P.G AND RESEARCH
DEPARTMENT OF STATISTICS

THANTHAI PERIYAR GOVERNMENT ARTS&SCIENCE COLLEGE
(AUTONOMOUS)
TIRUCHIRAPPALLI – 620 023.

SYLLABI

M.Sc (Statistics)

From 2023-24 onwards

Question Paper Pattern

For all Core courses, Choice Base Elective Cources the Question Pattern is as follows.

Section - A (10 x 2 = 20)

Answer ALL the questions

Two questions from each unit of the syllabus.

Section - B (5 x 5 = 25)

Answer ALL the questions

Five questions in either or pattern with internal choice covering all the five units of the syllabus.

Section - C (3 x 10 = 30)

Answer any THREE questions

Five questions covering all the five units of the syllabus.

For Non Major Elective Courses the Question Pattern is as follows:

Five out of Eight questions covering all the five units. **(5 x 15 = 75 marks)**

THANTHAI PERIYAR GOVERNMENT ARTS AND SCIENCE COLLEGE (AUTONOMOUS), TIRUCHIRAPPALLI-23.

COURSE PATTERN FOR M.Sc (Statistics) - 2022-2023 ONWARDS

SL. NO.	PART	COURSE		COURSE TITLE	Exam	Hrs.	Credit	CIA	Semester Exa	Total
I SEMESTER										
1	-	Core	I	ADVANCED OPERATIONS RESEARCH	3	6	5	25	75	100
2	-	Core	II	ESTIMATION THEORY	3	6	5	25	75	100
3	-	Core	III	DISTRIBUTION THEORY	3	5	4	25	75	100
4	-	Core	IV	MEASURE AND PROBABILITY THEORY	3	5	4	25	75	100
5	-	Core	V-P	R-PROGRAMMING (LAB)	3	6	4	40	60	100
6	-	SEC	I-P	SKILL ENHANCEMENT COURSE – I TORA (OR)	3	2	2	25	75	100
				TOTAL		**30**	**24**	**165**	**435**	**600**
II SEMESTER										
7	-	Core	VI	REAL ANALYSIS AND LINEAR ALGEBRA	3	5	5	25	75	100
8	-	Core	VII	STOCHASTIC PROCESSES	3	5	5	25	75	100
9	-	Core	VIII	STATISTICAL QUALITY CONTROL	3	5	4	25	75	100
10	-	Core	IX-P	COMPUTATIONAL ANALYSIS	3	5	4	40	60	100
11		CBE	I	DISCIPLINE SPECIFIC ELECTIVE – I	3	5	3	25	75	100
12	-	NME	I	Non-Major Elective – I Medical Labouratory Technology	3	3	2	25	75	100
13		SEC	II-P	SKILL ENHANCEMENT COURSE – II (Industrial Statistics using Software Packages)	3	2	2	25	75	100
				TOTAL		**30**	**25**	**190**	**510**	**700**
III SEMESTER										
14	-	Core	X	TESTING OF HYPOTHESIS	3	6	5	25	75	100
15	-	Core	XI	LINEAR MODEL & DESIGN OF EXPERIMENT	3	5	4	25	75	100
16	-	Core	XII-P	COMPUTER LAB FOR DATA ANALYSIS	3	5	4	40	60	100
17	-	CBE	II	DISCIPLINE SPECIFIC ELECTIVE – II	3	4	3	25	75	100
18	-	CBE	III	DISCIPLINE SPECIFIC ELECTIVE – III	3	5	3	25	75	100
19		NME	II	Non-Major Elective – II Domestic Chemistry	3	3	2	25	75	100
20		SEC	III-P	SKILL ENHANCEMENT COURSE – III (Python)	3	2	2	25	75	100
				TOTAL		**30**	**23**	**190**	**510**	**700**
IV SEMESTER										
21	-	Core	XIII	PROGRAMMING IN C++ WITH APPLICATIONS	3	6	4	25	75	100
22	-	Core	XIV-P	COMPUTER PROGRAMMING USING C++ (LAB)	3	5	4	40	60	100
23	-	CBE	IV	DISCIPLINE SPECIFIC ELECTIVE – IV	3	5	3	25	75	100
24	-	SEC		SKILL ENHANCEMENT COURSE – IV (Research Tools and Techniques)		2	2	25	75	100
25		EA		EXTENSION ACTIVITY		-	1	25	75	100
26		Project				12	4	25	75	100
				TOTAL		**30**	**18**	**165**	**435**	**600**
				GRAND TOTAL		**120**	**90**	**710**	**1890**	**2600**

Note:

1. Internship/Field Visit/Industrial Visit is mandatory for course completion.
2. Core Based Elective course will be chosen from the pool of elective courses.

Program Specific Outcomes (PSOs)

On successful completion of M. Sc. Statistics program, the students will be expected to:

PSO1 Comprehend the theoretical aspects of statistics

PSO2 Recognize the application of statistics in diversified fields

PSO3 Develop computer programs and codes for statistical computation

PSO4 Utilize statistical software effectively for data analysis

PSO5 Understand the conditions and limitations of statistical methods in application

PSO6 Critically analyze statistical data and make interpretations

Program Outcomes (POs)

On successful completion of the M. Sc. Statistics program, the graduates will be able to:

PO1 Possess adequate knowledge in theory and applications

PO2 Adopt conceptual ideas, principles and methods in diversified fields of study

PO3 Utilize analytical skills for basic mathematical computation

PO4 Utilize software skills for statistical computation

PO5 Prepare to participate in competitive examinations at the state and national level

PO6 Acquire skills to meet the challenges in job placements

PO7 Gain impetus to move for learning at higher level

PO8 Gain effective skills to perform data analysis using statistical tools

PO9 Identify potential areas of applications of statistical theory

PO10 Recognize the importance and value of statistical principles and approach for problem solving on a diversified disciplines

Duration for all Practical examinations: 3 Hours

For Practical:

Internal		**External**	
Continuous Performance	**20 Marks**	**Record**	**10 Marks**
Model Exam	**10 Marks**	**Examination**	**50 Marks**
Record	**05 Marks**		
Attendance	**05 Marks**		
Total	**40 Marks**	**Total**	**60 Marks**

List of Core Based Elective Courses:

1. MULTIVARIATE STATISTICAL ANALYSIS
2. ADVANCED SAMPLING THEORY
3. ACTURIAL STATISTICS
4. RELIABILITY AND SURVIVAL ANALYSIS
5. TIME SERIES ANALYSIS
6. DATA MINING

Non-Major Elective Courses:

Receiving from P.G Departments:

Sl.No	Title	Offering Department
1.	**MEDICAL LABORATORY TECHNOLOGY**	**Bio-Chemistry**
2.	**DOMESTIC CHEMISTRY**	**Chemistry**

Offering to other P.G Departments:

Sl.No	Title	Receiving Department
1.	**STATISTICAL FOUNDATION FOR COMPUTER SCIENCE**	**Computer Science**
2.	**BIO-STATISTICS**	**Bio-Chemistry**

CORE - I

ADVANCED OPERATIONS RESEARCH

Semester – I **Credits : 5**

Code: **Hours : 6**

Course Objective:

To impart knowledge on the various advanced topics of Operations Research and their usage in real life.

Course Outcome:

Students can understand and apply the advanced topics of Operations Research in the field of real life situation.

Unit - I

Linear Programming Problem (LPP), Graphical Method,Algebraic solutions,Simplex method, Penalty method, Two-Phase Simplex, Duality in Linear Programming, Dual Simplex Method and Revised Simplex Method.

Unit – II

. Integer Programming -Pure and Mixed integer programming problem, Construction of Gomory's constraints, Gomory's fractional cut method for all integer, fractional cut method for mixed integer and Branch and Bound method, Applications of Integer Programming.

Unit – III

Non-Linear Programming Problem (NLPP) - Formulating a non-linear programming problem, Kuhn-Tucker conditions for non-linear programming. Quadratic Programming - Wolfe's and Beale's algorithms for solving quadratic programming problem.

Unit - IV

Game Theory – Two person Zero Sum Games – The Maximi-Minimax principle - Games without saddle points – Mixed Strategies – Graphic Solutions of 2 X n and m X 2 Games. Dominance Property.

Unit - V

Queuing system – Elements of Queuing system – Operating Characteristics of a Queueing system – Deterministic Queueing system - Classification of Queueing Models – Definition of Transisent and steady states – Poisson Queueing systems- Single Server models with finite and infinite – Multi Server Models with finite and infinite-Problems only.

Book for Study:

Kanti Swarup, P.K Gupta and Man Mohan, Operations Research, Sultan Chand, New Delhi.

Books for Reference:

1. Hamdy A.Taha, An Introduction to Operations Research, Prentice Hall of India, New Delhi.
1. Ravindran.A, Don.T.Phillips and James J.Solberg, Operations Research Principles and Practice, John Wiley & Sons.
2. Pannerselvam.R., Operations Research, Prentice Hall of India, New Delhi.
3. Prem Kumar Gupta, Hira. D.S., Operations Research, S.Chand & Company Ltd, New Delhi.

