DEPARTMENT OF STATISTICS

CHOICE BASED CREDIT SYSTEM (CBCS)
Learning Outcome-based Curriculum Framework (LOCF)
SYLLABUS

Master of Science

2023 - 2024

MADRAS CHRISTIAN COLLEGE
(AUTONOMOUS)
College with Potential for Excellence
Affiliated to University of Madras
Tambaram
Chennai – 600 059

MADRAS CHRISTIAN COLLEGE

VISION

Madras Christian College aspires to be an Institution of excellence transforming lives through education with a commitment to service.

MISSION

Madras ChristianCollege (MCC) with the inspiration of the love of God offers to people of all communities education of the whole person, which is congruous with God's revelation in Christ of the true nature of humanity and is appropriate to the needs of India and of the world.

Graduate Attributes

The Madras Christian College defines the philosophy underpinning its academic programmes and student life experience on campus through the Graduate Attributes (GA), that describe the knowledge, competencies, values and skills students imbibe for holistic development and contribution to society. These attributes encompass characteristics that are transferable beyond the domain of study into the national and international realm fostered through curricular, co-curricular and extra-curricular engagements.

GA 1: Intellectual Competencies

- Graduates of MCC have a comprehensive and incisive understanding of their domain of study as well as the capability for cross-disciplinary learning.
- They have the ability to apply the knowledge acquired through the curriculum as well as self-directed learning to a broad spectrum ranging from analytical thinking to synthesise new knowledge through research.
- Forming independent individual opinions regarding academic cores and socially relevant issues

GA 2: Professional Ethics

- Graduates of MCC develop ethical and professional behaviour, which will be demonstrated in their chosen careers and constructive citizenship roles.
- They imbibe intellectual integrity and ethics in scholarly engagement and develop a spirit of inclusiveness through interactions with people of special needs and diversity.

GA3: Leadership Qualities

- Graduates of MCC inculcate leadership qualities & attitudes, and team behaviour along democratic lines through curricular, co-curricular and extra-curricular activities
- They develop managerial and entrepreneurial skills to ideate and create new opportunities along with career readiness and capacity to take up various competitive exams.

GA 4: Holistic Skill Development

- Graduates of MCC develop critical thinking, problem-solving, effective communication, emotional and social skills
- They develop digital competency to live, learn and serve in society.

GA 5: Cross-Cultural Competencies

- Graduates of MCC imbibe cross-cultural competencies through engaging with diverse linguistic, ethnic and religious communities providing scope to understand, accept and appreciate individuals at local, national and international levels.
- They develop a global perspective through contemporary curriculum, culture, language and international exchange programmes

GA 6: Service-Oriented Focus

- Graduates of MCC have sensitivity to social concerns and a conviction toward social justice through a commitment to active social engagement.
- They are endowed with a strong sense of environmental awareness through the curriculum and campus eco-system.

GA 7: Value-Based Spiritual Development

- Graduates of MCC are rooted in the principles of ethical responsibility and integrity permeated with Christian values leading to the building of character.
- They develop virtues such as love, courage, unity, brotherhood, industry and uprightness.

Programme Outcomes

Programme Outcomes (POs) of Madras Christian College define the minimum level that students are expected to do, achieve and/or accomplish in order to graduate from a particular programme. These Outcomes are a framework to assess the nature of learning activity experienced within the programme.

POs for Post Graduate Programmes

PG Programmes are designed to have the following outcomes:

On successful completion of the Post-graduate programme, the students will be able to

PO	PO	Descripton of PO	Mapped with GA
PO 1	Domain Knowledge	• Develop intensive and extensive knowledge and expertise in their respective domains • Evaluate and create/construct domain specific knowledge in areas of learning, research and industry • Formulate and extrapolate the knowledge gained to apply in real – life situations and competitive examinations • Develop an aptitude for self-directed learning for excellence in their chosen area within the domain of study	GA1, GA3, GA4
PO 2	Applicative knowledge and Lateral Thinking	• Translate theoretical understanding to experimental knowledge and solve complex problems using Systems/Design Thinking • Apply advanced knowledge and approaches to solve concrete and abstract problems in domain-related and multi-disciplinary issues. • Able to solve problems using unconventional and creative approaches	GA1, GA3, GA4

PO 3	Innovation and Research	• Develop aptitude for innovation and entrepreneurship • Identify contemporary research problems, analyze data and propose solutions	GA 1, GA4, GA5, GA6
PO 4	Scientific Communication skills	• Document, prepare and present scientific work as reports and research articles in academic forums • Critically assess, review and present theories, principles and concepts	GA 1, GA4, GA5, GA6
PO 5	Digital skills	• Use of domain-related advanced software resources, computational skills and digital tools for data analysis, visualization and interpretation • Ethically apply digital skills to creatively communicate a wide range of ideas and issues related to academic experiences	GA1,GA2, GA3,GA4
PO 6	Ethical practices	• Apply domain specific ethical principles and practices in academic, professional and social engagements	GA 2,GA6,GA7
PO 7	Career readiness and higher education	• Choose from diverse career options available in local, national and international realms. • Carry out further research or pursue higher education in the country or abroad	GA1, GA2, GA5

PROGRAM SPECIFIC OUTCOMES (PSO's)*

At the time of graduation they would be able to:

PSO #	Statement	Mapped with PO#
PSO 1	Acquire and to present core knowledge of the basic and advanced concepts of statistics	**PO1, PO2, PO4**
PSO 2	Respond to issues with a problem solving approach by enabling the students to analyze and interpret data and to draw valid conclusions.	**PO3, PO4, PO6**
PSO 3	Equip the students with the latest computing tools/ software and to apply in real time problems	**PO5, PO6**
PSO 4	Understand the applications of statistics in clinical studies, agriculture, industry and population studies	**PO7**
PSO 5	Make the students employable for potential opportunities in the field of data science, data analytics, research and development units of big corporate and state owned statistical forums	**PO7**

Curriculum Template for (M. Sc. STATISTICS)
(Effective from 2023-2024 onwards)

Semester	Core/ Elective	Course code	Course title	Instruction hours per Cycle	Duration of exam	Marks			Credits
						ICA	ESE	Total	
I	**Core**	232ST1M01	Real Analysis and Linear Algebra	6	3	50	50	100	4
	Core	232ST1M02	Measure and Probability Theory	6	3	50	50	100	4
	Core	232ST1M03	Advanced Operations Research	6	3	50	50	100	5
	Core	232ST1M04	Practical I (OR problems-calculator based)	6	4	50	50	100	4
	Elective	232ST1E01	Programming in R	6	3	50	50	100	5
II	**Core**	232ST2M01	Experimental Design	6	3	50	50	100	5
	Core	232ST2M02	Advanced Distribution Theory	6	3	50	50	100	4
	Core	232ST2M03	Sampling Theory	5	3	50	50	100	4
	Core	232ST2M04	Practical II (DOE, DT and ST problems- calculator based)	5	4	50	50	100	4
	Elective	232ST2E01	Advanced Python	6	3	50	50	100	5
	Internship (Between II and III Semesters)								2
III	**Core**		Multivariate Analysis	6	3	50	50	100	5
	Core		Theory of Estimation	6	3	50	50	100	4
	Core		Reliability Theory	5	3	50	50	100	4
	Core		Practical III (Estimation and Multivariate Problems using R)	5	4	50	50	100	4
	Elective		Stochastic Processes	6	3	50	50	100	5
			Clinical Trials & Data Mining	6	3	50	50	100	
IV	**Core**		Statistical Quality Control	6	3	50	50	100	5
	Core		Testing Statistical Hypothesis	6	3	50	50	100	5
	Core		Project and Viva-Voce	6		50	50	100	5
	Core		Practical IV (SQC and TSH using R)	6	4	50	50	100	4
	Elective		Big Data Analytics	6	3	50	50	100	5
			Population Studies	6	3	50	50	100	
Optional for (I/ II /III/IV) Semesters	**Elective**		Machine Learning Techniques	6	3	50	50	100	5
			Survival Analysis	6	3	50	50	100	
			Time Series & Forecasting	6	3	50	50	100	

Curriculum Overview Table		
Part	**Credits**	**Hours / Cycle**
III – Core theory (mandatory)	13+13+13+10=49	18+17+17+12=64
III – Core Elective	5+5+5+5=20	6+6+6+6=24
III – Core Practical*	4+4+4+4=16	6+5+5+6=22
III – Internship / Field work	2	
III – Project	5	6
IV – Personlaity Development / Soft Skill	8	2+2=4
Total	100	120

M.Sc. Statistics -Syllabus Revision Details

Course code	Course title	Type of Change	% of Change
Semester I			
232ST1M01	**Major:** Real and Linear Algebra	Revised & Title changed	50
232ST1M02	**Major:** Measure and Probability Theory	Revised	10
232ST1M03	**Major:** Advanced Operations Research	Revised	10
232ST1M04	**Major:** Practical I	Revised	10
232ST1E01	**Elective:** Programming in R	New Course	100
Semester II			
232ST2M01	**Major:** Experimental Design	Revised & Title changed	20
232ST2M02	**Major:** AdvancedDistribution Theory	Revised	10
232ST2M03	**Major:** Sampling Theory	Revised	10
232ST2M04	**Major:** Practical II	Revised	10
232ST2E01	**Elective:** Advanced Python	New Course	100
Semester III			
	Major: Multivariate Analysis	Revised	20
	Major: Theory of Estimation	Revised	10
	Major: Reliability Theory	Revised	10
	Major: Practical III	New Course	100
	Elective: Machine Learning Techniques	New Course	100
	Elective: Clinical Trials & Data Mining	Revised & Title changed	50
Semester IV			
	Major: Statistical Quality Control	Revised	10
	Major: Testing Statistical Hypothesis	Revised	10
	Major: Project and Viva-Voce	No Change	0
	Major: Practical IV	New Course	100
	Elective: Big Data Analytics	Revised	10
	Elective: Population Studies	New Course	100
Optional Electives for (I/ II /III/IV)Semesters			
	Elective: Stochastic Processes	Revised	50
	Elective: Survival Analysis	New Course	100
	Elective: Time Series & Forecasting	New Course	100
		Total percentage of Changes	**42.4**

SEMESTER I

REAL ANALYSIS AND LINEAR ALGEBRA

Course Code	**232ST1M01**		
Credits	**4**		
Hours / Cycle	**6**		
Category		**Core**	**Theory**
Semester	**I**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1.To study the concepts of metric space, derivatives and integrals of function. 2.To describe vector space and matrix algebra of functions. 3.To equip the students with the knowledge of real analysis and linear algebra for clearing the competitive exams.**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Recall the basic concepts of real valued functions of metric space, Riemannintregral, Derivatives and linear algebra.**	**PSO1**	**K1**
CO 2	**Understand the Riemann intregral, Derivatives along with mathematical expression and properties of vector spaces and subspaces**	**PSO2**	**K2**
CO 3	**Apply the sequence and the series of the function and different types of linear transformations.**	**PSO3**	**K3**
CO 4	**Analyse the problem based on the theorems of real valued functions, vector spaces, matrices and different linear forms**	**PSO4**	**K4**
CO 5	**Evaluatethe theory of linear algebra and real analysis in various field of statistical theory development.**	**PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Functions Continuous at a point on the real line – Reformulation – Functions Continuous on a Metric Space – Open Sets – Closed Sets – Discontinuous functions on the real line – More about Open Sets – Connected Sets – Bounded Sets and Totally Bounded Sets – Complete Metric Space – Continuity of Inverse Functions – Uniform Continuity.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Sets of Measure Zero-Definition of the Riemann Integral-Existence of Riemann Integral Properties of Riemann Internal – Derivatives Rolle's Theorem – Law of Mean – Fundamental Theorem of Calculus – Taylor's Theorem.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Sequence and Series of Functions – Pointwise Convergence of Sequence of Functions – Uniform Convergence of Sequence of Functions – Fourier Series – Dirichlet Conditions – Half-Range Expansions.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Vector Spaces: Elementary Basic Concepts – LinearDependence and Bases - Inner Product Spaces: Inner Product Spaces – Schwarz Inequality - Orthogonal Space - Gram Schmidt orthogonalization process.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Linear transformations: The Algebra of linear transformations - Characteristic Roots. Matrices: Matrices - Canonical Forms: Triangular Forms - Hermitian, Unitary and Normal Transformations.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Goldberg. R. Richard (1970): Methods of Real analysis, Oxford and IBH Publishing Co-Private Ltd., New Delhi.
2. Chandrasekaran Rao and Narayanan K.S. (2008), *Real Analysis (Vol.II)*, S. ViswanathanPvt. Ltd., Chennai. (Chapter – 9)
3. M.L. Santiago (2001), *Modern Algebra*, Tata McGraw-Hill Publishing Co. Ltd,. (Chapters6 & 7)
4. Walter Rudin (1976), *Principles of Mathematical Analysis*, Third Edition, McGraw Hill.
5. Keith Nicholson(2018), *Linear algebra with applications*, Open Edition, Base Textbook Verson.
6. N. Herstein (2014),*Topics in Algebra*, Wiley India (P) Ltd., New Delhi, Second Edition, 2014.(Chapter 4 and 6)

References

1. S.C. Malik and Savita Arora (2017): *Mathematical Analysis*, New Age International Publications, New Delhi.
2. S. G. Venkatachalapathy (2009): *Real Analysis*, Margham Publications, Chennai.
3. H. L. Royden (1988), *Real Analysis* (Third Edition), Prentice – Hall of India Private Ltd., New Delhi.

