M. Sc. Statistics

Syllabus

AFFILIATED COLLEGES

## Program Code:

2020 – 2021 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A" Grade by NAAC,
Ranked 13th among Indian Universities by MHRD-NIRF,
World Ranking: Times -801-1000,Shanghai -901-1000, URAP - 982)

Coimbatore - 641 046, Tamil Nadu, India

Program Educational Objectives (PEOs)	
On successful completion of the **M. Sc., Statistics** program, the graduates will be able to:	
PEO1	Get employment in government, public, private, industrial, health, business, banking, agricultural and educational sectors
PEO2	Expand their knowledge to set their career in research and higher studies
PEO3	Comprehend the statistical concepts and principles for interdisciplinary research
PEO4	Excel in statistical computing
PEO5	Acquire proficiency in adopting statistical software for data analysis
PEO6	Nurture advancement in statistical theory and applications
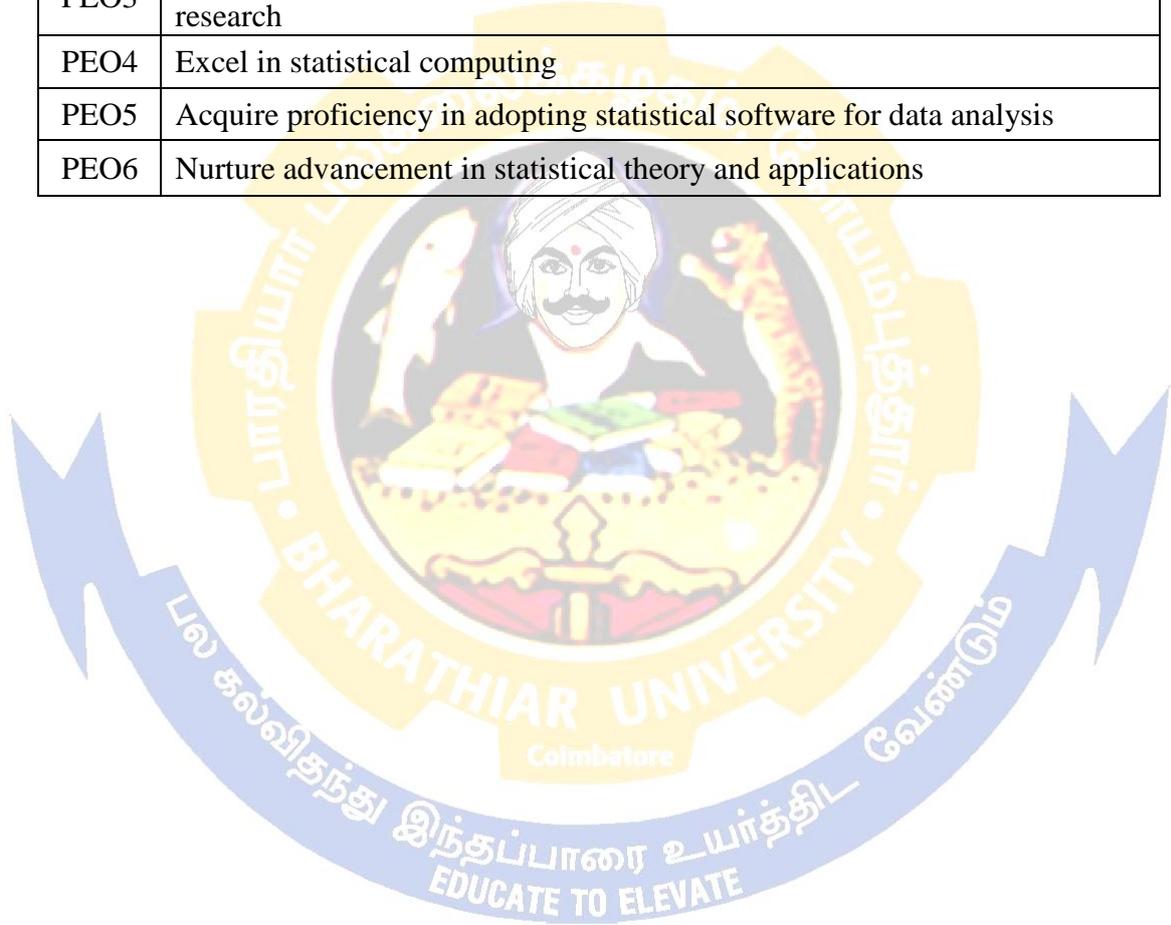
Program Specific Outcomes (PSOs)	
On successful completion of M. Sc., Statistics program, the students will be expected to:	
PSO1	Comprehend the theoretical aspects of statistics
PSO2	Recognize the application of statistics in diversified fields
PSO3	Develop computer programs and codes for statistical computation
PSO4	Utilize statistical software effectively for data analysis
PSO5	Understand the conditions and limitations of statistical methods in application
PSO6	Critically analyze statistical data and make interpretations
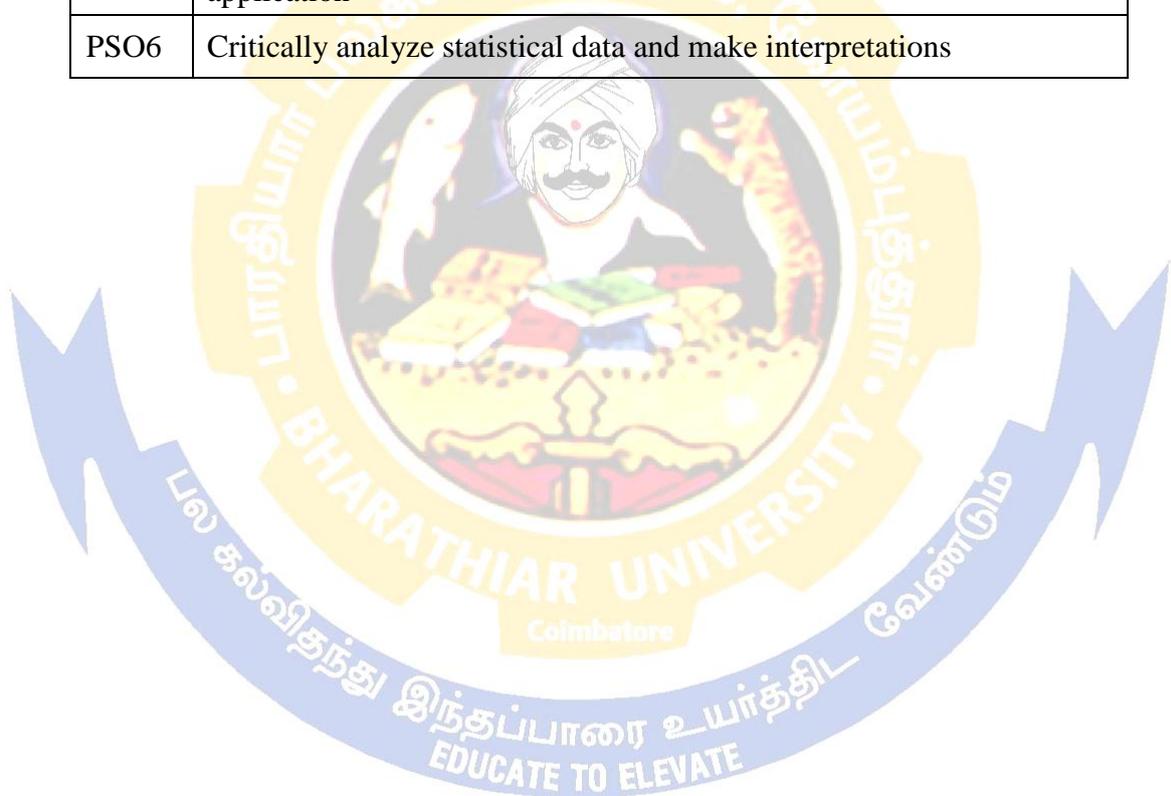
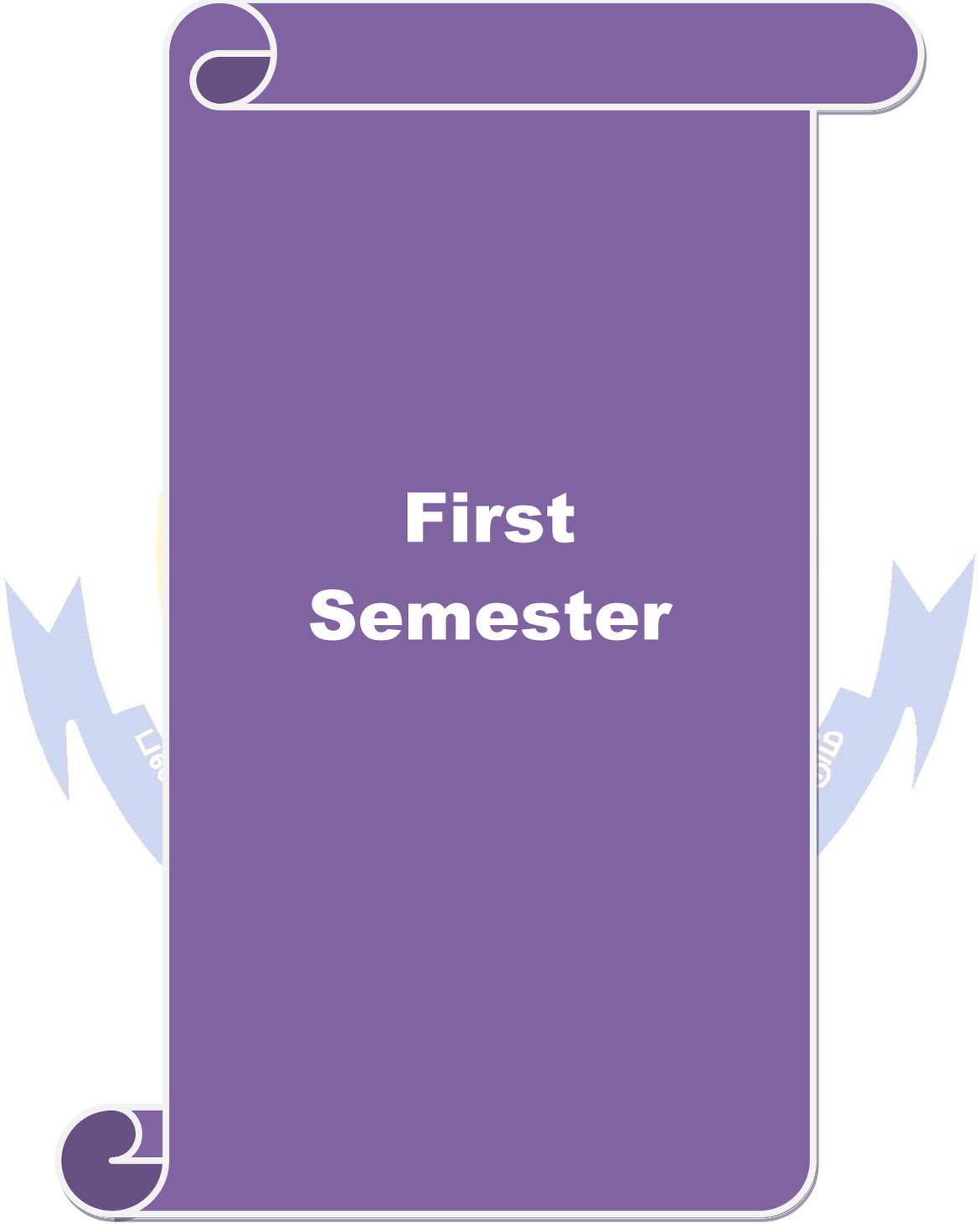| **Program Outcomes (POs)**	
On successful completion of the **M. Sc., Statistics** program, the graduates will be able to:	
PO1	Possess adequate knowledge in theory and applications
PO2	Adopt conceptual ideas, principles and methods in diversified fields of study
PO3	Utilize analytical skills for basic mathematical computation
PO4	Utilize software skills for statistical computation
PO5	Prepare to participate in competitive examinations at the state and national level
PO6	Acquire skills to meet the challenges in job placements
PO7	Gain impetus to move for learning at higher level
PO8	Gain effective skills to perform data analysis using statistical tools
PO9	Identify potential areas of applications of statistical theory
PO10	Recognize the importance and value of statistical principles and approach for problem solving on a diversified disciplines

