



MSc., BIostatISTICS

(SEMESTER PATTERN)

(Under Choice Based Credit System)

PROSPECTUS

REGULATIONS AND SYLLABUS
(Candidates admitted from 2025 onwards)

Preamble

ICMR-National Institute of Epidemiology Vision & Mission

Vision

“To be a catalyst for a vibrant national health system through responsive research, education and training in epidemiology and public health.”

Mission

“To effectively contribute in enhancing the quality of life of Indian citizens and influencing public health practice and policies through research, education and training.”

About MSc., Biostatistics at ICMR-National Institute of Epidemiology, Chennai

The MSc Biostatistics program at the ICMR–National Institute of Epidemiology, Chennai, was established in the year **2016** as part of the institute’s vision to build national capacity in advanced statistical methods for health research. It is offered under the ICMR School of Public Health (ICMR-SPH) and is affiliated with Periyar University, Tamil Nadu.

The program was launched to address the growing need for trained biostatisticians who can contribute to data-driven decision-making in public health and medical research. Over the years, the MSc Biostatistics course has provided students with a strong foundation in statistical theory, epidemiological applications, and modern data analysis techniques.

Supported by ICMR-NIE’s experienced faculty and its strong research ecosystem, the program offers a unique blend of classroom teaching, hands-on statistical computing, and exposure to real-world datasets from national health programs.

With this initiative, ICMR-NIE continues to fulfil its mission of nurturing skilled professionals, contributing to high-quality public health research and evidence-based policymaking in India.

MSc Biostatistics Course

Eligibility criteria

- Bachelor Degree in Statistics
- Any Bachelor Degree with statistics as ancillary /allied subject

MSc. Biostatistics Course structure

- **Two years** programme with **four semesters** under CBCS regulations
- Odd semester **July to November** (90 working days)
- Even semesters **January to May** (90 working days)
- One month (approx) semester break each in December & June
- The duration for **completion of the course** is four semesters. The maximum allowed period for completion is **eight semesters**

- **75% attendance essential**

Any candidate who has failed to obtain the prescribed 75% attendance for valid reasons, on special permission from Director of NIE can be exempted and under any circumstances the exemption should not be granted for attendance **below 65%**.

Requirements for proceeding to subsequent semesters

- Candidates shall register their names for the First semester examination after the admission in the PG courses.
- Candidates shall be permitted to proceed from the First Semester up to the Final Semester irrespective of their failure in any of the Semester examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subject) Semester subjects.

Choice Based Credit System (CBCS) Regulations

Credit refers to describe the quantum of syllabus in terms of hours of study. It indicates differential weight-age given according to the contents & duration of the courses in the curriculum design.

Core Courses are compulsory subjects offered.

Elective Courses are courses offered by NIE

Supportive courses are of intermediary & introductory level in nature; aimed at bridging the gap in the curricula; Enabling improvement skills in computation & communication.

Human Rights is a compulsory credit course offered in the III semester.

The course is designed under lectures / practical work / Journal review/ Seminars / dissertation work / viva-voce.

Application procedure

Online application - advertised thro NIE & ICMR website

Application submission fee of Rs 1000/-drawn in favour of **Director NIE**

Course fee Rs 60,000 for four semesters (non refundable)Examination

fees as University norms

Method of Selection

- Review/Scrutiny of application form
- Written test/ personal interview

Reservation of seats and concession for SC /ST/ differently abled student as per Periyar University norms.

Written test/ personal interview will be held at NIE

Course Subjects

1. No. of Core papers:	13
Practicals:	3
(Including Journal review/seminar)	
2. Elective courses:	2 out of 4
3. Supportive courses:	2 out of 4
4. Dissertation/project work:	1
Total	21

Fee Structure for MSc. Biostatistics Studies

S.No	Particulars	I st year (Rupees)	II nd year (Rupees)
1.	Admission fee	1000	
2.	Registration fee	2000	
3.	Tuition fee	15000	15000
4.	Library fee	1000	1000
5.	Development of infrastructural facilities	2000	2000
6.	Internet/ Bar coded IdentityCard /Calendar/Magazine	500	500
7.	Laboratory fee	4500	4500
8.	Computer facilities	4000	4000
9.	Dissertation evaluation fee	-	3000
	Total	Rs.30,000	Rs.30,000
	Grand total	Rs. 60000	

Accommodation

On-campus limited hostel accommodation is available. Allotment will be based on the first come first served basis.

MSc BIOSTATISTICS FRAME WORK

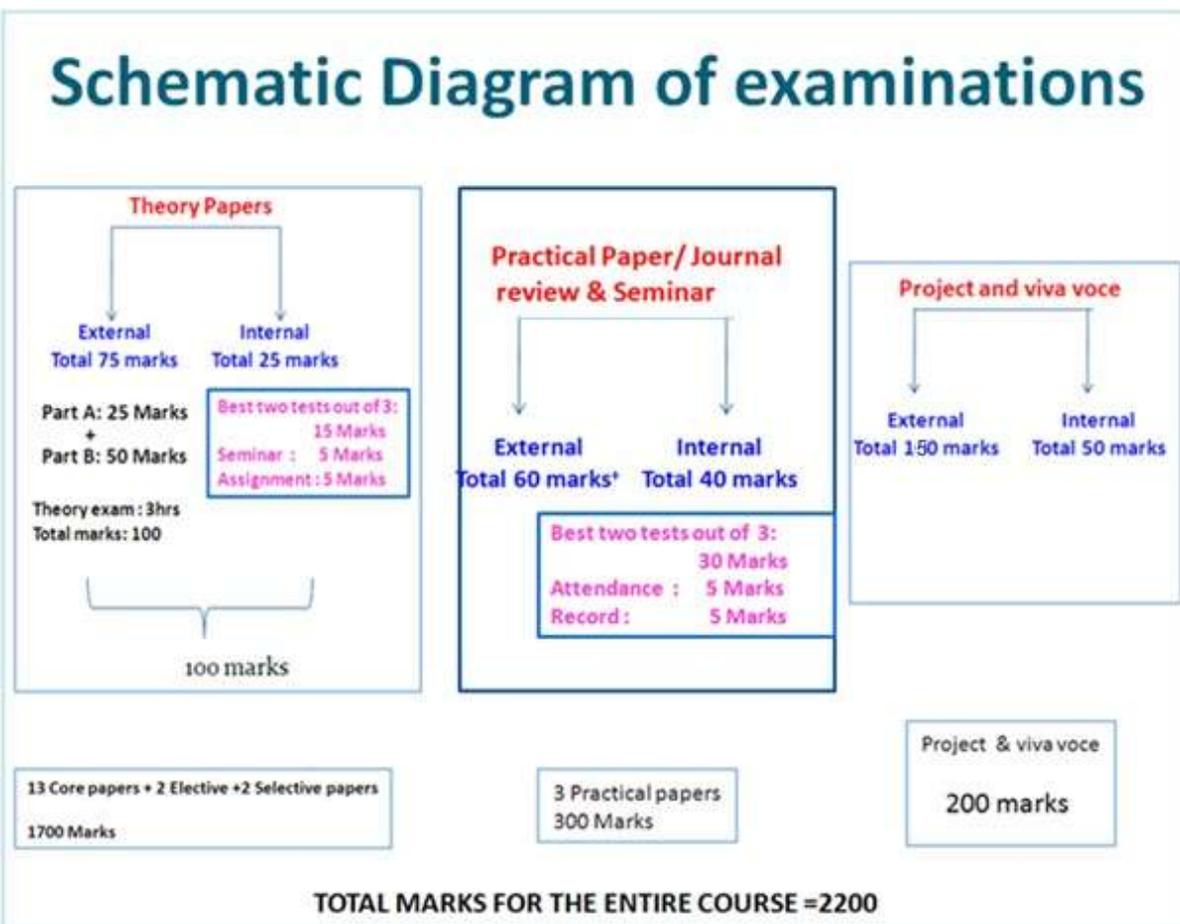
Subject Code Semester -I	Title of the Paper	Weekly Contact Hours	Credits	Internal Marks	External Marks	Total Marks
25MBSC01	Probability and Distribution Theory	5	5	25	75	100
25MBSC02	Statistical Inference I – Estimation	5	5	25	75	100
25MBSC03	Epidemiology	5	5	25	75	100
25MBSC04	Sampling methods and Sample Size determination	5	5	25	75	100
25MBSCP01	Practical I - Statistical Data Analysis – I using R/SAS/SPSS/STATA	6	3	40	60	100
25MBSE01	Elective-I	4	4	25	75	100
	Total	30	27	165	435	600
Semester -II						
25MBSC05	Population Studies	4	4	25	75	100
25MBSC06	Statistical Inference II – Testing of Hypotheses	4	4	25	75	100
25MBSC07	Longitudinal Data Analysis	4	4	25	75	100
25MBSC08	Linear Models and Regression Analysis	4	4	25	75	100
25MBSCP02	Practical II - Statistical Data Analysis – II using R/SAS/SPSS/STATA	6	3	40	60	100
25MBSS01	Supportive I	4	4	25	75	100
25MBSE02	Elective-II	4	4	25	75	100
	Total	30	27	190	510	700
Semester-III						
25MBSC09	Categorical Data Analysis	4	4	25	75	100
25MBSC10	Time Series and Survival analysis	4	4	25	75	100
25MBSC11	Multivariate Analysis	4	4	25	75	100
25MBSC12	Clinical Trials	5	5	25	75	100
25MBSC13	Human Rights	3	3	25	75	100
25MBSS02	Supportive II	4	4	25	75	100
25MBSCP03	Practical III - Statistical Data Analysis – III using R/SAS/SPSS/STATA	6	3	40	60	100
	Total	30	27	190	510	700
Semester-IV						
25MBSPR01	Internship - Dissertation & Viva voce	30	11	50	150	200
	Total	30	11	50	150	200
CUMULATIVE TOTAL		120	92	545	1555	2200
Total weekly contact hours :120			Total number of credits:92			

