M.Sc. (Biostatistics)

Semester Course

DEPARTMENT OF EPIDEMIOLOGY AND BIOSTATISTICS
BELAGAVI, KARNATAKA

Contents

Mission

"To strengthen research in each and every KLE constituent units,
And
Sensitize faculty for quality research culture of Internationally established standards"

Preamble

Biological sciences have very large variability, and it is difficult to understand completely all the parameters contributing for the event under study. In this situation applied statistics, as a science, has a great role to play for identifying the variables and their contributions in health and disease.

Statistics has been responsible for accelerating progress in all applied sciences by defining the correct methods of planning, collecting, analyzing and interpreting data for establishing cause and effect relationship.

No science can be learned or progress without continuous updates, hence collecting meaningful information, organizing information, and interpretation of the process and its outcome, is always the necessity of all applied sciences, so the applied statistics does not need introduction.

Department of Epidemiology and Biostatistics

The Department of Epidemiology and Biostatistics is aimed to help in meeting the mandatory need of teaching and research of applied statistics in various Graduate, Post Graduate, Post P.G. and Ph.D. Courses offered by KLEs J. N. Medical College, Belagavi, KLEs V.K. Institute of Dental Science, Belagavi, KLEs College of Pharmacy, Bangalore, KLEs College of Pharmacy, Belagavi, KLEs College of Pharmacy, Hubli, KLEs Institute of Physiotherapy, Belagavi, KLEs Institute of Nursing, Belagavi, and KLEs BMK Ayurveda College of Belagavi.

Department of Epidemiology and Biostatistics has been offering the following courses from academic year 2014:

- ✓ B. Sc. Biostatistics & Population Sciences (3 Years) – 12^{th} Standard (Pre-University) with Statistics or Mathematics, Biology along with Mathematics are also eligible.

- ✓ M.Sc. in Biostatistics (2 Years) – Three years graduate degree with statistics or mathematics,
- ✓ M. Sc. in Population Studies (2 Years) (Hybrid Mode – Offline & Online) - Three years graduate degree in any subject with Statistics/ Mathematics or graduates in Health Science subjects including Nursing and Pharmacy.
- ✓ Ph.D. in Biostatistics – Candidates with Post Graduation in Statistics or Mathematics from a recognised University.

Other Courses

- ✓ Certificate Course in Biostatistics (Hybrid Mode – Offline & Online) – designed to meet the research need of Research Scholars and faculty.
- ✓ P.G. Diploma in Biostatistics (Hybrid Mode – Offline & Online) - Medical and Allied subject graduates interested to pursue research career, with at list one paper in Statistics at Graduation level or Certificate in Biostatistics from any University.
- ✓ Intensive Course in Biostatistics & Research Methodology (Regular 4 Weeks/Part Time 6 Weeks, through contact teaching modules) – This is a skill enhancement course, and can be attended by any graduate desirous to develop research aptitude.

Its faculty with necessary knowledge and skills to deal with statistical analyses in applied research, and to train in quantitative analysis, along with risk managerial skills in their field of interest is well equipped. Substantial facilities are available for higher education.

M.Sc. in Biostatistics

The syllabus of the M.Sc. in Biostatistics course, besides compulsory background courses and courses of general interest, includes a variety of subjects in the field of statistics - theoretical and applied - as subjects of interest in Public Health, Medicine, Hospital Management, Pharmacy, Physiotherapy, Statistical Softwares and Demography. The M.Sc. in Biostatistics course will provide trained manpower, for the sectors needing to churn data for decision making.

Objectives of Programme/Course

1. To understand and gain specialized knowledge and skills required to teach Biostatistics and Research Methodology

2. To understand and apply statistical methods for design, monitor and manage Research in Medical and Allied fields.
3. To understand the existing statistical method and participate in a research team in the development and evaluation of new statistical methodology

Careers

Internationally and nationally the demand for trained Biostatisticians far exceeds the availability. Furthermore, the course adds value to medical practice, healthcare and research.

Eligibility

Graduates with Statistics/ Mathematics from any recognized university from Karnataka or other university with minimum 50 percent marks for general category, and 45 percent for SC, ST and OBC will qualify for admission to M.Sc. in Biostatistics course.