BHARATHIAR UNIVERSITY : : COIMBATORE 641 046
M. Sc. Statistics Curriculum (Affiliated Colleges)
(For the students admitted during the academic year 2020 – 21 onwards)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
	Real Analysis	4	6	-	25	75	100
	Linear Algebra	4	6	-	25	75	100
	Distribution Theory	4	6	-	25	75	100
	Sampling Theory	4	6	-	25	75	100
	Statistical Practical I	-	-	3	-	-	-
	Elective I	4	6	-	25	75	100
	Total	**20**	**30**	**3**	**125**	**375**	**500**
SECOND SEMESTER							
	Probability Theory	4	6	-	25	75	100
	Statistical Inference I	4	6	-	25	75	100
	Demographic Methods	4	6	-	25	75	100
	Operations Research	4	6	-	25	75	100
	Statistics Practical I	4	-	3	40	60	100
	Elective II	4	6	-	25	75	100
	Total	**24**	**30**	**3**	**165**	**435**	**600**
THIRD SEMESTER							
	Statistical Inference II	4	6	-	25	75	100
	Multivariate Analysis	4	6	-	25	75	100
	Statistical Quality Control and Reliability	4	6	-	25	75	100
	Econometrics	4	6	-	25	75	100
	Statistics Practical II	-	-	3	-	-	-
	Elective III	4	6	-	25	75	100
	Total	**20**	**30**	**3**	**125**	375	**500**
FOURTH SEMESTER							
	Linear Models and Design of Experiments	4	6	-	25	75	100
	Stochastic Processes	4	6	-	25	75	100
	Applied Regression Analysis	4	6	-	25	75	100
	Computer Practical using R	4	-	6	25	75	100
	Statistics Practical II	4	-	3	40	60	100
	Project/Dissertation with Viva-voce[*]	6	-	8	25	125	150[*]
	Total	**26**	**18**	**17**	**165**	**485**	**650**
	Grand Total	**90**	**108**	**26**	**580**	**1670**	**2250**

