3	Advanced Sample Surveys	4	
4	Advances in Statistics	4	

Course-1: Research Methodology in Statistics

Concept of research in statistics, Types of research: Qualitative and quantitative, Empirical and normative, Basic and applied, Scientific and experimental methods in research, Interdisciplinary and multidisciplinary research.

Research designs, Definition and identification of a research problem, Aims and objectives of research, Significance and types of hypothesis; Sampling methods, Planning and organisation of sample survey.

Review of published literature in the relevant field, Writing of research proposal and report, Structure & contents of report, Presentation of findings, Pictures and graphs, Styles of referencing and citation, Bibliography, editing, Publication in research journals, Ethical issues in research, forms and consequences of plagiarism, copyright regulations.

Reference Books:

1. Anderson, J., Durston, B.H. and Poole, M. (1970). Thesis and Assignment Writing, Wiley Eastern. Ltd. New Delhi.
2. Kothari, C.R. and Garg, G. (2014). Research Methodology: Methods and Techniques, 3rd Edn., New Age International Publishers.
3. Pannerselvan, R. (2006). Research Methodology, Prentice-Hall of India Pvt., New Delhi.

Course-2: Computer Applications in Research

Word processing, Equation editor, Editing. Introduction to spreadsheet applications, its features and functions, Statistical data analysis related to courses 1, 3 and 4, Generating charts/graph/diagrams and other features of spreadsheet.

Presentation using Power Point, its features, Customising and making presentations, tables, charts.

Statistical programming with R: Simple manipulations using numbers and Vectors-objects & their attributes-arrays, matrices-lists Data Frames-grouping, Loops conditions, User defined functions, Probability distributions and statistical models in R.

Simulations: Concepts and advantages of simulation-Event type of simulation-Random variable Generation- $U(0,1)$, Exponential, Gamma and Normal Random Variables-Monte Carlo technique, EM algorithm. The MCMC principle, Jack-knife technique, Bootstrap, Gibbs sampling methods.

Reference Books:

1. Frye, Curtis D. et al, 2007 Microsoft Office System Step-By-Step (Book/CD) (New Delhi: PHI, 2007).
2. Anita Goel, Computer Fundamentals, Pearson, 2012.
3. P. K.Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers, 2007.
4. Chambers, J. (2008). Software for Data Analysis: Programming with R, Springer, New York.
5. Dalgaard, P. (2008). Introductory Statistics with R, Springer Science, New York.

Course-3: Sampling Methods

Inverse sampling, Sampling with varying probabilities, Ordered and unordered estimators (case of two draws), Sampling strategies due to Horvitz Thomson, Yates and Grundy, Midzuno Sen, Rao-Hartley-Cochran method of sampling, Post-stratification, Effect of increasing the number of strata, Effects of inaccuracies, Construction of strata, Deep stratification, Method of collapsed strata, Ratio and regression estimators in stratified sampling, Quenouille's method for reducing bias in ratio estimate (Jack Knife), Multivariate extension of ratio estimation, ratio, regression and product methods of estimation in double sampling using p-auxiliary variables, Sampling with varying probabilities: ratio and product estimates and their variance, Successive sampling, sub sampling: three-stage sampling with equal first stage and second stage units), three-stage sampling with unequal first and second stage units, Two dimensional systematic sampling, Estimation of variance (systematic sampling),

Non-sampling errors: mathematical model for the measurement of observational errors, Estimation of the different components of the variance, Incomplete samples: effects of non-response, Hansen and Hurwitz technique, Politz and Simmons techniques, Warner's randomised response technique, Imputation method, Bootstrap, Calibration technique.