Total Intake – 21

Selection Procedure

To maintain high academic standards, the selection of students will be by:

- Written examination, and
- Personal interview

Evaluation and teaching schedule

The course will include theory classes followed by practical assignments comprised of four semesters of two years duration. The practical assignments will be evaluated for the Internal Assessment marks. Average marks obtained in practical assignments, and an examination as replica of final examination before final examination in each semester will be the Internal Assessment marks.

Students will have to complete dissertation by using data from Hospital/National Sample Surveys. This will give them necessary exposure to understand the real data generation and data management issues.

Final year students will also be the members of consultancy teams for data preparation for analysis; cleaning, analysis and interpretation of thesis data of Research Scholars.

Attendance

Students are expected to have 80% of total attendance in theory and practical's. However, students will be expected to cover missed theory and practical classes, giving extra time after discussing with the concerned teachers.

Medium of instruction: English

Course Fees: As per University norms

Duration of course - Two years of four semesters

Examination pattern

Theory					
Type of questions	**No. of questions**	**Questions to be answered**	**Marks per question**		**Total marks**
Long Essay	**03**	**02**	**20**		**2 x 20=40**
Short answer	**07**	**05**	**08**		**5 x 08=40**
Sub Total: 14 papers of 80 marks each (14 x 80=1120)					1120
Theory's Internal assessment (14 x 20=280)					280
Practical, Research project/ Dissertation					
Details/ semester	1st	2nd	3rd	4th	Total
Practical Viva-Voce	50 30	50 30	50 30	50 30	320
Internal/ assessment	20	20	20	20	80
Project/ Dissertation					
Details	**Synopsis**	**Data quality**	**Analysis/ interpretation**	**Defense**	**Total**
Report	**25**	**60**	**65**	**50**	**200**
G. Total					**2000**

One External Examiner and one Internal will form the practical examination team.

Internal Assessment

For internal assessment 35% marks are essential to appear for University theory examinations.

Evaluation

Minimum 50% overall, 50% marks in theory, and practical, and 35% in Internal Assessment is eligibility to appear for University Examination, together shall qualify to pass the Certificate Course in Biostatistics.

The mode of evaluation for Project Report will be based on the presentation of the project report by the candidate before the Examiner and the Faculty of the University Department of Epidemiology and Biostatistics, which will be arranged after theory Examination.

Results

A candidate who scores less than 50% of the total marks in an individual subjects, has to reappear for the same subject in subsequent examination conducted by the university.

- Class shall be awarded asper University rules

  Grade percent marks

  A+ 90% and Above

  A 75% and above but less than 90%

  B 60% and above but less than 75%

  C 50% and above but less than 60 %

Syllabus

First Year – Semester I

Paper 1: Basic Mathematics and Statistics	Total (48Lecture + 32Practical)/Week
Basic Mathematics (Lectures) Integration (2), Differentiation (2), Matrices (4), Determinants (1), Difference tables and methods of Interpolation(4), Newton's and Lagrange's methods of Interpolation (2), Divided Differences, Numerical Differentiation and Integration (3), Trapezoidal Rule, Simpson's One-third Formula (2), Iterative Solution of Non-Linear Equations (2). **Basic Statistics** Statistical population and sample from a population **Data Types** Qualitative, Quantitative, Semi-quantitative, Types of scales - nominal, ordinal, ratio, continuous and interval (2). **Collection and Scrutiny of Data** Primary data - Designing a Questionnaire and a Proforma, Checking their consistency (2). Secondary Data - its major sources including some government publications (1). **Presentation of Data** Construction of tables with one or more factors of classification (2). **Diagrammatic and Graphical Representation** Frequency distributions, Cumulative Frequency Distributions and their Graphical Representation, Histogram, Frequency Polygon and Ogives. Stem and Leaf Chart. Box Plot (5). **Analysis of Quantitative Data** Measures of Central Tendency, Location (4), Dispersion and Relative Dispersion, Skewness and Kurtosis (5). **Analysis of Categorical Data** Measures of Central Tendency & Dispersion, Consistency of categorical data, Independence and Association of Attributes. Measures of Association. Odds Ratio and Relative Risk (5).	**Practical: Basic Mathematics:** Integration, Differentiation, Matrices, Determinants (6), Difference tables and methods of Interpolation, Newton's and Lagrange's methods of Interpolation (2), Divided differences, Numerical Differentiation and Integration (2), Trapezoidal Rule, Simpson's one-third Formula (2), Iterative Solution of Non-linear Equations (2). **Basic Statistics** Construction of tables with one and more factors of classification (4). **Diagrammatic and Graphical Representation** Grouped data. Frequency Distributions, Cumulative Frequency Distributions and their Graphical Representation, Histogram, Frequency Polygon and Ogives, Stem and Leaf Chart, Box Plot (8). Dispersion and Relative Dispersion, Skewness and Kurtosis (4). **Analysis of Categorical Data** Measures of Central Tendency & Dispersion, Association for two - three-way classified data. Odds Ratio and Relative Risk (3).