Elective courses

Elective Subject Code	Title of the Paper
25MBSE01	Data Management
25MBSE02	Spatial Statistics
25MBSE03	Health informatics
25MBSE04	Bayesian Statistics

Supportive courses

Supportive Subject Code	Title of the Paper
25MBSS01	Scientific communication
25MBSS02	Health Systems
25MBSS03	Health Economics
25MBSS04	Field Epidemiology



Grading System

The term Grading system indicates a seven-point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class as given below.

Marks & grades

RANGE OF MARKS	GRADE POINTS	LETTER GRADE	DESCRIPTION
90 – 100	9.0 – 10.0	O	OUTSTANDING
80 – 89	8.0 – 8.9	D+	EXCELLENT
75 – 79	7.5 – 7.9	D	DISTINCTION
70 – 74	7.0 – 7.4	A+	VERY GOOD
60 – 69	6.0 – 6.9	A	GOOD
50 – 59	5.0 – 5.9	B	AVERAGE
00 – 49	0.0	U	RE-APPEAR
ABSENT	0.0	AAA	ABSENT

Course Competencies

- Develop an efficient design for collecting, recording, and storing non spatial & spatial data collected in the conduct of public health and medical research.
- Develop sample size and statistical power calculations for basic study designs including those utilized in clinical trials.
- Produce edited data sets suitable for statistical analyses.
- Perform analyses of stated hypotheses using a variety of analytical tools including analysis of variance, multiple regression, nonparametric statistics, logistic regression, multivariate analyses, spatial data analysis and methods for analyzing rates and failure time data.
- Interpret results of advanced statistical analyses and use these results to make relevant inferences from data.
- Develop written presentations based on intermediate to advanced statistical analyses for both public health professionals and educated lay audiences.
- Develop oral presentations based on intermediate to advanced statistical analyses for both public health professionals and educated lay audiences.

MSc., BIOSTATISTICS CURRICULUM

Probability and Distribution Theory

Unit 1

Types of data

- Qualitative and quantitative data
- Cross sectional and time series data
- Discrete and continuous data
- Nominal, ordinal, ratio and interval scales

Presentation of Data

- Frequency distribution and cumulative frequency distribution
- Diagrammatic and graphical presentation of data
- Construction of bar, pie diagrams, histograms, Box-Whiskers plots, frequency polygon, frequency curve and ogives

Unit 2

Measures of central tendency

- Mean
- Median
- Mode

Measures of Dispersion

- Concept of dispersion, characteristics for an ideal measure of dispersion. Absolute and relative measures based on
- Range, inter quartile range, quartile deviation
- Coefficient of quartile deviation
- Mean deviation, coefficient of mean deviation
- Standard deviation (σ), coefficient of variation
- Properties of these measures.

Moments, Skewness and Kurtosis

- Moments about mean and about any point
- Derivation of their relationships
- Effect of change of origin and scale on moments
- Coefficients of Skewness and Kurtosis with their interpretations.

Unit 3

Probability Theory

Random experiment/trial

- Sample point, sample space, operation of events
- Exhaustive, equally likely and independent events
- Definition of probability-classical, relative frequency
- Statistical and axiomatic approach, conditional probability
- Addition & multiplication laws of probability

Random Variable and Probability Functions

- Definition of random variable,
- Discrete and continuous random variable,
- Probability function,
- Probability mass function
- Probability density functions, distribution function and its properties
- Functions of random variables
- Joint, marginal and conditional probability distribution function

Unit 4

Mathematical Expectation and Generating Functions

- Definition and its properties-moments, addition and multiplication theorem of expectation. Conditional expectation and conditional variance.
- Moments generating function, cumulant generating function, probability generating function along with their properties.

Unit 5

Distribution Theory

Discrete Probability Distributions

- Bernoulli distribution
- Binomial distribution
- Poisson distribution
- Geometric
- Negative Binomial distribution
- Hypergeometric

Continuous Probability Distributions

- Uniform distribution
- Normal distribution and Standard Normal distribution
- Exponential distribution
- Lognormal
- Chi-square distribution

- t - distribution
- F – distribution
- Gamma distribution
- Beta distribution

BOOKS RECOMMENDED

1. Goon A.M., Gupta M. K., Dasgupta B (2008): Fundamentals of Statistics, Published by Prentice Hall, 2nd edition.
2. Gupta S.C.& Kapoor V.K, (2000): Fundamentals of & Mathematical Statistics, Sultan Chand Sons 10th edition.
3. Croxton F.E., Cowden D.J. & Kelin S, (1967): Applied General Statistics, Prentice Hall.
4. Hogg and Craig, Introduction to Mathematical Statistics, (2013): Prentice Hall, 7th edition.
5. Steel and J H Torrie, Principles and procedures of statistics, (2007): McGrawHill, 2nd edition.

BOOKS FOR READING (FREE e-BOOKS)

1. <http://www.e-booksdirectory.com/listing.php?category=15>
2. <http://www.analyticsvidhya.com/blog/2016/02/free-read-books-statistics-mathematics-data-science/>

Statistical Inference I – Estimation**Unit 1****Introduction of statistical Inference**

- Basic Concepts: Parameter, Random sample
- Sampling distributions - Marginal and Joint distributions
- Types of estimation: Point and Interval estimation
- Bias of an estimate
- Knowledge and concept of standard errors - Mean, Proportion, Standard deviation

Unit 2**Point Estimation**

- Properties of a good estimator: Unbiased, sufficiency, efficiency and consistency

Concept and application of:

- MVUE, BLUE
- Cramer-Rao's inequality
- Battarcharya inequality
- Chapmen Robbins inequality
- CAN Estimator
- RAO Blackwell theorem
- Fisher's information

Unit 3**Methods of Estimation**

- Method of moments
- Method of maximum likelihood and its properties
- Method of minimum Chi-square
- Methods of least squares

Unit 4**Interval Estimation**

- Concepts of Interval estimation
- Confidence Interval for attributes
- Confidence Interval for small samples (t,f, χ^2 ,distributions)
- Confidence Interval for large samples

Unit 5**Bayesian Inference**

- Concept of Bayesian inference
- Bayes Theorem
- Prior, Likelihood and posterior distributions

- Credible interval
- Comparison of frequentist and Bayesian inference

BOOKS RECOMMENDED

1. Daniel, W. W (2005): Biostatistics- A foundation for analysis in the HealthSciences, John Wiley & Sons, 7th edition.
2. Hogg, R. V., McKean, J. W. and Craig, A. T. (2006): Introduction to Mathematical Statistics, 6th edition, Pearson Education.
3. Rohatgi, V.K. and Saleh, A.K.(2001): An Introduction to Probability and Statistics, John Wiley & Sons. (Chapter 8, Section 8.1 through 8.8)

BOOKS FOR REFERENCE

1. Gupta, SC and Kapoor, V.K. (2015): Fundamentals of Mathematical Statistics, 12th Revised Edition
2. Lehmann, E.L and Casella, G. (2006): The theory of point estimation, 2nd Edition
3. Rohatgi, V. K (2003): Statistical Inference
4. Rajagobalan, M. and Dhanavanthan, P. (2012): Statistical Inference
5. Zacks, S. (1971): The theory of Statistical Inference

Epidemiology

Unit 1 Introduction to Epidemiology

- What is epidemiology?
- Definition, scope, and uses of epidemiology
- The historical context Origins

Unit 2 Measures of disease and death frequency

- Concept of health and disease
- Morbidity measures:
 - Incidence proportion and Incidence density
 - Prevalence
 - Relationship between Incidence and Prevalence
- Mortality measures
 - Mortality rates
 - Infant mortality
 - Child mortality rate
 - Maternal mortality rate
 - Adult mortality rate
 - Case fatality
 - Proportionate mortality
 - Years of potential life lost
- Age-standardized rates (Direct and Indirect standardization)
- Life expectancy
- Disability measures
- Concept of surveillance
- Validity of diagnostic and screening tests