WEB RESOURCES:

1. https://youtu.be/rDDmPvSAll
2. https://youtu.be/vUMGvpsb8dc
3. https://youtu.be/y7rEGCsymzs
4. www.iso90002000.com
5. www.statsoft.com

CORE - II

ESTIMATION THEORY

Semester – I **Credits : 5**

Code: **Hours : 6**

Course Objectives

- To understand various concepts and methods of estimation at Post Graduate level.
- To develop the knowledge to solve practical problems.

Course Outcomes

- Students gain analytical skills in selected areas of Estimation Theory.
- An understanding of Estimation principles, techniques and knowledge towards applications of statistical theory.

Unit -I

Parametric point estimation. Consistency – weak consistency, consistency in rth mean, strong consistency, sufficient conditions for consistency. Efficiency of estimators. Sufficient statistics – Factorization theorem, Distributions admitting sufficient statistic, procedure for finding minimal sufficient statistic.

Unit – II

Unbiased estimator. Uniformly minimum variance unbiased estimator (UMUE) - necessary and sufficient conditions for an unbiased estimator to be UMVUE; Completeness and boundedly completeness; relationship between complete statistic and minimal sufficient statistic; Rao-Blackwell theorem, Lehmann-Scheffe theorem, Information inequality – Cramer-Rao (CR) inequality, Kiefer-Chapman-Robbins (KCR) inequality, Bhattacharya inequality.

Unit – III

Methods of point estimation – Method of Moments, Method of Maximum Likelihood. Method of minimum chi-square, Method of modified minimum chi-square. Properties of these estimators (both large and small samples).

Unit - IV

Interval estimation – Fundamental notions of interval estimation, Shortest length confidence intervals and their construction-Single Proportion,Difference of Proportions, Single Mean and Difference of Means.Construction of confidence intervals applying maximum likelihood estimator.

Unit – V

Bayes estimation – concept of prior, posterior distributions. Bayes estimator under quadratic error loss function – Elementary notions of minimax estimation – application.

Books for Study:

1. Rohatgi,V.K and Saleh, A.K.Md.E, (2011),An Introduction to Probability and Statistics Second Edition, John Wiley & Sons, New York.
2. Lehmann, E.L. and Casella,G. (1998) Theory of Point Estimation, 2/e , Springer , New York.
3. Casella G and Berger R L, (2002). Statistical Inference, Second Edition, Thompson Learning, New York. (Reprint, 2007).
4. Goon, A M, Gupta M.K and Dasgupta B, (1989), An Outline of Statistical Theory, Vol. II, World Press, Kolkata.

Books for Reference:

1. Rao, C.R, (2009), Linear Statistical Inference and Its Applications, Second Edition, John Wiley & Sons, New York, US.
2. Mood A.M, Graybill F.A and Boes D.C, (1974), Introduction to Theory of Statistics, Third Edition, McGraw-Hill International Edition.
3. Bansal, A.K, (2007), Bayesian Parametric Inference, Narosa Publishing House, New Delhi.

WEB RESOURCES:

1. https://youtu.be/L-dYNx63v54
2. https://youtu.be/k-eh0bnc-j0
3. www.statistical estimation theory.com

CORE – III
DISTRIBUTION THEORY

Semester– I **Credits : 4**

Code: **Hour : 5**

Course Objectives

The main objectives of this course are to:

Study the methods of deriving the distributions of functions of random variables.

Understand bivariate and multivariate distributions.

Derive the compound and truncated distributions

Understand the distribution of quadratic forms.

Understand the properties of the distribution of order statistics.

Course Outcome

On the successful completion of the course, student will be able to:

Apply the concept of transformations to find the distribution of function of random variables

Understand the properties of Bivariate Normal Distribution

Derive the properties and apply the results of compound and truncated distributions

Explain the need for non-central distributions and derive the properties of the same

Derive the distribution and properties of order statistics and apply the same to real life problems

Unit – I

Distribution of sum, difference, quotient and product of two dimensional independent random variables using Jacobian of transformation – concept of delta method – approximating distributions of sample moments.

Unit – II

Bivariate Normal – Moment Generating Function-Marginal and Conditional distributions. Moments-Distribution of correlation coefficient when population correlation coefficient is equal to zero, Distribution of regression coefficients.

Unit – III

Compound, truncated and mixture distributions: Left truncated Binomial-Left truncated Poisson-Left and Right truncated Normal distributions– Non-central t, F and chi-square distributions.

Unit – IV

Distribution of Quadratic forms in normal random variables, their mean and variance, Independence of Quadratic forms, Independence of linear and Quadratic forms, Fisher-Cochran's theorem.

Unit – V

Order Statistics: Distribution and properties – Joint and marginal distributions - distribution of median and range – extreme values and their asymptotic distributions – applications.

Books for Study:

1. Johnson and Kotz(1970), Distribution in Statistics, Vol I, II and III, Wiley, U.P, India.
2. Kendall, M.C., and Stuart, A.(1963), The Advanced theory of Statistics Vol I – Distribution theory, Charles Griffin and Company Ltd, London.
3. Gupta S.C, and Kapoor V.K (2013), Fundamental of Mathematical Statistics. - Sultan Chand & Sons, New Delhi.

Books for Reference:

1. Anderson,T.W (1983), An introduction to multivariate statistical analysis, 2nd edition, John wiley, New Jersey, Canada.
2. Hogg R.V and A.T.Craig (1972), An introduction to mathematical statistics, 3rd edition, Amerind, New york, London.
3. Kshirsagar, A. M. (1972), Multivariate analysis, Mancell Dekker, New york.
4. Rohatgi, V.K. (1988), An introduction to probability theory and Mathematical Statistics, Wiley Eastern Ltd, New Delhi.
5. Rao, C.R. (1973),Linear Statistical Inference and its applications, 2nd edition, Wiley Eastern, New Delhi.

WEB RESOURCES:

1. https://nptel.ac.in/courses/111/104/111104073/

2. https://nptel.ac.in/content/storage2/courses/111104073/Module14/Lecture42.pdf

3.https://www.youtube.com/watch?v=XIWIOQVKXpI

CORE – IV

MEASURE AND PROBABILITY THEORY

Semester – I **Credits : 4**

Code : **Hours : 5**

Course Objectives:

The main objectives of this course are to:

- Understand the concept of measure and probability theory.
- Explore the basic and advance concepts available in measure and probability.
- Develop the mathematical probability and their applications.

Course Outcomes:

Student will be able to:

- Understand the meaning of measure and probability
- Comprehend the concepts of sets, functions, measure and probability space
- Provide basic and advanced applications of measure and probability
- Identify application of inequalities in probability theory
- Explore the application of law of large numbers and central limit theorems

Unit – I

Measure Theory - Limits of sequence of sets, classes of sets – Field, Sigma Field and Monotone class, Measure and Measure Space – Measurable function.

Unit – II

Lebesgue – Stieltjes measure, Measure integral and its properties, Dominated convergence theorem – Radon–Nikodymn theorem, almost everywhere convergence, convergence in measure and convergence in mean.

Unit – III

Events, sample space, different approaches to probability, random variables and random vector, Distribution functions of random variables and random vector, Expectation and moments, basic, Markov, Chebyshev's, Holder's, Minkowski's and Jensen's inequalities.

Unit – IV

Independence of sequence of events and random variables, conditional probability, conditional expectation, Characteristic functions and their properties, inversion formula, convergence of random variables, convergence in probability, almost surely, in the r-th mean and in distribution, their relationships, convergence of moments, Helly-Bray theorem, continuity theorem and convolution of distributions.

Unit – V

.Central limit theorem, statement of CLT, Lindeberg, Levy and Liapounov forms with proof and Lindeberg Feller's form examples. Khintchine weak law of large numbers, Kolmogorovinequality, strong law of large numbers

Books for Study:

1. Basu, A.K. (1999) Measure theory and Probability, PHI.
2. Bhat, B. R. (2014) , Modern Probability Theory-An Introductory Text Book, Third Edition, New Age International.
3. Feller.W. (1968) Introduction to Probability and Application,
4. 4. Rohatgi,V.K.(1985) An Introduction to Probability Theory and Mathematical Statistics,
   Wiley Eastern Ltd.Wiley Eastern Company.

Books for Reference:

1. De Barra, G. (1991) Measure theory and Integration, Wiley Eastern Ltd.,
2. Rohatgi V.K.(2002) : Introduction to Mathematical Statistics, Wiley.

WEB RESOURCES:

1. http://nptel.ac.in/courses/111/101/111101005
2. http://nptel.ac.in/courses/111/102/111102111
3 . http://nptel.ac.in/courses/111/102/111102111

CORE – V-P
R PROGRAMMING (LAB)

Semester – I **Credits : 4**

Code: **Hours : 6**

Course Objectives:

The main objectives of this course are to:

- Understand the operations and functions of R Programming,
- Perform statistical analysis using built-in functions
- Learn and write customized program for mathematical and statistical problems

Course Outcomes:

On the successful completion of the course, student will be able to:

- Understand the basics of R language
- Apply the logical skills for performing statistical analysis
- Use appropriate diagrams and charts for all kinds of data
- Write and execute the R Code for multivariate analysis

Unit -I

Diagrammatic and Graphical Representation using ggplot. Frequency Distribution table. Measures of Central Tendency. Measures of Dispersion. Measures of Skewness and Kurtosis

Unit -II

Simple linear Correlation Co.efficient, Simple Linear Regression equations, Multiple linear Regression equation.