Paper 2: Probability Theory	Total(48Lecture + 32Practical)/Week
Probability theory Important Concepts in Probability(2), Definition of probability - classical and relative frequency approach to probability (2), Cramer and Kolmogorov's approaches to probability, merits and demerits of these approaches (only general ideas to be given) (2). **Random Experiment** Trial, sample point and sample space, definition of an event, operation of events, mutually exclusive and exhaustive events. Discrete sample space, properties of probability based on axiomatic approach, conditional probability, independence of events, Bayes' theorem and its applications. Random Variables(5), Definition of discrete random variables, probability mass function, idea of continuous random variable, probability density function, illustrations of random variables and its properties (5), Expectation of a random variable and its properties -moments, measures of location(4), Dispersion, skewness and kurtosis, probability generating function (if it exists), their properties and uses (8). **Standard univariate discrete distributions and their properties** Discrete Uniform, Binomial, Poisson, Hypergeometric, and Negative Binomial distributions (8). Continuous univariate distributions- uniform, normal, Exponential, Chi-Square, and Gamma distributions. Bivariate normal distribution (including marginal and conditional distributions) (10). Chebyshev's inequality and applications, statements and applications of weak law of large numbers and central limit theorems (2).	**Probability theory** **Random Experiment** Bayes' theorem and its applications. Random Variables (3), Discrete random variables, probability mass function, idea of continuous random variable, probability density function, illustrations of random variables and its properties (5), Expectation of a random variable and its properties -moments, Measures of Location (4), **Random Experiment** Dispersion, skewness and kurtosis, probability generating function (if it exists), their properties and uses (6). Discrete Uniform, Binomial, Poisson, Hypergeometric, and Negative Binomial distributions (6). Continuous univariate distributions- uniform, normal, Exponential, Chi-Square, and Gamma distributions. Bivariate normal distribution (including marginal and conditional distributions) (8).
Paper 3: Sampling Techniques and Designs	Total (48Lecture + 32Practical)/ Week
Sampling techniques Concepts of sampling vs. population (2), Simple random (6), Stratified (6), Cluster (4), Systematic (4), Multistage (4), Inverse (1), Non-probability (quota, purposive) (1), **Designs with Sample Size** Case control studies (4) Retrospective Studies (2) Prospective Studies (1)	**Sampling techniques** Simple random sampling (4), Stratified (6), Cluster (4), systematic (2), Multistage (1), Inverse (1), Non-probability (quota, purposive), **Designs with Sample Size** Case control studies (2) Retrospective Studies (2) Prospective Studies (2)

