SEMESTER: 3

COURSE CODE: ST 231
COURSE TITLE: THEORY OF ESTIMATION

Course Outcomes

On completion of this course, the students will be able to**:**

CO1: List the ideal properties of point estimators of an unknown parameter of a distribution and select the best estimators using different properties.

CO2: Derive the UMVUE of a parameter or function of a parameter.

CO3: Determine UMVUE using Rao Blackwell and Lehmann Scheffe Theorems

CO4: Determine estimators of unknown parameters using methods like MLE, Method of moments etc.

CO5: Realize the asymptotic properties of MLE

CO6: Understand Basics of Interval Estimation

C07: Differentiate between classical and Bayesian inference

C08: Outline Bayes estimation of parameters of standard distributions

CO9. Describe the role of the posterior distribution, the likelihood function and the posterior distribution in Bayesian inference about a parameter.

Sl.No.	Outcomes On Completion of each module, Students should be able to:	Taxonomy level
MODULE I	MO1 Know whether an estimator is unbiased MO2 Know whether an estimator is consistent MO3 Explain minimal sufficiency. MO4 Determine sufficient statistic by factorization theorem. MO5 Apply Basu's Theorem	Evaluate Evaluate Understand Create Apply
MODULE II	MO1 UMVUE and its propeties MO2 Apply Rao-Blackwell Lehmann-Scheffe theorems to find UMVUE. MO3 Understand Fisher Inormation measure MO4 Calculate Cramer-Rao inequality and Chapman -Robbin's bound.	Understand Apply Understand Evaluate Apply
MODULE III	MO1 Apply different methods of estimation-method of moments, MLE, Minimum & modified minimum chi-square MO2 Concepts of Interval Estimation	Apply Understand Apply

	MO3 Properties of MLE	
MODULE IV	M01. Differentiate between classical and Bayesian Inference M02. Design basic elements of Bayesian Inference M03. Calculate Bayes estimators of parameters of standard distributions.	Understand Apply Apply

Module I

Point estimation: unbiasedness; Definition and examples of: mean square error, Bias of an estimator, asymptotically unbiased estimator. Consistency (strong, weak and squared error), Sufficient condition for weak consistency. Invariance property of consistent estimator, CAN estimator, BAN estimator. Sufficiency- Factorization criterion for sufficiency, Minimal Sufficient Statistic and its construction (concept and example). Completeness, complete sufficient statistics for exponential family of distributions, Ancillary statistic and Basu's theorem.

Module II

UMVU estimators and its properties, Rao-Blackwell theorem, Lehman-Scheffe theorem and its applications. Fisher's information measure, Cramer- Rao inequality and its generalizations through higher order derivatives, Bhattacharya bounds, Chapman-Robin's bound. Efficient estimators.

Module III

Methods of estimation- maximum likelihood, method of moments, method of minimum Chi-square, modified minimum Chi-square. Properties of MLE (such as function of sufficient statistic, invariance property, uniqueness). Theorems regarding consistent solution of likelihood equations (viz. uniqueness, asymptotically normal and efficient). Interval Estimation-(Basic concepts and definition only)

Module IV

Limitations of classical inference, decision rule, loss function. Bayes and minimax decision rules. Types of loss (squared and modulus). Prior distribution, Posterior distribution, Bayes solution (Theorem associated to quadratic loss and problems in case of binomial and Normal). Conjugate prior family. Jeffrey's Prior.

Text Books:

1. Rohatgi, V. K. and Saleh, A.K.M (2001). An Introduction to Probability and Statistics, 2nd edn, John Wiley and Sons.
2. Mukhopadhyay, P. (2006). Mathematical Statistics, Books and Allied (P) Ltd., Kolkatta.
3. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference, PHI Learning Pvt Ltd, New Delhi.