Reference Books:

1. Singh, D. and Chaudhary, F.S. (1986). Theory and Analysis of Sample Survey Designs. New Age International publishers.
2. Cochran, W.G. (1984). Sampling Techniques. 3rd Ed. Wiley.
3. Des Raj and Chandhok (1998). Sampling Theory. Narosa.
4. Mukophadhyay, P. (1996). Inferential problems in survey sampling. New Age International (P).
5. Murthy, M. N. (1977) Sampling theory and methods. Stat. Publ. House, Calcutta.
6. Sukhatme, P.V. et al (1984). Sampling theory of surveys with applications. Iowa State Univ. Press.
7. Singh, S. (2003), Advanced Sampling Theory with Applications, Springer
8. Bradley Efron, R.J. Tibshirani, 1994, **An Introduction to the Bootstrap**, Chapman and Hall/CRC.
9. Stef van Buuren, 2012, Flexible Imputation of Missing Data, Chapman & Hall/CRC Interdisciplinary Statistics.
10. Claes Cassel, Carl-Erik Sarndal, Jan Hakan Wretman, 1992, **Foundations of Inference in Survey Sampling** 2nd Edition, Krieger Pub Co; 2nd edition.

Course-4: Regression Modeling and Bayesian Inference

Simple and multiple linear regression modeling: Assumptions, Estimation of the model Parameters; Residual analysis, Confidence and prediction intervals, Multi-collinearity, Selection of independent variables: Forward selection, Backward elimination and Stepwise procedures. GLM in exponential family of distributions, Partial least squares.

Bayesian approach, Concepts of the prior and posterior distributions. Bayes estimators for (i) Absolute error loss (ii) Squared error loss (iii) 0–1 Loss function (iv) Asymmetric loss functions. Generalisation to convex loss functions. Evaluation of the estimate in terms of the posterior risk.

Reference Books:

1. D. C. Montgomery and E. A. Peck (1982), Introduction to Linear Regression Analysis, John Wiley & Sons.
2. Rohatgi, V. K. (1999), An Introduction to probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi.
3. Lehmann, E. L. (1986) , Theory of Point Estimation.
4. Rao, C. R. (1973), Linear Statistical Inference.
5. Ferguson T. S. (1967), Mathematical Statistics. Academic Press.
6. Berger, J. O., Statistical Decision Theory and Bayesian Analysis, Springer Verlag.
7. Leonard T. and Hsu, J. S. J., Bayesian Methods, Cambridge University Press.

8. Box, G. P. and Tiao, G. C., Bayesian Inference in Statistical Analysis, Addison – Wesley.
9. Basu and Ebrahimi 1991, JSPI, asymmetric loss functions.
10. Zellner, 1986, JASA

**Indira Gandhi National Open University
School of Sciences**

Evaluation Methodology for Pre-Ph.D. Course Work

- The Ph.D. coursework may be prescribed for minimum 8 and maximum of 16 credits.
- The credit assigned to the Ph.D. course work shall be of minimum one semester duration and maximum two consecutive semesters.

S. No.	Components of evaluation for each course	Maximum Marks
1	Continuous Assessment I - Seminar	25
2	Continuous Assessment II *	25
3	Term End Examination	50
Total Marks		100

*Continuous Assessment II may include various options like assignment, lab-work, presentation of review of research papers, Viva-Voce, etc., whatever required.

- The Course-work per 4 credits course will be divided in the following manner:
 - Minimum number of hours for class room teaching learning: **30 hours**
 - Minimum number of hours for library work: **20 hours**
 - Minimum number of hours for tutorial and other interactive activities: **10 hours**
 - Atleast 80% attendance in the class room teaching shall be compulsory for each student pursuing Ph.D. programme.
 - On successful completion of the course-work, a student will be required to score atleast 55% marks separately in each component of assessment in each course.
 - In the term-end examination, the candidate has to answer five questions out of seven questions. Each question will carry 10 marks.
 - Candidate who has completed the course-work in M. Phil programme shall be exempted from the pre Ph.D. course-work.

**Indira Gandhi National Open University
School of Sciences**

Syllabus of Entrance Exam for Ph.D. Programme in Statistics
For research students admitted in 2017 Batch Onwards

Part-A: Research Methodology

Meaning of research, Role of research in important areas, Process of research, Types of research, research approach, Significance of research, Research problem: Definition, Selection and necessity of research problem.

Primary and secondary data, Qualitative and quantitative data, Classification of measurement scales, Goodness of measurement scales, Scaling, Scale classification bases, Scaling techniques, Methods of collecting primary data, Merits and demerits of different methods of collecting primary data, Non response, Classification and tabulation of data.