Case series studies (2) Case reports (1) Cohort Studies (4) Cross Sectional Studies (5) Longitudinal Studies (1)	Case series studies (1) Case reports (1) Cohort Studies (2) Cross Sectional Studies (3) Longitudinal Studies (1)
Paper 4: Methods in Statistical Inference	Total (48Lecture + 32Practical)/Week
Definition of a Random Sample Simulating random sample from Standard Distributions (4), Concept of derived distributions of a function of random variables (2). Concept of a statistic and its Sampling Distribution (2), Point estimate of a parameter(1), Concept of bias and standard error of an estimate (1). Standard Errors of Sample Mean (1), Sample Proportion (1). **Distributions** Sampling Distribution of sum of Binomial (1), Poisson (1) and mean of Normal distributions (2). Independence of Sample Mean and Variance in Random Sampling from a Normal Distribution (without Derivation) (1). **Statistical Tests** Statistical Tests and Interval Estimation (2), Null and Alternative Hypotheses (1), Types of Errors, p-values (2), Statement of Chi-square (2), t – test (1), and F statistics (2). Testing for the Mean and Variance of univariate Normal Distribution (1), Testing of equality of two Means (2) and testing of equality of two Variances of two univariate Normal Distributions and related Confidence Intervals (2). Testing for the significance of Sample Correlation Coefficient in Sampling from Bivariate Normal Distribution (1), Equality of Means and equality of Variances in Sampling from Bivariate Normal Distributions (2). **Large Sample Tests** Use of Central Limit Theorem for Testing and Interval Estimation of a Single Mean and a Single Proportion and difference of two Means and two Proportions (2), Fisher's Z transformation and its uses (1). Pearson's Chi-square test for Goodness of Fit and for Homogeneity for Standard Distributions (2). Contingency Table and test of Independence in Contingency Table (2).	**Methods in Statistical Inference** Random sample- Derived distributions of a function of random variables (2). Standard Errors of Sample Mean (1), **Distributions** Sampling Distribution of sum of Binomial (2), Poisson (2) Mean of Normal Distributions (2). Statistical **Statistical Tests** Tests and Interval Estimation (1) Chi-square (2), t - test (1), and F statistics (2). Testing for the mean and variance of univariate Normal Distribution (1), Testing of Equality of two means (1) and Testing of Equality of two variances of two univariate Normal Distributions and related Confidence Intervals (1). Testing for the significance of sample correlation coefficient in sampling from Bivariate Normal Distribution (2), Equality of means, equality of variances in sampling from Bivariate Normal distributions, **Large Sample Tests** Testing and interval estimation of a single mean and a single proportion and difference of two means and two proportions(2), Fisher's Z transformation and its uses (1). Pearson's Chi-square test for goodness of fit and for homogeneity for standard distributions (2). Contingency table and test of independence in a contingency table (1). **Meta-Analysis** Systematic Review & Meta-Analysis (6)

Meta-Analysis Systematic Review & Meta-Analysis (7)	

Mathematical Analysis

References

1. Apostol,T.M. (1985): Mathematical Analysis, Narosa Publishing House.
2. Burkill, J. C. (1980): A First Course in Mathematical Analysis, Vikas Publishing House.
3. Deshpande, J. V. (1981): Text Book of Mathematical Analysis, Tata McGraw Hill.
4. Goldberg, R. R. (1970): Methods of Real Analysis, Oxford and IBH
5. Khuri, A. I. (1983): Advanced Calculus with Applications in Statistics, Wiley.
6. Searle, S. R. (1982): Matrix Algebra Useful for Statistics, Wiley,
7. Shanti Narayan, (1998): Matrix Algebra, S. Chand & Co.

Basic Statistics

References

1. Bhat B.R, Srivenkatramana T and Rao Madhava K.S.(1996): Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
2. Croxton F.E, Cowden D.J and Kelin S (1973): Applied General Statistics, Prentice Hall of India.
3. Goon A.M., Gupta M.K., Das Gupta.B. (1991): Fundamentals of Statistics, Vol.I, World Press, Calcutta.

Additional references

1. Anderson T.W and Sclove S.L (1978) An Introduction to the Statistical Analysis of Data, Houghton Miffin\Co.
2. Cooke, Cramer and Clarke (): Basic Statistical Computing, Chapman and Hall.
3. Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
4. Snedecor G.W and Cochran W. G. (1967): Statistical Methods. Iowa State University Press.
5. Spiegel, M. R. (1967): Theory & Problems of Statistics, Schaum's Publishing Series.

Suggested readings

1. P.S.S. Sunder Rao, J. Richard, Introduction to Biostatistics and Research Methods, Prentice-Hall of India Private Limited, 2006.
2. Armitage, P., Statistical Methods in Medical Research, London, Blackwell Scientific Publications, 1989.
3. Hill, A.B., Principles of Medical Statistics, London, Edward Arnold, 1981.
4. Reid, Norma, G., Research Methods and Statistics in Health Care, London, Adward Anrold, 1987.
5. Omran, A.R. The Clark-Omran System of research design in epidemiology. Raleigh, NC: University of North Carolina, 1972.
6. Pauli, H.G. Training in research methodology: (Advisory Committee on Medical Research, 25th Session, Geneva, 10-13 October 1983). Geneva: World Health Organization, 1983.
7. Health Research Methodology, A Guide for Training in Research Methods, World Health Organization, Oxford University Press, 1993.