Suggested Reading

1. Herstein, I.N., (2009) *Topics in Algebra*, Second Edition, , Wiley Student Edition
2. Serge Lang (1970), *Linear Algebra*, Second Edition, Addison Wesley Publishing Co.,
3. Kenneth R. Davidson Allan P. Donsig, *Real Analysis and Applications Theory in Practice*, Springer

Web Resources

1. https://www.youtube.com/watch?v=md5UCR7mcIY&list=PLbMVogVj5nJSxFihVec4A3z_FOGPRCo-
2. https://www.youtube.com/watch?v=V_xMloDlD4o&list=PLbMVogVj5nJSxFihVec4A3z_FOGPRCo-&index=3
3. https://www.youtube.com/watch?v=Xx7ULr79fy0&list=PLbMVogVj5nJSxFihVec4A3z_FOGPRCo-&index=4
4. https://www.youtube.com/watch?v=Xx7ULr79fy0&list=PLbMVogVj5nJSxFihVec4A3z_FOGPRCo-&index=4
5. https://www.youtube.com/watch?v=icvUO26GVR8&list=PLbMVogVj5nJSxFihVec4A3z_FOGPRCo-&index=6
6. https://www.youtube.com/watch?v=icvUO26GVR8&list=PLbMVogVj5nJSxFihVec4A3z_FOGPRCo-&index=6
7. https://www.youtube.com/watch?v=9MCjyQSRmR8&list=PLFW6lRTa1g80fZ1giRbqbe_XdXPdkkyqY
8. https://www.youtube.com/watch?v=jZXHzpqvmM&list=PLbMVogVj5nJSxFihVec4A3z_FOGPRCo-&index=2
9. http://facultymembers.sbu.ac.ir/shahrokhi/ProBookMathAnal1.pdf
10. **https://www.math.ucdavis.edu/~linear/linear-guest.pdf**

Course Articulation Matrix

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3	3	-	3	-	-	-	3	-	-	-	-	K1
CO 2	-	-	3	3	-	3	-	-	3	-	-	-	K2
CO 3	-	-	-	-	3	3	-	-	-	3	-	-	K3
CO 4	-	-	-	-	-	-	2	-	-	-	3	-	K4
CO 5	-	-	-	-	-	-	2	-	-	-	-	3	K5,K6
Wt. Avg.	3	3	3	3	3	3	2	3	3	3	3	3	
Overall Mapping of the Course											PO – 2.86		
											PSO – 3		

MEASURE AND PROBABILITY THEORY

Course Code	**232ST1M02**		
Credits	**4**		
Hours / Cycle	**6**		
Category		**Core**	**Theory**
Semester	**I**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. Understand the concept of measure and probability theory.** **2. Explore the basic and advance concepts available in measure and probability.** **3. Develop the mathematical probability and their applications.**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Relate the definition of measure and probability**	**PSO1 PSO2**	**K1**
CO 2	**Comprehend the concepts of sets, functions, measure and probability space**	**PSO1 PSO2**	**K2**
CO 3	**Utilize basic and advanced applications of concepts of measure and probability**	**PSO1 PSO2 PSO4**	**K3**
CO 4	**Infer on application of inequalities in probability theory**	**PSO1 PSO2 PSO4**	**K4**
CO 5	**Explore the application of measure and probability theory in real life situations.**	**PSO1 PSO2 PSO4 PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Measure Theory - Limits of sequence of sets, classes of sets – Field , Sigma Field and Monotone class, Measure and Measure Space – Measurable function.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Lebesgue – Stieltjes measure, Measure integral and its properties, Dominated convergence theorem – Radon–Nikodymn theorem - almost everywhere convergence - convergence in measure - convergence in mean.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
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.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
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 - convolution of distributions.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Central limit theorem -Lindeberg, Levy and Liapounov forms with proof and Lindeberg Feller's form examples - Khintchine weak law of large numbers - Kolmogorov inequality - strong law of large numbers.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Basu, A. K. (2012). *Measure Theory and Probability*, Prentice Hall India Learning Private Limited, New Delhi.
2. Rohatgi, V. K., and Saleh, A.K.M.E. (2015), *An Introduction to Probability and Statistics*, Third Edition, John Wiley & Sons, NY.

References

1. Bhat, B. R. (2009). *Modern Probability Theory – An Introductory Text Book,* Third Edition (Reprint), New Age International Private Ltd., New Delhi.
2. Chow, Y.S. and Teicher, H. (1979) : I, Springer Verlag.
3. Billingsley, P. (1995). *Probability and Measure*, 3rd Edition. John Wiley &Sons,Singapore.

Suggested Reading

1. *De* Barra, G. (2000), *Measure Theory and Integration*, New Age International Private Ltd., New Delhi.
2. Athreya, K. B. and Lahiri, S. (2006) *Probability Theory*. Hindustan Book Agency.
3. Mukhopadhyay, P. (2018). *Mathematical Statistics*. Book and Allied Publishers Ltd., Calcutta

Web Resources

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

Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	2	2	2	2	-	-	-	2	2	-	-	-	**K1**
CO 2	2	2	2	2	-	2	-	2	2	-	-	-	**K2**
CO 3	2	2	2	2	-	2	2	2	2	-	2	-	**K3**
CO 4	2	2	2	2	-	2	2	2	2	-	2	-	**K4**
CO 5	2	2	2	2	-	2	2	2	2	-	2	2	**K5,K6**
Wt. Avg.	2	2	2	2	-	2	2	2	2	-	2	2	
Overall Mapping of the Course											**PO – 2**		
											PSO – 2		

Course Code	**232ST1M03**		
Credits	**5**		
Hours / Cycle	**6**		
Category		**Core**	**Theory**
Semester	**I**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. To impart the knowledge of formulation of problems using the linear programming method and its extensions** **2. To understand and compute quantitative metrics of performance for queueing systems.** **3. Explains about fundamental inventory control procedures and their usage**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Remember linear programming problem and to solve them using appropriate algorithms. To spell out types of queuing and inventory models**	**PSO1 PSO2**	**K1**
CO 2	**Illustrate Linear programming problem, Queueing models and inventory models**	**PSO1 PSO2 PSO4**	**K2**
CO 3	**Identify different linear and Non linear programming problems, different queueing models and inventory models**	**PSO1 PSO2 PSO4**	**K3**
CO 4	**Classify queueing models and inventory models and to study them in detail.**	**PSO1 PSO2 PSO4**	**K4**
CO 5	**Constuct linear programming problem, non linear programming problem, inventory models and inventory models for real time problems**	**PSO1 PSO2 PSO4 PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Theory of Linear programming - Simplex method - Duality- Sensitivity analysis –Revised simplex method- Parametric linear programming.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Integer programming – Cutting - plane algorithms - Branch and bound method. Dynamic programming - elements of DP model – examples of DP models and computations- Solutionof LPP by DP.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Non-linear programming-Kuhn-Tucker conditions– Lagrangian multipliers method - Quadratic programming (Wolfe's algorithm).	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Queueing Theory - Classification of queues - Detailed study of M/M/1 and M/M/C queues with finite and infinite capacity subject to general queue discipline - Pollazek-Khintchine formula-Tandem or series queues.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Inventory models- ABC inventory system - Deterministic models of followingtypes : single item static model with and without price breaks - Multiple item static model with storage limitation-Probabilistic models of the following types :Continuous review model -Single period models.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1.Taha,H.A (2017),*Operations Research– Anintroduction*,10th edition,Prentice-Hall,NewDelhi.

References

1. Hillier and Liberman (2021), *Introduction to Operations Research*, McGraw Hill International Edition
2. Nirmal Singh Kambo (2008), *Mathematical Programming Techniques*, East-West Press (Revised Edition).
3. Philips, D.T, Ravindra and Solberg,J. J(1991),*Operations Research-Principles and Practice*, Wiley, NewYork.

Suggested Reading

1. Sharma, J.K. (2008). *Operations Research: Theory and Application*, Third edition , McGraw-Hill
2. Bazara, M. S., Sherali,H. D. and Shetty, C. M. (2006): *Nonlinear Programming-Theory and Algorithms*. Wiley, Third Edition.

Web Resources

1. https://nptel.ac.in/content/syllabus_pdf/110106062.pdf
2. www.openintro.org/stat/down/OpenIntroStatFirst.pdf
3. https://www.classcentral.com/course/swayam-operations-research-14219

Note:Numerical problems to be avoided in the question paper.

Course Articulation Matrix													
Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	2	2	2	2	-	2	-	2	2	-	-	-	K1
CO 2	2	2	2	2	-	2	2	2	2	-	2	-	K2
CO 3	2	2	2	2	-	2	2	2	2	-	2	-	K3
CO 4	2	2	2	2	-	2	2	2	2	-	2	-	K4
CO 5	2	2	2	2	-	2	2	2	2	-	2	2	K5,K6
Wt. Avg.	2	2	2	2	-	2	2	2	2	-	2	2	
Overall Mapping of the Course											PO – 2		
											PSO – 2		

PRACTICAL -I

Course Code	**232ST1M04**		
Credits	**4**		
Hours / Cycle	**6**		
Category		**Core**	**Practical**
Semester	**I**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. To impart the significance of applications of Operations research** **2. To understand the theory through practical oriented training** **3. To provide hands on practical training on application of Operations research in real life problems**		
CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Tell the methods to solve linear and non linear programming problems, queueing models and inventory models**	**PSO1 PSO2**	**K1**
CO 2	**Demonstrate different methods of soiving linear and non linear programming problem,queueing models and inventory models**	**PSO1 PSO2**	**K2**
CO 3	**Apply various procedures for finding an optimal solution in linear and non linear programming problem, queueing and inventory models**	**PSO1 PSO2 PSO4**	**K3**
CO 4	**Distinguish between linear and non linear programming problems. Classify queue types and inventory models and to obtain their performance measure**	**PSO1 PSO2 PSO4**	**K4**
CO 5	**Build linear and non linear programming problems, queueing models and inventory models based on real life problems**	**PSO1 PSO2 PSO4 PSO5**	**K5,K6**

SYLLABUS

Calculator Based Practical

1) Simplex Method
2) Big M Method
3) Two-phaseMethod
4) Duality
5) Dual Simplex Method
6) Sensitivity Analysis
7) Revised Simplex Method
8) Parametric Programming
9) Gomory's Pure Integer Problem
10) Gomory'sMixedIntegerProblem
11) BranchandBoundMethod
12) Examples of Dynamic Programming Models
13) Solution of Linear Programming Problems by Dynamic Programming
14) Kuhn-Tucker conditions
15) Lagrangian Multipliers Method
16) QPP
17) (M/M/1):(∞/FCFS)
18) (M/M/1):(N/FCFS)
19) (M/M/c):(∞/FCFS)
20) (M/M/c):(N/FCFS)
21) Machine-RepairmanProblem
22) Single Item Static Model
23) Single Item Static Model with PriceBreaks
24) Multiple Item Static Models with Limitations
25) ContinuousReviewModel
26) s-S Policy

Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	2	2	2	2	-	2	-	2	3	-	-	-	**K1**
CO 2	2	2	2	2	-	2	-	2	3	-	-	-	**K2**
CO 3	2	2	2	2	-	2	2	2	3	-	2		**K3**
CO 4	2	2	2	2	-	2	2	2	3	-	2	-	**K4**
CO 5	2	2	2	2	-	2	2	2	3	-	2	2	**K5,K6**
Wt. Avg.	**2**	**2**	**2**	**2**	**-**	**2**	**2**	**2**	**3**	**-**	**2**	**2**	
Overall Mapping of the Course											**PO – 2**		
											PSO - 2.25		

PROGRAMMING IN R

Course Code	232ST1E01		
Credits	5		
Hours / Cycle	6		
Category		Elective	Theory
Semester	I		
Year of Implementation	From the academic year 2023_2024 onwards		
Course Objectives	1. To develop the programming skills using R 2. To gain familiarity about how to apply statistical tools in R 3. To impart knowledge about Random number generation in R		

CO	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
On completing the course successfully, the student will be able to			
CO 1	Define the fundamentals of R, Exploratory data analysis and Random number generation	PSO1 PSO3	K1
CO 2	Understand the elementary concepts of Exploratory data analysis and Statistical tools.	PSO2 PSO3	K2
CO 3	Select the right statistical test for the given data	PSO3 PSO4	K3
CO 4	Apply the statistical tools in R programming	PSO3 PSO4	K4
CO 5	Evalluate the interpretation of Statistical tools using R programming	PSO3 PSO4 PSO5	K5,K6

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to R- Basic Data Types -Vector -Matrix -List-Data Frame-Qualitative Data-Quantitative Data-Numerical Measures	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Probability Distributions-Interval Estimation-Hypothesis Testing-Type-II-Errors-Inference about Two Populations	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Goodness of fit-Analysis of Variance-Non-parametric methods-Simple linear regression	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Multiple Linear regression-Logistic Regression-Rigid Regression-Logit Probability-Measurement Intervals – R Shiny and its uses.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Random number generation: Simulation of random numbers-Uniform random generation-Generation of non-uniform random variables-Simple discrete random variables like Bernoulli, Binomial, Uniform- Inversion methods.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Yau, C. (2013). *R tutorial with Bayesian statistics using OpenBUGS*. Amazon Digital Services Inc, 554.
2. Asmussen, S., & Glynn, P. W. (2007). *Stochastic simulation: algorithms and analysis* (Vol. 57, pp. 487-488). New York: Springer.