*Project/Dissertation Report:

Total: 150 marks |

Internal Assessment: 25 marks | Report Evaluation: 100 marks | Viva-voce: 25 marks |

First Semester

Course code		Title of the Course	L	T	P	C
Core		Real Analysis	6	-	-	4
Pre-requisite		Skills in Basic Understanding of Mathematics	Syllabus Version		2020-21	

Course Objectives:

The main objectives of this course are to:
1. Impart the understanding of the basic concepts of real analysis
2. Enhance the ability of proving the theorems in real analysis
3. Introduce the meaning and importance of convergence of sequence and series of real numbers
4. Comprehend the concepts which are essential for learning other courses

Expected Course Outcomes:

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

1	Understand the basic notions of sets of real numbers	K2
2	Verify the conditions for integrability of a real valued function	K1-K3
3	Apply the tests for examining the convergence of improper integrals	K1-K4
4	Find the minima and maxima of functions of several variables	K1-K5
5	Identify whether the given sequence and series of real numbers converge or diverge	K1-K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Point Set Topology	16 hours

Interior point, open and interior sets. Limit point, closed set. Bolzano-Weierstrass theorem..

Unit:2	Rieman - Stieltjes (R - S) Integral	18 hours

Upper and lower R-S integrals. Necessary and sufficient condition for R-S integrability. Algebra of R-S integrable functions. Class of R-S integrable functions. Integration by parts. First mean value theorem and Cauchy's mean value theorem for R-S integrals

Unit:3	Improper Integrals and Convergence	18 hours

Comparison tests and Cauchy's test for the convergence of improper integrals. Abel's and Dirichlet's tests. Absolute convergence. Beta and Gamma integrals, their properties and relationship. Legendre's duplication formula. Stirlings' approximation.

Unit:4	Improper Integrals and Convergence	18 hours

Integrals involving parameters. Uniform convergence, Differentiation under the integral sign. Changing the order of integration. Maxima and minima of functions of several variables. Results without proofs. Applications. Lagrange multiplier. Applications.

Unit:5	Sequences and Series of Functions	18 hours

Sequences and series of functions. Limit superior and limit inferior of sequence of functions. Point wise and uniform convergence of sequences of functions. Weierstras' M – test. Consequences of uniform convergence. Point wise and uniform convergence of series of functions. Consequences of uniform convergence. Term by term differentiation and integration of series of functions.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	**90 hours**

Text Book(s)

1	Goldberg, R. R. (1976). Methods of Real Analysis, Oxford & IBH Publishing Company, New Delhi
2	Malik, S.C., and Arora, S. (2009). Mathematical Analysis, Second Edition, New Age International, New Delhi.
3	Ajit Kumar and Kumaresan, S. (2014). A Basic Course in Real Analysis, Chapman and Hall/CRC Press.

Reference Books

1	Apostol, T. M. (1986). Mathematical Analysis, Second Edition, Addison-Wesley, New York
2	Rudin, W. (1985). Principles of Mathematical Analysis, McGraw-Hill, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.jirka.org/ra/realanal.pdf
2	http://synechism.org/primer/primer-real-analysis.pdf

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	L	S	M	S	S	M	M
CO2	S	S	S	L	S	M	S	M	M	L
CO3	S	S	S	L	S	M	S	M	L	M
CO4	M	S	S	L	M	M	S	L	L	L
CO5	M	S	S	L	M	M	S	S	L	S

*S-Strong; M-Medium; L-Low

Course code		Title of the Course	L	T	P	C
Core		**Linear Algebra**	6	-	-	4
Pre-requisite		Basics of Modern Algebra	**Syllabus Version**		2020 -21	

Course Objectives:

The main objectives of this course are to:
1. Impart the understanding of the basic concepts of vector spaces, inner product space and linear algebra
2. Enhance the ability of proving the theorems in linear algebra
3. Introduce the meaning and applications of characteristic roots and vectors
4. Introduce the concept of generalized inverse of a matrix

Expected Course Outcomes:

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

1	Evaluate basis and dimension of a vector space	K1-K3
2	Apply orthogonal and non-singular transformation	K1-K3
3	Find generalized inverse of a matrix	K3,K5
4	Derive the characteristic roots and vectors	K1-K5
5	Determine the nature of quadratic forms and reduction of quadratic forms	K1-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**Vector Spaces**	18 hours

Vector spaces, subspaces, linear dependence and independence of vectors. Basis and dimension of a vector space. Finite dimensional vector spaces. Null space and nullity of a matrix.

Unit:2		**Inner Product Spaces**	18 hours

Inner product and orthogonal vectors. Gram-Schmidt orthogonalisation process, orthonormal basis. Orthogonal matrices and their properties. Linear transformations. Properties of non-singular and orthogonal transformations.

Unit:3		**Characteristics Roots and Vectors**	18 hours

Characteristic roots and characteristic vectors. Cayley-Hamilton theorem. Minimum polynomial, similar matrices, algebraic and geometric multiplicities of a characteristic root. Spectral decomposition of a real symmetric matrix.

Unit:4		**Quadratic Forms**	18 hours

Quadratic forms. Congruent transformations, congruence of symmetric matrices. Canonical reduction and orthogonal reduction of real quadratic forms. Nature of quadratic forms. Sylvester's law of inertia. Simultaneous reduction of a pair of quadratic forms.

Unit:5		**Generalized Inverse**	16 hours

Generalised inverse of matrix. Properties and computations of g-inverses. Moore-Penrose inverse. Vector and matrix derivatives.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars - webinars		
	Total Lecture hours	**90 hours**

Text Book(s)

1	Rao, A. R., and Bhimasankaram, P. (2000). Linear Algebra, Second Edition, Hindustan Book Agency, Hyderabad.
2	Hohn, F.E. (1971). Elementary Matrix Algebra, Amerind Publishing Co. Pvt. Ltd., New Delhi.