References:

1. Casella, G. and Berger, R.L. (2002). Statistical Inference, 2nd edn. Cengage Learning, New Delhi
2. Lehmann, E.L. (1983). Theory of Point Estimation, Wiley, New York.
3. Rao, C.R. (1973). Linear Statistical Inference and Its Applications, 2/e, Wiley Eastern Ltd.
4. Wasan, M.T. (1970). Parametric Estimation, Mc-Graw Hill, New York.
5. Ferguson, T.S. (1967). Mathematical Statistics. Academic Press, New York.
6. Kale B.K. (1999). A First Course on Parametric Inference. Narosa Publishing House.
7. Mood, A.M, Graybill F.A. and Boes D.C. (2001). Introduction to the Theory of Statistics, 3rd edn., Mc- Graw Hill Inc, New York.
8. Srivastava, Khan and Srivastava (2014), Statistical Inference: Theory of Estimation, PHI, India

COURSE CODE : ST232

COURSE TITLE : TESTING OF HYPOTHESES

COURSE OUTCOMES

On completion of this course, the students will be able to**:**

C01: List out the fundamental concepts of testing of hypothesis.

C02: Formulate hypothesis for a given problem.

C03: Find most powerful test for testing simple hypothesis against simple alternatives.

CO 4: Find UMP test for testing composite hypothesis.

CO 5: Derive likelihood ratio test for testing the hypothesis for normal populations.

CO 6: Obtain sequential probability ratio test for testing the hypothesis.

CO7: Obtain OC function and ASN function for Binomial, Poisson and Normal distributions.

CO8: Perform a suitable non-parametric test for a given data.

MODULE OUTCOMES

Sl.No.	Outcomes On completion of each module, students should be able to:	Taxonomy level
Module I	MO1: Distinguish between randomized and non-randomized test. MO2: Apply Neyman-Pearson lemma to find most powerful test. MO3: Find UMP for simple hypothesis. MO4: Articulate monotone likelihood ratio property. MO5: Find UMP test for composite hypothesis	Identify Apply Apply Understand Apply
Module II	MO1: Find UMPU test. M02: Explain generalizations of Neyman-Pearson lemma. M03: Articulate α- similar test and LMP test. M04: Articulate the connection between test of hypothesis and confidence set. MO5: Apply likelihood ratio test principle for testing the mean and variance for a normal population. MO6: Apply likelihood ratio test principle for testing the equality of means and variances for two	Evaluate Understand Understand Evaluate Apply Apply

	normal population	
Module III	MO1: Articulate sequential probability ratio test. MO2: Derive SPRT for test the parameters of normal distribution, binomial and Poisson distributions. MO3: Identify Walds fundamental identity. MO4: Find OC function and Average Sample Number of a SPRT.	Understand Apply Understand Understand
Module IV	MO 1 : Perform chi square test of goodness of fit MO 2 : Perform one sample non-parametric test. MO 3 : Perform two sample non-parametric test. MO4 : Apply Spearman's rank correlation coefficient and Kendall's Tau for testing association.	Apply Apply Apply Apply

COURSE CONTENT

Module I

Fundamental concepts of hypothesis testing, test function, randomized and non-randomized tests, size and power function of a test, most powerful (MP) test and uniformly most powerful (UMP) test; Test of a simple hypothesis: Neyman-Pearson lemma. Test of a composite hypothesis: family of distributions with monotone likelihood ratio, UMP test for certain one-sided hypothesis concerning a real valued parameter, UMP tests for some two-sided hypothesis in case of one parameter exponential family.

Module II

Unbiased tests, UMPU test, generalization of Neyman-Pearson lemma (statement and applications only), α- similar test and LMP tests (concepts only). likelihood ratio test

(LRT), asymptotic properties; LRT for the parameters of normal distributions, connection between tests of hypothesis and confidence sets.

Module III

Sequential methods: Sequential Probability Ratio Test (SPRT), Wald's fundamental identity, OC and ASN functions; Applications to binomial, Poisson and normal distributions.

Module IV

Non parametric tests: Chi-square goodness of fit test, Kolmogorov-Smirnov test (one sample and two sample tests), Sign test, Wilcoxon signed rank test, run test, Wald-Wolfowitz run test, median test, Mann-Whitney Wilcoxon test; Tests for association based on Kendall's Tau and Spearman's rank correlation coefficient. Kruskal –Walli's test, Friedman test.

