

**SYLLABUS FOR
SIX-MONTHLY PH.D. PRE-REGISTRATION
COURSE WORK IN STATISTICS
DIBRUGARH UNIVERSITY**



(Recommended by DRC in Statistics, D.U. in its meeting held on 28/01/2016 and approved by Research Council in its meeting and passed by the Academic Council meeting and effective from)

**Dept. of Statistics
Dibrugarh University**

**Six-Monthly Ph.D. Pre-Registration Course Work in Statistics
Dibrugarh University**

Course Structure

Courses	Course Title	Distribution of Marks		
		Internal Assessment	End Semester	Total
I	Research Methodology and Computer Based Practical	40	60	100
II	Computer Programming	40	60	100
III	Optional (any one) 1. Applied Regression Analysis 2. Industrial Quality Management 3. Reliability Engineering 4. Distribution Theory 5. Applied Stochastic Processes 6. Robust Inference 7. Non – parametric Inference 8. Multivariate Statistical Methods 9. Advance Econometrics 10. Demography	40	60	100
IV	Assignment	80 (Assignment Writing)	20 (Viva-Voce on Assignment)	100

Six-Monthly Ph.D. Pre-Registration Course Work in Statistics
Department of Statistics, Dibrugarh University

Paper – I : Research Methodology & Computer Based Practical

Total Marks : 100

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

1st half : Research Methodology

Unit – I **[4 + 4]**

Research : Meaning – Purpose – Types of research – significance of research in science and technology.

Unit – II (A) **[3 + 5]**

Steps in Research : Identification, selection and formulation of research problem- Research questions-Research design-Formulation of hypothesis-Review of literature.

Unit – II (B)

Philosophy of Science. **[1 + 1]**

Unit – III **[3 + 5]**

Sampling Techniques : A brief review of various methods.

Unit – IV **[4 + 6]**

Processing Data : Checking – Editing – Coding – Transcriptions and Tabulation-Data analysis-Meaning and methods-Quantitative and Quantitative analysis.

Unit – V **[6 + 8]**

Structuring the Report : Chapter format – Pagination- Identification-Using quotations- Presenting footnotes- abbreviations-Presentation of tables and figures-Referencing- Documentation-Use and format of appendices- Indexing.

2nd half : Computer Based Practical

Unit – I : Use of Computer in Research : **[10 + 15]**

Introduction to Computer Fundamentals, Hardware, Software. Working with MS-DOS, LAN (Novell Netware) environment, Windows Operating System.

DBMS : Data Base Management Systems; Data Base Operations like Creation, Updation, Indexing/Sorting and Searching of Data, Report and Label Generations, Programme Writing. MS-Office : MS Word, Excel, PowerPoint.

Spreadsheet : Introduction to Spread sheet applications, Data Entries, Statistical, Logical and Financial Functions, Graphical Applications and Data Analysis.

Unit – II : Data Analysis with Statistical packages : **[9 + 16]**

Analysis Design : Quantitative data analysis. Research and use of Statistical packages for quantitative research data analysis. Introduction to Statistical packages in Social Sciences Research. Data preparation using various packages/editors, Data Definition.

Transformation and System files generation.

Statistical Analysis : Frequency, Cross tabulation, Descriptive Statistics, T-test, Means, Correlations, Analysis of Variance, Regression, Non-parametric test, Tables and Reports, Factor, Cluster and Discriminant Analysis.

Paper II : Computer Programming

Total Marks : 100

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

1. Programming with R : Introduction to programming with R, flow control such as for () loop, while() loop, if () statement, repeat () loop, break statement, break, next statement etc. use of function to manage the complexity, miscellaneous programming tips. **[10 + 15]**
2. Simulation by using R programming : generation of pseudorandom numbers, generation of random variables possessing specific distribution such as binomial, poisson, exponential, normal etc. **[10 + 15]**
3. Introduction to Latex, document setting, necessary code (`\textbf`, `\textit`, `\Large` etc.), useful packages, counters, lengths. **[8 + 13]**
4. Lists (`itemize`, `enumerate`), basic math type setting (writing equations, theorems, tables), commands with parameters (`\frac {numerator}{denomenator}`), commands without parameters (letters and symbol, operators - `\sum`, `\lim`, `\product`, ...), graphics, presentations, bibliographies. **[12 + 17]**