8. Armitage, P., Statistical Methods in Medical Research, London, Blackwell Scientific Publications, 1989.
9. Altman, D.G., Practical Statistics for Medical Research, London, Chapman and Hall, 1992.
10. Indrayan A, Basic Methods of Medical Research, Third Edition, AITBS Publishers, J-5/6 Krishna Nagar, Delhi – 110051, India.

Probability Theory

1. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997): Statistics: A Beginner's Text, Vol. II, New Age International (P) Ltd.
2. Edward P.J., Ford J.S.and Lin (1974): Probability for Statistical Decision-Making, Prentice Hall.
3. Goon A.M., Gupta M.K., Das Gupta.B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
4. Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.

Additional references

1. Cooke, Cramer and Clarke (): Basic Statistical Computing, Chapman and Hall.
2. David S (1996): Elementary Probability, Oxford Press.
3. Hoel P.G (1971): Introduction to Mathematical Statistics, Asia Publishing House.
4. Freund J.E (2001): Mathematical Statistics, Prentice Hall of India.
5. Goon A.M., Gupta M.K., Das Gupta.B. (1991): Fundamentals of Statistics, Vol.I, World Press, Calcutta.
6. Hodges J.L and Lehman E.L (1964): Basic Concepts of Probability and Statistics, Holden Day.
7. Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.

Additional references

1. Bhat B.R. Srivenkatramana T and Rao Madhava K.S. (1997): Statistics: A Beginner's Text, Vol. II, New Age International (P) Ltd.
2. Rohatgi V.K (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley & Sons.
3. Snedecor G.W and Cochran W. G. (1967): Statistical Methods. Iowa State University Press.

Sampling

1. Cochran W.G and Cox G.M (1957): Experimental Designs, John Wiley and Sons.
2. Das M.N and Giri (1986): Design and Analysis of Experiments, Springer Verlag
3. Murthy M.N(1967): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
4. Sampath S. (2000): Sampling Theory and Methods, Narosa Publishing House.
5. Sukhatme B.V(1984) : Sample Survey methods and Its Applications, Indian Society of Agricultural Statistics.
6. Des Raj (2000) : Sample Survey Theory, Narosa Publishing House.
7. Goon A.M.,Gupta M.K.,Das Gupta.B. (1986): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
8. Kempthorne O. (1965): The Design and Analysis of Experiments, Wiley Eastern.

Semester – II

Paper 1: Regression Analysis	Total (48Lecture + 32Practical)/Week
Regression Analysis Bivariate Data (1), Scatter diagram (2). Product Moment Correlation Coefficient and its properties (5) Coefficient of Determination (1). Correlation ratio (2). Concepts of Error in Regression (1). Principle of Least Squares (2). Fitting of Linear Regression and related results (6). Fitting of curves Reducible to Polynomials by transformation (8). Rank correlation — Spearman's and Kendall's measures (5). **Multivariate data** Multiple Regression (7), Multiple correlation and Partial correlation in three variables, their Measures and related results (8).	**Regression Analysis** Scatter diagram (2). Product Moment Correlation Coefficient and its properties (2). Error in regression (2). Fitting of Linear Regression and related results (5). Fitting of curves reducible to Polynomials by transformation (6). Rank correlation — Spearman's and Kendall's measures (4). **Multivariate data** Multiple Regressions (5), Multiple correlation and partial correlation in three variables, their measures and related results (6).
Paper 2: Multivariate Analysis	Total (48Lecture + 32Practical)/Week
Multivariate analysis Linear (8), Logistic (7), Survival analysis (7), Path analysis (6), Multicollinearity and Homoscedasticity and adjusting for them in Regression models (4), Discriminant Analysis (8), Factor Analysis with its uses, including their utility in Health and Disease (8).	**Multivariate analysis** Linear (5), Logistic (4), Survival analysis (5), Path analysis (5), Multicollinearity and Homoscedasticity and adjusting for them in Regression models (1), Discriminant Analysis (4), Factor Analysis with its uses, including their utility in Health and Disease(4).
Paper 3: Demography-I	Total (48Lecture + 32Practical)/Week
Census and Population Structure • Population Censuses World and India (2) • Concepts of population evolution (2) • Population change (4) • Population Structure, including their stability and its measures (6) **Fertility** • Terms and Concepts, Importance of the fertility study in population dynamics; Basic terms and concepts used in the study of fertility (2) • Measures of Fertility, Basic Fertility Measures – Crude Fertility Rate, General Fertility Rate, Age Specific Rate, Total Fertility Rate, Order-Specific Fertility Rates – Marital Specific Fertility Rates – Standardized Birth Rates and Coale's Fertility Indices Cohort Measures Birth Interval Analysis Reproduction Measures – Gross Reproduction Rate and Net Reproduction Rate (10) • **Mortality and Life Table** Concepts and Measures of Mortality (12) & Life Tables (10)	**Census and Population Structure** Population change (4), Population Structure including their Stability and its Measures (4), **Fertility, Mortality & Life Tables** Fertility (8), Mortality (8) Life Tables (8)