Reference Books

1	Graybill, F.A. (1983). Matrices and Applications in Statistics, Wadsworth Publishing Company, Belmont, California, USA.
2	Hoffman, K. M., and Kunze, R. (2013). Linear Algebra, Second Edition, Prentice-Hall of India Pvt. Ltd, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	http://www.astronomia.edu.uy/progs/algebra/Linear_Algebra,_4th_Edition__(2009)Lipschutz - Lipson.pdf
2	https://www.khanacademy.org/math/linear-algebra/vectors-and-spaces
3	https://nptel.ac.in/courses/111/106/111106051/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	L	S	M	S	S	M	M
CO2	S	S	S	L	S	M	S	M	M	L
CO3	S	S	S	L	S	M	S	M	L	M
CO4	M	S	S	L	M	M	S	L	L	L
CO5	M	S	S	L	M	M	S	S	L	S

*S-Strong; M-Medium; L-Low

Course code		Title of the Course	L	T	P	C
Core		**Distribution Theory**	**6**	**-**	**-**	**4**
Pre-requisite		Basic Understanding of Probability Distributions	**Syllabus Version**		**2020-21**	

Course Objectives:

The main objectives of this course are to:
1. Introduce various types of probability distributions with illustrations and properties
2. Provide knowledge on order statistics and their sampling distributions
3. Introduce distribution of several random variable and study the multivariate normal distribution and its properties.

Expected Course Outcomes:

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

1	Derive properties of random variables and probability distributions	K1-K2
2	Obtain the joint, marginal and conditional distributions	K1-K3
3	Evaluate the sampling distribution of order statistics and find the sampling distributions of range and median	K2-K3
4	Derive properties of multivariate normal distribution	K2-K3
5	Classify the quadratic forms and obtain the distribution of quadratic forms	K1-K5

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**Distribution Functions**	18 hours

Distribution function of a random variable and its decomposition into discrete and continuous parts. Standard discrete and continuous distributions. Distribution of a function of random variables. Truncated, compound distributions. Non-central chi square, t, and F distributions (no derivations).

Unit:2	**Distributions of Functions of Variables**	18 hours

Jointly distributed random variables. Joint, marginal, and conditional distributions. Marginal and expectations. Distributions of functions of several variables. Order statistics. Distributions of functions of order statistics.

Unit:3	**Characteristic Functions**	18 hours

Characteristic function and its properties. Statements of inversion theorem and Levy's continuity theorem. Their applications.

Unit:4	**Multivariate Normal Distribution**	18 hours

Multivariate normal distribution. Marginal and conditional distributions. Independence of subvectors. Distribution of a linear function of a normal random variable. Characteristic function of multivariate normal distribution and applications.

Unit:5	**Distribution of Quadratic Forms**	16 hours

Distribution of quadratic forms. Cochran's theorem Independence of quadratic forms. Independence of linear and quadratic forms.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	**90 hours**

Text Book(s)

1	Mukhopadhyay, P. (1996). Mathematical Statistics, New Central Book Agency, Calcutta.
2	Rohatgi, V.K. and Saleh, A.K.Md. E. (2002). An Introduction to Probability and Statistics, John Wiley, New York.
3	Hogg, R.V., McKean, J. W., and Craig, A. T. (2012). Introduction to Mathematical Statistics,Seventh Edition, Pearson Education, London.
4	Johnson, R. A., and Wichern, D. W. (2013). Applied Multivariate Statistical Analysis Sixth Edition, Pearson New International Edition.

Reference Books

1	Anderson, T.W. (1984). An Introduction to Multivariate Analysis, 2/e, John Wiley, New York.
2	Hsu, Hwei. (2009). Probability, Random Variables, and Random Processes, Schaum's Outlines, Tata McGraw-Hill, New Delhi.
3	Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://swayam.gov.in/nd2_cec20_ma01/preview
2	https://nptel.ac.in/courses/111/104/111104032/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	S	S	S	M	M	S
CO2	S	S	M	L	S	S	S	M	M	S
CO3	S	S	M	L	S	S	S	M	M	M
CO4	S	S	M	L	S	S	S	L	L	L
CO5	S	S	M	L	S	S	S	L	L	M

*S-Strong; M-Medium; L-Low

Course code		Title of the Course	L	T	P	C
Core		**Sampling Theory**	6	-	-	4
Pre-requisite		Basic Notions of Descriptive Statistics	**Syllabus Version**		2020-21	

Course Objectives:

The main objectives of this course are to:
1. Impart the significance of theory and applications of sampling
2. Enhance the ability of deriving the properties of methods of drawing samples
3. Comprehend the concepts of sampling for effective application for designing sample surveys

Expected Course Outcomes:		
On the successful completion of the course, student will be able to:		
1	Understand the importance of sampling and sample surveys	K2
2	Adopt suitable sampling methods for given situations	K2, K3
3	Observe the effectiveness of sample surveys	K1,K4
4	Design and perform sample surveys	K3,K5
5	Draw random samples using various sampling methods and study the properties	K1-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**Notions of Sample Survey and Methods**	**18 hours**

Census and sample surveys – principal steps in a sample survey – Pilot survey – NSSO, CSO and its functions. Concept of sampling and non-sampling errors – sources of non-sampling errors – response errors, Randomized response technique-Finite population – sampling techniques – SRSWR/SRSWOR.

Unit:2		**Stratified Sampling**	**16 hours**

Stratified random sampling – systematic random sampling and results on estimation of population mean and total – Allocation problems in stratified random sampling.

Unit:3		**Cluster Sampling**	**18 hours**

Ratio and Regression estimators based on SRSWOR and Stratified random sampling. Cluster sampling – clusters of equal size – estimation of mean and its variance – optimum cluster size.

Unit:4		**Probability Proportional to Size Sampling**	**18 hours**

Unequal probability sampling: PPSWR/WOR, Cumulative total and Lahiri's scheme. Methods and related estimators of finite population mean – Hurwitz-Thompson estimators – Desraj estimator for a general sample size and Murthy estimator for a sample of size.

Unit:5		**Two-stage and Double Sampling Methods**	**18 hours**

Two stage sampling with equal first stage units – estimation of mean and its variance (Determination of sampling, sub sampling fractions) – optimum allocation. Double sampling: Double sampling for stratification – Double sampling for Ratio estimator – Double sampling for Regression estimator.

Unit:6		Contemporary Issues	2 hours
Expert lectures, online seminars – webinars			
		Total Lecture hours	90 hours

Text Books	
1	Cochran, W.G. (1977). Sampling Techniques, Third Edition, John Wiley & Sons, NY.
2	Des Raj (1978), Sampling Theory, Tata-McGraw Hill, New Delhi.
3	Singh D., and Chowdhary, F. S. (2018). Theory and Analysis of Sample Survey Design, New Age International Private Ltd., New Delhi.
4	Mukhopadhyay, P. (2011). Applied Statistics, Second Edition, Books & Allied Ltd, India.
Reference Books	
1	Murthy, M. N. (1967). Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/104/111104073/
2	https://nptel.ac.in/content/storage2/courses/111104073/Module14/Lecture42.pdf
3	https://www.mooc-list.com/tags/sampling-methods
Course Designed By:	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	S	M	S	M	M	S
CO2	M	S	M	L	S	M	S	M	M	S
CO3	S	S	M	L	S	M	S	M	M	M
CO4	S	S	M	L	S	M	S	L	L	L
CO5	S	S	M	L	S	N	S	L	L	M