Unit 3 Measures of Association and Effect

- Relative risk (RR)
- Odds ratio (OR)
- Attributable risk and Population Attributable Risk (PAR)

Unit 4 Types of epidemiological studies

1. Types of study designs - overview

2. Ecological studies
3. Cross-sectional studies
4. Case-control studies
5. Cohort studies
6. Experimental studies

Unit 5 Threats of validity and interpretation in epidemiological studies

- Selection bias
- Measurement bias
- Confounding
- Effect Measure Modification
- Random error

BOOKS RECOMMENDED:

1. R Bonita, R Beaglehole. T Kjellström, (2006): Basic Epidemiology 2nd Edition.
http://apps.who.int/iris/bitstream/10665/43541/1/9241547073_eng.pdf
2. Dicker, Richard, (2006): Principles of Epidemiology in Public Health Practice, 3rd edition. <http://www.cdc.gov/ophss/csels/dsepd/ss1978/ss1978.pdf>
3. Altman D G, (2006): Practical Statistics for Medical Research, London: Chapman and Hall, 2nd edition.
4. Leon Gordis M, (2004): Epidemiology, NA Saunders Company, 3rd edition.

BOOKS FOR READING

1. RC Brownson and DB Petittis (1998): Applied Epidemiology: Theory to Practice. Oxford University Press, 2nd edition.
2. SM Teutsch and RE Churchill (1994): Principles and Practice of Public Health Surveillance. Oxford University Press, 2nd edition.
3. CDC's Morbidity and Mortality Weekly Reports (MMWR) .[Http://www2.cdc.gov/mmwr](http://www2.cdc.gov/mmwr)

Sampling Methods and Sample Size determination

Unit 1

Introduction

- Population vs sample
- Sample frame, sampling unit, sampling error
- Precision & bias – representativeness
- Advantages of sampling method
- Some uses of sample surveys
- The principal steps in a sample survey
- The role of sampling theory
- Probability sampling
- Non-Probability sampling: Convenient sampling, Purposive sampling, Snow ball sampling, Response driven sampling
- Alternatives to Probability sampling, Use of normal distribution, Bias and its effects, The mean square error

Unit 2

Simple random sampling

- Simple random sampling, Selection of simple random sample, definitions and notation, properties of the estimate, variance of the estimates
- The finite population correction, Estimation of the standard error from a sample, confidence limits
- Random sampling with replacement
- Estimation of a ratio, Estimates of means over subpopulations, Estimates of totals over subpopulations
- Comparisons between domain means, Validity of the normal approximation, Linear estimators of the population mean

Unit 3

Stratified random and Systematic sampling

- Description, Notation, Optimum allocation
- Estimation of sample size with continuous data, proportions
- Relative precision of stratified and simple random sampling

- Systematic sampling relative to cluster sampling
- Comparison of Systematic with stratified random sampling
- Stratified systematic sampling

Unit 4 Cluster sampling & Multistage sampling

- Complex survey sampling
- Design effect
- Weighting in sample surveys
- Finite population correction, response rate and non-response bias
- Reasons for cluster sampling, A simple rule
- Cluster sampling for proportions
- Cluster Units of unequal size
- Sampling with probability proportional to size
- Selection with unequal probabilities with replacement
- Probability proportional to its size measure

Unit 5 Sample size estimation

- A hypothetical example, Analysis of the problem, The specification of precision
- The formula for n in Sampling for proportions, Rare items- Inverse sampling, The formula for n with continuous data
- Advance estimates of population variances, Sample size with more than one item
- Sample size when estimates are wanted for subdivisions of the population
- Sample size in decision problems
- The design effect
- Sample size determination for cohort, case-control, and cross-sectional designs

BOOKS RECOMMENDED

1. William G. Cochran, (1997): Sampling Techniques, , John Wiley & sons 3rd edition.

2. Murthy M N (2012): Sampling Theory and methods, Statistical publishing Society, Calcutta 2nd edition.
3. Levy PS, Lemeshow S (1999): *Sampling of Populations: Methods and Applications*, New York: Wiley Interscience, 3rd edition.
4. Lohr SL (2009): *Sampling: Design and Analysis*. Duxbury Press, 2nd edition.
5. Wayne Fuller (2009): *Sampling Statistics*, Wiley, 1st edition.

BOOKS FOR REFERENCE

1. *Foundations of Inference in Survey Sampling* (1997), Cassel, C.M., Sarndal, C.E. and Wretman, John Wiley & Sons, 2nd edition.
2. Floyd J. Fowler (1995), *Improving Survey Questions: Design and Evaluation*, Sage Publications, 2nd edition.

Population Studies

Unit 1

Introduction to Demography

- Definition of Demographic, Nature and Scope of Demographic and
- uses of Demographic data
- Source of vital statistics: census method; Salient feature and uses
- Sources of Demography Data: Civil registration system,
- Secondary sources – SRS – Surveys
- Demography transition.

Unit 2

Measures of Mortality and

Fertility

- Nature and Uses of Mortality Statistics
- Mortality measures: Merits and demerits of Crude Death Rate (CDR) and Age-Specific Death Rates, Infant Mortality Rate (IMR)
- Maternal Mortality Rate and Ratios
- Basic terms and concepts used in the study of fertility
- Measures of fertility: Crude Birth Rate, Age specific fertility rate, General fertility rate, Total fertility rate, Gross reproductive rate and Net reproductive rate, Order-specific fertility rates.
- Life table and Abridged life table concepts

Unit 3

Standardization & Population distribution

- Need and importance of standardization
- Direct and indirect technique of standardization of rates and ratios in the light of mortality
- Decomposition of Infant mortality rate and its sub-divisions
- Population density, Dependence ratio, labour force.
- Population pyramid – type of population pyramid and draw pyramid, sex ratio.

Unit 4

Population classification and indices of dissimilarity

- Population classification - Urban-Rural International Standard definitions.
- Urbanization, Factor responsible for urbanization.
- Rank size Rule for growth pattern
- Index of dissimilarity, Theil's index, Isolation index, Clustering
- Gini Concentration Ratio and Lorenz Curve

Unit 5 Mobility, Migration and Population projection

- Concept of mobility and Migration
- Types of migration, internal migration patterns and characteristics in developing countries.
- Measures of migration Balancing equation.
- Population Projection: Type of population projection, Arithmetic growth, geometric growth and exponential growth.

BOOKS RECOMMENDED

1. Goon A.M., Gupta M. K., Dasgupta B (2008): Fundamentals of Statistics, Published by Prentice Hall, 2nd edition.
2. Gupta S.C.& Kapoor V.K, (2000): Fundamentals of & Mathematical Statistics, Sultan Chand Sons 10th edition.
3. Pathak, K.B. and F.Ram, (1998): Techniques of Demographic Analysis, Mumbai, Himalaya Publishing House, Chapter 4
4. Jacob S. Siegel, David A. Swanson (2004): The methods and Materials of Demography, Elsevier Inc.

BOOKS FOR REFERENCE:

1. Hinde, Andrew (1998), Demographic Methods, London: Edward Arnold, 1st edition.
2. Asha A. Bhende ,Tara kanitkar (1999): Himalaya Publishing House Pvt Ltd, 12th Edition.
3. Keyfitz, (1985): Applied mathematical Demography, Springer-

Verlag, New York, 2nd edition.

4. Shrivastava, O.S. (1995): Demography and population Studies, Vikas Publishinghouse private limited, 2nd edition.

Statistical Inference II – Testing of Hypotheses**Unit 1****Introduction**

- Definition and concepts of Hypothesis testing
- Critical region
- Types of errors
- Size and Power of the test
- Randomised and Non randomised tests
- Interpretation and importance P value
- Steps for conducting hypothesis testing

Unit 2**Hypothesis Testing**

- Concept of Most powerful and uniformly most powerful test
- Likelihood ratio test
- Neyman - Pearson lemma and its application
- Testing of hypothesis based on Binomial, Poisson, Exponential and Normal distributions

Unit 3**Small and Large Sample Tests**

- Small and large sample tests for single mean, proportion, variance
- Small and large sample tests for two means, proportions, variances
- Test for correlation coefficient
- Fishers Z transformation

Unit 4**Non parametric Tests**

- Concepts of nonparametric tests
- Wald Wolfowitz run test
- Median test/ Mann Whitney U test
- Wilcoxon signed rank tests
- Kolmogrov - Smirnov tests
- Kruskal Wallis test
- Friedman test
- Chi square test - Goodness of fit, chi square test for independence, trend chi square, McNemar's chi square test
- Measures of Agreement: Kappa, ICC, Bland Altman

Unit 5**Sequential Probability Ratio Test (SPRT)**

- Sequential methods
- SPRT – definition and concepts
- Properties of SPRT
- Applications of SPRT
- Operating characteristic (OC) and Average sample number(ASN) functions

BOOKS RECOMMENDED

1. Conover, W. J. (2006): Practical Non- parametric Methods in Statistics, 2ndedition, (Unit 5).
2. Daniel, W.W. (2006): Biostatistics: A foundation for analysis in the HealthSciences, John Wiley & Sons, 7th edition (Unit 5).
3. Rohatgi,V.K. (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern, 3rd edition (Chapter 14-14.5 for SPRT).
4. Rohatgi, V.K. and Saleh, A.K. (2001): An Introduction to Probability and Statistics,John Wiley & Sons, 3rd edition (Chapters 8 - 8.3, 9, 10- 10.1,10.2,10.6, 11 - 11.3).