References :

1. W. John Braun and Duncan J. Murdoch : **A First Course in Statistical Programming with R**. Cambridge University Press, The Edinburgh Building, Cambridge CB2 8RU, UK, Published in the United States of America by Cambridge University Press, New York. ISBN-13 978-0-511-50614-7, 2007
2. Joseph Adler, R in a Nutshell, O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472, 2010. ISBN: 978-0-596-80170-0
3. Mike Allerhand, A Tiny Handbook of R. Springer Briefs in Statistics, 2011. ISBN 978-3-642-17979-2.
4. Zaven A. Karian, Edward J. Dudewicz : Handbook of Fitting Statistical Distributions with R, Chapman & Hall/CRC, Taylor & Francis Group, 2011. 978-1-58488-711-9
5. G. Jay Kerns, Introduction to Probability and Statistics Using R. Copyright © 2010 G. Jay Kerns, 2010. ISBN: 978-0-557-24979-4.
6. Y. Cohen and J.Y. Cohen, Statistics and Data with R: An applied approach through examples. John Wiley & Sons Ltd., 2008. 978-0-470-75805-2
7. "The Not so Short Introduction to LaTeX" (2011) by Tobias Oetiker, Publisher: Tobias Oetiker and Contributors (Free e-Book)
- 8.. "More Math into LaTeX" (2007) by George Grätzer 4th edition, Springer, ISBN 978-0387322896
9. "LaTeX Beginner's Guide" (2011) by Stefan Kottwitz, publisher: Packt Publishing, ISBN: 9781847199867
10. "Latex : A Document Preparation System" (2002) by Leslie Lamport Publisher: Pearson India, ISBN: 9788177584141

Paper III : Optional (any one)**Total Marks : 100****1. Applied Regression Analysis****Distribution of Marks**

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

General Regression Model :

Residual Analysis and its importance in Regression Analysis. Methods for scaling residuals. The PRESS Statistic, Detection and Treatment of outliers. Tests for lack of fit.

Regression Diagnostics :

Detecting influential observations – Leverage, Studentized residuals, DFBETAS, DEFITS
Treatment of influential observations. [18 + 24]

Bootstrapping in Regression :

Meaning and its importance, Bootstrap sampling and confidence interval in Regression.

[6 + 10]

Generalized Regression Models :

Generalized Linear Regression Model Vs General Linear Regression Model, Poisson, Negative Binomial and Logistic Regression Models. [10 + 16]

Applications :

Application of Regression models in Medical Sciences, Industries & other real life situations.

[6 + 10]

References :

1. Montgomery D.C. Peck, E.A., Vinning G.G. : Introduction to Linear Regression Analysis, Wiley series in Probability and Statistics.
2. Netor J, Wasserman, W. : Applied Linear Statistical Model, Richard D. Irwin Inc.
3. Draper N.R., & Smith. H. : Applied Regression Analysis Wiley Series in Probability and Stats.
4. Mukhopadhyay, P. : Mathematical Statistics Central. New Book Agency (P) Ltd.
5. Chatterjee, S. & Price B. : Regression Analysis by Example John Wiley.

2. Industrial Quality Management

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Quality Culture : Philosophies of Quality by Quality Gurus, Statistical Process Control (SPC) techniques. CUSUM, MA, EWMA & VSI Charts Process, Capability Indices. Multivariate Quality Control. [14 + 21]

Acceptance Sampling Plans :

Advance Sampling Plans for variables and attributes. Sequential Sampling plans and CVA plan. [7 + 12]

Taguchi's approach to Quality Control :

On-line and Off-line Quality Control. ISO 9000 series of Quality System, Total Quality Management (TQM), Concept of use of Six-Sigma limits. [14 + 20]

Quality Education. Use of DOE in Quality Control. [5 + 7]

References:

1. Montgomery Douglas, C. (1991): Introduction of Statistical Quality Control, John-Wiley and Sons, New Delhi, New York.
2. Taguchi,G.(1986) : Introduction to Quality Engineering: Design quality into Product and Processes, Asian Productivity organisation, Tokyo
3. Duncan, A.J. (1970) : Quality control and Industrial Statistics, D.B. Tarapore vala Sons and Co. ,Bombay
4. Grant, E.L. and Leavenworth, R.S.(1964): Statistical Quality Control, McGraw Hill, New York.
5. Bowker, A.H. and Goode, H.P. (1952): Sampling Inspection by Variable McGraw-Hill, New York.
6. Mahajan M. (2004) : Statistical Quality Control Dhan Pat Rai & Co. (Pvt.) Ltd., Delhi.
7. Khanna, O.P. (2001) : Statistical Quality Control Dhan Pat Rai & Co. (Pvt.) Ltd., Delhi.
8. Joseph & Susan Berk (1995) : Total Quality Management – Aggarwal & Company
9. Oakland, John, S. (2005) : Statistical Process Control – Butterworth – Helenemman

3. Reliability Engineering

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Different concepts in Reliability Theory, Redundancy, Maintenance. IFR, AFRA, DFR and DFRA distributions. Renewal Process, Distribution of number of Renewals, Moments of the number of Renewals, Renewal function and its asymptotic form, Renewal density, variance and higher moments. [8 + 12]

Coherent System, Reliability of Coherent Systems and Bounds on their reliabilities. Redundancy : Time to failure models with imperfect switching. [5 + 6]

Stress-Strength model: Exponential and Normal with imperfect switching. Cascade System with Exponential Normal and Gamma distribution. [7 + 12]

Estimation: Censoring, Estimation from Exponential and Normal Distribution. Accelerated Life testing: Different models. Estimation using Power rule Model. [8 + 12]

Theory of Simulation: Monte Carlo Method. Application to Stress-Strength Models. [8 + 12]

Recent applications of reliability (Case Studies) [4 + 6]

References :

1. Balaguruswamy, E. (1984) : Reliability Engineering, Tata McGraw Hill
2. Barlow, R.E. and Proschan, F. (1965) : Mathematical Theory of Reliability, John Wiley and Sons, New York.
3. Barlow, R.E. and Proschan, F. (1975) : Statistical Theory of Life Testing and Reliability.
4. Barlow, R.E. and Scheur, E.M. (1971) : Estimation from Accelerated Life Tests. Technometrics, Vol. 13, No. 1, pp. 145 - 149
5. Kapoor, K.C. and Lamberson, L.R. (1977) : Reliability Engineering, John Wiley And Sons, New York.
6. Mann, N.R. and Schafer, R.E. and Singpurwalla, N.D. (1974) : Methods for Statistical Analysis of Reliability and Life Data, John Wiley and Sons, New York.
7. Sinha, S.K. (1986) : Reliability and Life Testing, Wiley Eastern, New Delhi.
8. Trivedi, K.S. (1994) : Probability and Statistics with Reliability Queuing and Computer Science Applications, Prentice Hall of India, N.D.

4. Distribution Theory

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Random variable, Distribution function, Expectation Generating functions, Moment inequalities, Limit theorems; Order Statistics; Truncation; Mixture and Generalized distribution; Joint distribution; Conditional distribution; Independence. [8 + 12]

Univariate and Multivariate Probability distributions : Binomial, Poisson, Negative Binomial, Hyper Geometric, Power series distribution, Modified Power series distribution, Factorial series distribution, Gould series distribution, Able series distribution. Bivariate Binomial, Poisson, Negative Binomial distributions. Uniform, Normal, Exponential, Gamma, Beta distributions. Bivariate normal distribution. [11 + 18]

Distribution of functions of Random Variables : CDF technique, MGF technique and Method of transformation. [8 + 11]

Parametric Estimation : MLE, Method of moments, Minimum Chi-square, Minimum distance methods. [7 + 10]

Testing : Chi-square goodness of fit, KS goodness of fit, Equality of two distributions, LR test, Score test, Wald test. [6 + 9]

References:

1. An Introduction to Probability and Statistics- V.K. Rohatgi, A.K.Md. Saleh, 2nd edition, Wiley.
2. Univariate Discrete Distribution -N. L. Jhonson, A. W. Kemp, S. Kotz.
3. Continuous Univariate Distribution- Vol.1 and Vol.2 - N. L. Johnson, S. Kotz, N. Balakrishnan
4. Continuous Multivariate Distributions- S. Kotz , N. L. Johnson, N. Balakrishnan.
5. Topics in Statistical Methodology- S. Biswas
6. The Advance theory of Statistics- Vol. 1 - Distribution Theory: M. G. Kendall & A. Stuart
7. Mathematical Statistics- P. Mukherjee, Central Book Agency, 2nd edition.
8. Mathematical Methods of Statistics- Harald Cramer
9. Order Statistics- H.A. David.
10. Introduction to Theory of Statistics – Mood, Graybill, Boes, Tata McGraw Hill.

5. Applied Stochastic Processes

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Semi-Markov Processes – computations of holding, sojourn, expected first reaching and return times, visiting rates and limiting results; Machine-repair model, ruin model and social mobility modeling. [10 + 12]

Markov-Jump-Processes (MJP) – time homogeneous and non-homogeneous MJP, Kolmogorov differential equation (Forward and Backward), HSD, SD, AD and marriage model. Exposure to the recent advancement. [11 + 18]

Poisson Processes (PP) – uniqueness and characterization of P.P., compound P.P., non-homogeneous P.P., pure-birth and birth-and-death processes; P.P. and its contagious relatives. [11 + 18]

Revisit to the works of Doob, Kolmogorov, Karlin, Cox, Weiner, Miller, Ross and Medhi. [8 + 12]

References :

1. Goswami A, Rao B.V. : A course in Applied Stochastic Processes, Hindustan Book Agency, first edition, 2006.
2. Min. D.L. : Applied Probability Models, DUXBURY, first reprint 2002.
3. Medhi J : Stochastic Processes 2nd edition, New Age International Publishers, 2001.
4. Ross S.M. : Stochastic Processes, 2nd edition, WSE, Wiley, 2004
5. Ross S.M. : Introduction to Probability Models, 8th edition, ELSEVIER, Academic Press, 2003
6. Ross S.M. : Probability Models for Computer Science, first edition, ELSEVIER, Academic Press, 2002
7. Thowasian A.J. : The Structure of Probability Theory with Applications, McGraw Hill Book Company, 1969, first edition.

6. Robust Inference

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Concept of Robustness, Robustness of t and F tests. Estimation procedures for censored samples: type II censoring, truncated distribution, estimation of parameters for type II censored samples, BLUE, MLE, MMLE, Robust estimators, Adaptive estimators. MMLE for normal, lognormal, logistic distribution, exponential distribution. MML for raleigh, truncated distribution. [20 + 30]

Robust tests for location - for equal and unequal scale parameters. Sprott approach to robust tests, Robust confidence intervals. The Bayesian approach. Robust regression via MMLE's, Huber robust regression procedure, Robust ANOVA; Goodness of fit tests; Model discrimination, Directional tests, omnibus tests, test for outliers. [20 + 30]

References :

1. Tiku, M.L. Tan, W.Y. and Balakrishnan : Robust Inference, Marcel Dekker, Inc.
2. Huber, P.J. : Robust Inference : A review Ann. of Math. Stats 43, 1041 – 1067
3. Herber, P.J. : Robust Statistics, New York, Wiley.

7. Non – parametric Inference

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Non-parametric and Distribution – free tests, Asymptotically distribution –free tests, Asymptotic Relative Efficiency (ARE) of tests, Power function and their properties. Two sample tests : Sign-Rank test, Wilcoxon test, Mann- Whitney test, Multi-sample tests : Kruskal – Wallis test, Mood’s Median test, Friedman’s test, Linear rank tests for two sample and multi-sample problems (Location and Scale Problem). Tests for one-way and two-way layout, Test for ordered alternatives : Jonckheere – Terpstra Tests, Page test, Non-parametric Tests for Umbrella Alternatives, Non-parametric tests for the Behrens-Fisher problem : Distribution – free adaptive tests. Distribution – tests for Straight –line Regression. Non-parametric point estimation. [40 + 60]

References :