Unit -III

Testing of Hypothesis: One Sample t test- Independent t test- Paired t test - Chi Square Test : Independence of Attributes - Chi Square Test: Goodness of Fit.

Unit - IV

Design of Experiments - Completely Randomized Design - Randomized Block Design - Latin Square Design.

Unit - V

Statistical Quality Control: $\bar{X}$ Chart, R Chart, p Chart, C Chart, d Chart and U Chart Fitting of Distributions: Binomial Distribution- Poisson Distribution - Normal Distribution.

Books for Reference:

1. Purohit, S. G., Gore, S. D., and Deshmukh, S. R. (2009). Statistics Using R, Narosa Publishing House, New Delhi.
2. Quick, J. M. (2010). Statistical Analysis with R, Packt Publishing Ltd., UK.

WEB RESOURCES:

1. https://swayam.gov.in/ndl_noc19_ma33/preview
2. https://swayam.gov.in/nd2_aic20_sp35/preview
3. https://nptel.ac.in/courses/111/104/111104100

SEC – I

SKILL ENHANCEDMENT COURSE – 1 : TORA(LAB)

(Operations Research Software)

Semester – I **Credits : 2**

Code: **Hours : 2**

Course Objectives:

The main objectives of this course are to:

- Understand the functions of operations research.
- Perform statistical analysis using TORA software.
- Learn and develop problems related to Operations Research.

Course Outcomes:

On the successful completion of the course, student will be able to:

- Understand the basics of Operations Research.
- Apply the technique of TORA for performing Operations Research Problems.
- Develop these ideas for new problems.
- Execute the TORA for Operations Research Problems.

List of Topics to be covered:

1. Linear Programming Problem.
2. Transportation Problem.
3. Integer Programming Problem.
4. PERT & CPM.
5. Queueing Analysis.
6. Zero Sum Games.

Link to download TORA:

C:\Users\Office\AppData\Local\Temp\Rar$DI61.424\tora.CAB

CORE - VI

REAL ANALYSIS AND LINEAR ALGEBRA

Semester – II **Credits : 5**

Code: **Hours : 5**

Course Objectives:

The main objectives of this course are to:

- Impart the understanding of the basic concepts of real analysis and linear algebra
- Enhance the ability of proving the theorems in real analysis and linear algebra
- Understand the meaning of convergence of sequence and series of real numbers
- Comprehend the concepts which are essential for learning other courses

Course Outcomes:

On the successful completion of the course, student will be able to:

- Identify the given functions are continuous or discontinuous.
- Examine the convergence of sequence and series of real numbers.
- Understand the conditions for integrability of a real valued function.
- Derive the characteristic roots and vectors.
- Determine the nature of quadratic forms and reduction of quadratic forms

Unit – I

Metric space –open, closed sets-Intervals(rectangles), Real valued continuous functions-Discontinuities-compact sets, Bolzano-Weirstrass theorem, Heine-Borel theorem.

Unit – II

Derivatives-Maxima and minima –Rieman integral & Riemann –Stieltjes integral with respect an increasing integrator –properties of R.S.integral. Functions of several variables, constrained and unconstrained maxima-minima of functions, partial and total derivatives.

Unit - III

Basic properties of matrices(Orthogonal, idempotent, kronecker product, projection operators etc.,) Linear dependence , independence and rank of a matrix:characteristics roots and polynomial, multiplicity of characteristic roots;Cayley Hamilton theorem; inverse of matrix and determinants.

Unit - IV

Reduction of matrices, Echelon form, Hermite canonical form, diagonal reduction, rank factorization, triangular reduction Jordan form; Symmetric matrices and its properties; Decomposition like, singular value decomposition, spectral decomposition , Cholesky decomposition etc.,

Unit - V

Matrix differentiation: Generalized inverse an its properties , Different classes of generalized inverse. Properties of g-inverse. Moore and Penrose g-inverse and its properties. Quadratic forms and their classifications, definiteness, index and signature, extremum; transformation and reduction of quadratic form; application of quadratic forms.

Books for study:

Goldberg, R.R. (1970) Methods of Real Analysis, Oxford & IBH, New Delhi.

Books for Reference:

1. Apostol, T.M. (1997) Mathematical Analysis, Narosa, New Delhi.
2. Somasundaram,D. (2002) Mathematical Analysis, Narosa, New Delhi.
3. Datta, K.E. (1991) Matrix and Linear Algebra, Prentice-Hall, New Delhi.
4. Rao, C.R. (1973) Linear Statistical Inference and its Applications, Wiley Eastern, New Delhi
5. Searle, S.R. (1973) Linear Models, Wiley, New York.
6. Ramachandra Rao, A. and Bhimasankaran, P.(1992) LinearAlgebra, Tata McGraw Hill, New Delhi.

WEB RESOURCES:

1. https://youtu.be/dxoArRt7lww
2. https://youtu.be/MHDUCp40Acg
3. www.statsoft.com
4. www.realseries.com

CORE-VII
STOCHASTIC PROCESSES

Semester – II **Credits : 5**

Code: **Hours : 5**

Course Objectives:

The main objectives of this course are to:

- Understand the fundamental concept of random process and its variants.
- Understand the Chapman-Kolmogorov equation and its applications.
- Compute transition probability matrix and its long run distribution.
- Inculcate various models of stochastic process and its applications.
- Impart knowledge on various stationary time series modeling techniques

Course Outcomes:

On the successful completion of the course student will be able to

- Compute n-step transition probability matrix and its long run.
- Classify the states of Markov chain
- Know the concept of branching process and to compute extinction probabilities
- Know the concept of renewal process and its applications
- Forecast using various stationary time series techniques

Unit –I

Definition of Stochastic process – Specification of Stochastic Processes. Stationary Processes – Second order process, Stationarity, Gaussian processes. Martingales: Definition and properties,. Martingales in discrete time - Supermartingales and submartingales - Continuous Parameter Martigales- Martingale convergence theorem and its applications.

Unit – II

Markov chains – Definitions and examples. Higher order transition probabilities: Chapman – Kolmogrov equation. Classification of States and Chains – Determination of Higher order Transition Probabilities -Aperiodic Chain:Limiting Behaviour. Stability of a Markov system.

Unit – III

Poisson process – Poisson process and related distributions. Pure Birth Process – Birth and Death process – Simple examples. Branching process – properties of generating function of branching process – Probability of extinction – fundamental theorem of branching process.

Unit - IV

Renewal theory - Renewal equation - Stopping time - Wald's equation - Elementary renewal theorem and its applications - Renewal reward processes - Residual and Excess life times - Markov renewal and Semi Markov processes.

Unit – V

Queuing model M/M/1: Steady State Behaviour - Steady State Solution, Waiting time distribution. Queueing Model M/M/S - Steady State Solution, Waiting time distributions – simple problem.

Books for Study:

Medhi, J. (2017). Stochastic Processes, Fourth Edition, New Age International (P) Ltd. New Delhi.

Books for Reference:

1. Cinlar, E. (2013) Introduction to Stochastic Processes, Courier Dover, New York.
2. Cox, D.R. and Miller,A.D (1984) The Theory of Stochastic Processes, Chapman &Hall,London.
3. Harris, T.E. (1963): Theory of Branching Processes, Courier Dover, New York.
4. Karlin, S. and Taylor, H.M. (1975): A First Course in Stochastic Processes, Vol. I. Academic Press, New York.
5. Linda J.S. Allen (2011) An Introduction to Stochastic Processes with Applications to Biology, 2/e,Chapman& Hall/CRC, London.
6. Papoulis, A. and Pillai, U.S. (2006). Probability, Random Variables and Stochastic Processes,4/e, Tata McGraw-Hill, New Delhi.

WEB RESOURCES:

1. https://www.youtube.com/watch?v=TuTmC8aOQJE&t=8s
2. www.wikipedia.org /markov chain.html
3. www.wikipedia.org /ergodic theory.html
4. www.wikipedia.org / stochastic process.html

CORE - VIII

STATISTICAL QUALITY CONTROL

Semester – II **Credits : 4**

Code: **Hours : 5**

Course Objectives:

The main objectives of this course are to:

- Understand the application of Statistics in industrial environment.
- Acquire knowledge on manufacturing process changes and process variability
- Attain proficiency in process capability analysis

Course Outcomes

On the successful completion of the course, student will be able to:

- Construct control charts for the large and smaller shifts in the process parameters
- Effectively interpret the results from the control charts
- Carry out process capability analysis
- Adopt appropriate sampling inspection plans for given conditions

Unit – I

Quality – Quality Improvement – Dimensions of Quality – Quality Engineering terminology – Statistical methods for Quality Control and Improvement – Management aspects of Quality Improvement: Quality Planning, Quality assurance, Quality control and improvement, Quality Philosophy and Management Strategies: Deming's 14 points, Total Quality Management, Quality Systems and Standards – Quality Costs.

Unit - II

Statistical Process Control: Chance and assignable causes of Quality Variation – Statistical basis of the control charts – Average run length – Average time to signal – Rational subgroup – Analysis of patterns on control charts – Rest of the magnificent seven – Implementing SPC in a Quality Improvement Program.

Unit – III

Process Capability Analysis (PCA) – PCA using Histogram or a probability plot – Process Capability Ratios (PCR) – PCR for an Off-Center Process – Normality and the PCR – Confidence intervals and tests on PCR – PCA using a Control Chart, PCA using Designed experiments – PCA with attribute data.