References

1. Cohen, Y., & Cohen, J. Y. (2008). *Statistics and Data with R: An applied approach through examples*. John Wiley & Sons.
2. Hothorn, T., &Everitt, B. S. (2014). *A handbook of statistical analyses using R*. CRC press.
3. Crawley, M. J. (2012). *The R book*. John Wiley & Sons.
4. Lumley, T. (2011). *Complex surveys: a guide to analysis using R*. John Wiley & Sons.
5. Kerns, G. J. (2010). *Introduction to probability and statistics usin R*. Lulu. com..

Suggested Reading

1. Zhang, Z., & Wang, L. (2017). *Advanced statistics using R*. Granger, IN: ISDSA Press. Accessed on December, 3, 2021.
2. Dalgaard, P. (2008). *Statics and Computing Introductory Statistics with R*. Springer.
3. Schumacker, R. E. (2014). *Learning statistics using R*. Sage Publications.
4. Hui, E. G. M. (2019). *Learn R for Applied Statistics*. Eric Goh Ming Hui.
5. Venables, W. N., & Smith, D. M. (2003). *An introduction to R: notes on R: a programming environment for data*

analysis and graphics, version 1.9.

Web Resources

1. https://www.math.csi.cuny.edu/~verzani/R/AMS-MAA-Jan-09.pdf
2. R Programming Tutorial - Learn the Basics of Statistical Computing, https://www.youtube.com/watch?v=_V8eKsto3Ug
3. https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf
4. https://cran.r-project.org/web/packages/randtoolbox/vignettes/fullpres.pdf
5. https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf

Course Articulation Matrix

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	2	2	-	2	2	2	-	2	-	2	-	-	K1
CO 2		--	2	2	2	2	-	-	2	2	-	-	K2
CO 3	-	-	-	-	2	2	2	-	-	2	2	-	K3
CO 4			-	-	2	2	2	-	-	2	2	-	K4
CO 5					2	2	2	-	-	2	2	2	K5,K6
Wt. Avg.	2	2	2	2	2	2	2	2	2	2	2	2	
Overall Mapping of the Course											PSO-2		
											PO-2		

SEMESTER II

EXPERIMENTAL DESIGN

Course Code	232ST2M01		
Credits	5		
Hours / Cycle	6		
Category		**Core**	**Theory**
Semester	II		
Year of Implementation	From the academic year 2023_2024 onwards.		
Course Objectives	1. To understand the various methods used in experimental design 2. To develop the skill of identifying a real time problem and to use an appropriate design 3. To know the applications of design of experiments in various fields of research		

CO	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
On completing the course successfully, the student will be able to			
CO1	Recall the basic concepts of experimental design	PSO1	K1
CO2	Understand and compare the various methods used in experimental design	PSO1	K2
CO3	Choose a suitable design to a real time problem and to plan the layout of the study	PSO2 PSO4 PSO5	K3
CO4	Analyze the problem using ANOVA and examine the results of the experiment	PSO2 PSO3 PSO4 PSO5	K4
CO5	Interpret the findings of the experiment and develop plan of action for the future needs in various fields of research.	PSO2 PSO4 PSO5	K5,K6

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	**Review of basic designs:** Analysis of Variance - contrast- Orthogonal contrast- linear models-fixed, random and mixed effect models- Completely Randomized design – Randomized Block Design – Latin Square Design – Efficiency of RBD relative to CRD and efficiency of LSD relative to CRD.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	**Two, three and mixed level factorial experiments**: 2^4, 3^3 and n x p factorial design – Total and Partial confounding of 2^4 factorial design- confounding in 2^p blocks of 2^k factorial designs – Single replicate of 2^k design.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	**Two level fractional factorial designs**: one-half and one-quarter fraction of 2^k Design-Resolution III, IV and V designs.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	**Incomplete block designs**:Balanced Incomplete Block Design- Parametric relationship- Intra and Inter block analysis- Partially Balanced Incomplete block designs with 2 associate classes –Intra Block Analysis- Basic concepts in Lattice designs and Youden square design.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	**Spit plot designs**:Split-plot, Split-split plot, Strip-plot and Strip-split-plot designs **Resource surface design:** Basic methodology in resource surface design –first order model- method of steepest ascent.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1.Montgomery, D. C. (2017). *Design and analysis of experiments*. John wiley& sons.NewYork.
2.Das, M. N and Giri, N. S. (1986). *Design and Analysis of Experiments*.2/e, Wiley Eastern .New Delhi.
3. Gupta, S. C., &Kapoor, V. K. (2020). *Fundamentals of mathematical statistics*. Sultan Chand & Sons.NewDelhi

References

1.Cochran, W. G and Cox, G. M. (1957).*Experimental Design*, John Wiley &sons, New York.
2. Kempthorne, O. (1976). *Design and Analysis of Experiments*. John Wiley & Sons, New York
3. Fisher, R. A. (1953). *Design and Analysis of Experiments*. Oliver and Boyd, London.

Suggested Reading

1. Mukhopadhaya, P, (2011), *Applied Statistics,* Books & Allied Ltd.
2. Federer, W. T (1963), *Experimental Designs – Theory and Applications*,McMillanCo. NewYork.

Web Resources

1. https://drs.icar.gov.in/ebook/EBADAT/2-Basic%20Statistical%20Techniques/10-IBD-vksharma.pdf
2. http://home.iitk.ac.in/~shalab/anova/chapter6-anova-bibd.pdf
3. https://www.math.montana.edu/jobo/st578/sec5a.pdf

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Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	3	3	-	1	-	-	-	3	-	-	-	-	**K1**
CO 2	3	3	-	1	-	-	-	3	-	-	-	-	**K2**
CO 3	-	-	3	2	-	1	3	-	3	-	3	2	**K3**
CO 4	-	-	3	3	2	2	3	-	3	2	3	2	**K4**
CO 5	-	-	3	3	-	2	3	-	3	-	3	3	**K5,K6**
Wt. Avg.	**3**	**3**	**3**	**2**	**2**	**1.6**	**3**	**3**	**3**	**2**	**3**	**2.3**	
Overall Mapping of the Course											**PO –2.5**		
											PSO – 2.6		

ADVANCED DISTRIBUTION THEORY

Course Code	232ST2M02		
Credits	4		
Hours / Cycle	6		
Category		Core	Theory
Semester	II		
Year of Implementation	From the academic year 2023_2024 onwards.		
Course Objectives	1. To study advanced discrete and continuous probability distributions as well as bi-variate and multivariate probability distributions. 2. To apply the knowledge of probability and random variables course to study the properties of these probability distributions. 3. To familiarise students with genesis & applications of these advanced probability distributions with probability models for data.		
CO	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
On completing the course successfully, the student will be able to			
CO1	Study the discrete and continuous probability distributions and their real life applications	PSO1 PSO2	K1
CO2	Understandthe concept of the bi-variatedistributions, transformation of univariate, multivariate density functions and the nature of data to perform appropriate analysis.	PSO2 PSO3	K2
CO3	Apply compound, truncated, mixture and non-central distributions to real time data.	PSO3 PSO4	K3
CO4	Establish the quadratic forms in Normal variants with Maximum likelihood estimates and to illustrate the characteristic features of various probability distributions	PSO4	K4
CO5	Choose an appropriate probability distribution for a given discrete or continuous random variable and determine the role of Empirical function with real life applications.	PSO5	K5,K6

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Beta, Gamma, Cauchy, Lognormal, Logistic, Laplace, Logarithmic and Hyper-geometric distributions – Bi-variate discrete distributions: Bi-variate binomial and bi-variate Poisson distributions – Multi nominal distribution.	**20**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Non-central sampling distributions - Chi-square, t and F distributions and their properties - Compound and mixture of distributions: Binomial, Poisson and Normal distributions - Truncated distributions - Order statistics, their distributions and properties.	**20**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Multivariate Normal Distribution (singular and non-singular) - Characteristic function - Moments - Marginal and conditional distributions - Independence of variables – Linear transformation - Distribution of sample mean vector.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Maximum likelihood estimates of the mean vector and dispersion matrix - Independences of maximum likelihood estimates of mean vector and dispersion matrix.	**16**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Distribution of quadratic forms in Normal variables - Independence of two quadratic forms and independence of quadratic form and linear form - Cochran's theorem.	**16**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Anderson, T. W (1984), *An Introduction to Multivariate Statistical Analysis*, John Wiley and Sons
   David, H. A (1981), Order Statistics, John Wiley
2. Johnson, N. L and Kotz, S (2004), *Distributions in Statistics, Continuous Univariate Distributions*, Vols. I to 4, John Wiley and Sons.
3. Johnson N. L, Kotz, S and Balakrishnan, N (2004), *Discrete Multivariate Distribution*, John Wiley and Sons, New York.
4. Searle, S. R (1971), *Linear Models*, John Wiley and Sons, New York

References

1. Hogg, R.V and Craig, A.T (2002), *Introduction to Mathematical Statistics*, 4th edition, Colliner McMillan.
2. Rao, C. R (1973), *Linear Statistical Inference and its Applications*, Wiley Eastern.
3. Johnson, N.L., Kotz, S. and Balakrishnan, N. (2004). *Continuous Univariate Distribution.* Vol. 1 John Wiley and Sons,(Asia) Pte.Ltd. Singapore.
4. Johnson, N.L., Kotz, S. and Balakrishnan ,N(2004). *Continuous Univariate Distributions* Vol. 2. John Wiley and Sons,(Asia) Pte.Ltd. Singapore

Suggested Reading

1. Rohatgi, V. K (1984), *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern.
2. Albert W. Marshall, Ingram Olkin (2007) - *Life Distributions: Structure of Nonparametric, Semi parametric, and Parametric Families*, Springer Series in Statistics

Web Resources

1.https://www.webpages.uidaho.edu/~stevel/519/Applied%20Multivariate%20Statistical%20Analysis%20by%20Johnson%20and%20Wichern.pdf
2. https://nptel.ac.in/courses/111/104/111104032/
3. https://onlinecourses.swayam2.ac.in/cec21_ma02/preview
4. https://www.coursera.org/courses?query=probability%20distribution

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3	3	3	3	-	3	-	-	3	2	--	-	-	K1
CO 2	-	-	2	3	3	3	-	-	-	3	2	-	-	K2
CO 3	-	-	-	-	3	3	3	-	-	-	2	2	-	K3
CO 4	-	-	-	-	-	-	3	-	-	-	-	3	-	K4
CO 5	-	-	-	-	-	-	3	-	-	-	-	-	3	K5,K6
Wt. Avg.	3	3	2	3	3	3	3	-	3	2.5	2	2.5	3	
Overall Mapping of the Course												PO – 2.86		
												PSO – 2.60		

SAMPLING THEORY

Course Code	232ST2M03		
Credits	4		
Hours / Cycle	5		
Category		Core	Theory
Semester	II		
Year of Implementation	From the academic year 2023_2024 onwards.		
Course Objectives	1. To introduce advanced sampling techniques and its theoretical aspects. 2. To identify the sampling method that best suits the problem. 3. To compare the efficiency of the different sampling techniques.		