1. Siegel, S. : Nonparametric Statistics for Behavioral Sciences, McGraw Hill Book Company.
2. Bradley, J.V. : Distribution – free Statistical Tests, Prentice – Hall, Inc. Englewood Cliffs
3. Hajek, J. Sidak, Z : Theory of Ranks, Academic Press.
4. Hollander, M and Wolfe, D.A. : Non-parametric Methods, Wiley
5. Noether, G.E. : Elements of Nonparametric Statistics, Wiley
6. Gibbons, J.D. : Nonparametric Statistical Inference, McGraw Hill
7. – Do- : Non parametric Methods in Quantative Analysis, Holt Pub.
8. Conover, W.J. : Practical Non-parametric Statistics, Wiley.
9. Lehmann, E.L. : Non-parametric Methods Based on Ranks, Holden Day, Sanfrancisco.
10. Randle, R.H. and Wolfe, D.A. : Introduction to Theory of Non-parametric Statistics.
11. Puri, M.L. and Sen, P.K. : Non-parametric Methods in Multivariate Analysis, Wiley.
12. Hajek, J. : Non-parametric Statistics, Holden Day.
13. Maritz, I.S. : Distribution –Free Statistical Methods, Chapman and Hall.

8. Multivariate Statistical Methods

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Principal Component Analysis (PCA)

Introduction ; Population and Sample Principal Components; Method of extraction of Principal Components; Properties of PC; Summarizing sample variations by PCs; [14 + 21]

Canonical Correlation Analysis (CCA)

Introduction; Canonical variate and Canonical correlations; Population & Sample canonical correlation Analysis; Interpretation of canonical correlation Analysis. [12 + 18]

Cluster Analysis

Introduction; Similarity Measures : Distance type & Matching type measures clustering methods : Agglomerative : Methods (Nearest neighbor method) [14 + 21]

References :

- (1) Applied Multivariate Statistical Analysis – Richard A. Johnson, Dean W. Wichern, 5th ed.; Pearson Education.
- (2) An Introduction to Multivariate Statistical Analysis – T.W. Anderson, John Wiley.
- (3) Multivariate Analysis & its Applications – K.C. Bhuyan, New Central Book Agency.
- (4) Methods for Statistical Data Analysis of Multivariate Observations – Gnanadesikan. R, John Wiley.
- (5) Multivariate Analysis – Khirsagar A.M., Marcel Dekker.
- (6) Linear Statistical Inference and its Applications – Rao CR, John Wiley.
- (7) Multivariate Statistical Methods - Donald F. Morrison, McGraw Hill.
- (8) Applied Multivariate Analysis – B. M. Singh.

9. Advanced Econometrics

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Pre-requisite: (Review of different methods of detection of autocorrelation in linear regression model. Relative efficiency of different estimation methods with autocorrelated errors – OLS, GLS, Cochrane - Orcutt methods. Equivalence of Weighted Least Squares (WLS) method and GLS method in case of heteroscedasticity).

Multicollinearity Diagnostics – Examination of Correlation matrix, Variance of Inflation Factors, Eigen System Analysis of $X'X$. Other diagnostics solution to the multicollinearity problem – Ridge Regression and its properties. [10 + 14]

Simultaneous equation Models :Structural form and Reduced form. Estimation of the Reduced form parameters. Rank and order conditions of indentifiability. Estimation and Inferences for Simultaneous equation statistical models (GLS, 2SLS, 3SLS, FIML and LIML) [13 + 20]

Bayesian Inference : Introduction to Bayesian inference. Bayesian inference in linear regression models (known and unknown disturbance variance case) [7 + 8]

Time Series Analysis and Forecasting : Stationarity of a time series. Different tests for testing the Stationarity of a time series, Review of AR, MA and ARIMA models. Riddell and Smiths ARIMA (p,d,q) (P, D, Q)S model and its development. The Vector Auto Regression (VAR) approach to forecasting, Co-integration and its importance in Econometric Analysis. [10 + 18]

References :