*S-Strong; M-Medium; L-Low

Second Semester

Course code			Title of the Course	L	T	P	C
Core			**Probability Theory**	6	-	-	4
Pre-requisite			Basics of Random Variables and Probability	**Syllabus Version**			

Course Objectives:

The main objectives of this course are to:
1. Introduce the notions of random variables, probability, probability distributions and
2. Derive properties of probability distribution functions
3. Study the nature of sequence and series of random variables through laws of large numbers and central limit theorems

Expected Course Outcomes:

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

1	Define random variables and derive the properties of probability and probability distributions	K1-K3
2	Comprehend the concepts of generating functions and characteristic functions	K2-K3
3	Understand the concept of convergence of sequence and series of random variables	K2-K4
4	Identify the application of inequalities in probability theory and identify the nature of the sequence of random variables	K1-K6
5	Explore the application of law of large numbers and central limit theorems	K1-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**Random Variables**	**18 hours**

Functions and Inverse Functions - Simple Functions. Random Variables: One and Two Dimensional Random Variables – Random Vector - Limits of Random Variables – Definition of Probability – Simple Properties – Discrete Probability Space – General Probability Space – Induced Probability Space – Probability Generating Function and its Properties.

Unit:2		**Properties of Distribution Functions and Inequalities**	**18 hours**

Distribution Function of a Random Variable and a Random Vector. Decomposition of Distribution Functions – Jordan's Decomposition Theorem — Mathematical Expectation: Definition, and Properties – Moments – Moment Generating Function and its Properties. Inequalities: Jensen's Inequality, Schwartz inequality, Holder's Inequality – Minkowski's Inequality - Basic Inequality - Chebychev's Inequality – Markov's Inequality.

Unit:3		**Convergence of Random Variables**	**18 hours**

Convergence of Random Variables: Concept - Cauchy's Criterion for Convergence - Mutual Convergence, Types of Convergence - Convergence in Probability, Convergence Almost Surely, Convergence in Distribution, Convergence in Mean, Monotone Convergence Theorem – Fubini's Theorem (Statement only)

Unit:4		**Characteristic Function and Properties**	**16 hours**

Characteristic Function: Definition and Properties – Uniquness Theorem - Inversion Formula – Problems – Borel-Cantelli Lemma - Borel's 0-1 Law - Kolmogorov's 0-1 Law - Bochner's Theorem (Statement only)

Unit:5	**Law of Large Numbers and Central Limit Theorem**	18 hours

Law of Large Numbers: Concept – Definition of Weak and Strong Law of Large Numbers – Bernoulli's and Khintchine's Weak Law of Large Numbers - Kolmogorov's Strong Law of Large Numbers – Simple Problems. Central Limit Theorem: de Moivre – Laplace Central Limit Theorem - Lindeberg – Levy's Central Limit Theorem - Liaponov's form of Central Limit Theorem - Lindberg – Feller Central Limit Theorem (Statement only) – Simple Applications.

Unit:6	**Contemporary Issues**	2 hours

Expert lectures, online seminars – webinars

		Total Lecture hours	90 hours

Text Book(s)

1	Rohatgi, V. K., and Saleh, A.K.M.E. (2015), An Introduction to Probability and Statistics, Third Edition, John Wiley & Sons, NY.
2	Bhat, B. R. (2007). Modern Probability Theory, Third Edition, New Age International (P) Ltd., New Delhi.
3	Hogg, R. V., Mckean, and Craig, A. T. (2012). Introduction to Mathematical Statistics, Seventh Edition, Pearson Education, New Jersey.

Reference Books

1	Dudewicz, E. J., and Mishra, S. N. (1988). Modern Mathematical Statistics, John Wiley and Sons, New York.
2	Feller, W. (1972). Introduction to Probability Theory and its Applications, Vol. I/II, Third/Second Edition, John Wiley and Sons, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

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

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	S	S	M	L	S	
CO2	S	M	M	L	S	S	S	M	M	S
CO3	S	M	M	L	S	S	S	M	L	M
CO4	M	M	M	L	S	S	S	M	L	L
CO5	S	M	M	L	S	S	S	M	M	M

*S-Strong; M-Medium; L-Low

Course code		Title of the Course	L	T	P	C
Core		**Statistical Inference I**	6	-	-	4
Pre-requisite		Knowledge in Probability Theory and Probability Distributions	**Syllabus Version**		**2020-21**	

Course Objectives
The main objectives of this course are to:
1. Introduce the concept of parametric estimation
2. Establish the properties of estimators, discuss the methods of estimation and construct confidence intervals for unknown parameters
3. Discuss the Bayesian concepts for decision theory

Expected Course Outcomes		
On the successful completion of the course, student will be able to:		
1	Establish the properties of estimators and derive estimators of unknown parameters	K1-K3
2	Obtain the optimal estimator for a given parametric function	K3-K6
3	Apply various methods of point estimation	K1-K3
4	Study asymptotic properties of estimators	K1-K5
5	Construct confidence intervals for population parameters	K1-K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create		

Unit:1		**Concept of Estimation Theory**		**18 hours**
Point Estimation – Estimators: Basics of Unbiasedness, Consistency and Efficiency, and their Properties. Families of Distributions – Exponential Families and Group families. Sufficiency – Factorization Theorem - Minimal Sufficiency – Completeness. Uniformly Minimum Variance Unbiased Estimator – Rao-Blackwell and Lehmann – Scheffe Theorems.				

Unit:2		**Bounds of Estimators and Consistency**		**18 hours**
Fisher's Information Measure – Cramer-Rao Inequality, Bhattacharya Bounds, Chapman-Robbins Bounds – Fisher's Information Matrix Simultaneous Estimation of Parameters of Univariate and Bivariate Normal Distributions. Consistency – CAN Estimators. Example for Consistent Estimators from Pitman Family. Information on Lower bound for Asymptotic Variance. Efficiency – Asymptotic Relative Efficiency				

Unit:3		**Methods of Estimation**		**18 hours**
Method of Moments, Method of Minimum Chi-square, Method of Modified Minimum Chi-square, Methods of Estimation: Method of Minimum Variance, Method of Maximum Likelihood – Asymptotic Properties of Maximum Likelihood Estimators. Method of Least Squares.				

Unit:4		**Interval Estimation**		**18 hours**
Confidence Level and Confidence Coefficient. Pivotal Quantity Method – Shortest Confidence Interval. Construction of Confidence Intervals for Population Proportion and difference Between two Population Proportions, Confidence Intervals for Mean and Variance of a Normal Population – Confidence Intervals for Difference Between Means and for Ratio of the Variances of Two Normal Populations.				