Paper 4: Demography-II	Total (48Lecture + 32Practical)/Week
Urbanization & Migration Urbanization (8), • Definition and Importance; • Process-level and tempo of urbanization • Urban population growth and its components, • urban size class structure • Data sources; • Current urbanization process in developed and developing countries with special focus on India • Major urbanization problems and policies in developing countries with focus on India. Migration (6) • Concepts, pattern, determinants and consequences of migration and issues related to migration Concept of mobility and migration, sources and quality of data, types of migration, census definition of migrants, limitations. • Measures of Migration Direct estimation of lifetime and inter-censal migration rates from census data. Indirect measures of net internal migration: Vital Statistics Method, National Growth Rate Method and Census and Life Table Survival Ratio methods. Methods of estimating international migration. Migration surveys **Socio-cultural** Marriage, Education (6), Population theories, Population Policies, including their utility in Health (8), Human Resource Management (6). **Projections** Methods in Population Projections and its utility in Health and Human Resource Management (12), Concepts of population projections; population estimates, forecasts and projections, uses of population projections. Methods of interpolation; extrapolation using linear, exponential, polynomial, logistics, Gompertz curves and growth rate models. **National health and family planning programmes: (2)**CNA, RCH, National Population Policy, National Health Policy, and National Rural Health Mission 2005-2012.	**Urbanization & Migration** Urbanization (6), Migration (6), Marriage (5), Education (5), Population Projections (10)

Multivariate

1. Draper, N.R., and Smith, H., Applied Regression Analysis, New York, John Wiley & Sons, 1981.
2. Hand, D.J., and Taylor,C.C., Multivariate Analysis of Variance and Repeated Measures, London, Chapman and Hall, 1987.
3. Maxwell, A.E., Multivariate Analysis in Behavioural Research, London, Chapman and Hall, 1977.
4. McCullagh, P., and Nelder, T.A., Generalized Linear Models, London, Chapman and Hall, 1990.
5. Cochran, W.G., and Cox, G.M. Experimental Designs, Bombay; Asia Publishing House, 1962.

Demography

1. Murdock S.R., Ellis D.R., Applied Demography : An Introduction for Basic Concepts Methods and Data, Bouldev, Co., West View Press,1991.
2. United Nations Manual X, Indirect Techniques of Demography Estimation, New York, United Nations Population Division,1983.
3. Keyfitz N, Applied Mathematical Demography, Second Edition, New York, Springer Verlag, 1985.
4. Brass W, The Relational Gompertz Model of Fertility by Age of Women. World Fertility Survey Data, London, World frtility Survey, 1980.
5. Bongaarts J, Population Policy Options in the Developing World, New York, Population Council, Research Division Working Paper No. 59, 1994.
6. Bongaarts J, Bulatao RA, Completing the Population Transition, New York, Population Council, Research Division Working Paper No. 125, 1999.
7. Singh S.N., M.K.Premi, P.S.Bhatia , Ashish Bose Population transition in India Vol.1 & 2, B.R. Publishing Corporation, Division of D.K Publishers. Distributors (P) Ltd , Delhi 110007,1989.
8. Henry S Shryock, Jacob S Siegel & Associates, The Methods & Material of Demography, U.S. Bureau of the Census, U.S. Government Printing Office, Washington D.C. - Vol I & II, 1980.