Unit – IV

Cumulative Sum Control Chart: V Mask Procedure – Exponentially Weighted Moving Average Control Chart – Moving Average Control Chart – Modified and Acceptance Control Charts – Group Control Charts.

Unit – V

Acceptance sampling - lot formation – sampling inspection by attributes – single sampling plans – OC function – rectifying inspection - Double and multiple sampling plans – OC, ASN, ATI and AOQ functions - Use of Dodge – Roming and other tables of plans. AQL, LTPD, producer's risk and consumer's risk on OC curve - operation and use of single, double and multiple sampling plans.

Book for Study:

Douglas C. Montogomery (2013), Statistical Quality Control. A Modern Introduction, John Wiley, 6thEdn

Books for Reference:

1. Juran (1998) , Quality Control Handbook, McGraw Hill, 4thEdn.
2. Mahajan (1997), Statistical Quality Control, DhanpathRai & Sons.

WEB RESOURCES:

1. www.iso90002000.com, www.statsoft.com
2. http://bmepedia.weebly.com/uploads/2/6/6/8/26683759/unit_4_quality_control.pdf
3. https://nptel.ac.in/courses/116/102/116102019/

CORE – IX-P
COMPUTATIONAL ANALYSIS

Semester – II **Credits : 4**

Code: **Hours : 5**

Course Objectives:

- To impart knowledge on the various advanced topics of Operations Research and their usage in real life.
- Understand the application of Statistics in industrial environment.

Course Outcomes:

Students can understand and apply the advanced topics of Operations Research in the field of real life situation.

Unit - I

Linear Programming Problem (LPP), Graphical Method, Algebraic solutions, Simplex method, Penalty method, Two-Phase Simplex, Duality in Linear Programming, Dual Simplex Method and Revised Simplex Method.

Unit – II

. Integer Programming -Pure and Mixed integer programming problem, Gomory's fractional cut method for all integer, fractional cut method for mixed integer and Branch and Bound method.

Unit – III

Hotelling-T^2 distribution – generalized T^2 statistic– Mahalanobis-D^2 statistic.

Unit – IV

Linear Discriminant function. Fisher's discriminant Function for two population and several populations. Canonical correlation – derivation of canonical correlation coefficients. Principal component Analysis.

Unit – V

Cumulative Sum Control Chart: Exponentially Weighted Moving Average Control Chart – Moving Average Control Chart – Modified and Acceptance Control Charts – Group Control Charts.

Books for Study:

1. Kanti Swarup, P.K Gupta and Man Mohan, Operations Research, Sultan Chand,
2. New Delhi.
3. Johnson, R.A. and D.W. Wichern.(2013). Applied Multivariate Statistical Analysis (Sixth Edition), Pearson New International Edition.
4. Douglas C. Montogomery (2013), Statistical Quality Control. A Modern Introduction, John Wiley, 6thEdn

Books for Reference:

1. Hamdy A.Taha, An Introduction to Operations Research, Prentice Hall of India,

   New Delhi.
2. Ravindran.A, Don.T.Phillips and James J.Solberg, Operations Research Principles

   and Practice, John Wiley & Sons.
3. Morrison, D.F. (2004). Multivariate Statistical Methods (Fourth Edition). Duxbury Press, New York.
4. Kendall, M.G., Stuart, A. and Ord, K.J. (1973).The Advanced Theory of

   Statistics. (Fourth Edition), Vol. 2, Charles Griffin company Ltd.

SEC – II

SKILL ENHANCEDMENT COURSE – II : INDUSTRIAL STATISTICS USING SOFTWARES (LAB)

Semester – II **Credits : 2**

Code: **Hours : 2**

Course Objectives:

The main objectives of this course are to:

- Understand the application of Statistics in industrial environment.
- Acquire knowledge on manufacturing process changes and process variability
- Attain proficiency in process capability analysis

Course Outcomes

On the successful completion of the course, student will be able to:

- Construct control charts for the large and smaller shifts in the process parameters using statistical software
- Effectively interpret the results from the control charts
- Carry out process capability analysis
- Adopt appropriate sampling inspection plans for given conditions

List of Topics to be covered:

- Measures of Central Tendency, Measures of Dispersion and Skewness and Kurtosis

✓ Arithmetic Mean, Median, Mode
✓ Standard Deviation
✓ Measures of Skewness and Kurtosis.

- Correlation and Regression:

✓ Karl Pearson Coefficient of Correlation
✓ Spearman's Rank Correlation
✓ Simple Linear Regression

- Testing of Hypothesis

✓ One sample t test
✓ Independent t test
✓ Paired t test
✓ ANOVA – One way and Two way

- Magnificent Tools

✓ Histogram
✓ Cause and Effect Diagram
✓ Scatter Diagram
✓ Control Charts
    - $\bar{X}$ Chart, R Chart, p Chart, d Chart, C Chart and U Chart
    - Moving average Control Chart
    - Cumulative Sum Control Chart
✓ Process Capability Analysis
    - Cp and Cpk

CORE – X
TESTING OF HYPOTHESIS

Semester – III **Credits : 5**

Code: **Hours : 6**

Course Objectives:

The main objectives of this course are to :

- Know the principle and concepts of hypothesis testing.
- Understand Neyman-Pearson fundamental lemma for testing statistical hypothesis.
- Understand the MP Test , UMP Test and LR Test.
- Understand the sequential test procedure and SPRT.
- Know to apply Non-parametric tests.

Course Outcome

On the successful completion of the course, student will be able to:

- Determine the size of critical region and power of test function.
- Apply the NP lemma to real life problem solving.
- Apply a sequential procedure for a specified stopping rule and the decision rule.
- Apply the likelihood ratio test to the hypothesis of real life situations.
- Test statistical hypothesis by selecting suitable test procedure.

Unit – I

Randomized and non-randomized tests. Neyman – Pearson fundamental lemma, Most Powerful test, Uniformly most powerful test, Uniformly most powerful test for distributions with monotone likelihood ratio, Generalization of fundamental lemma (statement only)

Unit - II

Unbiasedness for hypothesis testing, Uniformly Most Powerful Unbiased Tests, UMP Unbiased tests for one-parameter exponential family, Similar regions and complete sufficient statistic, Tests with Neyman Structure, Uniformly most powerful similar tests.

Unit - III

Invariant tests – maximal invariant statistic, uniformly most powerful invariant tests. Likelihood Ratio tests, Consistent tests. Asymptotic properties of likelihood ratio tests.

Unit - IV

Sequential test –Sequential Probability Ratio Test (SPRT). OC and ASN functions of SPRT and their derivation. Optimum properties of SPRT.

Unit - V

One sample non-parametric tests – Kolmogorov–Smirnov test, Sign test, Wilcoxon's Signed Rank test, Test for randomness. Two-sample non-parametric tests – Kolmogorov- Smirnov test, Wald-Wolfowitz runs test, Mann-Whitney U test, Median test. Kruskal-Wallis Test and Friedman's test.

Books for Study:

1. Srivastava, M. K. and Srivastava,N. (2009) Statistical Inference: Testing of Hypotheses, PHI Learning, New Delhi.
2. Rohatgi, V.K. and Saleh, A.K.MD.E. (2011) An Introduction to Probability and Statistics, Wiley, New York.
3. Rao, C.R. (1998) Linear Statistical Inference and its applications, Wiley Eastern, New Delhi.
4. Gibbons, J. D., and Chakraborti, S. (2010). Nonparametric Statistical Inference (Fifth Edition).Taylor & Francis, New York.

Books for Reference:

1. Lehmann E.L. and Casella, G. (1998) Testing statistical hypotheses,2/e, Springer, New York.
2. Casella, G. and Berger, R.L. (2002). Statistical Inference (Second Edition). Thompson
3. Learning, New York. (Reprint, 2007).
4. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference. PHI Learning Pvt. Ltd., New Delhi.
5. Conover, W. J. (1999). Practical Nonparametric Statistics (Third Edition). John Wiley&Sons, New York. (Reprint, 2007).
6. Goon, A.M., Gupta, M. K., and Dasgupta, B. (1989).An Outline of Statistical Theory,
7. Vol.II, World Press, Kolkata. Publishing House, New Delhi. (Reprint, 2007).
8. Mukhopadhyay, P, (2002), Mathematical Statistics, Book and Allied Publishers, New Delhi.

9. Wald, A. (1982). Sequential Analysis, John Wiley & Sons, New York.

WEB RESOURCES:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=34
2. https://nptel.ac.in/courses/103/106/103106120/
3. Introduction to Statistical Hypothesis Testing – IIT Madras

CORE - XI

LINEAR MODELS AND DESIGN OF EXPERIMENTS

Semester –III **Credits : 4**

Code: **Hours : 5**

Course Objectives:

The main objectives of this course are:

- To teach the students to understand the theoretical concepts of the general linear model and its types.
- To make the students familiar with various experimental designs.
- To make the students understand some advanced concepts of design of experiments.

Course Outcomes

On the successful completion of the course, Student will be able to:

- Remember and understand the theoretical underpinning of the linear model, analysis of variance and design of experiments
- Understand the type of any given experiment and the type of design apt for its analysis
- Apply various design of experiments in several practical situations and evaluate its results
- Make further analyses which are specific to the objectives of any experiment.