Unit:5	Basic Concepts of Decision Theory	16 hours

Loss Function, Risk Function and Convex Loss Function – Prior and Posterior Distributions – Natural Conjugate Priors – Jeffrey's Non-informative Priors – Bayes Estimators under Squared Error, Absolute Error and LINEX Loss Function.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars – webinars

	Total Lecture hours	90 hours

Text Book(s)

1. Goon, A, M., Gupta, M. K., and Dasgupta, B. (1989). An Outline of Statistical Theory, Vol. II, World Press, Kokata.

2. Rohatgi, V. K. and Saleh, A. K. Md. E. (2001). An Introduction to Probability and Statistics, Second Edition, John Wiley and Sons, New York.

3. Rajagopalan, M., and Dhanavanthan, P. (2012). Statistical Inference, PHI Learning Pvt., Ltd., New Delhi.

Reference Books

1. Kale, B. K. (1999). A First Course on Parametric Inference, Narosa Publishing House, New Delhi.

2. Dudewicz, E. J., and Mishra, S. N. (1988). Modern Mathematical Statistics, John Wiley & Sons, NY.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://swayamprabha.gov.in/index.php/Syllabus/detail/10774
2. https://swayam.gov.in/nd1_noc20_ma19/preview
3. https://nptel.ac.in/courses/111/105/111105043/

Course Designed By:

Mapping with Programme Outcomes									
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	L	S	M	S	M	L	M
CO2	S	M	M	L	S	M	S	M	M	S
CO3	S	M	M	L	S	M	S	M	M	M
CO4	S	S	M	M	S	M	S	M	L	L
CO5	S	M	M	M	S	M	S	M	L	M

*S-Strong; M-Medium; L-Low

Course code		Title of the Course	L	T	P	C
Core		**Demographic Methods**	**6**	**-**	**-**	**4**
Pre-requisite		Basics of Population and Data	**Syllabus Version**		2020 -21	

Course Objectives:

The main objectives of this course are to:
1. Learn the principles of demography and vital statistics
2. Acquire knowledge of computing mortality and fertility rates.
3. Discuss the significance of life table, and the meaning of population projection and migration.

Expected Course Outcomes:

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

1	Compute birth and death rates, and other vital statistics.	K1-K3
2	Understand the meaning of population projection and migration	K1-K3
3	Construct life table and make interpretations	K1-K4
4	Apply the method of making projection	K1-K4
5	Construct population growth model	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Demography**	18 hours

Meaning, Scope and Its Development – Demographic Data and their Sources – Chandrasekar and Deming Index – Population Size and Growth in India – Tends and Differentials in World Population.

Unit:2		**Mortality and Its Measures**	18 hours

Mortality: Basic Measurements – Crude, Specific, Standardized Rates. Life tables: Meaning, Construction, Interpretation and Use of Life Tables. Force of Mortality – Abridged Life Tables.

Unit:3		**Fertility and Its Measures**	18 hours

Fertility: Basic Measurement – Gross and Net Reproduction Rate – Cohart Fertility Analysis – fertility Models. Population Regulation Programs in India – Demography Transition Theory.

Unit:4		**Distribution of Population and Migration**	18 hours

Special Distribution of Population – Basic concepts – Measurements and models of Migrations. Urban Development – Components of Urban and Metropolitan Growth – Urbanization in Developed and Developing Countries.

Unit:5		**Population Growth and Methods of Projection**	16 hours

Components of Population Growth and Change – Methods of Projection – Logistic Equation – Component Method of Projection. Stable Population Theory.

Unit:6		**Contemporary Issues**	2 hours

Expert lectures, online seminars - webinars

		Total Lecture hours	**90 hours**

Text Book(s)
1	Mukhopadhyay, P. (2011): Applied Statistics, Second Edition, Books and Allied (P) Ltd., India.
2	Goon, A. M., Gupta, M. K., and Dasgupta, B. (2008). Fundamentals of Statistics, Vol. II,Ninth Edition, World Press, India.
3	Gupta, S. C., and Kapoor, V. K. (2016). Fundamentals of Applied Statistics, Sultan Chand &Sons Private Limited, New Delhi.

Reference Books
1	Bogue, D. J. (1969). Principles of Demography, Wiley, New York.
2	Biswas, S. (1988). Stochastic Processes in Demography & Application, Wiley Eastern Ltd., India
3	Barclay, G. W. (1958). Techniques of Population Analysis, John Wiley and Sons, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
1	https://nptel.ac.in/courses/109/104/109104045/
2	https://swayam.gov.in/nd1_noc19_hs39/preview
3	https://nptel.ac.in/courses/109/104/109104150/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	S	M	S	L	M	L
CO2	S	M	M	M	S	M	S	L	L	L
CO3	S	M	M	M	S	M	S	M	L	M
CO4	S	M	M	L	S	M	S	L	L	S
CO5	S	M	M	L	S	M	S	L	L	M

*S-Strong; M-Medium; L-Low

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		**Operations Research**	6	-	-	4
Pre-requisite		Basic knowledge in Mathematical Computation	**Syllabus Version**		2020-21	

Course Objectives

The main objectives of this course are to:
1. Understand the importance and concepts of optimization
2. Obtain the optimal solution for both linear and non-linear problem
3. Form and address solution to any real time optimization problem

Expected Course Outcomes

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

1	Formulate managerial decision making problems using game theory and apply the methods of solving linear programming problems	K2-K3
2	Effectively apply approaches for solving nonlinear programming problems	K2-K4
3	Understand and adopt transportation and assignment algorithms	K2-K3
4	Construct inventory models and compute economic order quantity	K2-K5
5	Formulate replacement problems and carryout network analysis	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Notions of Operations Research**		18 hours

Operations Research: Meaning, Objectives and Scope. Phases of Operations Research – Optimization Techniques and their Importance. Game Theory: Zero-sum games, Maximin and Minimax Criteria – Minimax and Saddle Point Theorems – Dominance Property. Linear Programming Problem (LPP): General Formulation - Illustrations – Methods of Solving LPP - Graphical and Simplex Methods – Concept of Cycling and Degeneracy. Problem of Duality - Dual Simplex Method – Simple Problems.

Unit:2		**Transportation and Assignment Problems**		16 hours

Transportation Problems (TP): Mathematical Formulation – Illustrations - Relationship Between TP and LPP – Methods for finding Basic Feasible Solutions – Optimality – Transportation Algorithm – Concept of Degeneracy – Unbalanced Transportation Problem. Assignment Problem – Formulation - Illustrations – Method of Solving an Assignment Problem

Unit:3		**Integer and Dynamic Programming**		18 hours

Integer Programming Problem (IPP): Gomary's Constraints, Cutting Plane Algorithm – Geometrical Interpretation of Cutting Plane Method – Branch and Bound Technique. Dynamic programming. Sequencing: Processing 'n' jobs through 2 machines – Processing 'n' jobs through 3 machines – Processing 'n' jobs through 'm' machines.

Unit:4		**Inventory Control**		18 hours

Theory of Inventory: Meaning of Inventory – Economic Order Quantity - Deterministic and Probabilistic Inventory Models - Models with and without Shortages – Concept of ABC Analysis.