1. Gujarati, D.: Basic Econometrics, McGraw Hill, New edition.
2. Intrilligator, M.D. (1980): Econometric models – Techniques and applications. Prentice.
3. Johnston, J. (1984) : Econometric methods, Third edition, McGraw Hill
4. Kelin, I.R. (1962) : An Introduction to Econometrics, Prentice Hall of India
5. Box, G.E.P. and Jenkins, G.M. (1976): Time Series Analysis – Forecasting and Control, Holden-day, San Francisco.
6. Anderson, T.W. (1971): The Analysis of Time Series, Wiley, N.Y.
7. Montgomery, D.C. and Johnson, I.A. (1977) : Forecasting and Time Series Analysis, McGraw Hill.
8. Kendall, Sir Maurice and Ord., J.K. (1990) : Time Series (Third Edition), Edward Arnold.
9. Brockwell, P.J. and Davis, R.A. : Time Series : Theory and Methods (Second Edition), Springer-Verlag.
10. Fuller, W.A.(1976): Introduction of Statistical Time Series, John Wiley, N.Y.
11. Granger, C.W.J. and Newbold (1984) : Forecasting Econometric Time Series. Third Edition, Academic Press.
12. Priestley, M.B. (1981) : Spectral Analysis and Time Series, Griffin, London.

10. Demography

Distribution of Marks

Internal Assessment	–	40 Marks
End Semester Examination	–	60 Marks

Review of Basic Measures of Fertility :

Definition of natural fertility, fertility, fecundity, fecundability; Basic measures of fertility; Cohort and period measures of fertility; Sources of fertility data; Nuptiality, Nuptiality Table and Measurements; Parity progression ratios (PPRs). Coale's fertility indices; Coale's-Trussel model of natural fertility; SMAM, P/F Method to estimate fertility; Decomposition of fertility; Age-pattern of Fertility, Estimating fertility through PPRs, Calculation of Bongaarts' Indices, Rele's method of estimating fertility, Reverse survival method of estimating fertility; Coale's (1981) Robust Procedure to Estimate fertility from single census; Estimating of fertility from CEB data using Gompertz relational model; Estimating fertility from historical data; Estimating sex ratio at birth, birth intervals. [18 + 25]

Health and Mortality : [22 + 35]

1. Concepts and definitions

Health, morbidity, disease burden, disability, prevalence and incidence, etc.

2. Sources of health data/information; Civil Registration, Sample Registration System (SRS), census and other large scale surveys - completeness and quality of data.

3. Applications of health measures in planning, monitoring and evaluation;

- CDR, IMR or ASDR for estimating immunization needs, clustering, patterning of death, etc.

- Advance methods of estimating/assessing mortality.

- Construction and applications of life tables (multiple decrement), model life tables and its construction.

4. Age pattern of mortality: focus on adult mortality and morbidity/disease pattern

5. Avoidable mortality

6. Measures of health and burden of disease

- Concepts of health expectancy, DALY, survivorship curve; epidemiological estimates for diseases (Years of Lost due to Disability- YLD)

- Introduction and use of DISMOD – II software (WHO)

7. Indian Health System: structure, functioning, and organization

- Structure: Centre (MoHFW, Departments of Health, Family Welfare, AYUSH) and state

- Indian health policies – NHP, NPP, other health programmes, etc.

References :

1. Bongaarts, J and Potter, R (1983) Fertility, Biology and Behavior: An Analysis of the Proximate Determinants. Academic Press, New York.

2. Preston, Samuel H., Heuveline, Patrick, and Guillot, Michel (2001) Demography: Measuring and Modeling Population Processes. Oxford: Blackwell Publishers.

3. Siegel, Jacob S., and David A. Swanson (eds.), (2004) The Methods and Materials of Demography (Second edition). San Diego: Elsevier Academic Press.

4. Palmore, James A. and Gardner, Robert W. (1983) *Measuring Mortality, Fertility and Natural Increase: a Self-Teaching Guide to Elementary Measures*. Honolulu: EastWest Population Institute, East-West Center.
5. Pollard, A.H., Yusuf, Farhat and Pollard, G.N. (1990) *Demographic Techniques* (third edition). Sydney: Pergamon Press.
6. Rowland, Donald T. (2006), *Demographic Methods and Concepts*. New York: Oxford University Press.
7. Pathak, K.B. and Pandey, A (1994) *Biosocial Aspects of Human fertility*. B. R. Publishing Corporation, Delhi.
8. Keyfitz, N and Caswell, H (2005) *Applied Mathematical. Demography-Third Edition*. Springer Science+Business Media, Inc