UNIT – I

General linear model - models with full rank and less than full rank -least square and maximum likelihood estimators of the parameters and properties Gauss-Markov theorem - Testing the Hypothesis $\beta = \beta^*$.

UNIT – II

Introduction to design of experiments – Analysis of Randomized Block Design and Latin square design - Efficiency of Completely Randomized Design, Randomized Block Design and Latin square design - Missing plot techniques for Randomized Block Design and Latin square design with one and two missing observations.

UNIT –III

Factorial Experiment: Main effects, Interaction effects, Contrast and Orthogonal Contrasts – Designs for 2^2 , 2^3 2^n and 3^2 factorial experiments. Yates Method of Computation - Total and Partial confounding in 2^3 experiments – Analysis of Split Plot Design.

UNIT – IV

General block designs- concepts of connectedness, balancedness and orthogonality. – Incomplete Block Designs - Balanced Incomplete Block Designs (BIBD) and its parametric relations – Information (C) matrix and criteria for connectedness of block designs - Intra and Inter block analysis of BIBD – Concept of Youden square design.

UNIT –V

Partially Balanced Incomplete Block Design (PBIBD) with 'm' associate classes – Group Divisible, Triangular and $L_{(2)}$ Type Association schemes - classifications and parametric relations of PBIBD – Intra block analysis of PBIBD(2) – Need and scope of response surface experiments - first order and second order response surface design.

Books for Study:

1. Montgomery. D.C.(1994) Design and Analysis of Experiments, 3rd edition, John Wiley.
2. Joshi,D.D. Linear Estimations and Design and analysis of experiments, Wiley Eastern ltd., New Delhi.

Books for Reference:

1. Das, M.N. and Giri, N.C, (1997), Design and analysis of experiments, Wiley Eastern Ltd., New Delhi.
2. Graybill,F.A.: An Introduction to Linear Statistical Models, McGraw Hill, NewYork.
3. Gupta S,C and Kapoor V.K (1993): Fundamental of Applied Statistics. - Sultan Chand & Sons, New Delhi.

WEB RESOURCES:

1. www.wikipedia.org/agricultural experiment
2. www.wikipedia.org/basic designs.htmlwww.khanacademy.org

CORE – XII P

COMPUTER LAB FOR DATA ANALYSIS

Semester – III **Credits : 4**

Code: **Hours : 5**

Course Objectives:

The main objectives of this course are to:

- Provide intensive training in statistical computation using software
- Impart knowledge in handling statistical data for analysis
- Instill the students to familiarize with the application of statistical tools

Course Outcomes:

Student will be able to:

- Use the software for various applications.
- Draw statistical graphs, charts and diagrams.
- Compute statistical measures using software.
- Perform statistical data analysis.

UNIT - I

Measures of Central Tendency, Measures of Dispersion and Skewness and Kurtosis

- ✓ Arithmetic Mean, Median, Mode ,Geometric Mean and Harmonic Mean
- ✓ Range, Quartile Deviation, Mean Deviation and Standard Deviation
- ✓ Measures of Skewness and Kurtosis.

UNIT - II

Correlation and Regression:

- ✓ Karl Pearson Coefficient of Correlation
- ✓ Spearman's Rank Correlation
- ✓ Simple Linear Regression
- ✓ Logistic Regression
- ✓ R-square and Multicollinearity

UNIT - III

Test for Normality

Parametric test

- ✓ t test – one sample & two samples
- ✓ ANOVA – One way & Two way

UNIT - IV

Non-parametric Tests

- ✓ Chi-square test
- ✓ Run test
- ✓ One sample K-S test
- ✓ Two independent sample
- ✓ Two related sample
- ✓ K- related sample
- ✓ McNemar test

Unit - V

Data Reduction (manual calculation not necessary)

- ✓ Factor Analysis
- ✓ Cluster Analysis
- ✓ Discriminant Analysis

SKILL ENHANCEDMENT COURSE – III : INDUSTRIAL STATISTICS USING SOFTWARES(LAB - PYTHON)

Semester – III **Credits : 2**

Code: **Hours : 2**

Course Objectives:

The main objectives of this course are to:

- Understand the application of Statistics
- To impart the knowledge on basics of Python programming, functions, and simple data structures

Course Outcomes

Student will be able to:

- Use the software for various applications.
- Draw statistical graphs, charts and diagrams.
- Compute statistical measures using software.
- Perform statistical data analysis.

List of Topics to be covered:

- **Diagrammatic and Graphical Representation**
  - ✓ Line Diagram
  - ✓ Bar Diagram
  - ✓ Pie Diagram
  - ✓ Histogram
  - ✓ Frequency Curve
- **Measures of Central Tendency**
  - ✓ Arithmetic Mean, Median, Mode
- **Measures of Dispersion**
  - ✓ Range and Standard Deviation
- **Measures of Skewness and Kurtosis**.
- **Correlation and Regression**:
  - ✓ Karl Pearson Coefficient of Correlation
  - ✓ Spearman's Rank Correlation
  - ✓ Simple Linear Regression

CORE XIII
PROGRAMMING IN C++ WITH APPLICATIONS

Semester – IV **Credits : 4**

Code: **Hours : 6**

Course Objectives:

Understand the operations and functions of C++Programming

Perform statistical analysis using built-in functions

Learn and write customized program for mathematical and statistical problems

Course Outcomes:

Understand the basics of C++ Language.

Apply the logical skills for performing statistical analysis

Use appropriate plots, charts and diagrams for all kinds of data .

UNIT -I

C++ character set, Constants, Variables and Expressions. Basic structure of a "C++" program. Operators - Pre-processor directives - Library functions - Input-output functions.Decision making statements - Loop statements.

UNIT -II

Functions by Reference. Introduction to Pointers and Structures - File handling. Simple programs need to be written based on above concepts. Arrays – User defined functions – Calling functions by Value – Calling

UNIT -III

Object Orient Programming(OOP): Class – Objects – Member data – Member functions - Constructors – Destructors – Function overloading – Function overriding – Calling functions using objects as arguments. Inheritance – Simple, Multiple and Multi-Level inheritance with public, private and protected access modifiers. Polymorphism - Virtual functions – Friend functions. Introduction to I/O streams.

UNIT -IV

C++ Programs for Statistical Data Analysis: Formation of frequency distribution – Computation ofmean, median, mode, minimum, maximum,range,quartiles,variance,standard deviation, co-efficient of variation, first four central moments, co-efficient of skewness, kurtosis based on univariate raw data set.

UNIT - V

Computation of simple Correlation and Regression co-efficients and curve fitting.Fitting of Binomial and Poisson distributions for the given data. Student 't' test for single mean, two means, correlation co.efficient, large sample tests.

Book for Study:

Balagurusamy, E. (2000) Object Oriented Programming C++, Tata McGraw Hill, New Delhi.

Books for Reference:

1. Jesse Liberty. (1999) C++ Unleashed, Techmedia, New Delhi.
2. Robert Lafore. (1988) Object Oriented Programming in Turbo C++, Galgotia Publications, New Delhi.

WEB RESOURCES:

1. https://www.tutorialspoint.com/What-are-the..
2. https://www.invensis.net/blog/applications-of-c-c-plus-plus-in-the-real-world

CORE – XIV-P

COMPUTER PROGRAMMING USING C++(LAB)

Semester – IV **Credits : 4**

Code: **Hours : 5**

Course Objectives:

The main objectives of this course are to:

- To understand the operations and functions of C++ Programming
- Perform statistical analysis using built-in functions
- Develop skills to write codes in C++ language
- Develop an understanding of the compilation process

Course Outcome:

On the successful completion of the course, student will be able to:

- Develop program writing skills on basic concepts of mathematical terms.
- Writing the programs on descriptive statistical tools.
- Writing the programs on bivariate statistical tools.
- Writing the programs on inferential statistical tests.

UNIT - I

Program for arranging a given set of n numbers and names in ascending order, descending order,

UNIT - II

Program for finding the smallest value of given n-values, finding the largest value given n-values.

UNIT - III

Program for finding n-factorial, finding ${}^{N}C_{r}$ value and solving Quadratic equations.

UNIT- IV

Program for finding the value of Range and Co-efficient of Range of ‘n’ given values, Arithmetic Mean, Median, Mode, Geometric Mean and Harmonic Mean, Standard deviation, Co-efficient of Standard deviation, Variance and Co-efficient of Variation.

UNIT - V

Program for finding correlation co-efficient, Regression co.efficients, Regressionequations. Test of Significance: Small Samples tests and Large Sample tests.

Books for Study:

1. Balagurusamy, E. (1998). Object Oriented Programming with C++, Tata McGrawHill Publishing Company Limited, New Delhi.
2. Venugopal, K. R., Rajkumar, B., and Ravi Shankar, T. (1999). Mastering C++,Tata McGraw – Hill, New Delhi

Books for Reference:

1. Somashekar, M. T., Guru, D. S., Negendraswamy, H. S., and Manjunatha, K. S. (2012)
2. Object Oriented Programming with C++, Prentice Hall Learning (India) PrivateLimited.

SEC – IV

SKILL ENHANCEDMENT COURSE – IV:

RESEARCH TOOLS AND TECHNIQUES

Semester – IV **Credits : 2**

Code: **Hours : 2**

Course Objectives

The main objectives of this course are to:

- Understand the basics and various types of research.
- Understand how to write research report.