Unit:5		**Replacement Problems and Network Analysis**		18 hours

Replacement Problems: Replacement of Items that deteriorate – Replacement of items that fail completely – Individual and Group Replacement Policies. Network Analysis: Concept – Network Diagram – Fulkerson's Rule. Project Management and Scheduling – PERT and CPM: Meaning

and Description – Determination of Critical Path.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	**90 hours**

Text Book(s)

1	Sharma, S. D. (2017). Operations Research: Theory, Methods and Applications, Kedar Nath, Ram Nath and Co, Meerut
2	Kanti Swarup, Gupta, P. K., and Man Mohan. (2017). Operations Research, Nineteenth Edition, Sultan Chand & Sons, New Delhi.

Reference Books

1	Taha, H.A. (2008). Operations Research, Pearson Education India, New Delhi.
2	Hillier, F. S. and Lieberman, G. J. (2009). Introduction to Operations Research, Ninth Edition, McGraw-Hill, Holden-Day.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://swayam.gov.in/nd2_cec20_ma10/preview
2	https://swayam.gov.in/nd1_noc19_ma29/preview
3	https://nptel.ac.in/courses/112/106/112106131/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	S	M	S	L	M	L
CO2	S	S	M	L	S	M	S	L	L	L
CO3	S	S	L	L	S	M	S	M	L	M
CO4	S	S	M	L	S	M	S	L	L	S
CO5	S	S	S	L	S	M	S	L	L	M

Third Semester

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		**Statistical Inference II**	**6**	**-**	**-**	**4**
Pre-requisite		Sampling, Distribution, Estimation Theory	**Syllabus Version**		**2020-21**	

Course Objectives

The main objectives of this course are to:
1. Introduce concepts and procedure required for testing the statistical hypotheses
2. Inculcate the ability to construct the test functions
3. Set up likelihood ratio tests and derive the properties relating to likelihood ratio tests
4. Explain the importance of nonparametric concepts and test procedures
5. Introduce the concept of sequential analysis

Expected Course Outcomes

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

1	Make inferences about statistical unknown population parameters based on random samples	K1-K5
2	Formulate statistical hypothesis	K2-K3
3	Test statistical hypothesis by selecting suitable test procedure.	K2-K4
4	Determine the size of critical region and power of test function.	K2-K5
5	Solve real life problems by applying suitable parametric / nonparametric / sequential testing procedures.	K3-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**Notions of Hypothesis Testing**	**18 hours**

Concept of Hypothesis Testing: Basic Definitions – Simple and Composite Hypotheses, Null and Alternative Hypotheses, Critical Region, Type I and II Errors. Statistical Tests: Randomized and Nonrandomized Tests, Level and Power of the Test. Most Powerful Tests (MPT) and Uniformly Most Powerful Tests (UMPT): Neyman – Pearson Lemma (with Proof) - Generalized Neyman – Pearson Lemma (Statement Only) – Applications

Unit:2		**Most Powerful Tests**	**18 hours**

Monotone Likelihood Ratio (MLR) Property – Families with MLR. Unbiased Tests: Construction of Most Powerful and Uniformly Most Powerful Unbiased Tests for Exponential Distributions - Applications. Locally Most Powerful Tests. Similar Regions.

Unit:3		**Likelihood Ratio Test**	**18 hours**

Likelihood Ratio Test (LRT): Definition, Derivation of test function, Asymptotic Distribution of LRT statistic, Consistency of LRT, Construction of Tests based on Basic Statistical Distributions. Invariance Tests – Maximal Invariant Test Statistic.

Unit:4		**Nonparametric Tests**	**16 hours**

Concept and Importance. Problem of Location: Sign Test and Wilcoxon's Signed-Rank Test. Problem of Fit: Kolmogorov – Smirnov One-Sample and Two-Sample Tests. Median Test. U Statistic: Definition and Properties. Mann-Whitney U Test - Chi-square Test for Homogeneity. Kruskal – Wallis Test. Applications of Nonparametric Tests.

Unit:5	Sequential Analysis	18 hours
Basic Ideas of Sequential Sampling – Sequential Decision Procedure: Stopping Rule and Decision Rule - Wald's Equation. Sequential Probability Ratio Test (SPRT): Procedure, Decision Lines, Stopping Bounds and their Approximations, OC and ASN Functions, Applications Based on Basic Statistical Distributions.		
Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	90 hours

Text Book(s)

1	Goon, A, M., Gupta, M. K., and Dasgupta, B. (1989). An Outline of Statistical Theory, Vol. II, World Press, Kolkata.
2	Rohatgi, V. K. and Saleh, A. K. Md. E. (2001). An Introduction to Probability and Statistics, Second Edition, John Wiley and Sons, New York.
3	Rajagopalan, M., and Dhanavanthan, P. (2012). Statistical Inference, PHI Learning Pvt., Ltd., New Delhi.

Reference Books

1	Lehmann, E. L. (1986). Testing Statistical Hypotheses, Second Edn., John Wiley & Sons, NY
2	Gibbons, J. D. and Chakrabarthi, S. (2010). Nonparametric Statistical Inference, Fifth Edition, Chapman and Hall/CRC Press, FL
3	Wald, A. (1982). Sequential Analysis. John Wiley & Sons, NY

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=34
2	https://nptel.ac.in/courses/103/106/103106120/
3	

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	M	S	M	M	L
CO2	S	S	S	M	S	M	S	M	M	S
CO3	S	S	M	M	S	M	S	M	M	S
CO4	S	S	M	M	S	M	S	L	L	S
CO5	S	S	M	M	S	M	S	L	L	M

*S-Strong; M-Medium; L-Low

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		**Multivariate Statistical Analysis**	6	-	-	4
Pre-requisite		Linear Algebra, Probability theory, Sampling theory, Statistical Inference-Estimation theory	**Syllabus Version**		2020-21

Course Objectives

The main objectives of this course are to:
1. Inculcate deep knowledge on various multivariate distribution and multivariate techniques
2. Develop clear idea on when and where to use dependence and interdependence multivariate methods
3. Bridge the relation between multivariate analysis and machine learning and strengthen the applications in diversified spectrum of fields.

Expected Course Outcomes

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

1	Derive the properties of multivariate normal distribution	K1–K6
2	Test the significance of sample covariance matrix, understand the importance Hotelling's T^2 statistic	K1–K6
3	Extract principal components and apply factor analysis	K1–K6
4	Classify the observations into one of several populations	K1–K6
5	Carryout multivariate data analysis	K1–K6

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**Multivariate Normal Distirbution**	18 hours

Definitions of Random Vector, Bivariate and Multivariate Distributions – Singular and Non-singular Normal Distributions. Bivariate Normal and Multivariate Normal Distributions - Derivation of Probability Density Function – Mean Vector and Covariance Matrix - Characteristic Function – Moments - Marginal and Conditional Distributions - Distribution of Linear and Quadratic Functions of Normal Variables.