BOOKS FOR REFERENCE:

1. Gupta S.C. and Kapoor V. K. (2008): Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 12th Revised Edition
2. Kale, B. K. (1999): A first course on parametric inference, Alpha Science International Ltd; 2nd edition
3. Lehmann, E. L. (1986): The theory of Statistical hypothesis, 4th Edition
4. Rohatgi, V. K. (2003): Statistical Inference, Dover Publications Inc
5. Rajagobalan, M. and Dhanavanthan, P. (2012): Statistical Inference, PHI Learning
6. Zacks, S. (1971): The theory of Statistical Inference
7. Gibbons. (1985): Non Parametric Statistical Inference, Chapman and Hall/CRC, 6th Edition

Longitudinal Data Analysis

Unit 1 Analysis of Variance

- Analysis of variance(ANOVA): One Way, Two Way & generalization
- Single factor ANOVA
- Two-factor ANOVA with unequal and equal replication (with/without interactions)
- Multiple comparison tests-Tukey, Newman-Keul, Scheffe tests

Unit 2 Designs of Experiments

- Principals of Designs of Experiments
- Completely Randomized Designs (CRD)
- Randomized Block Designs (RBD)
- Latin Square Designs (LSD)
- Factorial Designs ($2^2, 3^2$)
- ANCOVA (for CRD and RBD)

Unit 3 Repeated measures analysis and mixed models

- Difference between cross-sectional, time-series, longitudinal and clustered data
- Exploratory data analysis for longitudinal data
- Repeated measures ANOVA
- Linear mixed effect model: fixed effects and random effects

Unit 4 Generalized Estimating Equations (GEE) and Marginal Models

- Introduction to Generalized Estimating Equations (GEE)
- Marginal models for longitudinal data
- Estimation of GEE parameters
- Correlation structures in GEE: Exchangeable, independent and unstructured
- Missing data: mechanisms and analysis approaches

Unit 5 Bioassay

- Introduction - Direct assays: the nature of direct assays, precision of estimates and the design of direct assays.
- Dose Response Relations: Indirect assays, the dose response regression
- Standard curve estimation, slope estimation, and simultaneous trial

BOOKS RECOMMENDED

1. Das, M.N. and Giri N.C. (2006): Design and Analysis of Experiments Delhi. NewAge International (P) Ltd., New, 2nd edition.
2. Montgomery D.C (2006): Design and Analysis of Experiments, Wiley India 5thEdition.
3. Garrett Fitzmurice, Nan Laird, James Ware (2011): Applied Longitudinal Analysis, 2nd Edition.
4. Zar, J.H. (2007): Biostatistical Analysis, Pearson Education 4th edition.
5. Govindarajulu, Z. (2000): Statistical techniques in Bioassay, Thomson Duxbury, 2nd edition.

BOOKS FOR REFERENCE

1. Morrison, 91990): Multivariate Statistical Methods, McGraw-Hill, 3rd edition.
2. Johnson, R.A. and Wichern, D.W. Applied Multivariate Statistical Analysis, Pearson Education, Asia 5th edition.
3. Agresti, A. (2002): Categorical data analysis, John Wiley & Sons, 3rd edition.

Linear Models and Regression Analysis

Unit 1 Simple linear regression

- Assumptions and Estimation of model parameters
- Standard error of estimators
- Testing of hypotheses on slope and intercept (β 's)
- Coefficient of determination (R^2)

Unit 2 Multiple linear regressions

- Least square estimation of model parameters
- Variance covariance of least squares estimators
- Estimation of error variance
- Tests of hypotheses of regression parameters
Significance of regression (ANOVA, R^2 and adjusted R^2)
- Regression with Dummy variables- Concepts and application
- Model Diagnostics

Unit 3 General linear Models (GLM)

- Introduction - Gauss Markov Setup
- Assumptions - Homoscedasticity & Heteroscedasticity
- Multicollinearity and its solutions
- Autocorrelation - Durbin – Watson test
- Variance stabilizing transformations to linearize the model
- Analytical methods for selecting a transform
- Detection of influential observation – cook's statistics, DFFITS, DFBETAS, Residual analysis & plots

Unit 4 Variable Selection

- Selection of Variables – forward selection, backward elimination and stepwise regression (algorithms only)
- Weighted least squares
- Concept of the log-likelihood and the likelihood ratio test ($-2 \log L$)
- Information Criteria: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), Deviance Information Criteria (DIC)

Unit 5 Advanced Regression techniques

- Nonlinear regression – transformation to a linear model, Usefulness, Limitations
- Polynomial Regression
- Ridge Regression: Introduction, estimation of shrinkage parameter, and practical applications.
- LASSO Regression: Concept of sparsity, comparison with Ridge, and interpretation.
- Trade – off between Bias and Variance in regularization
- Use of Re – sampling Procedures in regression

BOOKS RECOMMENDED

1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction to Linear regression analysis, John Wiley and Sons, Inc. 3rd edition Chapters 2, 3, 4, 5, 6, 8 (8.1,8.2), 9, 10, 12 (12.1,12.3,12.4), 14 (14.1.2).
2. Zar, J.H. (2006): Biostatistical Analysis, Pearson education, 4th edition Chapter 18 (18.1, 18.2,18.4,18.5).

BOOKS FOR REFERENCE

1. Draper, N.R. and Smith, H. (2003): Applied Regression Analysis, John Wiley and Sons, Inc. 3rd edition.
2. Johnston, J. (1984): Econometric methods, McGraw Hill International, 3rd edition.

Categorical Data Analysis

Unit 1 Contingency table analysis

- Introduction - Nature of Categorical data - Statistical inference for a proportion
- Contingency Tables and their distribution: Binomial and Multinomial sampling
- Table structure comparing proportions - Comparing proportions in two-by-two tables: Difference of proportions
- Relative risk - Odds Ratio - Properties of Odds Ratio - relationship between Odds Ratio and Relative Risk

Unit 2 Measures of Association

- Nominal and Ordinal Measures of Association - Inference for Contingency tables: Interval estimation for difference of proportions, odds ratio, log odds ratio and relative risk
- Testing Independence in Two-Way tables: Pearson and Likelihood-ratio chi-square tests - Yate's correction for continuity-Residuals for cells in a contingency table-Partitioning chi-squared
- Trend tests for 2 x J tables - Testing Independence for Ordinal Data-Fisher Exact Test for 2 x 2 tables - Exact Inference for small samples - Association in Three-Way Tables: Partial Tables - Marginal and conditional and Odds Ratios - Homogeneous Association - Cochran-Mantel-Haenszel methods
- Models for Matched pair: McNemar test for Binary and their related models
- The Intraclass correlation for Binary and continuous and Cronbach's Alpha test

Unit 3 Generalized Linear Models

Binary Data

- Logit models for Binary data-Binomial GLM for 2 x 2 contingency tables
- Logistic regression: Interpreting logistic regression - Inference for logistic regression
- Probit regression
- Maximum likelihood estimate - test of overall regression and goodness of fit
- Deviance statistic, Wald test, LR test, Score test-Logistic regression diagnostics

- Multiple variable Logistic Regression
- Alternative Models for Ordinal Responses:
Conditional Logistic Regression for Matched- pairs and Logistic Regression for Matched Case- control studies

Unit 4 Logit models for multinomial responses

- Nominal Responses: Baseline-Category Logit Model
- Ordinal Responses: Cumulative Logit Models
- Ordinal Responses: Cumulative Link Models
- Random effect: Generalized Linear Mixed Models
The Generalized Linear Mixed Model (GLMM), Random effects models for Binary Data and Multilevel (Hierarchical) Models

Unit 5 Loglinear models for contingency tables

- Loglinear Models for Two-Way Tables
- Loglinear Models for Independence and Interaction in
Three-Way Tables
- Inference for Loglinear Models
- Loglinear Models for Higher Dimensions

BOOKS RECOMMENDED

1. Agresti, A. (2002): Categorical data analysis, John Wiley & Sons, 3rd edition.
2. McCullagh, P. and Nelder, J.A. (1991): Generalized Linear Models, Chapman and hall, London, 2nd edition.
3. Draper NR and Smith H (1981): Applied Regression Analysis, John Wiley & Sons, 3rd edition.
4. Hosmer D., Lemeshow S., Sturdivant RX. Applied Logistic Regression, ISBN-13: 978-0470582473 ISBN-10: 0470582472, 3rd edition.