CO	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
On completing the course successfully, the student will be able to			
CO1	Retain the ideas and theoretical foundations behind various sampling methods.	PSO1	K1
CO2	Recognise how various sampling techniques differ from each other.	PSO1	K2
CO3	Determine the sampling methods which best suits the problem.	PSO3 PSO4 PSO5	K3
CO4	Investigate and compare the unbiasedness and efficiency of the sampling techniques.	PSO2	K4
CO5	Assess the benefits and drawbacks of various sampling plans.	PSO2	K5,K6

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	**Ratio and Regression Estimators** Asymptotic variance of ratio estimators - Bias in ratio estimation - Ratio estimation in stratified sampling - Combined and separate ratio estimators - Multivariate ratio estimators - Variance of regression estimators - Regression estimation in stratified sampling - Comparison of ratio and regression estimators.	**20**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	**Probability Proportion to Size with Replacement Sampling** Estimation of population mean, total – Selection of a ppswr sample – Comparison with simple random sampling with replacement – Estimation of gain due to ppswr sampling – The efficiency of ppswr sampling with respect to srswr for a given cost.	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	**Cluster Sampling** Estimate of mean per element and its variance - Optimum cluster size - Clusters of unequal size - Sampling with unequal probabilities with and without replacement - Various estimators and their mean square errors – Efficiency of Cluster Sampling..	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	**Two-stage Sampling** Two-Stage Sampling - Units of equal size - Variance of estimated mean, optimum sampling and sub-sampling fractions - Stratified sampling of first stage units - Units of unequal size - sampling with equal and unequal probabilities with and without replacement - Different estimates and their mean square errors – Efficiency of Stratification in two-stage sampling.	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	**Two-Phase Sampling** Two-Phase Sampling - The technique and its uses - Double sampling for stratification - Estimate of the mean and its variance - Double sampling for regression estimation - Estimate of the mean and variance.	**10**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Cochran, W. G. (2011). *Sampling techniques*. John Wiley & Sons.
2. Mukhopadhyay, P. (2008). *Theory and methods of survey sampling*. PHI Learning Pvt. Ltd.

References

1. Singh, D., &Chaudhary, F. S. (1986). *Theory and analysis of sample survey designs*. John Wiley & Sons.
2. Sukhatme, B. V., Sukhatme, B. V., Sukhatme, S., & Ashok, C. (1984). *Sample Survey methods and its Applications*. Indian Society of Agricultural Statistics.
3. Sampath, S (2000), *Sampling Theory*, Narosa Publications Ltd, New Delhi.
4. Raj, D., &Chandhok, P. (1998). *Sample survey theory*. Narosa.

Suggested Reading

1. Wu, C., & Thompson, M. E. (2020). *Sampling theory and practice*. Cham: Springer International Publishing.
2. Warwick, D. P., &Lininger, C. A. (1975). *The sample survey: Theory and practice*. McGraw-Hill.

Web Resources

1. https://fsapps.nwcg.gov/gtac/CourseDownloads/IP/Cambodia/FlashDrive/Supporting_Documentation

/Cochran_1977_Sampling%20Techniques.pdf
2. http://home.iitk.ac.in/~shalab/course1.htm
3. http://www.mim.ac.mw/books/S.%20Sampath%20Sampling%20theory%20and%20methods%202001.pdf

Course Articulation Matrix													
Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3	2	-	2	-	-	-	3	-	-	-	-	K1
CO 2	3	2	-	2	-	-	-	3	-	-	-	-	K2
CO 3	-	-	-		2	1	3	-	-	3	3	3	K3
CO 4	-	-	3	2	-	1	-	-	3	-	-	-	K4
CO 5	-	-	3	2	-	1	-	-	3	-	-	-	K5,K6
Wt. Avg.	3	3	3	2	2	1	3	3	3	3	3	3	
Overall Mapping of the Course											PO – 2.43		
											PSO – 3		

PRACTICAL II

Course Code	**232ST2M04**		
Credits	**4**		
Hours / Cycle	**5**		
Category		**Core**	**Practical**
Semester	**II**		
Year of Implementation	**From the academic year 2023_2024 onwards.**		
Course Objectives	**1.To Provide Practical Knowledge in analyzing problems in design of experiments, distribution theory and sampling theory** **2.To demonstrate hands on experience to solve real time problems** **3. To know the applications of design of experiments in various fields of research**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Recall the various techniques used in solving problems in design of experiments, distribution theory and sampling theory.**	**PSO1**	**K1**
CO 2	**Understand and compare the procedures used in solving the problems.**	**PSO1**	**K2**
CO 3	**Select a suitable technique for the problem under study.**	**PSO2** **PSO4** **PSO5**	**K3**
CO 4	**Analyze the problem using the choosen technique and examine the results.**	**PSO2** **PSO3** **PSO4** **PSO5**	**K4**
CO 5	**Interpret the findings of the end resultfor the problem taken for study.**	**PSO2** **PSO4** **PSO5**	**K5,K6**

SYLLABUS

Calculator Based Practical

I. Applied Design of Experiments

1. 2^4factorialexperiment
2. 2^4 factorial experiment-Totalconfounding.
3. 2^4 factorial experiment–Partial confounding.
4. Singlereplicateof2^4 factorialexperiment
5. nxpFactorialexperiment
6. Split-plot experiment
7. Stripplotexperiment
8. BIBD –Intra and Inter Block Analysis
9. PBIBD(2) – Intra Block Analysis
10. Youden Square Design

II. Distribution Theory

1. Fittingofa)Cauchyb)Lognormalc)Logisticd)Laplaceande)TruncatedBinomialandPoissondistributions
2. Marginal and conditional distributions of multivariate normal distribution

III. Sampling Techniques

1. SimpleRandomSampling
1. Ratio Estimator
2. Ratio Estimators in Stratified Sampling
3. RegressionEstimator
4. Regression Estimators in Stratified Sampling
5. Probability Proportionalto SizeSampling
6. ClusterSampling
7. Two-Stagesampling
8. Two-Phase Sampling

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Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	3	3	-	1	-	-	-	3	-	-	-	-	**K1**
CO 2	3	3	-	1	-	-	-	3	-	-	-	-	**K2**
CO 3	-	-	3	2	-	1	2	-	3		3	2	**K3**
CO 4	-	-	3	2	3	2	2	-	3	2	3	2	**K4**
CO 5	-	-	3	3	--	2	2	-	3		3	2	**K5,K6**
Wt. Avg.	**3**	**3**	**3**	**1.8**	**3**	**1.6**	**2**	**3**	**3**	**2**	**3**	**2**	
Overall Mapping of the Course											**PO -2.4**		
											PSO -2.6		

ADVANCED PYTHON

Course Code	232ST2E01		
Credits	5		
Hours / Cycle	6		
Category		Elective	Theory
Semester	II		
Year of Implementation	From the academic year 2023_2024 onwards.		
Course Objectives	1. To learn how to use lists, tuples, and dictionaries in Python programs and to identify Python object types. 2. To learn how to use indexing and slicing to access data in Python programs. 3. To learn how to use exception handling in Python applications for error handling.		

CO	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
On completing the course successfully, the student will be able to			
CO1	Relate to the semantics of Python programming language and the process of structuring the data using lists, dictionaries, tuples, strings and sets.	PSO1 PSO2 PSO3	K1
CO2	Interpret the basic principles of Python programming language.	PSO1 PSO3	K2
CO3	Develop many advanced Python methods and variables.	PSO2 PSO3	K3
CO4	Dissect the commonly used operations involving file systems and regular expressions.	PSO3 PSO4	K4
CO5	Perceive the basics of machine learning and also understand the advantage of using Python libraries for implementing Machine Learning models.	PSO3 PSO5	K5,K6

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Operations in List, Tuples, Dictionary, Set and Frozen Set – String Operations – Functions – Defining and Calling Function – Recursive function .	**17**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	NumPy arrays – 1-d, multidimensional arrays and matrices; Mathematical operations with arrays – Slicing and addressing arrays – SciPy – Scientific Computing library of Python – Data Manipulation with Pandas –Introduction– DataFrame–Reading and writing CSV, XLS files – Working with missing data, categorical data.	**21**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	PyPlot – Basic Plotting; Logarithmic Plots – Plots with multiple axes –Visualization with Matplotlib and Seaborn: Bar Plots – Scatter Plot – Heat Map – Histograms – Box and Whisker plot.	**16**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	List Comprehension – Lambda – Regular Expression – Enumeration – Iterators.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Handling IO Exceptions – Metadata– Errors – Runtime Errors – Exception Model – Garbage Collections	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Jake vanderPlas (2017), *Python Data Science Handbook – Essential Tools for Working with Data*, O'Really
2. David J. Pine (2019), *Introduction to Python for Science and Engineering*, CRC Press
3. Mark Lutz (2010), *Programming Python*, O`Reilly, 4th Edition

References

1. Robert Johansson (2019), *Numerical Python – Scientific Computing and Data Science Applications with NumPy, SciPy And Matplotlib*, Apress
2. Robert Sedgewick, Kevin Wayne, Robert Dondero (2016), *Introduction to Programming in Python: An Inter-disciplinary Approach*, Pearson India Education Services Pvt. Ltd.
3. Nelli, F (2018),*Python Data Analytics: with Pandas, NumPy and Matplotlib*, Apress.

Suggested Reading

1. *Python Notes for Professionals* – GoalKicker.com
2. Mark Summerfield (2009), *Programming in Python 3*, Pearson Education.

Web Resources

1. https://www.youtube.com/c/365DataScience
2. https://www.youtube.com/c/AppliedAICourse
3. https://www.youtube.com/c/DataEngineeringSimplified
4. https://www.youtube.com/c/DataScienceAlivemachine_learning_artificial_tamil
5. https://www.youtube.com/c/Freecodecamp

Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	2	3	2	2	3	2	-	2	2	3	-	-	**K1**
CO 2	2	3	-	2	3	-	-	2	-	3	-	-	**K2**
CO 3	-	-	2	2	3	2	-	-	2	3	-	-	**K3**
CO 4	-	-	-	-	3	2	3	-	-	3	2	-	**K4**
CO 5	-	-	-	-	3	2	3	-	-	3	-	2	**K5,K6**
Wt. Avg.	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**2**	
Overall Mapping of the Course											**PO – 2.43**		
											PSO – 2.20		

6. https://www.youtube.com/c/Datacamp
7. https://www.youtube.com/c/Intellipaat
8. https://www.youtube.com/c/khanacademy
9. https://www.youtube.com/user/krishnaik06
10. https://www.youtube.com/c/NeetCode

SEMESTER III

MULTIVARIATE ANALYSIS

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Core**	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2023_2024 onwards.**		
Course Objectives	**1. To understand the various techniques used in Multivariate study** **2. To acquire the skill of identifying a real time problem and to use an appropriate multivariate technique** **3. To know the applications of Multivariate techniques in various fields of research**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO1	**Recall the various techniques used in a multivariate study**	**PSO1**	**K1**
CO2	**Compare and demonstrate the various tools to handle multivariate problems**	**PSO1**	**K2**
CO3	**Identfiy a suitable multivariate tool to a real time problem and to plan the strategies for solving the problem.**	**PSO2 PSO4 PSO5**	**K3**
CO4	**Analyze the multivariate data and conclude the findings of the study**	**PSO2 PSO3 PSO4 PSO5**	**K4**
CO5	**Evaluate the conclusions drawn and develop plan of actions for future through prediction in various field of research.**	**PSO2 PSO4 PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**Cos**	**BLOOM'S TAXONOMY LEVEL**
I	**Test for Mean Vectors:** Hotelling's T^2statistic- Invariant Property- one sample and two sample problems -Beheren Fisher problem- Mahalanobis D^2-statistic - Problem of symmetry - Test for equality of sub- vectors –Profile analysis - Multivariate analysis of variance - one-way analysis	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	**Test for Covariance Matrices:** Testing hypothesis for single covariance matrix and several covariance matrices -Testing the independence of sets of variables. **Wishart Distribution**: Wishart matrix- Distribution of wishart matrix (without proof) -Generalization of Chi-Square distribution- Properties: Characteristic function, sum of wishart matrices, linear transformation, Marginal distributions	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	**Discriminant Analysis:** Classification problem- Standards of good classification-Procedures of classification into one of two populations with known probability distributions– Linear, Quadratic, Fisher's linear discriminant functions - Determination of error rates by confusion matrix. **Cluster Analysis**: Distance measures- similarity measures for binary variables - Hierarchical clustering techniques :Agglomerative techniques - Single linkage and Complete linkage methods – Non-hierarchical clustering technique -K-means method.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	**Principal Component Analysis**: Extraction of components- Properties and characteristics of components- Total variation, relative importance --Standardization of variables and components.. **Factor Analysis:** Orthogonal factor model- Principal component method of extracting factors- Factor rotation- varimax rotation- factor scores	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	**Canonical Correlation Analysis**: Extraction of canonical correlations and canonical variable- Testing the significance of canonical correlation- Interpretation of canonical variables. **Multiple Regression Analysis**: Fitting of regression equation with quantitative and qualitative variables- Detection and correction of multi-collinearity problems: Principal component method, Ridge Regression- Generalized Linear Model-Logistic regression – Logit models-Confusion matrix.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Anderson,T.W(2009).*An Introduction to Multivariate Statistical Analysis.* John Wiley and Sons.