Text Books:

1. Rohatgi, V. K. and Saleh, A.K.M (2003). An Introduction to Probability and Statistics, John Wiley and Sons.
2. Mukhopadhyay, P. (2006). Mathematical Statistics, Books and Allied (P) Ltd., Kolkatta.
3. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference, PHI Learning Pvt Ltd, New Delhi.
4. Gibbons, J.D. (1985): Non-Parametric Statistical Inference, 2nd edn. Marcel Dekker Inc.
5. Manoj Kumar Srivastava and Namita Srivastava (2014). Statistical Inference Testing of Hypotheses, PHI Learning Pvt Ltd, New Delhi.

References:

1. Lehmann E.L. (1986): Testing Statistical Hypotheses, 2nd edn. John Wiley & Sons, New York.
2. Ferguson, T.S. (1967). Mathematical Statistics. Academic Press, New York
3. Kendall, M.G. and Stuart, A. (1967). The Advanced Theory of Statistics, vol 2, 2nd edn. Mc-Millan, New York.
4. Shao, J. (2003). Mathematical Statistics, 2n edn. Springer-Verlag, New York.

COURSE CODE : ST 233

COURSE TITLE : MULTIVARIATE ANALYSIS

COURSE OUTCOME

On completion of the course, students should be able to:

CO1: Describe Random vectors, multiple and partial correlation coefficients.
CO2: Describe multivariate normal distribution and its properties.
CO3: Obtain the distributions of quadratic forms in a multivariate random vector.
CO4: Random sampling from a multivariate normal population.
CO5: Obtain the estimators for parameters of a multivariate normal distribution.
CO6: Test the hypothesis regarding parameters of a multivariate normal distribution.
CO7: Test the hypothesis regarding the significant of multiple correlation coefficients.
CO8: Classify individuals/items in to one of k multivariate normal populations.
CO9: Perform principal component analysis and factor analysis

MODULE OUTCOME

MODULE	**Module outcomes** *On completion of each module, students should be able to:*	**Taxonomy Level**
MODULE I	MO1: Describe random vectors and their properties MO2: Define the multivariate normal density function. MO3: Obtain the characteristic function of a multivariate normal density function. MO4: Find the distribution of linear combination of multivariate normal random vector using characteristic function MO5: Characterize quadratic forms of multivariate distribution. MO6: Apply Cochran's theorem to find distribution of quadratic forms of multivariate normal random vector	Remember Remember Understand Apply Apply Understand

MODULE II	MO1: Obtain the MLEs of mean and variance of multivariate normal distribution MO2 : Obtain the characteristic function of Wishart distribution MO3 : Show that Whishart distribution possess additive property MO4 : Find the distribution of sample dispersion matrix	Evaluate Apply Understand Remember
MODULE III	MO1: Test the mean vector of a multivariate normal distribution MO2: Test the equality of means of two multivariate normal distributions MO3: Use Hotelling's T^2 and Mahalanobis D^2 statistics in testing hypothesis regarding multivariate normal distributions. MO4: Find the relationship between Hotelling's T^2 and Mahalanobis D^2 statistics MO5: Find the distribution of sample multiple correlation for multivariate normal distribution	Apply Apply Apply Understand Remember
MODULE IV	MO1: Perform principal component analysis and factor analysis MO2: Classify individuals/items in to one of k multivariate normal populations MO3: Identify canonical variables and quantify canonical correlation MO4: Explain factor analysis and cluster analysis	Analysis Analysis Analysis Apply

COURSE CONTENT

MODULE I

Random vectors, expectation and covariance of random vectors and their properties. Quadratic forms, Characteristic functions in higher dimensions. Multiple correlation and partial correlation (illustrative examples).

Multivariate normal distribution, singular normal distribution, characteristic function. Marginal and conditional distribution, additive property, distribution of linear combination of normal random vectors. Distribution of quadratic forms, Cochran's theorem (statement only).

MODULE II

Random Sampling from multivariate normal distribution, Distribution of sample mean vector, MLE of mean vector and dispersion matrix.

Wishart distribution: definition and properties, analogy with chi-square distribution, characteristic function, additive property, generalized variances, partitioned Wishart matrix, distribution of sample dispersion matrix.