BOOKS FOR REFERENCE

1. Agresti, A. (1991): An Introduction to Categorical data analysis, John Wiley & Sons, 2nd edition.
2. Armitage, P. and Berry, G. (1987): Statistical methods in Medical Research, Blackwell Scientific Publications, USA, 3rd edition.
3. Deshpande, J.V., Gore, A.P. and Shanubhogue, A. (1995): Statistical Analysis of

- NonNormal Data, New Age International Publishers Ltd., New Delhi, 1st edition.
4. Hardin, J.W., and Hilbe, J.M. (1994): Generalized Estimating Equation, Chapman andHall, London, 2nd edition.
 5. Hosmer, D.W. and Lemeshow, S.(1989): Applied Logistic Regression, John Wiley & Sons Inc, 2nd edition.

Time Series and Survival analysis

Unit 1

Introduction and definition of time series analysis

- Components of time series, Trend, seasonal variations, cyclic variations, irregular component
- Method of curve fitting by principle of least squares
- Moving average method
- Analysis of seasonal fluctuations
- Construction of seasonal indices using method of simple averages
- Ratio to trend method
- Ratio to moving average method.

Unit 2

Stationary and Nonstationary Time series Models

- Auto correlation function (ACF), Partial Auto correlation function (PACF), Autoregressive (AR) Processes, Moving Average (MA) Processes, ARMA Processes, ARIMA Processes, Seasonal ARIMA Models
- Fitting Models to Data: Model identification, Parameter estimation, Model diagnostics and model selection
- Forecasting: Point estimates for forecasts, forecast errors, forecast intervals

Unit 3

Introduction and terminology used in Survival analysis

- Survival functions- Concept of Time and event
- Censoring mechanism and truncations
- Order and Random Censoring
- Survival, hazard and density functions
- Survival Function Calculation Using Actuarial Life Table Method
- Mean and median residual life and their elementary properties
- Shapes of hazard and survival functions: Exponential, Gamma, Weibull, Lognormal

Unit 4

Kaplan Meier Survival curves and comparison of survival curves

- Point estimation, Confidence Intervals, Scores, tests based on maximum likelihood estimation
- Kaplan Meier methods -Estimation of the hazard and survivor functions
- Kaplan-Meier life table and product-limit methods
- Log rank test, Gehan Test, Mantel Haenzel Test, Tarone - Ware tests, Efron tests

Unit 5 Regression Analysis

- Cox's proportional hazard model
- Evaluating Proportional Hazards assumption
- Residuals and model diagnostics
- Time dependent covariate model
- Stratified Cox analysis

BOOKS RECOMMENDED

1. Montgomery, D.C., Jennings, C.L. and Kulachi, M. (2008) Introduction to Time Series Analysis and Forecasting. WileyBlackwell, New Jersey.
2. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction to Linear regression analysis, third edition, John Wiley and Sons, Inc.
3. Draper, N.R. and Smith, H. (2000) : Applied Regression Analysis, 2nd edition, John Wiley & Sons.
4. Spyros Makridakis, Steven C. Wheelwright and Victor E. McGee (2012), Forecasting Methods and Applications – Second Edition, John Wiley & Sons.
5. T.M.J.A.Cooray(2008): Applied Time Series Analysis and Forecasting, NAROSApublishing house Pvt.Ltd
6. Box, G.E., Jenkins, G.M. and Reinsel, G.C. (2013) Time Series Analysis: Forecasting and Control. 4th Edition, John Wiley & Sons, Hoboken, 746 p.
7. Cowpertwait, P.S.P. and A.V. Metcalfe (2009). Introductory Time Series with R. Springer --Verlag, New York.
8. Shumway, R.H. and D.S. Stoffer (2010). Time Series Analysis and Its Applications, with R Examples, 3rd ed., Springer--Verlag, New York.
9. Lee ET, Statistical Methods for Survival Data Analysis, 1992, John Wiley & Sons.
10. Hosmer DW and Lemeshow S, Applied Survival Analysis: Regression Modeling of Time to Event Data, 1999, John Wiley & sons.
11. Kleinbaum DG and Klein M. Survival Analysis: A self-learning text, 2nd edition, 2005, Springer science & business media Inc.

BOOKS FOR REFERENCE

1. Barlow, R. E. and Proschan, F. (1975): Statistical Theory of Reliability and Life testing,Holt, Rinehart and Winston, New York, 2nd edition.

2. Johnson, E.R.E. and Johnson, N.L. (1980): Survival models and Data Analysis, JohnWiley and Sons, 3rd edition.
3. Lee, C.T. (1997): Applied survival analysis, John Wiley, 2nd edition.
4. Croxton F.E., Cowden D.J. & Kelin S (1973): Applied General Statistics, Prentice Hall, 1st edition.
5. Johnson RA and Wichern DW (1984): Applied Multivariate Statistical Analysis, JohnWiley & sons, 2nd edition.

Multivariate Analysis

Unit 1

Multivariate Normal Distribution

- Definition, mean vector, variance-covariance matrix, properties (Distribution of the sample mean vector, Sample dispersion matrix, Partial and multiple correlation coefficients)
- Maximum likelihood estimators for mean vector, variance- covariance matrix
- Null distribution, Hotelling's T^2 statistic, Generalized T^2 statistic, Mahalanobis D^2 statistic, Wishart distribution: Application for single and multiple populations,
- Tests of hypotheses concerning mean vector, variance- covariance matrix (one sample and two sample problems)

Unit 2

Principal component analysis

- Extraction of components - characteristics and properties of components
- Total variation, relative importance, standardization
- Covariance structures - interpretation of principal components
- Introduction to factor analysis
- Orthogonal factor model
- Estimation by maximum likelihood
- Principal component methods
- Factor scores - factor rotation
- Canonical correction analysis

Unit 3

Classification and discrimination

- Classification problem
- Standards of good classification
- Procedures of classification into one of two populations with known probability distributions
- Evaluation of classification function
- Fisher's linear discriminant function - Classification and discrimination procedure for discrimination between two multivariate normal population, test associated with discriminant function, probabilities of misclassification and their estimates

Unit 4

Cluster analysis

- Distance and similarity measures

- Agglomerative methods
- Single linkage
- Average linkage
- Complete linkage methods

Hierarchical clustering methods

- Introduction to Hierarchical clustering methods
- Non-hierarchical clustering methods
- Advantage and disadvantage of Hierarchical clustering methods
- K means method.

Unit 5

Supervised Learning

Concept and application of:

- Decision tree
- Random forest
- Classification and Regression tree(CART)
- K- Nearest Neighbor(KNN)
- Support Vector Machine (SVM)

BOOKS RECOMMENDED

1. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Statistical Analysis, Pearson Education, Asia, 6th edition.
2. Morrison (1990): Multivariate Statistical Methods, McGraw-Hill,.
3. Allen Agresti (1990) Categorical data analysis, 2nd edition.

BOOKS FOR REFERENCE

1. Anderson, T. W. (2003): An Introduction to Multivariate Statistical Analysis, , JohnWiley & Sons, 3rd edition
2. Hair, J.F., Anderson, R.E., Tatham. R.L. and Black, W.C. (2006): Multivariate DataAnalysis, Pearson Education, Asia, 5th edition
3. Anderson, T.W.2009. An Introduction to Multivariate Statistical Analysis, 3rd Edition, John Wiley.
4. Everitt B, Hothorn T, 2011. An Introduction to Applied Multivariate Analysis with R, Springer.
5. Barry J. Babin, Hair, Rolph E Anderson, and William C. Blac, 2013,

- Multivariate Data Analysis, Pearson New International Edition.
6. Johnson RA and Wichern DW, Applied Multivariate Statistical Analysis, 1984, John Wiley & sons.
 7. Chatfield C. and Collins AJ. Introduction to Multivariate Analysis., 1980, Chapman & Hall.
 8. Seber, GAF, Multivariate Observations, 2004, Wiley series in probability and statistics.
 9. Brain S. Everitt and Graham Dunn (2001): Applied Multivariate Data Analysis, 2nd Ed.(chap 4)
 10. Neil H.Timm (2002): Applied Multivariate Analysis–Springer-Verlag
 11. Dallas E.Johnson (1998) :Applied Multivariate Methods For Data Analysts- Duxbury Press.
 12. William R Dillon and Mathew Goldstein (1984): Multivariate Analysis Methods And Applications, John Weily
 13. E. Alpaydin (2015) – Introduction to Machine Learning, 3rd Edition, MIT Press
 14. Pratap Dangeti (2017) – Statistics for Machine Learning, Packt Publishing.