2. Johnson, R. A., &Wichern, D. W. (2007). *Applied Multivariate Statistical Analysis*. Prentice Hall International.

3. Montogomery, D.C., Peck, E.A., & Vining, G.C. (2003). *Introduction to Linear Regression Analysis.* Wiley. NY.

References

1. Giri, N.C. (2003). *Multivariate Statistical Inference.* Academic Press. NY
2. Everitt, B.S. & Dunn, G. (2001). *Applied multivariate Data analysis.* Arnold Publishers. London.
3. Alan Agresti (2007). Categorical Data Analysis, Wiley. NY

Suggested Reading

1. Morrison, D.F. (1990). *A multivariate statistical methods*, McGraw hall, NewDelhi.
2. Brain Everitt&TorstenHothorn (2011). An Introduction to Applied Multivarite Analysis with R. Springer

Web Resources

1. https://www.math.hkust.edu.hk/~makchen/MATH4424/Chap9.pdf
2. http://home.iitk.ac.in/~shalab/regression/Chapter9-Regression-Multicollinearity.pdf
3. https://www.wallstreetmojo.com/discriminant-analysis/

Course Articulation Matrix

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	-	1	-	-	-	3	-	-	-	-	K1
CO2	3	3	-	1	-	-	-	3	-	-	-	-	K2
CO3	-	-	3	1	-	1	3	-	3		3	2	K3
CO4	-	-	3	1	2	2	3	-	3	2	3	2	K4
CO5	-	-	3	3	--	2	3	-	3		3	3	K5,K6
Wt. Avg.	3	3	3	1.4	2	1.6	3	3	3	2	3	2.3	
Overall Mapping of the Course											PO – 2.4		
											PSO – 2.6		

THEORY OF ESTIMATION

Course Code			
Credits	4		
Hours / Cycle	6		
Category		**Core**	**Theory**
Semester	III		
Year of Implementation	From the academic year 2023_2024 onwards.		
Course Objectives	1. To understand the basic concepts of point and interval estimation. 2. To examine the properties of a good estimator and also to construct various inequalities and confidence intervals related to estimators. 3. To apply different estimating procedures to obtain estimators for the parameters of different populations and to analyse the asymptotic behaviour of estimators.		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO1	Relate tothe strong theoretical foundation to deal with real life situations in estimating the parameters of the population..	PSO1 PSO2	K1
CO2	Outline the different estimation methods	PSO1 PSO2	K2
CO3	Make use of the properties of a good estimator.	PSO1 PSO2 PSO3	K3
CO4	Examine the confidence intervals of parameters	PSO3 PSO4	K4
CO5	Arrive at a desired estimator by determining a probability distribution for the measured data, and the distribution's dependence on the unknown parameters of interest.	PSO4 PSO5	K5,K6

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Point Estimator and its optimal properties :Unbiasedness and asymptotic unbiasedness - Minimum Variance Estimators – Cramer-Rao Bound – Chapman-Robin Bound - Bhattacharya system of lower bounds.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Sufficient Statistics - Completeness – bounded completeness - Complete sufficient statistics - Factorization theorem – Rao-Blackwell theorem – Lehman-Scehffe Theorem - Minimum Variance Bound Estimators	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	ML Estimators - CAN Estimators - Moment Estimators - CAN properties of ML estimators and moment estimators - ML estimation based on grouped, truncated and censored data.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Minimum Chi-square estimation - Bayesian Estimators - Estimation procedure for scale and location parameters - Sequential Estimation.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Construction of shortest length confidence bounds based on sufficient statistics - Reliability estimation - Construction of confidence interval for reliability for one parameter family of pdf's.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Lehmann, E. L (1983), *Theory of Point Estimation*, John Wiley and Sons.
2. Rohatgi, V. K (1984), *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern.

References

1. Kale, B.K (1999), *A First Course on Parametric Inference*, Narosa Publication, New Delhi.
2. Mood, A.M. Graybill, F.A. and Boes, D.C (1974), *Introduction to the Theory of Statistics*, McGraw Hill Co.
3. Sinha, S. K (1986), *Reliability Life Testing*, Wiley Eastern.

Suggested Reading

1. Denuit, M., Hainaut, D. and Trufin, J. (2019), *Effective statistical learning methods for actuaries [Generalised Linear Models] GLMs and extensions*, Springer, ISBN 978- 3030258207
2. McCullagh, P. and Nelder, J.A. Chapman (1989), *Generalized linear models*. 2nd ed., CRC Press.

Web Resources

1. https://nptel.ac.in/courses/111/105/111105043/ 2.
2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ma19/

Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	2	1	2	2	-	3	-	3	2	-	-	-	K1
CO 2	2	1	2	2	-	3	-	1	2	-	-	-	K2
CO 3	2	1	2	2	2	3	-	2	2	2	-	-	K3
CO 4	-		-	-	2	3	2	-	-	2	2	-	K4
CO 5	-	-	-	-	-	-	2	-	-	-	2	2	K5,K6
Wt. Avg.	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	
Overall Mapping of the Course											**PO – 2**		
											PSO – 2		

RELIABILITY THEORY

Course Code			
Credits	4		
Hours / Cycle	5		
Category		**Core**	**Theory**
Semester	III		
Year of Implementation	From the academic year 2023_2024 onwards.		
Course Objectives	1. To understand the fundamental concepts in reliability theory such as hazard rate, MTBF, series and parallel sytems. 2. To understand statistical modelling of reliability of components based on lifetime data. 3. To develop probabilistic modelling of reliability of complex systems.		

CO	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
On completing the course successfully, the student will be able to			
CO 1	Define Reliability in quantitative measures to help in modelling.	PSO1 PSO4 PSO5	K1
CO 2	Relate to the importance of Reliability theory in the field of Engineering.	PSO1 PSO2 PSO3 PSO4 PSO5	K2
CO 3	Explore advanced topics on System Reliability.	PSO1 PSO2 PSO3 PSO4	K3
CO 4	Examine the ageing properties of main distributions in Reliability theory.	PSO1 PSO4	K4
CO 5	Model and evaluate the reliability of complex systems.	PSO2 PSO3 PSO4 PSO5	K5,K6

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	**Basic Concepts** Definition and importance of reliability - Survival function, hazard rate, residual lifetime, mean residual lifetime, MTSF - Derivation of these measures with reference to Exponential, one parameter and two parameter Gamma, Lognormal, Weibul.	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	**System Reliability Models** Reliability of structures : Series systems - Parallel systems, series-parallel, parallel-series (m,n) systems - Standby systems - series-parallel systems - Systems subject to two types of failure - Examples involving exponential and lognormal distributions.	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	**System Maintainability** Concept of system maintainability: Systems of order 2- two unit standby system with exponential repair - (1,2) systems with exponential repair - (1,2) systems with arbitrary repair.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	**System Maintainability with Parallel Repair** (m,n) systems with parallel repair - Standby systems with parallel repair.	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	**System Availability** System availability measures: Point availability - Interval availability - Average availability - Steady state availability - Derivation of point availability and steady state availability for one unit system - Series systems with repair - Standby systems with repair.	**12**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

John, G. Rau (1964), *System Reliability in Engineering*, John Wiley.

References (3 – 5)

1. Lawless, J. F. (1982). *Statistical models and methods for lifetime data*, Wiley. *New York*.
2. Sinha, S. K. (1986). *Reliability and life testing*. John Wiley & Sons, Inc.
3. Barlow, R. E., &Proschan, F. (1975). *Statistical theory of reliability and life testing: probability models*. Florida State Univ Tallahassee.

Suggested Reading

1. Zacks, S. (2012). *Introduction to reliability analysis: probability models and statistical methods*. Springer Science & Business Media.
2. Bain, L. (2017). *Statistical analysis of reliability and life-testing models: theory and methods*. Routledge.

Web Resources

1. http://ndl.ethernet.edu.et/bitstream/123456789/4817/1/12pdf.pdf
2. http://mycsvtunotes.weebly.com/uploads/1/0/1/7/10174835/reliability_engineering.pdf
3. https://beckassets.blob.core.windows.net/product/readingsample/796712/9781852339500_excerpt_001.pdf

Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	3	3	-	3	-	-	2	3	-	-	2	2	**K1**
CO 2	2	2	2	2	2	2	2	3	2	2	2	2	**K2**
CO 3	2	2	2	2	2	2	2	3	2	2	2	-	**K3**
CO 4	3	3	-	3	-	-	2	3	-	-	2	-	**K4**
CO 5	-	-	2	2	2	2	2	-	2	2	2	2	**K5,K6**
Wt. Avg.	**2.5**	**2.5**	**2**	**2.4**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**K1**
Overall Mapping of the Course											**PO – 2.20**		
											PSO –2.20		

PRACTICAL III

Course Code			
Credits	**4**		
Hours / Cycle	**5**		
Category		**Core**	**Practical**
Semester	**III**		
Year of Implementation	**From the academic year 2023_2024 onwards.**		
Course Objectives	**1. To impart programming skills using R Language.** **2. Apply the programming skills to the real life data and arrive solutions.** **3. Arriving conclusions from the results.**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Relate to the analysis involved in studies with multiple variables.**	**PSO1 PSO4 PSO5**	**K1**
CO 2	**Understand and compare the multivariate techniques**	**PSO1 PSO2 PSO4**	**K2**
CO 3	**Applying software skills learnt during the course to perform analysis.**	**PSO2 PSO3 PSO4 PSO5**	**K3**
CO 4	**Analyze the problem using the choosen technique and examine the results.**	**PSO2 PSO3 PSO4 PSO5**	**K4**
CO 5	**Interpret the results and drawing conclusions.**	**PSO2 PSO4 PSO5**	**K5,K6**

SYLLABUS	
Ex.No	**Solving Problems Using R**
1	**Hotelling's T 2 -statistic : One sample problem**
2	**Hotelling's T 2 -statistic : Two sample problem**
3	**Beheren Fisher problem**
4	**Test for equality of Sub-Vectors**
5	**Multivariate Analysis of variance - one way analysis**
6	**Problem of Symmetry**

Course Articulation Matrix

7	**Test for independence of sets of variables**
8	**Test for equality of Covariance matrices**
9	**Cluster Analysis – Hierarchical clustering technique**
10	**Cluster Analysis- K means clustering technique**
11	**Discriminant Analysis**
12	**Principal Component Analysis**
13	**Canonical Correlation Analysis**
14	**Multiple linear Regression**
15	**Logistic Regression**
16	**ML Estimators**
17	**Modified Chi-square Estimation**
18	**Reliability Estimation**
19.	**Bayesian Estimation**
20.	**Confidence Interval**

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3	3	-	2	-	-	2	3	-	-	3	2-	K1
CO 2	3	3	3	2	-	2	2	3	3	-	3	-	K2
CO 3	-	-	3	2	3	2	2	-	3	2	3	2	K3
CO 4	-	-	3	2	3	2	2	-	3	2	3	2	K4
CO 5	-	-	3	2	--	2	2	-	3	-	3	2	K5,K6
Wt. Avg.	3	3	3	2	3	2	2	3	3	2	3	2	
Overall Mapping of the Course											PO -2.57		
											PSO -2.60		

STOCHASTIC PROCESSES

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Elective**	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1.To motivate the students to approach the random variables with respect to time.** **2.To give insight to improve the skills in probabilistic model constructing.** **3.To inculcate sound knowledge in the applied areas of stochastic processes**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Label the Markov chain with reference to classes of states and relate with Gambler's Ruin Problem and Mean Time in Transient States.**	**PSO1**	**K1**
CO 2	**Demonstrate Continuous-Time Markov Chains and apply to Birth and Death Processes.**	**PSO2**	**K2**
CO 3	**Apply Markov models to construct Renewal process**	**PSO4**	**K3**
CO 4	**Discover branching process with reference to Markov chains.**	**PSO4**	**K4**
CO 5	**Construct Differential Equations for a WienerProcess and Interpret diffusion equations of Brownian motion for Markov Processes with Continuous State Space.**	**PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Markov Chains: Stochastic Processes and Examples. Markov Chain – Introduction and Examples – Chapman–Kolmogorov Equations –Classifications of States – Limit Theorems. Transitions among Classes, Gambler's Ruin Problem and Mean Time in Transient States.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Continuous-Time Markov Chains: Introduction – Continuous–Time Markov Chains – Birth and Death Processes –Kolmogorov Differential Equations.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Renewal Theory: Introduction–Renewal Function and Renewal Equation - Distribution of the number of renewals – Limit Theorems –Wald's Equation – The Key Renewal Theorem.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Branching Processes: Introduction – Properties Generating Function – Probability of Extinction – Distributionof Total Number of Progeny.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Markov Processes with Continuous State Space: Brownian motion – Wiener Process – Differential Equations for a WienerProcess – Kolmogorov Diffusion Equations.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Sheldon M. Ross , Reprint (2013),*Stochastic Processes*, Second edition, Wiley Ltd, India
Unit 1 - Chapter 1 (1.9) , Chapter 4(4.1and4.2)
Unit 2 - Chapter 5 (5.1 to 5.4)
Unit 3 - Chapter 3 (3.1 to 3.4)
2. Medhi, J (2020), *Stochastic Processes*, 5th Edition, New Age International (P) Ltd., Publishers, New Delhi
Unit 4 - Chapter 9 (9.1 to 9.4)
Unit 5 - Chapter 5 (5.1 to 5.4)

References

1. Bhatt, U. N (1984), *Elements of Applied Stochastic Processes*, John Wiley,New York.
2. Parzen, E (1999), *Stochastic Processes*, SIAM, Philadelphia.
3. Veerarajan, R (2008), *Probability, Statistics and RandomProcesses*, Third Edition, Tata Mcgrw–hill Publishing Education.