MODULE III

Tests of hypothesis about mean vector of multivariate normal distribution, equality of mean vectors of two multivariate normal distributions- Hoteling's T^2 and Mahalanobis' D^2

Sampling distributions of sample correlation coefficient and multiple correlation coefficient and tests of significance .

MODULE IV

Classification problems: Classifying to one of k multivariate normal populations, Bayes' solution, Fisher's discriminant function, Definition of principal components-extraction of principal components, definition and derivation of canonical variables and canonical correlation, Application of factor analysis and cluster analysis-Orthogonal factor model.

Text Books:

1. Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, John Wiley, New York.
2. Johnson, R.A. and Wichern, D.W. (1992). Applied Multivariate Statistical Analysis, 3rd edn., Prentice- Hall, London.
3. Muirhead, R.J. (1982). Aspects of Multivariate Statistical Theory, John Wiley, New York.

References:

1. Graybill,F.A. (1961). An Introduction to Linear Statistical Model, Vol 1, Mc Graw Hill, New York.
2. Kendall, M.G. (1958). A Course in Multivariate Analysis, Griffin, London.
3. Rohatji, V.K. and Saleh, A.K.M.E. (2003). An Introduction to Probability Theory and Mathematical Statistics, 2nd edn., John Wiley & Sons, New York.
4. Srivastava, M.S. and Khatri, C.G. (1979). An Introduction to Multivariate Statistics, North Holland.

COURSE CODE : ST 234

COURSE TITLE : OPERATIONS RESEARCH

COURSE OUTCOMES

On completion of the course, the students should be able to:

CO1: Describe Simplex method to solve the linear programming problem.
CO2: Explain the steps in solving a linear programming problem by two-phase method.
CO3: Explain the concept of duality in linear programming problem.
CO4: Give the outline of dual simplex method.
CO5: Describe the computational procedure of optimality test in a transportation table.
CO6: Explain the Hungarian method to solve the Assignment problem.
CO7: Give an account of different types of inventory models and inventory cost.
CO8: Derive an EOQ formula for different rate of demand in different cycles.
CO10: Formulate and solve the purchase inventory problem with one price break.
CO11: Derive the steady state solution of M/M/1 queue model.
CO12: Obtain expected number of units in the M/G/1 queueing system under steady state.
CO13: Derive an expression of the average annual cost of an item over a period of n years.
CO14: Describe Bellmen's principle of optimality.

MODULE OUTCOMES

Sl. No:	**Outcomes** On completion of each module, students should be able to:	**Taxonomy Level**
Module I.	M01. Explain the concepts of linear programming problem. M02. Solve the linear programming problem by using Simplex method. M03. Computational steps of Two-phase and Big-M Method M04. Write the dual of the given linear programming problem. M05. Find the initial basic feasible solution to the given Transportation problem. M06. To determine the optimum assignment problem.	Understand Apply Remember Evaluate Evaluate Evaluate

Module: II	M01. Describe the problem of replacement of items whose maintains cost increase with time. M02. Discuss Kuhn-Tucker necessary and sufficient conditions in a non-linear programming problem. M03. Explain Dynamic Programming problem M04. Discuss different models in connection with Dynamic Programming Problem	Understand Evaluate Understand Analysis
Module III	M01. Discuss the characteristics of queueing process M02. Explain the role of Poisson distribution and exponential distribution. M03. Obtain the steady state solution of M/M/1, M/M/C and M/Ek/1 queueing models M04. Discuss Little's Formula M05. Discuss M/G/1 model and Pollaczek-Khintchine formula	Understand Understand Evaluate Apply Understand
Module IV	M01. Explain Inventory control, inventory costs, concept of EOQ, deterministic and probabilistic inventory models. M02. Derive an expression for EOQ for deterministic inventory models with and without shortages M03 Discuss EOQ problem for probabilistic inventory models. M04. Discuss EOQ models with quantity discounts	Understand Apply Apply Evaluate

COURSE CONTENT

MODULE I

Linear Programming Problem: basic feasible solution, graphical method, Standard form of an LPP, Simplex method of solving an LPP, Fundamental Theorem of an LPP, Two-phase method and Big-M method, degeneracy, duality in LPP, Fundamental Theorem of Duality.