Course Outcome

On the successful completion of the course, student will be able to:

- Understand the research process .
- Write a research report.

UNIT -I

An introduction: Meaning- Objective-Motivation in research-Types of Research Significance of Research- Defining the Research Problem- Necessity of defining the problem-Technique involved in defining a problem.

UNIT -II

Research Design: Meaning and need of Research Design-Features of a good design-Different research designs. Sampling Design: Census and Sample Survey, Implications of a sample design, Steps in sampling design.

UNIT - III

Criteria of selecting a sampling procedure, Characteristics of a good sample design, Different Types of Sample Design, Select a random sample, Random sample form an Infinite Universe, and Complex Random sampling design.

UNIT - IV

Interpretation and Report Writing: Meaning of Interpretation, Technique of interpretation, Precaution in Interpretation, Significance of Report writing, Different steps in report writing,

UNIT - V

Layout of the Research Report, Types of reports, Mechanics and precautions for writing a Research Report.

Book for Study:

- Kothari C.R: Research Methodology, New Age International Publishers, Chennai.

CBE: DISCIPLINE SPECIFIC ELECTIVE

MULTIVARIATE STATISTICAL ANALYSIS

Semester:II **Credits : 3**
Code: **Hours : 5**

Course Objectives:

- To provide the knowledge of various Multivariate Distributions
- To understand the concepts to solve practical problems using varioustechniques in real life problem.

Course Outcome:

- An understanding of various Multivariate Distributions and techniques
- Students gain ability and confidence to analyze and solve practicalproblems in selected area.

Unit - I

Multivariate normal distributions and its properties – Marginal and conditional distributions.Characteristic function and moments. Distribution of linear functions – Determination of mean and variance covariance matrix of multivariate normal distribution. Distribution of sample mean vector and sample dispersion matrix. Maximum likelihood estimation of the parameters of multivariate normal distribution.

Unit – II

Hotelling-T^2 distribution and its applications – derivation of generalized T^2 statistic and its distribution – Uses of T^2 statistic – optimum properties of T^2 statistic – Mahalanobis- D^2 statistic and its distribution – relation between T^2 and D^2 – Generalised variance – Wishart distribution and its properties(with Proof).

Unit –III

Classification problems – Classification into one of two populations (known and unknown distributions) – Classification into one of several populations – Linear Discriminant function. Fisher's discriminant Function for two population and several populations.

Unit - IV

Canonical correlation – derivation of canonical correlation coefficients. Principal components – definition – maximum likelihood estimates of the principal components and their variances – determination of principal components.

Unit - V

Factor Analysis– Estimation of Factor Loadings. Factor rotation – Factor scores. Cluster analysis: similarity and distance measures- Hierarchal clustering techniques.

Books for Study:

1. Johnson, R.A. and D.W. Wichern.(2013). Applied Multivariate Statistical Analysis (Sixth Edition), Pearson New International Edition.
2. Anderson, T.W.(2003). An Introduction to Multivariate Statistical Analysis(Third Edition), John Wiley & Sons Private Ltd., NewDelhi

Books for Reference:

1. Morrison, D.F. (2004). Multivariate Statistical Methods (Fourth Edition). Duxbury Press, New York.
2. Kendall, M.G., Stuart, A. and Ord, K.J. (1973).The Advanced Theory of Statistics.(Fourth Edition), Vol. 2, Charles Griffin company Ltd.
3. Kotz, S., Balakrishnan, N. and Johnson, N.L. (2000).Continuous Multivariate Distribution Models and Applications (Second Edition). Volume 1, Wiley - Inter science, New York.
4. Mardia, K.V., Kent, J. T and Bibby, J. M. (1979).Multivariate Analysis. AcademicPress, New York.
5. Rao, C.R. (2001). Linear Statistical Inference and its Applications (Second Edition), Wiley-Inter Science, New York.

WEB RESOURCES:

2. https://youtu.be/Wxqeyhpsw6A
3. https://youtu.be/M-ZuuKemqbQ
4. www.multivariateanalysis.com
5. www.statsoft.com

CBE: DISCIPLINE SPECIFIC ELECTIVE
ADVANCED SAMPLING THEORY

Semester:III **Credits : 3**
Code: **Hours : 4**

Course Objectives:

- Impart the significance of theory and applications o sampling
- Enhance the ability of deriving the properties of methods of drawingsamples
- Comprehend the concepts of sampling for effective application fordesigning sample surveys

Course Outcomes:

On the successful completion of the course student will be able to

- Understand the importance of sampling and sampling theory.
- Adopt the suitable sampling method for given situation.
- Observe the effectiveness of the sampling survey.
- Design and perform the sample survey.
- Draw the random samples using various sampling methods and study theproperties.

UNIT –I

Preliminaries-Simple Random sampling-PPS selection methods

UNIT -II

`Midzuno sampling method-PPSWR and PPSWOR sampling methods-Ordered and unordered estimators.

UNIT -III

Stratified sampling: Definitions and notations-Allocation problems-systematic sampling methods-Balanced, modified and centered systematic sampling methods-Yates corrected estimator.

UNIT -IV

Ratio Estimation –unbiased Ratio Type estimators-Regression estimation-Double sampling for Ratio and Regression Estimation.

UNIT -V

Multistage sampling –Randomized Response methods- Call Back Techniques.

Books for study:

1. Daroga Singh and F.S.Chaudhary(2014), Theory and Analysis of Sample survey Designs, The new AgeInternational Publishers, New Delhi. (Unit I,Unit-II , UNIT-III, UNIT-IV)
2. Cochran W.G.(2007)Sampling Techniques, Third Edition, JohnWiley & sons, New Delhi. (UNIT-V)

Books for Reference:

1. Kapoor V.K. and GuptaS.P(1978):Fundamentals of Applied Statistics, Sultan Chand & sons, New Delhi.
2. Desraj(1976), Sampling Theory , Tata McGraw Hill, New York(Reprint1979).
3. Murthy, M.N.(1997) , Sampling Theory and Statistical Methods, StatisticalPublishing Society, Kolkata.
4. Des Raj and Promod Chandhok(1998)Sample survey Theory, Narosa, NewDelhi.
5. Ardilly P and Yves T.(2006), Sampling methods: Exercise and Solution,Springer.

WEB RESOURCES:

1. https://nptel.ac.in/courses/111/104/111104073/
2. https://nptel.ac.in/content/storage2/courses/111104073/Module14/Lecture42.pdf.
3. https://youtu.be/3UFelQO7JS0.

CBE: DISCIPLINE SPECIFIC ELECTIVE
ACTUARIAL STATISTICS

Semester:III **Credits : 3**

Code: **Hours : 5**

Course Objectives

- To provide knowledge of various types of Life Tables and concepts inInsurance.
- To develop skills in solving practical problems in selected topics

Course Outcome

- An understanding of various concepts of selected areas.
- The ability and confidence to analyze and solve problems towards theInsurance

UNIT- I

Measures of Mortality:- Life tables and its relation with survival function - life table function at non integer age (fractional ages) – analytical laws of mortality - Gompertz and Makeham's laws of mortality – Select, ultimate and aggregate mortality tables.

UNIT -II

Abridged life tables – construction of abridged life tables – methods by Read and Merrell, Greville's, Kings and JIA method. Utility Theory – Insurance and Utility Theory.

UNIT- III

Life Assurance premiums: General considerations – Assurance benefits – Pure Endowment Assurance , Endowment Assurance, Temporary assurance, Whole life assurance – Commutation Functions D_x, C_x, M_x and R_x – Expressions for present values of Assurance benefits in terms of Commutation Functions. (Simple problems only)

UNIT- IV

Policy Values: Nature of reserve - prospective and retrospective reserves - fractional premiums and fractional durations - modified reserves - Continuous reserves - Surrender values and paid up policies - Industrial assurance - Children's deferred assurances - Joint life and last survivorship.

UNIT- V

Pension Funds: Capital sums on retirement and death- widow's pensions - Sickness benefits - Benefits dependent on marriage.

Books for Study:

1. Mathematical basis of life assurance IC-81, Insurance institute of India.
2. Gupta S,C and Kapoor V.K (1993): Fundamental of Applied Statistics. - SultanChand & Sons, New Delhi.
3. Barcley G.W. (1970) Techniques of Population Analysis, Wiley, New York.

Books for Reference:

1. Borowiak, D.S. and Shapiro, A.F. (2013) Financial and Actuarial Statistics: AnIntroduction, CRC Press, London.
2. Donald, D.W.A. (1970) Compound Interest and Annuities-certain, For The Instituteof Actuaries and the Faculty of Actuaries at the University Press.
3. Spurgeon, E.T. (2011) Life Contingencies,Cambridge University Press, Cambridge.
4. Hooker,P.F. Longley, L.H Cook (1957) Life and other contingencies, Cambridge.
5. Alistair Neill(1977) Life contingencies, Heinemann ProfessionalPublishing, Portsmouth.
6. Hossack,I.B. Pollard, J.H. and Zehnwirth, B.(1999) Introductory statistics withapplicationsin general insurance, Cambridge University Press, Cambridge.