Suggested Reading

1. Basu, A. K (2001), *Introduction to Stochastic Process*, Narosa PublishingHouse, New Delhi.
2. Karlin, S and Taylor, H. M (1975), *A First Course in Stochastic Processes*,Academic Press, New York.

Web Resources

1. https://searchworks.stanford.edu
2. https://www.journals.elsevier.com

3. https://www.routledge.com
4. https://www.researchgate.net
5. https://www.coursera.org
6. **https://web.ma.utexas.edu/users/gordanz/notes/introduction_to_stochastic_processes.pdf**

Course Articulation Matrix

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3	3	-	3	-	-	-	3	-	-	-	-	K1
CO 2	-	-	3	3	-	3	-	-	3	-	-	-	K2
CO 3	-	-	-	-	-	-	3	-	-	-	3	-	K3
CO 4	-	-	-	-	-	-	3	-	-	-	3	-	K4
CO 5	-	-	-	-	-	-	3	-	-	-	-	3	K5,K6
Wt. Avg.	3	3	3	3	-	3	3	3	3	-	3	3	
Overall Mapping of the Course											PO 3		
											PSO 3		

CLINICAL TRIALS AND DATA MINING

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Elective**	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. To understand the Foundation of Clinical Trials and Randomized control trials** **2. To Comprehend the Clinical data mining** **3. To hold the knowledge and application of Classfication techniques**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Define the basics of Clinical trails, Randomized control trails and Clinical Data mining**	**PSO1**	**K1**
CO 2	**Understand the concepts of Clinical trial,data management,Clinical data mining and Classification techniques**	**PSO2** **PSO3**	**K2**
CO 3	**Apply Clinical data mining and Classification techniques in practical situation**	**PSO3** **PSO4**	**K3**
CO 4	**Examine the Randomized control trails, Clinical data mining and its patterns**	**PSO3** **PSO4**	**K4**
CO 5	**Assess Classification techniques with data management**	**PSO3** **PSO4** **PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction: The Rationale of Clinical Trials: Phases of clinical trials Phase I, II, III and IV trials, The Historical Development of Clinical Trials, Organization and Planning.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	The Justification for Randomized control trials - Methods of Randomization - Blinding and Placebos - Crossover trials	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	The Size of a Clinical trial- Monitoring trial process- Forms and Data management	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Clinical data mining: Introduction, Classification: General approach to solving a classification problem – Decision tree induction – Model over-fitting- Evaluating the performance of the classifier – Method for comparing classifiers-– Rule based classifiers – Nearest Neighbor classifiers.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Artificial Neural Network – Support Vector Machine- Association analysis: Frequent item set generation – Rule generation- Compact representation of frequent item sets- Alternative methods for generating frequent itemsets- FP-Growth Algorithm - Evaluation of association patterns.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

3. Pocock, S. J. (2013). *Clinical trials: a practical approach*. John Wiley & Sons.
4. Tan, P. N., Steinbach, M., and Kumar, V. (2016). *Introduction to data mining*. Pearson Education India.

References

6. Dunham, M. H. (2006). *Data mining: Introductory and advanced topics*. Pearson Education India.
7. Han, J., Pei, J., and Tong, H. (2022). *Data mining: concepts and techniques*. Morgan kaufmann.
8. Piantadosi, S. (2017). *Clinical trials: a methodologic perspective*. John Wiley & Sons.
9. Gupta, G. K. (2014). *Introduction to data mining with case studies*. PHI Learning Pvt.Ltd..
10. Azzalini, A., &Scarpa, B. (2012). *Data analysis and data mining: An introduction*. OUP USA.

Suggested Reading

6. Fleiss, J. L. (2011). *Design and analysis of clinical experiments*. John Wiley & Sons.
7. Meinert, C. L. (2012). *ClinicalTrials: design, conduct and analysis* (Vol. 39). OUP USA.
8. Wang, D., and Bakhai, A. (2006). *Clinical trials: a practical guide to design, analysis, and reporting*. Remedica.
9. Sumathi, S., and Sivanandam, S. N. (2006). *Introduction to data mining and its applications* (Vol. 29). Springer.

Web Resources

6. https://liacs.leidenuniv.nl/~bakkerem2/dbdm2007/05_dbdm2007_Data%20Mining.pdf
7. https://www.hzu.edu.in/uploads/2020/10/Textbook-of-Clinical-Trials-Wiley-(2004).pdf
8. https://web.njit.edu/~wguo/Math654_2012/Math654_Lecture%202_2012.pdf
9. https://www.youtube.com/watch?v=ykZ_UGcYWg&list=PLLspfyoOYoQcI6Nno3gPkq0h5YSe81hsc

Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	2	2	-	2	-	-	-	3	-	-	-	-	**K1**
CO 2		--	2	2	2	2	-	-	2	2	-	-	**K2**
CO 3	-	-	-	-	2	2	2	-	-	2	2	-	**K3**
CO 4			-	-	2	2	2	-	-	2	2	-	**K4**
CO 5					2	2	2	-	-	2	2	2	**K5,K6**
Wt. Avg.	2	2	2	2	2	2	2	3	2	2	2	2	
Overall Mapping of the Course											**PSO-2.2**		
											PO-2		

SEMESTER IV

STATISTICAL QUALITY CONTROL

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Core**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. Understand the application of statistics in industrial environment.** **2. Acquire to knowhow manufacturing process changes and process variability.** **3. Attain proficiency in process capability analysis** **4. Instruct theory and practice of product control methodology**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Define the basic concepts of statistical quality control**	**PSO1**	**K1**
CO 2	**Explain about the process control techniques**	**PSO2** **PSO3** **PSO4**	**K2**
CO 3	**Apply the product control techniques**	**PSO2** **PSO4**	**K3**
CO 4	**List the various sampling plans**	**PSO2** **PSO4**	**K4**
CO 5	**Compare various sampling plans**	**PSO2** **PSO4** **PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Schewhart Control Charts – X-bar, R, p, np, c, and u charts (A review) – OCand ARL of control charts – uses of runs and related pattern of points – Control chartwith linear trend – Group control charts – Control charts based on coefficient ofvariation,extreme values, movingaverages.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Modified and Acceptance control charts – Cumulative control charts – use ofV-mask – ARL procedures – Statistical process control with correlated data – Processcapabilityanalysis– Economicdesign of control charts.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Acceptance sampling plans for attributes - single, and double plans withrectifying inspection – multiple sampling plans – Dodge and Roming LTPD andAOQLtables – MIL-STD-105D plans.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Sequential sampling plans – Sampling inspection for variables – singlesampling with known and unknown sigma plans – Philips standard plans – Shainin'sLotplot method.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Chainsamplingplans–Continuoussamplingplans–WaldWolfowitzplans–MAPDplans.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Montgomery, D. C (2009), *Introduction to Statistical Quality Control*, JohnWileyand Sons, NewYork.
2. Schilling, E.G., Neubauer, D.V.,(2017), *Acceptance Sampling in Quality Control*,MarcellDeckarInc,NewYork.
3. Duncan, A. J. (2003.). *Quality Control and Industrial Statistics*, Irwin-Illinois, US.

References

1. Schilling,E.G(1989),*AcceptanceSamplinginQualityControl*,MarcellDeckarInc,NewYork.
2. Bowker, A.H., and Lieberman, G.J. (1982). *Engineering Statistics*, Second Edition, Prentice Hall, New Delhi,
3. Grant,E.LandLeavenworth,R.S(2000),*StatisticalQualityControl*,Mc-GrawHill, NewYork.

Suggested Reading

1. Wetherill, G.B. (1977). *Sampling Inspection and Quality Control*, Second Edition, Chapman and Hall, London.
2. Muhammad Aslam, Mir Masoom Ali (2019), *Testing and Inspection Using Acceptance Sampling Plans*,Springer

Web Resources

1. https://nptel.ac.in/courses/116102019
2. http://bmepedia.weebly.com/uploads/2/6/6/8/26683759/unit_4_quality_control.pdf
3. http://www2.ing.unipi.it/lanzetta/stat/Chapter20.pdf
4. https://www.win.tue.nl/~adibucch/2WS10/SPClecturenotes.pdf

Course Articulation Matrix

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	2	2	-	2	-	-	-	2	-	-	-	-	K1
CO 2	-	-	2	2	2	2	2	-	2	2	2		K2
CO 3	-	-	2	2	-	2	2	-	2	-	2	-	K3
CO 4	-	-	2	2	-	2	2	-	2	-	2	-	K4
CO 5	-	-	2	2	-	2	2	-	2	-	2-	2	K5, K6
Wt. Avg.	2	2	2	2	2	2	2	2	2	2	2	2	
Overall Mapping of the Course											PO – 2		
											PSO – 2		

TESTING STATISTICAL HYPOTHESIS

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Core**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	1. **To introduce the concepts of hypothesis testing.** 2. **To differentiate between large and small samples and apply apt testing procedures and to explain various non-parametric tests and its applications.** 3. **To impart knowledge on techniques for testing of hypotheses towards decision support based on sample characteristics andto illustrate the real-life applications of testing problems and procedures.**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Relate to the basic ideas about testing procedures.**	**PSO1**	**K1**
CO 2	**Demonstrate solving practical statistical problems.**	**PSO1 PSO2**	**K2**
CO 3	**Apply hypothesis testing in various other fields**	**PSO2 PSO3**	**K3**
CO 4	**Take part in quality management using the theoretical concepts in hypothesis testing.**	**PSO3 PSO4**	**K4**
CO 5	**Solve problem in competitive exams related to Statistics.**	**PSO3 PSO4 PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Formulation of Hypothesis testing - MP and UMP level α test procedures – Neymann-Pearson Fundamental Lemma - Distributions with MLR property – Karlin-Rubin Theorem - LMP Test procedures.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Generalized Fundamental Lemma - UMP test procedures for two sided hypotheses on one parameter exponential family - Likelihood Ratio Test procedures - UMP test procedures in presence of nuisance parameters.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Unbiased tests - Similar tests and tests with Neyman structure - UMP unbiased test procedures in one parameter exponential family - LMP unbiased tests - Invariant tests and MP invariant tests.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Fundamental concepts - SPRT procedures for testing simple hypotheses versus simple alternative - Relationship between SPRT and Random walk - Optimum properties of SPRT - Derivation of power function and ASN function for SPRT procedures relating to Binomial, Poisson, Exponential and Normal distributions.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Relationship between confidence interval and Hypotheses testing problems - Derivation of UMA confidence interval for the parameters of Normal distributions - Non parametric tests : Sign test, Wilcoxon signed ranks test, Man-Whitney U-Test, Kolmogorov-Smirnov one sample and two sample test procedures.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Ferguson, T. S (1967), *Mathematical Statistics – A Decision Theoretic Approach*, Academic Press.

References

1. Lehmann, E. L (1986), *Testing Statistical Hypothesis*, John Wiley.
2. Gibbons, J. D (1985), *Non-parametric Methods in Statistics*, Second Edition, Marcel Dekker.

Suggested Reading

1. Rohatgi, V. K (1984), *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern.
2. Hogg, Tanis, Rao. (2009). *Probability and Statistical Inference.*7th Edition. Pearson.
3. Goon A.M., Gupta M.K. and Dasgupta B. (2002). *Fundamentals of Statistics*, Vol. I & II,8thEdn. The World Press, Kolkata.