Clinical Trials

Unit 1 Introduction to Clinical Trials

- Historical background – The need and ethics of clinical trials
- Organization and Planning, Main features of the study protocol
- Selection of patients, Treatment schedule, Evaluation of patient response
- Follow-up studies
- GCP/ICH guidelines
- Ethical Challenges in Emerging Medical Research
- Role of Institutional Review Boards (IRBs) and Ethics Committees

Unit 2 Different Phases of clinical trials

- Phase I, II, III and IV trials
- Basic study designs: Randomized control study, Nonrandomized concurrent control study
- Historical controls, cross-over design, withdrawal studies
- Group allocation design, hybrid designs
- Studies of equivalency
- Observational Studies and Real-World Evidence in Clinical Trials
- Adaptive and Bayesian Trial Designs

Unit 3 Methods of Randomization

- Fixed allocation randomization ,Stratified randomization,Adaptive randomization ,Unequal Randomization
- Blinding and Placebos: Unblinded, Single blind and Double-blind trials,conduct of double blind trials
- Crossover trials- Design, Analysis and interpretation
- Ethical and Practical Considerations in Randomization
- Stratified and Cluster Randomization Methods
- Minimization and Response-Adaptive Randomization

Unit 4 Analysis Strategies in clinical trials

- Method for dichotomous response variable
- Continuous response variables
- Repeated measures

- Cluster randomization and equivalency of intervention
- Multicenter trials
- Intention to Treat Analysis (ITT), Modified ITT, Per protocol analysis, As treated analysis, Stopping rules
- Handling Missing Data and Bias in Clinical Trials
- Multiple Testing and Adjustments in Clinical Trials

Unit 5

Clinical Trial Data management

- Introduction to RedCap
- Case report form design
- Database design
- Data collection system for good clinical practice
- Terminologies used in Clinical research
- Meta-Analysis and Systematic Reviews in Clinical Trials
- Risk-Based Monitoring and Data Integrity in Clinical Trials

BOOKS RECOMMENDED

1. Fundamentals of clinical trials (2010): Lawrence M. Friedman, Curt D.Furberg, David L. DeMets. Springer; 4th edition.
2. Clinical Trials (2006): A practical guide to design, analysis and reporting. Wang D, Bakhai A. Remedica; 1st edition.
3. SPIRIT 2013: New guidance for content of clinical trial protocols. Chan AW, TetzlaffJM, Altman DG, Dickersin K, Moher D. Lancet. 2013 Jan 12;381(9861):91-2.
4. Pocock, S.J. (1991): Clinical Trials – A Practical Approach, John Wiley and Sons.
http://onlinelibrary.wiley.com/doi/10.1002/0470842563.fmatter_indsub/pdf

BOOKS FOR REFERENCE

1. Fleiss, J.L. (1986): The design and analysis of clinical experiments John Wiley& Sons.
2. Meinert, C.L. (1986): Clinical trials: Design, Conduct and Analysis, Oxford university press.

http://samples.sainsburysebooks.co.uk/9781118031179_sample_388791.pdf

3. Piantadosi, S. (2005): Clinical Trials - A Methodological Perspective
Wileyseries in probability and Statistics, 2nd edition.

Human rights

Unit 1

Background

- Meaning and Definition of Human Rights
- Nature and Scope of Human Rights
- Different stages of human rights development
- The Natural Rights Theory, Moral Rights Theory and Legal Rights Theory
- Approaches to the Study of Human Rights: Western or Liberal approach. Marxian or Socialist approach. Third World approach

Unit 2

Human rights at various level

- Human Rights at Global Level UNO
- Human Rights – UDHR 1948 – UN Conventions on Human Rights:
- International Covenant on civil and Political Rights 1966
- International Convent on Economic,
- Social and Cultural Rights
- Racial Discrimination -1966 International.
- Instruments: U.N. Commission for Human Rights
- European Convention on Human Rights.

Unit 3

Human rights in India

- Development of Human Rights in India
- Human Rights and the Constitution of India
- Protection of Human Rights Act 1993-
- National Human Rights Commission
- State Human Rights Commission
- Composition Powers and Functions
- National Commission for Minorities, SC/ST and Woman
- Importance of the Fundamental Rights: Classification of Fundamental Rights

Unit 4

Human Rights Violations

- Human Rights Violations against Women,
- Human Rights Violations against Children,
- Human Rights Violations against Minorities, SC/ST and Transgenders
- The POCSO Act (Protection of Children from Sexual Offences)

- Preventive Measures.
- Violence, Forms of violence: psychological, verbal, economic, physical, sexual

Unit 5

Political issues

- Political, Economic and Health Issues
- Poverty, Unemployment
- Corruption and Human Rights
- Terrorism and Human Rights
- Environment and Human Rights
- Health and Human Rights
- Media and Human Rights in India
- Essential service, Strike, Right to Information, construction of Dams

BOOKS RECOMMENDED

1. Jagannath Mohanty, Teaching of Human sRights New Trends and Innovations, Deep & Deep Publications, Pvt. Ltd., New Delhi,2009
2. Ram Ahuja: Violence Against Women, Rawat Publications Jewahar Nager, Jaipur.1998.
3. Sivagami Parmasivam, Human Rights, Salem, 2008
4. Hingorani R.C.: Human Rights in India: Oxford and IBA, New Delhi

Data Management

- Unit 1** **Basics of computers and Data management**
- Introduction to computer
 - Working with files & folders
 - Software and its types
 - Virus Threat management
 - Basics of data management
 - Working with data base
 - Coding, data validation
 - Data quality and cleaning
 - Data dictionary and documentation
 - Backups
- Unit 2** **Data Management & Analysis**
- Designing Data Capture Interface with Entry/Edit/Delete Options
 - Data Matching/Compare
 - File Handling
 - Statistical Procedures
 - Programming EpiInfo
- Unit 3** **Large Scale Data Management**
- Introduction to RDBMS & SQL
 - Data processing architectures, Parallel processing
 - Distributed processing - Online analytical processing
 - Multi-query processing
- Unit 4** **Artificial Intelligence and Machine Learning**
- Introduction to AI
 - Agents and Environments
 - Concept of Rationality
 - Nature of Environments
 - Structure of agents
 - Heuristic search strategies , Heuristic functions
 - Online search agents and unknown environments

- Introduction to Machine Learning
- Review of Linear Algebra for Machine Learning
- Introduction and motivation for Machine Learning
- Example of Machine Learning applications

Unit 5 Data Sharing and Re-Use Policies

- Why data-sharing policies matter?
- Overview of Scientific Data Sharing
- Legal and ethical matter consideration of Research data
- Plan for Archiving and Preservation of Data

BOOKS RECOMMENDED

1. Fred R McFadden, Jeffery A Hoffer, Mary B. Prescott, (2000): Modern Database Management, Addison Wesley, 5th edition.
2. Andrew Vazsonyi, Richard 91980): Introduction to data processing, ISBN 10: 0256023433 ISBN 13: 9780256023435 3rd edition.
3. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems(2008): The Complete Book Prentice Hall, 2nd edition.
4. T. Özsu, P. Valduriez, Principles of Distributed Database Systems (2011): Springer, 3rd edition.
5. T. White, Hadoop (2012): The Definitive Guide, O'Reilly, 3rd edition.
6. J. Lin, C. Dyer (2010): Data-Intensive Text Processing with MapReduce, Morgan and Claypool, 1st edition.
7. E. Redmond, J. R. Wilson (2012): Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement, Pragmatic Bookshelf, 1st edition.