Introduction to sampling, Advantages of sampling over complete enumeration, Probability and non-probability sampling, Sampling and non-sampling errors, Basic concepts of simple random sampling and design of experiments.

Measures of central tendency, Measures of dispersion, Probability distributions (Binomial, Poisson, Normal), Simple correlation and regression, Multiple and partial correlation., Testing of hypothesis (z, t, F and chi-square tests).

Part-B: Statistics

Sample space, Probability, Conditional probability, Independent events, Bayes theorem, Random variables, Distribution functions (Univariate and Bi-variate), Moments and moment generating function, Independent random variables, Marginal and conditional distributions, Characteristic function, Central limit theorem (i.i.d. case).

Standard discrete (Rectangular, Geometric, Negative binomial, Hyper-geometric) and continuous distributions (Uniform, Exponential, Beta, Gamma), Bivariate normal distribution, Sampling distributions (t, F, z, chi-square).

Properties of good estimators (unbiasedness, Consistency, Efficiency, Sufficiency, Complete and minimal Sufficient statistic), Exponential families, Methods of estimation (least square, maximum likelihood, method of moments, minimum chi-square), Mean square error, Minimum variance unbiased estimators, Rao-Blackwell theorem, Lehmann-Scheffe theorem, Cramer-Rao lower bound,

Basics of testing of hypothesis, Neyman-Pearson lemma, Most powerful and uniformly most powerful tests, Likelihood ratio tests, Unbiased test, Non-parametric tests for one or more

samples problems (Sign, Wilcoxon, Mann-Whitney, Kolmogorov Smirnov, Run , Kruskal Wallies test).

Gauss-Markov theorem, Estimability of parameters in linear models, BLUE.

Markov chains with finite and countable state space, Classification of states, Limiting behavior of n-step transition probabilities, Stationary distribution, Poisson process, Birth-and-death process.

Multivariate normal and its properties, Distribution of quadratic forms, Canonical correlation, Principle components analysis, Factor analysis, Classification and discriminant analysis.

Stratified sampling, Systematic sampling, Probability proportional to size sampling, Ratio, regression and product methods of estimation, Cluster sampling, Multi stage sampling, Two-phase sampling, Successive sampling

Analysis of variance and covariance, Completely randomised designs, Randomised block designs, Latin-square designs, Missing plot techniques, Orthogonality, BIBD, 2^k factorial experiments, Confounding.

Linear programming problem, Simplex methods, Duality, Assignment, Transportation problems, Queuing theory, 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. Elementary inventory models.

**Indira Gandhi National Open University
School of Sciences**

Evaluation Methodology for Entrance Test

Section	Name of Section	Marks		Total Marks
		MCQs	Descriptive	
A	Research Methodology	35 questions of 1 mark each	3 questions of 5 marks each	50
B	Statistics	35 questions of 1 mark each	3 questions of 5 marks each	50
Total		70	30	100

- The admission in Ph.D. programme will comprise of an entrance test followed by an interview.
- Candidates who secure at least 50% marks in the entrance test (45% marks in case of SC/ST/PH) will be shortlisted (maximum five times of the vacant seats) for the interview as per IGNOU norms.
- Candidate who have qualified UGC-CSIR NET (including JRF)/State-level-eligibility-test/GATE/ teacher fellowship holder, would be eligible to appear directly in the interview.
- Candidate who took admission in M.Phil through entrance test and has completed successfully, would be eligible to appear directly in the interview.
- In the interview, the candidate has to give presentation on the topic/area of interest before the Doctoral Committee.
- At the time of interview, 30% weightage will be given to research aptitude, 50% to subject knowledge and 20% weightage to her/his communication skills.
- Admission will be offered to those candidates who are selected in the interview **depending upon their performance in the interview and the number of seats vacant and advertised in various areas of specialisation.** A waiting list may also be prepared.
- Selected candidates **will be enrolled provisionally** and will undergo course-work as prescribed by the DRC of the Discipline.
- Admission to Ph.D. Programme shall be confirmed after completion of course-work and the approval of the synopsis by the RC/RCSC.