WEB RESOURCES:

1. www.wikipedia.org/actuarial statistics**.**html
2. www.wikipedia.org/mortality table.html

CORE BASED ELECTIVE COURSE
RELIABILITY AND SURVIVAL ANALYSIS

Course Objectives:

The main objectives of this course are to:

- Understand the concepts and their interpretation in reliability and survivalanalysis.
- Know the Statistical methods used in reliability and life data analysis.
- Comprehend the importance of reliability theory in industries.
- Understand the concept of censoring and the various distributions used toanalyze survival data

Course Outcome:

On the successful completion of the course, student will be able to:

- Learn the concept of reliability and its various measures.
- Find failure rate, identify failure rate distributions.
- Compute reliability of components and systems.
- Learn the application of statistics in handling survival data.
- Learn the censoring scheme and likelihood function and its estimation. - Non-parametric estimation in lifetime data.

UNIT – I

Reliability concepts and measures; components and systems; coherent systems ; cuts and paths; modular decomposition; bounds on system reliability; structural reliability importance of components.

UNIT - II

Life distributions; reliability function; hazard rate; common life distributions exponential, Weibull and Gamma. Estimation of parameters and tests in these models.

UNIT - III

Reliability growth models; probability plotting techniques; Hollander-Proschan and Deshpande tests for exponentiality – Basic idea of accelerated life testing. Concepts of time, Order and random Censoring, likelihood in these cases.

UNIT – IV –

Life tables, failure rate, mean residual life and their elementary properties. Ageing classes and their properties. Estimation of survival function, Actuarial Estimator, Kaplan- Meier Estimator. Estimation under the assumption of IFR/DFR.

UNIT - V

Two sample problem-Gehan test, Log rank test. Semi-parametric regression : Cox proportional hazards model with one and several covariates. Rank test for the regression coefficients. Competing risks model, parametric and non-parametric inference for this model.

Text Books:

1. Barlow R.E. and Proschan F. (1985) Statistical Theory of Reliability and LifeTesting, To Begin with, Silver Spring.
2. Miller, R.G. (1981) Survival analysis, Wiley, New York.
3. Cox, D.R. and Oakes. D (1984) Analysis of Survival Data, Chapman & Hall, NewYork.

Reference Books:

1. Lawless J.F. (1982) Statistical Models and Methods of Life Time Data, Wiley, NewYork.
2. BainL.J. and Engelhardt, M. (1991) Statistical Analysis of Reliability and LifeTesting Models,Marcel Dekker, New York.
3. Nelson,W. (1982) Applied Life Data Analysis, Wiley, New York.
4. Zacks,S. (1995) Reliability Analysis, Springer, New York.
5. Gross,A.J. and Clark,V.A.(1975)Survival distribution: Reliability applications inthe Biomedical Sciences, Wiley, New Delhi.
6. Kalbfleisch, J.D. and Prentice, R.L.(1980)The Statistical Analysis of FailureTime Data, Wiley, New York .
7. Lawless,J.F.(1982)Statistical Models and Methods of LifeTime Data,Wiley, NewYork.

WEB RESOURCES:

1. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.639.9909&rep=rep1&type=pdf
2 https://www.mdpi.com/2504-4990/1/3/58/pdf
4. https://web.stanford.edu/~lutian/coursepdf/unit1.pdf

CORE BASED ELECTIVE COURSE

TIME SERIES ANALYSIS

Course Objectives:

1. To understand time series analysis and forecasting.
2. To gain some knowledge and skills on how to build ARIMA models.
3. Determining how well the models fit the data.
4. Develop the theory and methods of minimum mean square error forecastingfor ARIMA models.

Course Outcomes:

Students will be able to

1. Forecast the trend pattern exhibited by the given data by using variousmethods.
2. Model-building strategy for ARIMA modeling.
3. Use the Box-Jenkins approach to model and forecast time series dataempirically

UNIT -I

Models of Time Series – Additive and Multiplicative models – Analysis and forecasting – Elimination of trend – growth curve – Modified experimental curve (Method of three selected points only) - Gompertz curve- Logistic curve with examples.

UNIT- II

Stationary processes – Auto-covariance and autocorrelation functions and their properties – partial auto correlation function - Estimation of autocorrelation and its standard error.

UNIT- III

Linear stationary models - stationary and invertability - Autoregressive and Moving average processes and their autocorrelation functions- Autoregressive moving average processes. Linear non-stationary models - Autoregressive integrated moving average processes – integrated moving average processes.

UNIT -IV

Box-Jenkins models: Identification techniques - Initial estimates for different processes –AR, MA, ARMA - choice between stationary and non stationary models

– model diagnostic - model multiplicity - Study of residuals and diagnostic checking.

UNIT- V

Introduction to spectral analysis of weakly stationary processes - periodogram and correlogram analysis including computations based on Fourier transform. Use of spectral representation to show the existence of autoregressive processes and their representation as one-sided moving average processes.

Books for Study:

1. Box, G. E. P. and Jenkins, G.M. and Reinsel, G.C. (2013) Time Series Analysis -Forecasting and Control,4/e, Holden- Day, San Francisco.
2. Brockwell, P. J. and Davis, R. A. (2002) Introduction to Time Series and Forecasting.Taylor & Francis, San Francisco.
3. Gupta, S. C. and Kapoor, V.K. (2007) Fundamentals of Applied Statistics,4/e, SultanChand & Sons, New Delhi.

Books for Reference:

1. Anderson, T. W. (2011) The Statistical Analysis of Time Series, Wiley, NewYork.
2. Bloomfield, P. (2004) Fourier analysis of Time Series - An Introduction,2/e, Wiley,New York.
3. Kendall, M. G. and Stuart, A. (1976) The advanced Theory of Statistics, Vol.3,Charles Griffin, London.
4. Kendall, M. G. (1974) Time Series. Charles Griffin, London.
5. Montgomery, D. C. and Johnson, L. A. (1977) Forecasting and Time Series analysis.McGraw Hill, New York.

WEB RESOURCES:

1. www.tableau.com/learn/articles/time-series-analysis
2. https://www.educba.com/time-series-analysis

CORE BASED ELECTIVE COURSE

DATA MINING

Course Objectives:

1. To understand Data mining concepts.
2. To gain some knowledge and skills about different models.
3. Determining how well the models fit the data.

Course Outcomes:

Students will be able to

1. To understand the application of Data Mining.
2. To know the different algorithms..
3. Get the idea of applications of Data Mining.

UNIT I :

Introduction: Data mining - Kinds of data – Data mining Functionalities - Classification of Data mining Systems - Major Issues on Data mining - Introduction to OLAP - OLAP technology for Data Mining - Data warehousing - Data warehousing to Data mining - Optimizing Data for mining - Data preprocessing.

UNIT II :

Data Mining Primitives:Data mining Query language - Association Rules in large - Data mining - KDD Process - Fuzzy sets and logic - Classification and Prediction**:** Information retrieval - Dimensional Modeling of Data - Pattern Matching - Estimation Error- EM and MLE.

UNIT III :

Models based on Summarization: Bayes Theorem - Chi squared Statistics Regression - Decision Tree - Neural Networks - Genetic Algorithms - Cluster Analysis – Outlier - Cluster Vs Classification - Clustering Issues - Impact of Outliers on clustering- Clustering problems - Clustering Approaches.

UNIT IV :

Clustering Algorithms: Hierarchical algorithm – Single Link- MST Single Link - Complete Link - Average Link- Dendrogram - Partitional Algorithm – MST - Squared Error - K-Means - Nearest Neighbor – PAM – BEA – GA - Categorical algorithm - Large Database.

UNIT V :

Web Mining: Introduction - Web data - Web Knowledge Mining Taxonomy - Web Content mining - Web Usage Mining Research - Ontology based web mining Research - Web mining Applications.

Books for Study:

Berry, J.A. and Linoff, G.S. (2011) Data Mining Techniques (3/e),Wiley, New York.

Books for Reference:

1. Chattamvelli, R. (2009) Data mining Methods,Alpha Science International,Oxford.
2. Dunham, M.H. (2006) Data mining: Introductory and Advanced Topics, Pearson, New Delhi .
3. Gorunescu, F. (2010) Data mining Concepts, Models and Techniques.Springer, New York.
4. Han, J. and Kamber, M (2001) Data Mining Concepts and Techniques,Morgan Kaufmann Publications, Massachusetts.
5. Hand, D.Mannila, H. and Smyth, P (2001) Principles of Data mining, MIT Press,Cambridge.
6. Larose, D.T. (2005) Discovering Knowledge in Data: An Introduction to Data Mining,Wiley,Toronto.
7. Pujari, A.K. (2001) Data Mining Techniques, Universities Press, Hyderabad.
8. Sivanandam S.N. and Sumathi,S (2006) Data Mining Concepts, Tasks and Techniques, Springer, New Delhi.
9. Brieman, L. Friedman, J.H.Olshen, R.A. and Stone,C.J.(1984) Classification and regression trees, Wadsworth & Brooks, California.

WEB RESOURCES:

1. https://www.javatpoint.com/data-mining
2. https://www.ibm.com/cloud/learn/data-mining

Non-Major Elective - I

PYTHON PROGRAMMING

Course Objectives:

To impart the knowledge on basics of Python programming, functions, and simple data structures

Course Outcome

Recollecting the concept of operators, data types, and looping, functions and exception handling are learned.