Web Resources

1. https://www.khanacademy.org
2. https://www.nedarc.org
3. http://egyankosh.ac.in/

Course Articulation Matrix													
Course Outcomes	**Programme Outcomes**							**Programme Specific Outcomes**					**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1	2	2	-	2	-	-	-	3	-	-	-	-	**K1**
CO 2	2	2	2	2	-	2	-	3	2	-	-	-	**K2**
CO 3	-	-	2	2	2	2	-	-	2	2	-	-	**K3**
CO 4	-	-	-	-	2	2	3	-	-	2	2	-	**K4**
CO 5	-	-	-	-	2	2	3	-	-	2	2	2	**K5,K6**
Wt. Avg.	2	2	2	2	2	2	3	3	2	2	2	2	
Overall Mapping of the Course											**PO – 2.14**		
											PSO – 2.2		

PROJECT AND VIVA -VOCE

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Core**	**Practical**
Semester	**IV**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. To kindle interest of the subject among the students to think in an innovative manner** **2. To identify the problems in statistical study involving some planning, sampling and applications of the methods they have studied at the post graduate curriculum.** **3. To implement the theoretical concepts in day to day situations**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Spell out the applications of various statistical techniques learned in the entire course in the form of project work.**	**PSO1 PSO2 PSO4**	**K1**
CO 2	**Manage a real practical situation where a statistical analysis is sought**	**PSO1 PSO2 PSO4**	**K2**
CO 3	**Develop professional approach towards writing and presenting an academic report**	**PSO1 PSO2 PSO4**	**K3**
CO 4	**Get more insight about the opportunities in research/career.**	**PSO1 PSO2 PSO4**	**K4**
CO 5	**Know the works presented in various journals and current trends in their project/dissertation area. Get an idea of how new developments in the topic have arose and why new computational techniques are needed**	**PSO1 PSO2 PSO3 PSO4 PSO5**	**K5,K6**

CONTENT

A project work in their area of interest is required of every PG student. The students can use this to test their theoretical understanding of the courses they have covered in the PG curriculum. The student uses actual data toanalyze statistically and formulate conclusions that are both accurate and persuasive. As per this course a student has to submit a Dissertation based on their study and findings. The submission of the dissertation/Project work is compulsory for the successful completion of the course.

Marks for the Project work and Viva-voce will be based on the Continuous Assessment mark (50) and the End-of-Semester Examination mark (50).

The End-of-Semester Examination mark is composed of:

1. Evaluation of Dissertation - 80% Marks

2. Viva-voce - 20% Marks

Course Articulation Matrix													
Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	2	2	2	2	-	2	2	2	2	-	2	-	K1
CO 2	2	2	2	2	-	2	2	2	2	-	2	-	K2
CO 3	2	2	2	2	-	2	2	2	2	-	2		K3
CO 4	2	2	2	2	-	2	2	2	2	-	2	-	K4
CO 5	2	2	2	2	2	2	2	2	2	2	2	2	K5,K6
Wt. Avg.	2	2	2	2	2	2	2	2	2	2	2	2	
Overall Mapping of the Course											PO 2		
											PSO 2		

PRACTICAL IV

Course Code			
Credits	**4**		
Hours / Cycle	**6**		
Category		**Core**	**Practical**
Semester	**IV**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. To gain knowledge of various sampling inspection plans** **2. To analyse the state of control in industry production process** **3. To apply statistical test procedures for real life problems**		

CO	**Course Outcome(s)**		**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	Remember the concepts in process control, product control and sampling inspection plans.	**PSO1**	**K1**
CO 2	Gain knowledge about industrial application of quality control.	**PSO2** **PSO3** **PSO4** **PSO5**	**K2**
CO 3	Experiment the practical applicability of various sampling inspection plans	**PSO2** **PSO3** **PSO4** **PSO5**	**K3**
CO 4	Infer upon variable and sequential sampling inspection plans using OC and ASN functions.	**PSO2** **PSO3** **PSO4** **PSO5**	**K4**
CO 5	Justify using tests of significance and draw conclusions.	**PSO2** **PSO3** **PSO4** **PSO5**	**K5,K6**

SYLLABUS

Solving Problems Using R

I. PROCESSCONTROL

1. Controlcharts:
2. X-bar,R,σ,p,np,c, u(fixedandvariablesamplesizes)
3. Slopingcontrol charts
4. GroupControlcharts
5. CVchart
6. Modifiedcontrolcharts
7. Medianandmid-rangecharts
8. Chartsformovingaverages
9. Processcapabilityanalysis

II. PRODUCTIONCONTROL

10. Multiple sampling plan
11. Sequential sampling plans
12. Variablesamplingplans withknownσ
13. Variablesamplingplans withunknownσ
14. Sequentialsamplingplanforvariables
15. Chainsamplingplans
16. Continuoussamplingplans
17. Comparison of continuous sampling plans
18. Comparison of chain sampling plan
19. Shainin LotPlotmethod.

III. STATISTICALINFERENCE:TESTINGOFHYPOTHESES

20. Most powerful tests
21. Uniformly mostpowerful tests
22. Sequential probability ratio tests
23. Likelihood ratio tests
24. Non-parametric tests
25. Confidence intervals

Course Articulation Matrix

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	2	2	-	2	-	-	-	2	-	-	-	-	K1
CO 2	-	-	2	2	2	2	2	-	2	2	2	2	K2
CO 3	-	-	2	2	2	2	2	-	2	2	2	2	K3
CO 4	-	-	2	2	2	2	2	-	2	2	2	2	K4
CO 5	-	-	2	2	2	2	2	-	2	2	2	2	K5,K6
Wt. Avg.	2	2	2	2	2	2	2	-	2	2	2	2	
Overall Mapping of the Course											PO – 2		
											PSO – 2		

BIG DATA ANALYTICS

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Elective**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. To understand the Characteristics of Big Data and its patterns** **2. To Comprehend the Data Acquisition** **3. To grasp the knowledge and application of Batch Analysis and Real-time Analysis**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Define the basics of Characteristics of Big Data and its patterns, Data Acquisition and Batch Analysis and Real-time Analysis**	**PSO1**	**K1**
CO 2	**Understand the concepts of Characteristics of Big Data and its patterns, Data Acquisition and Batch Analysis and Real-time Analysis**	**PSO2**	**K2**
CO 3	**Apply Data Acquisition and Batch Analysis and Real-time Analysis in practical situation**	**PSO3** **PSO4**	**K3**
CO 4	**Examine the Characteristics of Big Data and its patterns**	**PSO2**	**K4**
CO 5	**Assess the Batch Analysis and Real-time Analysis with database tool**	**PSO3** **PSO4** **PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to Big Data – Characteristics of Big Data – Domain Specific Examples of Big Data– Analytics Flow for Big Data– Big Data Stack-Mapping Analytics Flow to Big Data Stack-Case Study: Genome Data Analysis and Weather Data Analysis-Analytics	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Big Data Patterns- Analytics Architecture Components & Design Styles-MapReduce Patterns-NoSQL-Key-Value Databases-Document Databases-Column Family Databases -Graph Databases	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	.Data Acquisition– Data Acquisition Considerations– Publish - Subscribe Messaging Frameworks-Big Data Collection Systems-Messaging Queues-Custom Connectors Big Data Storage-HDFS	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Batch Analysis– Hadoop and MapReduce-Examples-Pig - Case Study: Batch Analysis of News Articles-Apache Oozie-Apache Spark-Search Estimators of Auto covariance and Autocorrelation functions – Central limit Theorems for Stationary time Series – Estimation of the cross covariances	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Real-time Analysis- Stream Processing- In-Memory Processing- In-Memory Processing-Storm Case Studies-Interactive Querying- Spark SQL	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

5. Bahga, A., and Madisetti, V. (2016). *Big data science & analytics*: A hands-on approach. Vpt.

References

11. Zikopoulos, P., and Eaton, C. (2011). *Understanding big data: Analytics for enterprise class hadoop and streaming data*. McGraw-Hill Osborne Media.
12. Mayer-Schönberger, V., and Cukier, K. (2013). Big data: A revolution that will transform how we live, work, and think. Houghton Mifflin Harcourt.
13. Minelli, M., Chambers, M., and Dhiraj, A. (2013). *Big data, big analytics: emerging business intelligence and analytic trends for today's businesses* (Vol. 578). John Wiley & Sons.

Suggested Reading

10. Ohlhorst, F. J. (2012). *Big data analytics: turning big data into big money* (Vol. 65). John Wiley & Sons.
11. Ankam, V. (2016). *Big data analytics*. Packt Publishing Ltd.
12. Sedkaoui, S. (2018). *Data analytics and big data*. John Wiley & Sons.

Web Resources

10. https://www.youtube.com/watch?v=bY6ZzQmtOzk
11. https://www.youtube.com/watch?v=PaYFmUw8oHk&list=PLEiEAq2VkUULd0vvpOeU-hpw1DXLRv0dF
12. https://www.pvpsiddhartha.ac.in/dep_it/lecture%20notes/Big%20Data%20Analytics/4-

2%20BDA%20%20PPTS.pdf

13. https://www.iare.ac.in/sites/default/files/NEW%20LECHURE%20NOTES.pdf
14. https://mu.ac.in/wp-content/uploads/2021/11/FULL-BIG-DATA.pdf

Course Articulation Matrix													
Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	2	2	-	2	-	-	-	3	-	-	-	-	K1
CO 2	-	-	2	2	-	2	-	-	3	-	-	-	K2
CO 3	-	-	-	-	2	2	2	-	-	2	2	-	K3
CO 4	-	-	2	2	-	2	-	-	3	-	-	-	K4
CO 5	-	-	-	-	2	2	2	-	-	2	2	2	K5,K6
Wt. Avg.	2	2	2	2	2	2	2	3-	3	2	2	2	
Overall Mapping of the Course											PSO-2.4		
											PO-2		

Credits	**5**		
Hours / Cycle	**6**		
Category		**Elective**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2023_2024 onwards.**		
Course Objectives	**1. Understand theimportance of population studiesand Familiarize with the population composition based on sources of population data** **2. Study the causes and effects of rapid population growth** **3. Measures taken by the government to manage population growth**		
CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO1	**Define the interrelationship between population and society and compare the advantages and disadvantages of the different sources of population data.**	**PSO1 PSO2**	**K1**
CO2	**Understandthescope and importance of population study embeddedwithin the context in which people live.**	**PSO1 PSO2 PSO3**	**K2**
CO3	**Analyse the variables like age, sex, religion with respect to their influences with population growth, composition, and structure**	**PSO3 PSO4**	**K3**
CO4	**Describe the factors effecting demographic process offertility, mortality, migration and issues to population growth**	**PSO4 PSO5**	**K4**
CO5	**Evaluate the performance and challenges of population policyin India**	**PSO4 PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Demographic Concepts and Definitions: Population, Nuptiality, Fertility, Morbidity,Mortality, Migration, Urbanization; Basic Measures: Cohort, Period, Mid-Year Population;Nature and Scope of Population Studies; Its Relationship with Other Disciplines;Components of Population Change: Fertility, Mortality and Migration.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	History of Demographic Data: Major sources of data about the population in the past;Global Population Trends-Past, Present and Future Trends across the World, Continentsand Developed/Developing Countries; World Population Growth and Doubling Time;History of Population Growth in India; Current Population Scenario and DemographicProfile of India and States.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Basic Theories of Population: Malthusian, Marxian and Optimum Population Theories;Biological Theories of Herbert Spencer, Corrado Ginnis and Thomas Doubleday; Demographic Transition: Concept, Theory and Different Stages- Pre-Industrial Stage,Industrial Revolution, Post-Industrial Revolution.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Population Composition and Characteristics (India): Age-Sex Structure (Pyramid), SexRatio, Sex Ratio at Birth, Marital Status, Rural-Urban Distribution; Occupation, Education,Religion and Caste Composition; Age-Sex Structures of Population in Developed andDeveloping Countries; Importance of Age-Sex Structure in Population Dynamics andFactors Affecting Sex Ratio of the Population. Sex Ratio of India's Population and Role ofDifferent Factors in Changing Sex Ratio.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Determinants of Population Growth: World and India; Population Ageing: Socio-economicConsequences of Population Ageing in the World and India. Population Ageing andLabour Force: Implications of Population Ageing on Labour Force, Retirement and WorkParticipation among Elderly; Occupational Distribution among the Elderly;Demographic Dividend: Determinants and Consequences. Population Policies in India.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Bhende, A. and T. Kanitkar (2019), *Principles of Population Studies*, Himalaya Publishing House, Mumbai.
2. Bloom, D.E., D. Canning, et.al. (2002): *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change*. Santa Monica, CA, RAND
3. Bose, Ashish (2001), *Population of India: 2001 Census Results and Methodology*, B. R. Publishing Corporation, Delhi.

References

1. Agarwala, S. N. (1981), *India`s Population Problems*, Tata McGraw Hill, New Delhi.
2. Heslop A (1999), *Ageing and Development, Social Development Working Paper:* 3, Help Age International.
3. Bogue, Donald J. (1969), *Principles of Demography*, John Wiley and Sons Inc., New York.

Suggested Reading

1. Prskawetz, Bloom, and Lutz, eds., (2008), *Population Aging, Human Capital Accumulation, and Productivity Growth*, A Supplement to Population and Development Review.
2. Shrivastava, O. S. (1983), *A Text Book of Demography*, Vikas Publishing House Pvt. Ltd., Delhi.
3. Shryock, Henry S., Jacob S. Siegel and Associates (1976), *The Methods and Materials of Demography*, Academic Press, Inc., California.
4. United Nations (1973), *The Determinants and Consequences of Population Trends*, Vol. I, Department of Economic and Social Affairs, New York.
5. Weeks, John R. (2015), *Population: An Introduction to Concepts and Issues*, Wadsworth Publishing Company, California.