Web pages for reading

1. Why data-sharing policies matter <http://www.pnas.org/content/106/40/16894.full>
2. Alan E. Guttmachera, Elizabeth G. Nabel and Francis S. Collin Data Sharing and Consent March 2010 By Ciara Curtin <http://www.genomeweb.com/data-sharing-and-consent>
3. Guidelines for Responsible Data Management in Scientific Research <http://ori.hhs.gov/education/products/clinicaltools/data.pdf> pgs. 6-8

4. “Who Owns Research Data?”

http://ori.dhhs.gov/education/products/columbia_wbt/rcr_data/case/index.html#2

5. “Constructing Access Permissions”, University of Oregon Libraries:

<http://libweb.uoregon.edu/datamanagement/sharingdata.html#three>

Spatial Statistics

Unit 1 Introduction to Spatial Statistics

- Components of spatial data
- Geographical coordinates
- Map Projections
- Coordinate Systems
- Types of spatial data: Vector data and raster data
- Remotely sensed data
- Digitizing

Unit 2 Geographic Information Systems (GIS)

- What is GIS?
- GIS capabilities.
- Basic GIS Operations
- Visualization
- Types of Maps
- Exploratory spatial data analysis
- Sources of Spatial Data: Health Data, Census – Related Data, Geocoding, Remotely Sensed data

Unit 3 Spatial clustering of health events

- Mapping Smoothed Rates and Probabilities,
- Global and local indexes of spatial autocorrelation
- Moran's I and Assumptions
- Geary's C and Assumptions
- Spatial scan statistics for Binomial, Poisson model
- Getis – Ord
- Spatio-temporal analysis using SATSCAN

Unit 4 Geostatistics

- Introduction to Geostatistics, Isotropy, Random Fields and Stationarity
- Fitting semivariogram models
- Variogram function,
- Interpolation techniques,

- Kriging and their types.
- Inverse distance weighting method

Unit 5 Spatial Exposure Data to Health Events

- Introduction to spatial models and Disease mapping
- Spatially correlated data
- Linear regression models for Spatially Autocorrelated data
- Interpretation and use with spatial data
- GeoDa software overview

BOOKS RECOMMENDED

1. Lance A. Waller and Carol A. Gotway (2004): Applied Spatial Statistics for PublicHealth Data, John Wiley & Sons, 1st edition.
http://samples.sainsburysebooks.co.uk/9780471662679_sample_381451.pdf
2. Bailey, T.C. and A.C. Gatrell (1995): Interactive Spatial Data Analysis. Essex, England, Prentice Hall 1st edition.
3. A. E. Gelfand, P. J. Diggle, M. Fuentes and P. Guttorp (2011) “Handbook of Spatial Statistics edited by Gelfand, A. E., Diggle, P. J., Fuentes, M. and Guttorp, P.
4. N. Cressie (2015): Statistics for spatial data Wiley-Interscience; 2nd edition.
5. S. Banerjee, B. P. Carlin and A. E. Gelfand (2014): “Hierarchical modeling and analysis for spatial data”, Chapman & Hall/CRC 6th edition.

BOOKS FOR READING

1. Wiley. Cressie, N. and Wikle, C. (2011): Statistics for Spatio-Temporal Data. Wiley 1st edition.
2. Diggle, P. J. (2003) Statistical Analysis of Spatial Point Patterns 2nd edition.
3. Hodder Arnold. Diggle, P. J. and Ribeiro, R. J. (2007) Model-based Geostatistics. Springer 2nd edition.

Health Informatics

- Unit 1 Challenges of Health informatics**
- Introduction to Health informatics
 - Reading & Writing patient records
 - Creation of medical knowledge
 - Access to medical knowledge
- Unit 2 Principles of Health informatics – Part 1**
- Representation
 - Logic
 - Clinical terms
 - Knowledge representation
- Unit 3 Principles of Health informatics – Part 2**
- Standards in Health informatics
 - Probability and decision making
 - Probability and learning from data
- Unit 4 Archiving Change**
- Information Technology and Organizational transformation
 - Archiving change through information
 - Archiving change through information Technology
- Unit 5 Public Health Informatics**
- Conceptual and theoretical foundations of health policy formulation
 - Implementation and analysis in the health care sector with specific applications to health informatics.
 - Use of mobile health (mHealth) apps for chronic disease management
 - Data integration from multiple sources for epidemic surveillance
 - Role of informatics in pandemic preparedness and response
 - Geospatial analysis in tracking disease outbreaks using health informatics tools
 - Ethical and privacy concerns in public health data sharing

Book recommended

Taylor P, From Patient data to Medical knowledge – The principles and Practice of Health Informatics (2006); Blackwell Publishing – BMJ Books.

Books for Reading

1. Enrico Coiera Hodder Arnold , Guide to health informatics (2003) Second Edition.
2. Frank Sullivan, Jeremy C Wyatt, ABC of Health Informatics,(2006) Blackwell Publishing –BMJ Books.

Bayesian Statistics**Unit 1 Bayes law**

- Background and introduction
- The differences between Bayesian versus non Bayesian approaches;
- Baye's law for multiple events

Unit 2 Computational Bayesian Methods

- Introduction
- Informative priors
- Non informative priors
- Markov Chain Monte Carlo techniques
- Simple Gibbs sampling
- Concepts of Simple Metropolis Sampling
- Metropolis-Hastings (MH) algorithm

Unit 3 Specifying Bayesian Models

- Purpose
- Likelihood theory and estimation
- The Basic Bayesian Framework.
- Summarizing Posterior Distributions with intervals.
- Application

Unit 4 The Bayesian Prior

- The importance of priors
- Posterior distribution
- A Plethora of priors
- Conjugate priors
- Choice of priors
- Different posterior beliefs

Unit 5 Bayesian models

- Bayesian Hierarchical models
- Basic structure of the Bayesian Hierarchical Model
- A poison Gamma Hierarchical Model

- WinBUGS software
- OpenBUGS module

BOOKS RECOMMENDED

1. Jeff Gill, Bayesian methods: A Social and Behavioural Approach Chapman & Hall(CRC)
2. P M Lee, Bayesian Statistics: An Introduction, Arnold
3. Andrew Gelman, John B. Carlin, H.S. Stern, and D.B. Rubin, Bayesian Data Analysis,2nd Edition. Chapman & Hall (SFGEL)
4. G R Iverson, Bayesian Statistical Inference, Beverley Hills, CA: Sage (SF4 IVE)
5. J Albert, Bayesian Computation with R, Springer 2007
6. D V Lindley, An Introduction to Probability and Statistics from a Bayesian Viewpoint (2 vols - Part I: Probability and Part II: Inference), Cambridge UniversityPress (S 9 LIN).

BOOKS FOR READING

1. Sivia, D. and skilling J (2006). Data analysis: A Bayesian tutorial. Oxford: OxfordUniversity Press, 2nd edition.
2. Bernardo, J. M., & Smith, M. F. A. (1994). Bayesian theory. New York: Wiley, 1st edition.
3. Box, G. E. P., and Tiao, G. C. (1992). Bayesian inference in statistical analysis. NewYork: Wiley, 1st edition.

Scientific communication

- Unit 1** **Science Communication overview**
- What is Science Communication?
 - History of Science Communication
 - Goals for Science Communication
 - Motivations for Science Communication
 - Science Communication and Public Engagement
 - Ethics in Science Communication
- Unit 2** **Oral presentation**
- Single overriding communication objective (SOCO)
 - Preparing a talk
 - Visual aids
 - Delivering a talk
 - Storytelling in Scientific Presentations
 - Handling Q&A and Audience Interaction
- Unit 3** **Poster presentation**
- Single overriding communication objective (SOCO)
 - Preparing posters
 - Visual aids
 - Presenting a poster
 - Design Principles for Scientific Posters
 - Engaging with Viewers and Networking at Conferences
- Unit 4** **Manuscript writing**
- Argument matrix
 - Writing style
 - IMRD format
 - Referencing
 - Abstract writing
 - Common Pitfalls in Scientific Writing
 - Ethical Considerations in Publishing
- Unit 5** **Communication through media**

- Types of media
- Fundamentals of news media
- Role of news media in public health
- Soft skills for handling media
- Preparing message for print media, writing press release
- Preparing message and handling TV/radio media
- Science Blogging and Social Media Communication
- Crisis Communication in Science and Public Health

BOOKS RECOMMENDED

1. Laura Bowater, Kay Yeoman, (2012): Science Communication: A Practical Guide for Scientists. ©2013, Wiley-Blackwell.
2. Bucchi, M. & Trench, B. (Eds.) (2008). Handbook of Public Communication on Science and Technology. London: Routledge.
3. Cheng, D., Claessens, M., Gascoigne, T., Metcalfe, J., Schiele, B., & Shi, S. (eds.) (2008). Communicating Science in Social Contexts: New models, New Practices. New York: Springer.
4. Joseph E. Harmon and Alan G. Gross, The Craft of Scientific Communication ©2010 (Chicago Guides to Writing, Editing, and Publishing).
5. Schimel, Joshua (2011). Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded. Oxford University Press

BOOKS FOR READING

1. Marianne W. Zawitz, Bureau of Justice Statistics, Washington Statistical Society Methodology Seminars. Data Presentation: A Guide To Good Graphics. <http://www.science.gmu.edu/~wss/methods/zawitzg.html>
2. Phil Bartle. Report Writing. <http://www.scn.org/ip/cds/cmp/modules/rep-int.htm>
3. University of Wisconsin Cooperative Extension. Communicating Results: Tips and Practices (Power Point presentation). <http://www.uwex.edu/ces/pdande/evaluation/powerpt/TipsRS.PPT>
4. National Science Foundation. The 2002 User-Friendly Handbook for Project Evaluation. <http://www.nsf.gov/pubs/2002/nsf02057/start.html>

Health Economics

Unit 1 Tools for Health Economics

- Opportunity cost
- Demand and supply of health care, price elasticity of demand
- Utility functions
- Market structures, gross domestic product and inflation
- Equity and Efficiency
- Health Production Function and Its Applications
- Behavioral Economics in Health Care