Assignment problem, Hungarian method of assignment, transportation problem: basic feasible solution (North-West Corner Method, Least Coast Method and VAM Method) methods of finding optimum solution, degeneracy in transportation problem.

MODULE II

Replacement models: Types of failure, replacement of items deteriorates with time, replacement of items that fail completely.

Non-linear programming: General non-linear programming problems - Constrained optimization with equality and inequality constraints, Kuhn – Tucker conditions (statement only) and applications.

Dynamic programming - Characteristics of dynamic programming problem, different models - Single additive constraint and multiplicative separable return, single additive constraint and additively separable return, single multiplicative constraint and additively separable return, dynamic programming approach for solving a LPP.

MODULE III

Queueing Theory: Characteristics of queueing processes, role of Poisson distribution and exponential distribution in queueing theory, steady state solution of M/M/1 model, Waiting time distribution of M/M/1 model, steady state solution of M/M/C model and steady state solution of M/EK/1 queueing model, measures of effectiveness of these models, Little's Formula, M/G/1 model (description only) and Pollaczek–Khintchine formula.

MODULE IV

Inventory models: Meaning of inventory control, inventory costs, concept of EOQ, deterministic inventory models without shortages - Economic lot size model with constant demand, economic lot size model with different rates of demand in different cycles and economic lot size model with finite replenishment rate. Deterministic inventory models with shortages. Probabilistic inventory models - Single period model without setup cost, single period model with setup cost. The EOQ models with quantity discounts (one price break and two price breaks).

Text Books:

1. Gross, D. and Hariss, C.M. (2009). Fundamentals of Queueing Theory, John Wiley & Sons.
2. Kanthi Swarup, Gupta, P.K, and Man Mohan (2012). Operations Research, Sulthan Chand & Sons.
3. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India Limited

References:

1. Medhi J (2014) Introduction to Queueing Systems and Applications, New Age International Publishers
2. Mittal, K.V. and Mohan, C. (1996). Optimization Methods in Operations Research and System Analysis, New Age Publishers.
3. Paneerselvam, R. (2006). Operations Research, Prentice hall of India.
4. Rao S S. (1984), Optimization Theory and Applications, New Age Publishers, Wiley Eastern.

5. Ravindran, A., Philips, D.T. and Solberg, J. (2007). Operations Research: Principles and Practice, John Wiley & Sons, New York.
6. Taha, H. A. (2010). Operations Research, Macmillan India Limited.

COURSE CODE: ST 235

COURSE TITLE: Elective I - (i) MACHINE LEARNING

COURSE OUTCOMES

On completion of the course, students should be able to:

CO1. Analyze the data and understand the insights from it.

CO2. A clear understanding of machine learning algorithms and applications. CO3. Apply various ML techniques as per the requirements

CO4. To acquaint important multivariate methods

CO5. Apply clustering methods

CO6. Familiarize SVM, neural network, HMM, classification and regression trees

MODULE OUTCOMES

Sl. No:	**Outcomes** **On completion of each module, students should be able to:**	**Taxonomy Level**
MODULE 1.	MO1. Introduction to machine learning and applications MO2. Understanding supervised, unsupervised and reinforcement learning algorithms	Understand Understand
MODULE 2.	MO1: Introduction of Bayesian methods MO2: To get an idea about the parametric inference method MO3: Use of classifications and regression methods	Understand Understand Apply

MODULE 3.	MO1. Understanding various multivariate methods MO2. Introduction to multivariate classification MO3. Apply the concepts of clustering algorithms	Understand , Learning Understand Apply Apply
MODULE 4.	MO1. Understanding of kernel estimation, kNN estimation MO2. Applying classification tree, regression tree, random forest MO3. Real life applications of SVM, naive Bayes and HMM	Understand Understanding and apply Understanding and apply

COURSE CONTENT

MODULE I

Introduction to Machine Learning, its meaning and applications, Outline of Supervised Learning, Unsupervised Learning, Semi Supervised learning, Reinforcement Learning Dimensions of a Supervised Machine Learning Algorithm, Vapnik -Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning, Noise, Learning Multiple Classes.