Second Year

Semester – III

Paper 1: Design of Experiments	Total(48Lecture + 32Practical)/Week
Design of experiments Process of Randomization (2), Complete Randomized Design (4) Randomized Block Designs (4), Latin Square Designs (8), Factorial Designs (8), Analysis of Variance (one/ two way), Analysis of Covariance(8), Incomplete Non-Factorial and Cross-over Designs (8), Analysis of Categorical data (8), including their utility in Health and Experimental studies in Pharmacy, Physiotherapy, Nursing etc.	**Design of experiments** Process of Randomization (2), Complete Randomized Design (2) Randomized Block designs (2), Latin Square Designs (4), Factorial Designs (4), Analysis of Variance (one/ two way), Analysis of Covariance (4), Factorial Designs(4), Incomplete Non-Factorial and Cross-over Designs (4), Analysis of Categorical Data (6).
Paper 2: Non-parametric tests	Total(48Lecture + 32Practical)/Week
Non-parametric tests Definition of Order Statistics and their distributions(10), Non-Parametric tests; Chi square (test, Goodness of Fit, Independence), Fisher's exact test (8), McNemar test, Sign test for univariate and Bivariate Distributions (8), Wilcoxon Sign Rank Test, Mann-Whitney U test (5), Run test, Median test and Spearman's Rank Correlation test (5). Friedman's two way ANOVA and Concordance, Cochran Q test (5), Kruskal-Wallis test (7)	**Non-parametric tests** Order Statistics and their Distributions (4), Non-Parametric tests; Chi-Square (test, Goodness of Fit, Independence), Fisher's Exact Test (2), McNemar test, Sign test for Univariate and Bivariate Distributions (8), Wilcoxon Sign Rank Test, Mann-Whitney U test (6), Run test, Median test and Spearman's Rank Correlation test (2), Kruskal-Wallis test (6) Friedman's two way ANOVA and Concordance, Cochran Q test (4)
Paper 3: Epidemiological Methods and Research Methodology	Total(48Lecture + 32Practical)/Week
Epidemiological Methods Statistical Methods in Epidemiology of Communicable (10) and Non-Communicable Diseases (10). Methods to Valuate test's Efficacy in Hospital and Community Setup (4). **Research methodology** Concepts and definitions (1), Formulation of objectives (1), Study Designs and Basic Analytical Methods for their Analysis (5), Relevant Sampling Techniques (5), Importance of Sampling Size, Feasibility, drawing conclusions (2), Critical appraisal of Published Articles (2L), Methods of Data Collection (2), Questionnaire Development and Pre-Testing of Questionnaire (2), Internal & External Validity (Accuracy) of Questions (2), Study Designs (2).	**Epidemiological Methods** Statistical Methods in Epidemiology of communicable (4) and Non-Communicable Diseases (4). Methods to Valuate test's Efficacy in Hospital and Community Setup (5). **Research methodology** Formulation of Objectives (2), Study Designs and Basic Analytical Methods for their Analysis (4), Relevant Sampling Techniques(5), Importance of Sampling Size, Feasibility, drawing Conclusions (4), Critical Appraisal of Published Articles (4).

Paper 4: Research – Dissertation-I	**(No Written Examination)**
Writing Synopsis, seminars to finalize Synopses, Preparation of questionnaire, pre-testing and finalizing of Questionnaire, Data Collection	

Epidemiology

1. Siegel, S., Non-Parametric Statistics for Behavioural Sciences, New York, McGraw-Hill,1988
2. Park K., Test Book of Preventive and Social Medicine, Edition 21, 2011.
3. Lilienfed, A.M. and D. Lilienfed, Foundation of epidemiology, 2nd Edition, New York, Oxford Publications, 1979.
4. D.J.Finney (1978): Statistical Methods in Biological Assays, Charles Griffics & Co.
5. A.P. Gore and S.A. Paranjpe (2000): A Course in Mathematical & Statistical Ecology,
6. Kluwer. Z.Govindarajulu (2000): Statistical Techniques in Bioassay, 2nd Edition, S.Karger.
7. D.W.Hosmer & S.Lemeshaw (1989): Applied Logistic Regression Wiley.
8. R.C.Elandt Johnson (1975) : Probability Models & Statistical Methods in Genetics
9. Wiley. C.C.Li (1976): First Course in Population Genetics, Boxwood Press.
10. E.C.Pielou (1977): An Introduction to Mathematical Ecology, John Wiley.