Unit 2 Economic evaluation in health care

- Concept and need of health care evaluation
- Concept of efficiency and its types
- Influence of economic evaluation in policy making
- Frameworks used to prioritize different programs
- Types of economic evaluation in health care -
- Perspective of Economic Evaluation
- Interpreting CER and ICER results of economic evaluation
- Methods of economic evaluation – RCT and Decision modeling
- Budget Impact Analysis in Health Care
- Equity Considerations in Economic Evaluation

Unit 3 Costing and cost analysis

- Type of costs
- Perspectives of costing – Economic and financial
- Costing methods
- Designing a costing study
- Analysing cost data
- Sensitivity Analysis in Costing Studies
- Time Horizon and Discounting in Cost Analysis

Unit 4 Economic evaluation in health care

- Valuation of benefits – DALY, QALY, WTP
- Uncertainty analysis - Types of uncertainties, analysing uncertainties

- Decision rules and thresholds - Interpreting CER and ICER results
- Real-World Evidence in Economic Evaluation
- Ethical Considerations in Health Economic Evaluations

Unit 5 League tables and threshold

- Introduction to league tables and thresholds
- The problem of threshold in evaluating the cost
- The limits of cost effective analysis
- Using the Drummond checklist for critical appraisal of economic evaluation
- Health Technology Assessment (HTA) and Its Role in Decision Making
- Comparative Effectiveness Research in Health Economics

BOOKS RECOMMENDED

1. Charles E. Phelp (2009), Health Economics, Prentice Hall , 4th edition.
2. Yasodha Shanmugasundaram (1994) Theory and Practice of Health Economics in India Allied Publishers Ltd, 1st edition.
3. Government of India (1983) National Health Policy, New Delhi.
4. ICSSR AND ICMR (1981) Health for ALL 2000 A,D, ICSSR ,Delhi.
5. Naik J.P (1977) An alternative System of Health Care Services in India – Some Prospects ICSSR Delhi.
6. Panchamukhi, P.R (1980), Economics of Health: A Trend Report, Volume – VII Infrastructure, ICSSR Delhi.

BOOKS/WEB PAGES FOR READING

1. Health Economics Core Library Recommendations, 2011.
<https://www.nlm.nih.gov/nichsr/corelib/hecon-2011.html>
2. Introduction to Health economics
[http://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_sci
ence_students/LN_Intro_to_Health_Economics_final.pdf](http://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_sci ence_students/LN_Intro_to_Health_Economics_final.pdf)

Field Epidemiology

- Unit 1 Public health situation analysis**
- Framework of situation analysis
 - Data sources
 - Prioritization of public health problems
 - SWOT analysis
 - Health Needs Assessment and Burden of Disease Estimation
 - Role of Social Determinants in Public Health Analysis
- Unit 2 Disease surveillance**
- Managing and operationalizing the Disease surveillance system
 - Conduct basic time, place and person analysis of surveillance data
 - Use surveillance information for Action
 - Describing and evaluating a surveillance system
 - Digital and Real-Time Surveillance Systems
 - Community-Based Surveillance and Participatory Epidemiology
- Unit 3 Outbreak investigations**
- Conceptualize and undertake epidemiologic and laboratory investigations of outbreaks
 - Understand and undertake appropriate measures for preparation and response to outbreaks
 - Steps in conducting outbreak investigation
 - Risk Communication During Outbreaks
 - One Health Approach in Outbreak Investigation
 - Basics of Infectious Disease Transmission (Compartmental models, Reproductive number, Infectious period and incubation period, Attack rate and secondary attack rate)
- Unit 4 Public health programme evaluation**
- Concept and purpose of evaluation
 - Six steps of framework for public health programme evaluation
 - Logic model

- Elements of description of health programme
- Evaluation design and tools
- Interpreting results of evaluation
- Cost-Effectiveness and Impact Evaluation of Public Health Programs
- Ethical Considerations in Public Health Program Evaluations

Unit 5 Epidemiological Data

- Data Interpretation
- Validity
- Reliability
- Big Data and Machine Learning in Epidemiology
- Bias and Confounding in Epidemiological Studies

RECOMMENDED BOOKS

1. Michael Gregg (2008): Field Epidemiology, Oxford University Press, USA, 2nd edition.
2. ebook selected Chapters www.ciphi.ca/hamilton/Content/documents/fieldepi.pdf
3. Mark S. Dworkin (2011) Cases in Field Epidemiology: A Global Perspective. Publisher Jones & Bartlett Learning.
4. Jones & Bartlett (2012): Learning, Methods of field Epidemiology. Publisher Michaelbrown.
5. Anderson RM & May RM (1992) Infectious Diseases of Humans. Dynamics and Control. Oxford Science Pubs., ISBN 0-19-854040-X.

RECOMMENDED FOR READING

1. Beaglehole R, Bonita R. (1997): Public Health at the Crossroads. Cambridge University Press.
2. Breslow NE, Day NE, Davis W. Statistical methods in cancer research (1980) Vol 1. Case-control studies. IARC Scientific Publications No 32. ISBN 9283211324
3. Clayton D, Hills M (1993). Statistical Models in Epidemiology. Oxford University Press. ISBN 019852221-5.
4. Giesecke, J (2001); Modern Infectious Disease Epidemiology. Edward Arnold ISBN 034076423-6, 2nd edition.
5. Hennekens CH, Buring JE (1987): Epidemiology in Medicine. Little, Brown & Co., ISBN 0316356360

Health Systems

Unit 1

Organization and Structure of Health System in India

- Concept of six pillars of Health Systems - covering HS concepts, details of each of the system blocks with reference to India's health care system
- Universal Health Coverage - what it is, what is happening in the country and the issues related to it.
- Public health legislation - conceptual aspect of legislations, Various health legislations in India
- Role of Private Sector and Public-Private Partnerships in Health Care
- Health System Governance and Leadership in India

Unit 2

Health Policy

- Recognizing Policy – What is it? Who makes it? How is it made? What are its impacts? How is it evaluated? – Introducing the policy triangle framework.
- Theories of policy making – introducing the main frameworks and theories of the policy process.
- Health Policy and Equity – Addressing Social Determinants of Health
- Comparative Analysis of Health Policies in Different Countries

Unit 3

Policy implementation and Health service delivery in India

- Policy implementation and analysis – introducing various frameworks for the analysis of policy
- Trends in the development of the health system in India. Over view of Indian Health Policy with a Critical Analysis
- National Health Mission
- National Health Programmes
- Quality systems - NABH, NABL, six sigma, ISO, Accreditation, Indian public health standards
- Decentralization of Health Services and Role of Local Governance
- Challenges in Implementation of Health Policies in India

Unit 4 Health information systems

- HMIS and HMS
- ICD classification of diseases - Medical certification of deaths, ICD coding for hospitalizations
- Data Sources for Health in India
- Digital Health and Use of AI in Health Information Systems
- Big Data Analytics and Decision Support Systems in Health Care

BOOKS RECOMMENDED

1. Mark Britnell, In Search of the Perfect Health System, ISBN 9781137496614 Publication Date September 2015, Publisher Palgrave Macmillan.
2. LeighAnne Olsen, Dara Aisner, and J Michael McGinnis. The Learning Healthcare System, Institute of Medicine (US) Roundtable on Evidence-Based Medicine; Washington (DC): National Academies Press (US); 2007. ISBN-13: 978-0-309-10300-8 ISBN-10: 0-309-10300-2
3. OECD iLibrary, Health Care Systems Efficiency and Policy Settings ISBN 9789264094901 (PDF) ; DOI :10.1787/9789264094901-en http://www.oecd-ilibrary.org/social-issues-migration-health/health-care-systems_9789264094901-en
4. Corlien M. Varkevisser, Indra Pathmanathan, and Ann Brownlee Designing and conducting Health Systems Research Projects. KIT, IDRC / 2003-01-01, ISBN: Out of print / 380 pg., e-ISBN: 1-55250-069-1

25MBSCP01	6 hours/week	3 credits
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Practical I - Statistical Data Analysis – I using R/SAS/SPSS/STATA

Exercise based on 25MBSC01, 25MBSC02, 25MBSC03 and 25MBSC04

25MBSCP02	6 hours/week	3 credits
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Practical II - Statistical Data Analysis – II using R/SAS/SPSS/STATA

Exercise based on 25MBSC05, 25MBSC06, 25MBSC07 and 25MBSC08

25MBSCP03	6 hours/week	3 credits
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Practical III - Statistical Data Analysis – III using R/SAS/SPSS/STATA

Exercise based on 25MBSC09, 25MBSC10, 25MBSC11 and 25MBSC12

For Elective subjects- in addition to the above software's, EPI MAP/GEODA/WINBUGS will also be used.