MODULE II

Model Selection and generalization, Bayesian decision theory: Introduction, classification, losses and risks, discriminant functions, utility theory, association rules.

Parametric methods: Introduction, Maximum Likelihood Estimation, evaluating an estimator- bias and variance, Bayes' estimator, parametric classification, regression, tuning model complexity: bias/variance dilemma.

MODULE III

Model Selection Procedures, multivariate methods: multivariate data, parameter estimation, concept of imputation, multivariate normal distribution and multivariate methods of classification (concepts only, without any derivation), tuning complexity. Clustering: k means clustering, nearest neighbor method and hierarchical clustering (concept and applications only).

MODULE IV

Basic concepts and applications of: Kernel estimator, kNN estimator, classification tree, regression tree, neural network and random forests, support vector machine, naive Bayes and hidden Markov model (all without any derivation)

Text Books:

1. Alpaydin, E. (2009). Introduction to machine learning. MIT press.
2. Trevor, H., Robert, T., & JH, F. (2009). The elements of statistical learning: data mining, inference, and prediction.
3. Gupta, G.K. (2008): Introduction to Data Mining with case studies, Prentice – Hall of India Pvt. Ltd.

REFERENCES

1. Bhat, B. R. (1985). Modern Probability Theory: An Introductory Text Book, 2nd Edition, Wiley Eastern.
2. Brian Coffo. Statistical Inference for Data Science.
3. Tan, T., Steinbach, M. and Kumar, V. (2006): Introduction to Data Mining, Pearson Education.
4. Daniel T. Larose (2006): Data Mining: Methods and Models, John Wiley and sons. (relevant portions of Chapter 4).

COURSE CODE: ST 235

COURSE TITLE: Elective I- (ii) ORDER STATISTICS

COURSE OUTCOMES

On completion of the course, students should be able to:

CO1. Understand the basic properties of Order statistics.

CO2. Explain Probability mass function of order statistics arising from discrete and distributions.

CO3. Examine order statics of various types of discrete and continuous distributions CO4.Explains the properties and relations of moments of Oder statistics.

CO5. Realize the difference between discrete and continuous probability distributions. CO6. Explain the estimation and prediction under Order statistics.

CO7. Explain the concept of order statistics and solving problems related to it

CO8. Understanding concept of Record value and Concomitant Order statistics and their applications

MODULE OUTCOMES

Sl. No:	**Outcomes** On completion of each module, students should be able to:	**Taxonomy level**
Module I	MO1. Explains the basic concepts of distribution of single order statistic, joint distribution of two or more order statistics. MO2. Verify the Markov property of Order statistics. MO3. Examine the various properties of Order statistics. MO4. . Explain the concept of order statistics	Understand Remember Understand Understand
Module II	MO5. Explain the moments oforder statistic and its properties. MO6. Derive the recurrence relations on the single and product moments of order statistics. MO7. Describe Order statistics from symmetric population.	Understand Remember Understand
Module III	MO1. Examine order statics of various types of discrete and continuous distributions and articulate their properties	Apply
Module IV	MO1. Explain the different estimators used in order statistics MO2.Examine prediction of order statistics. MO3. Find the confidence interval using sample quantile.	Evaluate Apply Understand

COURSE CONTENT

MODULE I

Basic distribution theory: Distribution of single order statistic, joint distribution of two or more order statistics, conditional distributions and Markov chain property. Distribution of median, range and mid-ranges, Probability mass function of order statistics arising from discrete distributions.

MODULE II

Moments of order statistics, Identities on the moments of order statistics, recurrence relations on the single and product moments of order statistics. Discussion of the above relation for symmetric population.

MODULE III

Order statistics from specific population such as Bernoulli and three-point Discrete uniform distribution, exponential distribution, uniform, power function, normal and logistic distributions.

MODULE IV

Order statistics in statistical inference: Order statistics and sufficiency, linear estimations of location and scale parameters, Gupta's simplified linear estimator, prediction of order statistics, confidence intervals using sample quantile.