Semester – IV

Paper 1: Statistical Softwares	Total(48Lecture + 32Practical)/Week
Introduction to Computers, Hardware, Softwares (2) **Working with Software Packages** MS-Excel (2), SPSS & R software (4), Python (2) Tabulation and Frequency Tables (2). Bar Graphs, DOT Diagram and Histogram, Stem-and-Leaf Plots, Box Plots (4). **Summary Statistics** Two-way tables and plots (4). Product Moment Correlation Coefficient, Rank Correlation Coefficient (2). **Curve fitting by method of least squares** Exponential and Polynomial (4). Regression Analysis(4), Correlation ratios, Multiple and Partial Correlation Coefficients (4). Regression equations (6). Rank and Inverse of a Matrix Solution of set of Linear Equations (2). Fitting of Binomial, Poisson, Negative Binomial, Normal and Gamma Distributions (6).	**Working with Software Packages** MS-Excel (2), SPSS Classification & R Software (2), Tabulation and Frequency Tables (1). Bar Graphs, DOT Diagram and Histogram, Stem-and-Leaf Plots, Box Plots (4). **Summary Statistics** Two-way tables and plots (1). Product Moment Correlation Coefficient, Rank Correlation Coefficient (1). **Curve fitting by method of least squares** Exponential and Polynomial (3). Regression Analysis(4), Correlation ratios, Multiple and Partial Correlation coefficients (2). Regression equations (4). Rank and Inverse of a matrix Solution of set of linear equations (2). Fitting of Binomial, Poisson, Negative Binomial, Normal and Gamma Distributions (6).
Paper 2: Hospital Data Management and Population Genetics	Total(48Lecture + 32Practical)/Week
Medical Records Management and its Statistical Measures: Indoor and Outdoor Admissions Statistics (4), Bed Occupancy, Average Stay, Bed Turnover Rate (4), Including generating Evidence Based Medicine (EBM), using service data (4). **International Classification of Diseases** Concepts, Certification of Birth and Death, Generation of reports (8), Notifiable Diseases (2) **Population Genetics** Random mating, Genetical Variance and Correlations, Multiple Alleles and Blood types, Maximum Likelihood Method of Estimation, Sex linked Genes, Autopolyploid, Stationary Distributions of Genes Frequency (26).	**Medical Records Management and its Statistical Measures:** Indoor and Outdoor Admissions Statistics (4), Bed Occupancy, Average Stay, Bed Turnover Rate (4), Including generating Evidence Based Medicine (EBM) using service data (2). **International Classification of Diseases** Certification of Birth and Death, Generation of Reports (6), Notifiable Diseases (2) **Population Genetics** Random Mating, Genetical Variance and Correlations, Multiple Alleles and Blood types, Maximum Likelihood Method of Estimation, Sex Linked Genes, Autopolyploid, Stationary Distributions of Genes Frequency (14).
Paper 3rd & 4th: Research – Dissertation-II	**(No written examination)**
Data Cleaning, Analysis, Dissertation Writing, Publication of at least 1 paper.	

Stochastic Processes

References

1. Karlin, S. and Taylor, H. M. (1975). A first course in Stochastic Processes, Academic Press.
2. Hoel, P.mG., Port, S. C. and Stone, C. J. (1991). Introduction to Stochastic Processes, Universal Book Stall.
3. Parzen, E. (1962). Stochastic Processes, Holden-Day.
4. Cinlar, E. (1975). Introduction to Stochastic Processes, Prentice Hall.
5. Adke, S. R. and Manjunath, S. M. (1984). An Introduction to Finite Markov Processes, Wiley Eastern.
6. Medhi, J. (1996). Stochastic Processes, New Age International (P) Ltd.
7. Ross, S. M. (1983). Stochastic Processes, John Wiley.
8. Taylor, H. M. and Karlin,S. (1999). Stochastic Modelling, Academic Press.

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Sufficient number of books is available in the University/ Departmental Library.