Web Resources

1. **https://mis.alagappauniversity.ac.in/siteAdmin/ddeadmin/uploads/1/PG_M.A._Socialogy_M.A.%20(Sociology)%20-%20351%2013%20-%20Population%20Studies.pdf**
2. **https://users.pop.umn.edu/~rmccaa/3797/prbhbook.pdf**
3. **http://ndl.ethernet.edu.et/bitstream/123456789/87327/1/Int.%20to%20Population%20StudiesPOPS%201011%20Main%20Body.pdf**

Course Articulation Matrix

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3	3	2	3	-	3	-	3	2	--	-	-	K1
CO 2	3	3	2	3	3	3	-	2	3	2	-	-	K2
CO 3	-	-	-	-	3	3	3	-	-	2	2	-	K3
CO 4	-	-	-	-	-	-	3	-	-	-	3	2	K4
CO 5	-	-	-	-	-	-	3	-	-	-	2	3	K5,K6
Wt. Avg.	3	3	2	3	3	3	3	2.5	2.5	2	2.3	2.5	
Overall Mapping of the Course											PO – 2.86		
											PSO – 2.36		

Optional Electives

for

(I/ II /III/IV)

Semesters

MACHINE LEARNING TECHNIQUES

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Elective**	**Theory**
Semester	**I / II / III / IV**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1.To understand the need for machine learning for various problem solving 2. To study the various supervised, semi-supervised and unsupervised , reinforcement learning algorithms in machine learning 3.To understand the latest trends in machine learning 4. To design appropriate machine learning algorithms for problem solving**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Understand and outline problems for each type of machine learning**	**PSO1 PSO3**	**K1**
CO 2	**Apply various learning algorithm techniques in machine learning.**	**PSO1 PSO2 PSO3**	**K2**
CO 3	**Inspect a tool to implement typical Clustering algorithms for different types of applications.**	**PSO2 PSO3**	**K3**
CO 4	**Explain appropriate machine learning algorithms for problem solving**	**PSO3 PSO4**	**K4**
CO 5	**Discuss applications suitable for different types of Machine Learning with suitable justification.**	**PSO3 PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	**INTRODUCTION:** Learning – Types of Machine Learning – Supervised Learning – Unsupervised Learning – Reinforcement Learning – Design a Learning System – Data Preprocessing – Exploratory data analysis – data munging – data wrangling – Perspectives and Issues in Machine Learning.	**17**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	**SUPERVISED LEARNING:** Linear Regression – Logistic Regression – Linear Discriminant Analysis – Classification – Naïve Bayes Classifier – K-Nearest Neighbors (KNN) – Support Vector Machines – Linear learning machines and Kernel space – Decision Trees – CART – Ensembles method –Random forest – XGBoost.	**21**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	**UNSUPERVISED LEARNING:** Clustering – K-means clustering – K-medoids Clustering – Hierarchical Clustering – Anomaly Detection – Principle Component Analysis – Independent Component Analysis – Association Analysis – Apriori algorithm.	**16**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	**REINFORCEMENT LEARNING:** Reinforcement Learning – Key features of Reinforcement Learning – Elements of Reinforcement Learning – Value-based – Policy-based – Model-based– Types - positive and negative – The Bellman Equation – Models – Markov Decision Process – Q learning.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	**APPLICATIONS:** Recommendation Engine – Weather Report Case Study – IPL Data Case Study – Share -Market Case Study – Sentimental Analysis – Spam Analysis.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

4. Tom M. Mitchell (2013),*Machine Learning*, McGraw-Hill Education (India) Private Limited.
5. Giuseppe Bonaccorso, *Machine Learning Algorithms: A reference guide to popular algorithms for data science and machine learning* 1st Edition.

References

1. John Paul Mueller and Luca Massaron (2016), *Machine Learning For Dummies*, 1st Edition, ISBN-13 978-1119245513.
2. Joel Grus (2019), *Data Science from Scratch with Python*, O'Reilly, 2nd Edition.
3. Oliver Theobald**,***Machine Learning For Absolute Beginners: A Plain English Introduction* (Second Edition) (Machine Learning From Scratch Book 1), Kindle Edition

Suggested Reading

1. https://falksangdata.no/wp-content/uploads/2022/07/python-machine-learning-and-deep-learning-with-python-scikit-learn-and-tensorflow-2.pdf
2. http://www2.ift.ulaval.ca/~chaib/IFT-4102-7025/public_html/Fichiers/Machine_Learning_in_Action.pdf

Web Resources

1. **https://www.analyticsvidhya.**
2. **https://machinelearningmastery.com/**
3. **https://www.w3schools.com/**

4. https://www.javatpoint.com/machine-learning
5. https://www.tutorialspoint.com/machine_learning/index.htm

Course Articulation Matrix

Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	2	2	-	2	2	2	-	2	-	3	-	-	K1
CO 2	2	2	2	3	2	3	-	2	2	3	-	-	K2
CO 3	-	-	2	2	2	3	-	-	2	3	-	-	K3
CO 4	-	-	-	-	2	2	2	-	-	3	2	-	K4
CO 5	-	-	-	-	2	2	2	-	-	3	-	2	K5,K6
Wt. Avg.	2	2	2	1.4	2	2.4	2	2	2	3	2	2	
Overall Mapping of the Course											PO – 2		
											PSO – 2.2		

SURVIVAL ANALYSIS

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Elective**	**Theory**
Semester	**I / II / III / IV**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1. To discuss the purpose and role of survival analysis** **2. To enable students to analyse data from studies in which individuals are followed up until a particular event occurs.** **3. To describe the various methods used for modelling and evaluating survival data**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**Define survival analysis and types of censoring**	**PSO1 PSO2**	**K1**
CO 2	**Interpret life distribution and their properties and also to draw inference on parameters of life distribution.**	**PSO1 PSO2 PSO4**	**K2**
CO 3	**Apply various procedures for estimating survival functions.**	**PSO1 PSO2 PSO4**	**K3**
CO 4	**Classify test procedure for various non-parametric methods**	**PSO1 PSO2 PSO4**	**K4**
CO 5	**Build statistical models for survival data to predict the survival time, study the effects of factors by adjusting for the effects of covariates.**	**PSO1 PSO2 PSO4 PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Concept of Time and event. Order and Random Censoring. Censoring mechanism and truncations. Survival, hazard and density functions. Mean and median residual life and their elementary properties.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Life distributions: Exponential Gamma, Weibull, Lognormal, Pareto, Linear Failure rate.Parametric inference: Point estimation, Confidence Intervals, Scores, tests based on LR and MLE, Partial likelihood estimation-log logistic distribution, accelerated failure time model, Cox-Snell residuals.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	Estimation of survival function: reduced sample method, actuarial estimator, Nelson-Aalen estimator, Kaplan-Meier Estimator-life table estimation.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Nonparametric methods: Gehan Test, Log rank test. Peto'stest,Mantel - Haentzel Test, Tarone - Ware tests, Efron Tests	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Cox Proportional Hazard Model, Meaning of PH Assumption, ML Estimation of Cox Proportional PH Model, Adjusted Survival Curves using Cox PH Models, Evaluating the Proportional Hazard Assumption – Graphical Approach, Goodness of fit test approach,	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. Lee, E. T. (1992) *Statistical Methods for Survival Data Analysis* , 2 nd Edition, John Wiley and Sons

References

1. Klein, J.P. and Moeschberger, M.L.(2003): *Survival Analysis- Techniques for Censored and Truncated data*, Springer New York .
2. Armitage, P and Berry, G (2001): *Statistical Methods in Medical Research*, 4th edition, Wiley- Blackwell.
3. Altman D G(2006): *Practical Statistics for Medical Research*, London:Chapman and Hall

Suggested Reading

3. Therneau, T M and Grambsch, P M (2000): *Modeling Survival Data*, Extending the Cox Model, Springer, New York.
4. David Collett (2003): *Modelling Survivaldata in Medical Research*, Second Edition, Chapman & Hall/CRC

Web Resources

4. **https://tinyheero.github.io/2016/05/12/survival-analysis.html**
5. **https://towardsdatascience.com/introduction-to-survival-analysis-the-kaplan-meier-estimator-94ec5812a97a**
6. **https://www.measureevaluation.org/resources/training/online-courses-and-resources/non-certificate-courses-and-mini-tutorials/population-analysis-for-planners/lesson-7**

Course Articulation Matrix													
Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	2	2	2	2	-	2	-	2	2	-	-	-	K1
CO 2	2	2	2	2	-	2	2	2	2	-	3	-	K2
CO 3	2	2	2	2	-	2	2	2	2	-	3		K3
CO 4	2	2	2	2	-	2	2	2	2	-	3	-	K4
CO 5	2	2	2	2	-	2	2	2	2	-	3	3	K5,K6
Wt. Avg.	2	2	2	2	-	2	2	2	2	-	3	3	
Overall Mapping of the Course											PO – 2		
											PSO – 2.5		

TIME SERIES AND FORECASTING

Course Code			
Credits	**5**		
Hours / Cycle	**6**		
Category		**Elective**	**Theory**
Semester	**I / II / III / IV**		
Year of Implementation	**From the academic year 2023_2024 onwards**		
Course Objectives	**1.To upskill the students to construct mathematical models.** **2.To remaster the time series concepts.** **3.To elucidate the forecasting techniques applying different time series methods.**		

CO	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
On completing the course successfully, the student will be able to			
CO 1	**List the components of time series.**	**PSO1**	**K1**
CO 2	**Demostrate the tools of modern time series analysis.**	**PSO2**	**K2**
CO 3	**Construct the Auto – Regressive (AR) models and identify the estimation and forecasting with ARIMA models.**	**PSO4**	**K3**
CO 4	**Examine the vector autoregressive (VAR) models.**	**PSO4**	**K4**
CO 5	**Construct the auto-regressive conditional hetroscdasticity (ARCH)and Model volatility and auto-correlation in time series**	**PSO5**	**K5,K6**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Classical time series analysis – utility of time series analysis – components of time series data – measurement of trend, seasonality and cycles – moving averages and smoothing techniques to time series analysis - classical time Series decomposition models – additive and multiplicative models – forecasting usingsmoothing techniques and time series decomposition methods – applications in finance.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
II	Tools of modern time series analysis – **s**tochastic and stationary process – tests of stationary – trend vs difference stationery process – Dickey-Fuller and augmented Dickey-Fuller tests – Engle-Granger test – CRDW test – error correction mechanism.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
III	. Univariate time series analysis and forecasting – linear time series analysis – autocorrelation function and partial auto-correlation function – auto-regressive (AR) models, moving average (MA) models, Box-Jenkins (BJ) ARMA and ARIMA models – identification – estimation and forecasting with ARIMA models – economic applications.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	Multivariate time series analysis and forecasting – vector autoregressive (VAR) models – advantages and problems – estimation and forecasting with VAR – impulse response function – Johansen Co-integration test on VAR – Granger causality test – applications in finance.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	Modelling volatility and auto-correlation in time series – motivation and test for non-linearity – historical and implied volatility – auto-regressive conditional hetroscdasticity (ARCH) model – generalised ARCH model – applications in finance.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

Prescribed Books/Textbooks

1. D.N.Gujarati and Sangeetha(2009): *Basic Econometrics*, 5thedition,Tata McGraw-Hill.
2. Chris Brooks (2019): *Introductory Econometrics for Finance*, Cambridge University Press.
3. T.M.J.A. Cooray (2008): *Applied Time Series – Analysis and Forecasting*, Narosa Publications.

References

1. Hanke, J.E. and Wichern, D.W. (2007): *Business Forecasting*, 8th edition, Pearson education, Asia.

2. Spyros, G. Makridakis, Steven C.Wheeleright and Rob J.Hyndman, (2014). *Forecasting methods and applications* Wiley publication, 3e.

3. Wilfredo Palma (2016), *Time Series Analysis*, Wiley Publication.

Suggested Reading

1. Ruey S. Tsay (2010). *Analysis for Financial Time Series*, , 3e, Wiley publication.
2. Rob J. Hyndman and George Athanasopoulos (2018), *Forecasting Principles and Practice*, OTexts publication, 2018.

Web Resources

1. https://bit.ly/36yqp43
2. https://bit.ly/34RGKjW
3. https://bit.ly/3LR9ZUv

4. https://bit.ly/3LRfqCH
5. https://bit.ly/3BJJf3M
6. **https://people.stat.sc.edu/wang528/Stat%20720/STAT720%20Notes.pdf**

Course Articulation Matrix													
Course Outcomes	Programme Outcomes							Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3	3	-	3	-	-	-	3	-	-	-	-	K1
CO 2	-	-	3	3	-	3	-	-	3	-	-	-	K2
CO 3	-	-	-	-	-	-	3	-	-	-	3	-	K3
CO 4	-	-	-	-	-	-	3	-	-	-	3	-	K4
CO 5	-	-	-	-	-	-	3	-	-	-	-	3	K5,K6
Wt. Avg.	3	3	3	3	-	-	3	3	3	-	3	3	
Overall Mapping of the Course											PO – 3		
											PSO – 3		