Text Books

1. Arnold, B. C. and Balakrishnan, N. (1989) : Relations, Bounds and Approximations for order statistics, Lecture notes in Statistics No. 53, Springer- Verlag, New York.
2. Arnold, B. C., Balakrishnan, N. and Nagaraja, H. N. (1992) : A first course in Order Statistics, John Wiley, New York.
3. David, H. A. and Nagaraja, H. N. (2003): Order statistics, 3rd edition, John Wiley, New York.

COURSE CODE: ST 235

COURSE TITLE: Elective I- (iii) BIOSTATISTICS

COURSE OUTCOMES

On completion of the course, students should be able to:

CO1. Understand the concepts about Biostatistics.

CO2. Utilize the fundamental concepts in Epidemiology and its relation with real life situations.

CO3: Familiar with various observational study designs and sample size estimation .

CO4. Get skilled in data modeling through survival analysis of lifetime distributions.

MODULE OUTCOMES

Sl.no	Outcomes On completion of each module, students should be able to	Taxonomy Level
Module I	M01. Explain the importance of Biostatistics in Medicine and Biological sciences M02. Define basic terminologies related to Medical Science.	Understand Evaluate
Module II	M01. Asses validity and reliability of diagonostic and screening test. M02. Explain the use of ROC curve	Understand Apply
Module III	M01. Disclose the basic concepts of Epidemiology M02. Explain the importance of Logistic regression analysis and odds ratio	Understand Analysis
Module IV	M01. Describe the application of survival analysis in medical science by modeling	Apply

	data. M02. Understand the planning and design of clinical trial experiments in different phases.	 understand

COURSE CONTENT

Module I

Concepts of Biostatistics: Need for statistical methods in medicine,Public health and Biology. Measuring the occurrence of disease, Measures of morbidity - prevalence and incidence rate, association between prevalence and incidence, uses of prevalence and incidence, problems with incidence and prevalence measurements; Clinical agreement: kappa statistics, Mantel-Haenszel test; intra-class correlation. Study designs- cross sectional, case- control and cohort. Estimation of sample size in different study designs.

Module II

Assessing the validity and reliability of diagnostic and screening test: Validity of screening test –sensitivity, specificity, positive predictive value and negative predictive value; Reliability; Relationship between validity and reliability; ROC curve and its applications,

Module III

Epidemiology concepts: Association; causation; causal inference; Errors and bias; Confounding; Controlling confounding; Measurement of interactions; Estimating risk: Estimating association –absolute risk, relative risk, The Logistic Regression Model, The Logistic Function, Odds Ratio, The Logit of P, Logit Regression Coefficient as measures of effect on Logit P.

Module IV

Survival distributions and their applications viz. Exponential, Gamma, Weibull, Rayleigh, Lognormal, death density function for a distribution having bathtub shape hazard function. Tests of goodness of fit for survival distributions. Parametric methods for comparing two survival distributions -LR test. Planning and design of clinical trials, Phase I, II, and III trials.

Text Books

1.Daniel W. Biostatistics: A foundation for analysis in the health sciences. 10th edition. John Wiley & Sons.

2. P. Armitage, G. Berry & J. N. S. Matthews; 2002; Statistical Methods in Medical Research: 4^{th} Ed., Blackwell science.

3. Martin Bland, 2000 An introduction to medical statistics, Oxford university press.

4. Gross and Clark (1999) Survival distributions: Reliability applications in the Biomedical science: John Wiley & Sons

5. Mark Woodward ,Epidemiology- Study, Design & Analysis:. Chapman & Hall (CRC Series).

References

1. Altman Douglas G (2000). Practical Statistics for Medical Research Chapman & Hall London.

2. Alan J Silman & Gray j Macfarlance (2002), Epidemiological studies a practical guide:, 2^{nd} ed. Camebridge uni press.

3. Cox, D. R. and Oakes, D. (1984): Analysis of survival data, Chapman & Hall, New York.

4. D. Collet (2003), Modeling Survival Data in Medical Research: , CRC Press.

6.Carol Redmond & Theodore colton, 2001, Biostatistics in clinical trials:, John Wiley

7. Fleiss, J. L. (1989). The design and Analysis of Clinical Experiments, John Wiley & Sons.