Analyzing and applying the data structures list, tuples and dictionaries.

Unit – I

Basics of Python: Introduction – Variables – Executing Python from the Command line – Editing Python files – Python Reserved words – Basic Syntax – Comments – Standard data types.

UNIT – II

Relational and Logical operators – Bit-wise operators – Simple Input and Output

UNIT – III

Control statements and Data structures: Control flow and syntax – Indenting – if statement – Statements and expressions – String operations – Boolean expressions – while loop – break and continue – for loop

UNIT – IV

Lists: List – List slices – List methods – List loop – Mutability – Aliasing – Tuples: – Sets – Dictionaries concepts only

UNIT – V

Functions: Definition – Passing parameters to a function – Built-in functions – Variable – Number of arguments – Scope – Type conversion.

Books for Study:

1. Programming in Python 3: A Complete introduction to the Python Language, Mark Summerfield, Addison – Wesley Professional, 2009
2. Python: The Complete Reference, Martin C. Brown, McGraw – Hill, 2001
3. Problem Solving and Python Programming, First Edition, E. Balagurusamy (2017), McGraw Hill.

Books for Reference:

1. Think Python: How to Think Like a Computer Scientist, 2nd edition, Updated for Python 3, Allen B. Downey, Shroff, O'Reilly Publishers, 2016.
2. An Introduction to Python – Revised and updated for Python 3.2, Guido van Rossum and Fred L. Drake Jr, Network Theory Ltd., 2011.
3. Core Python Applications Programming, Wesley J Chun, Prentice Hall, 2012.

WEB RESOURCES:

1. https://www.python.org
2. https://www.python.org/about/gettingstarted
3. https://www.w3schools.com/python

Non-Major Elective - II

MEDICAL LABORATORY TECHNOLOGY

Course objectives:

1. To understand the laboratory principles of the modern laboratory set up.
2. To analyze the various laboratory equipment's and handling.
3. To understand the preparation of reagents.
4. To understand how to maintenance of laboratory records.
5. To Understand and apply biochemical investigations to develop a clinical diagnosis.

Course outcomes:

1. Discuss the laboratory principles and modern laboratory set up
2. Describe and identify the uses of various laboratory equipment's
3. Analyze the type of blood specimens and the criteria for specimen collection and storage
4. Apply the preparation of laboratory chemicals and the importance of record maintenance
5. Critically evaluate the role of clinical biochemistry in diagnosis, monitoring and treatment.

UNIT-I

Basic laboratory principles- Importance's of clinical laboratory - Safety measures - Chemical, fire & Electrical - Lab Technician Duties and Responsibilities – Professional Ethics in laboratory workers, Set up of Instruments in the Modern Laboratory

UNIT-II

Basic Laboratory Equipment's- Microscopy – Light and Contrast Microscopy-types, Incubator, Hot Air Oven, Colorimeter - Laminar Air flow Chamber, Water Bath, Centrifuge, Autoclave, Hemocytometer, Cell counter – Microtip pipette - Microtome – autoanalyzer – ELIZA reader

UNIT-III

Preparation of Reagents -Buffer and pH - Normal, Percent and Molar solutions -Normal saline, Standard solutions – Working and Stock standards, Clinical Laboratory records and maintenance -Quality control: Accuracy, Precision, and Reference values, use of chemicals and their interactions, disposal methods.

UNIT-IV

Basic Clinical Chemistry- Types of blood specimens for chemical analyses- Serum and Plasma, Collections and storage of specimens, Blood and Urine, Specimen transport, and processing - Diagnosis of different diseases- Acute and Chronic diseases -

UNIT-V

Biochemistry, Pathology and Microbiology – Carbohydrates, lipids, proteins, and their qualitative analysis – Cell morphological changes during injuries and infectious diseases and neoplastic changes in cells - Microbes – Important parasites (Malarian) , Intestinal protozoa (E. histolylica, and Amoebic), viuses (Hepatitis) – Laboratory diagnosis-

TEXTBOOKS:

1. Godkar P.B (2020), Textbook of Medical Laboratory Technology Vol 1 & 2, 3rd Edition, Bhalani Publishing House.
2. SANT M (2020). Textbook of Medical Laboratory Technology.CBS Publishers.
3. Monica Cheesbrough (1987), Medical Laboratory Manual for Tropical Countries, 2nd Edition, Butterworth-Heinemann Publications

BOOKS FOR REFERENCE:

1. Fischbach, 2005. Manual of lab and diagnostic tests, Lippincott Williams Wilkins, New York.

2. Gradwohls, 2000. Clinical laboratory methods and diagnosis. (ed) Ales C. Sonnenwirth and leonardjarret, M.D.B.I., New Delhi.

3. J Ochei and Kolhatkar, 2002. Medical laboratory science theory and practice, Tata McGraw-Hill, New Delhi.

4. Kanai L. Mukherjee, 2007, Medical laboratory technology Vol.1.Tata McGraw Hill *Diploma in Clinical Lab. Tech. – Colleges – 2015-16 onwards Annexure No.26C*

Non-Major Elective

STATISTICAL FOUNDATION FOR COMPUTER SCIENCE

Course Objectives:

To learn the basics of Descriptive and Inferential Statistics.

To understand the basics of Probability and Probability Distribution

Course Outcome

Knowledge of Application of Statistics in Computer Science is learned.

Unit – I

Meaning and definition of Statistics, importance and scope of Statistics, functions of Statistics, uses and limitations of Statistics. Data Collection and Presentation: Collection of data – Census – Sample surveys –Types of Data –Nominal, Ordinal, Interval and Ratio – Classification and Tabulation

Unit –II

Diagrammatic representations of data - Bar diagrams, simple, component, multiple and percentage, Pie diagrams. Graphical representations - Histogram, Frequency curve, frequency polygon and Ogives (Construction and uses).

Unit – III

Descriptive Statistics: Introduction - Population, Sample and Observation – Organizing and Summarizing Qualitative and Quantitative Data – Central tendency: Mean, Weighted mean, Median and Mode for ungrouped and grouped data – Dispersion: Range, IQR, Quartile deviation, Standard deviation and Variance –Co.efficient of Variation.

Unit – IV

Moments– Skewness –Karl Pearson Coefficient of Skewness – Kurtosis– Relationship between two variables: Correlation -types of Correlation – KP Coefficient of Correlation– Probable error – Spearmen's Rank correlation –Linear Regression

Unit – V

Hypothesis Testing and Statistical Significance: Concept of Null and Alternate hypothesis – p value `– Critical value – Significance level – Z test – Student t test – Chi-square test – Anova (one way).

Books for Study:

Fundamentals of Statistics, S. C Gupta, 6th revised and enlarged edition, Himalaya Publications, April 2004

Books for Reference:

Statistics and Mathematical logic courses – NPTEL.

WEB RESOURCES:

i. https://stats.libretexts.org/Bookshelves/Introductory_Statistics/Book%3A_Introductory_Statistics_(Shafer_and_Zhang)/01%3A_Introduction_to_Statistics
ii. https://www.analyzemath.com/statistics/introduction_statistics.html

Non-Major Elective

(For Bio-Chemistry)

BIO-STATISTICS

Course Objectives:

(i) To explain basic concepts of Biostatistics to biologists and biochemists

(ii) To help the biologists and biochemists in their data analysis

Course Outcome

Knowledge of Application of Statistics in Bio-Chemistry is learned.

Unit – I

Introduction – Basic Concepts – Measurements and Measurement Scales – Sampling and Statistical Inference – The Scientific method and the Design of Experiments - Computers and Biostatistical Analysis – Classification : Definition, Types of Classification – Tabulation: Definition – Structure of a table and Types of Tables

Unit – II

Descriptive Statistics : Introduction – the ordered Array – Frequency distribution – Measures of Central tendency : Arithmetic mean, Median and Mode – Simple Problems using biological data. Measures of Dispersion: Range, Quartile Deviation and Standard deviation – Simple problems using biological data.

Unit – III

Correlation: Introduction – The correlation model – Correlation coefficient - Types of Correlation – Scatter Diagram – Karl Pearson's coefficient of Correlation – Spearman's rank correlation – Simple Linear Regression: Introduction – The regression model - Simple regression equations – Evaluating the regression equation – Using the regression equation. Simple problems using biological data.

Unit – IV

Hypothesis Testing and Statistical Significance: Concept of Null and Alternate hypothesis – p value `– Critical value – Significance level – Z-test (Test for single mean and two means)- Student t test – Chi-square test – Anova (one way).

Unit – V

One sample non-parametric tests – Kolmogorov–Smirnov test, Sign test, Wilcoxon's Signed Rank test, Test for randomness. Two-sample non-parametric tests – Kolmogorov- Smirnov test, Wald-Wolfowitz runs test, Mann-Whitney U test, Median test. Kruskal-Wallis Test.

Book for Study:

- Wayne W. Daniel and Chad L Cross : BioStatistics A Foundation for data analysis in the Health Science, 10th Edition, Wiley.

Books for Reference:

Statistics and Mathematical logic courses – NPTEL.

WEB RESOURCES:

i. https://stats.libretexts.org/Bookshelves/Introductory_Statistics/Book%3A_Introductory_Statistics_(Shafer_and_Zhang)/01%3A_Introduction_to_Statistics
ii. https://www.analyzemath.com/statistics/introduction_statistics.html