Unit:2		**Estimation of Mean Vector and Covariance Matrix**	18 hours

Estimation of Mean Vector and Covariance Matrix: Maximum Likelihood Estimators – Computation of Sample Estimates. Distribution of Sample Mean Vector and Sample Covariance Matrix – Derivation of Wishart Distribution and its Characteristic Function – Properties of Wishart Distribution.

Unit:3		**Hotelling's T^2 Statistics and its Distirbution**	18 hours

Definition of Hotelling's T^2 statistic – Derivation of its Sampling Distribution. Mahalanobis D^2 statistic – Relationship Between T^2 and D^2 statistics – Applications of T^2 and D^2 statistics. Sampling Distributions of Simple, Partial and Multiple Correlation Coefficients in null case. Applications of these distributions.

Unit:4		**Problem of Classification and Discriminant Analysis**	16 hours

Problem of Classification – Concept and Importance – Classification under the Cases of two and k Multivariate Normal Populations – Criteria for Classification. Discriminant Analysis – Discriminant Functions – Applications – Mahalanobis Distance.

Unit:5	**Factor Analysis and Canonical Components**	18 hours

Principle Components and Factor Analyses: Concept and Importance – Method of Extracting Principal Components. Canonical Correlation Coefficients and Canonical Variables – Method of Determining Canonical Variables.

Unit:6	**Contemporary Issues**	2 hours

Expert lectures, online seminars – webinars

	Total Lecture hours	90 hours

Text Book(s)

1	Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, Third Edition, Wiley – Interscience, NY.
2	Johnson, R. A., and Wichern, D. W. (2013). Applied Multivariate Statistical Analysis Sixth Edition, Pearson New International Edition.

Reference Books

1	Kshirsagar, A. M. (1972), Multivariate Analysis, Marcel Decker, Inc., NY.
2	Morrison, D. F. (2004). Multivariate Statistical Methods, Fourth Edition, Duxbury Press, CA

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/104/111104024/
2	https://nptel.ac.in/courses/111/105/111105091/
3	https://nptel.ac.in/courses/106/106/106106139/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	S	M	S	L	M	L
CO2	S	M	M	L	S	M	S	L	L	M
CO3	S	M	M	M	S	M	S	M	L	M
CO4	S	M	M	M	S	S	S	M	M	S
CO5	S	S	M	M	S	S	S	M	M	M

*S-Strong; M-Medium; L-Low

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		**Statistical Quality Control and Reliability Theory**	6	-	-	4
Pre-requisite		Basics in Descriptive Statistics and Probability Distributions	**Syllabus Version**		2020-21	

Course Objectives

The main objectives of this course are to:
1. Understand the application of statistics in industrial environment.
2. Acquire knowhow on manufacturing process changes and process variability.
3. Attain proficiency in process capability analysis,
4. Instruct theory and practice of product control methodology.
5. Comprehend the importance of reliability theory in industries.

Expected Course Outcomes

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

1	Construct control charts for large and smaller shifts in the process parameters	K1,K3
2	Effectively interpret the results from the control charts	K4,K5
3	Carry out process capability analysis	K2,K3,K5
4	Adopt appropriate sampling inspection plans for given conditions	K2,K3,K6
5	Find failure rate, identify failure rate distributions, compute reliability of components and systems	K4,K5,K6

 K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Statistical Process Control**		18 hours

Statistical Quality Control – Concept, Meaning and Scope – Process and Product Control – Causes of Quality Variation - Shewhart Control Charts – Uses - Types of Control Charts. Basic Control Charts for Variables: Mean, Range and Standard Deviation Charts and their Applications – Control Charts for Attributes: p, d, c and u Charts and their Applications – OC and ARL Curves of Control Charts.

Unit:2		**Special Control Charts and Process Capability**		18 hours

Modified Control Charts and their Construction - CUSUM Control Charts: Decision Procedures - V – mask and Tabular CUSUM Procedures – Moving Range and Moving Average Charts – Exponentially Weighted Moving Average Charts. Process Capability Analysis and Gauge Capability Analysis - Multivariate Control charts: T^2 and Chi-square Charts.

Unit:3		**Attributes Sampling Plans**		18 hours

Basic Concepts of Acceptance Sampling: Merits, Demerits, Limitations, Definitions – Types of Sampling Plans – Sampling Plans by Attributes: Single, Double, Multiple and Sequential Sampling Plans – OC, ASN, AOQ and ATI Functions of Sampling Plans - Dodge - Romig LTPD and AOQL Tables - MIL-STD-105D Sampling Systems.

Unit:4		**Variables Sampling Plans**		18 hours

Sampling Plans by Variables – Basic Assumptions – Merits and Demerits – Known and Unknown Standard Deviation Single Sampling Plans – Construction of OC Curves – Determination of Parameters. Concept of Double Sampling by Variables - Continuous Sampling Plans: CSP-1, CSP-2, CSP-3 and Multi-level CSPs. Special Purpose Plans: Concepts of Chain and Skip-lot Sampling Plans.

Unit:5	Notions of Reliability	16 hours

Concept of Reliability, Components and Systems, Hazard Rate and Reliability Function - Life-time Distributions: Exponential, Gamma and Weibull Models, Models for Wear-out failures, IFR and DFR distributions – Estimation of Parameters. System Reliability with Independent Components - Serial, Parallel and Mixed Systems.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	90 hours

Text Book(s)

1	Duncan, A. J. (2003.). Quality Control and Industrial Statistics, Irwin-Illinois, US.
2	Grant, E. L., and Leavenworth, R. S. (2000). Statistical Quality Control, Seventh Edition, Tata McGraw Hill, New Delhi.
3	Montgomery, D. C. (2009). Introduction to Statistical Quality Control, Sixth Edition, Wiley India, New Delhi.
4	Ross, S. M. (2009). Introduction to Probability Models, Tenth Edition, Academic Press, MA, US.

Reference Books

1	Barlow, E.B., and Proschan, F. (1981). Statistical theory of Reliability and Life Testing: Probability Models, Second Edition, Published by Holt, Rinehart & Winston, Inc.
2	Schilling, E. G., and Nuebauer, D.V. (2009). Acceptance Sampling in Quality Control Second Edition, CRC Press, New York.
3	Sinha, S. K. (1986). Reliability and Life Testing, Wiley.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

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

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	L	M	L
CO2	S	S	M	M	S	M	S	M	M	L
CO3	S	M	M	M	S	S	S	M	M	M
CO4	S	M	M	M	S	M	S	M	S	S
CO5	S	M	M	M	S	S	S	L	S	M

*S-Strong; M-Medium; L-Low

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		**Econometrics**	6	-	-	4
Pre-requisite		Basic knowledge in linear models and their properties	**Syllabus Version**		2020-21	

Course Objectives

The main objectives of this course are to:
1. Develop knowledge on concepts of methodology, nature and scope of Econometric analysis
2. Inculcate the ideas of applications of econometrics
3. Understand and explore the concepts of linear models
4. Explore prominent estimation methods for linear regression model and simultaneous equation models

Expected Course Outcomes

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

1	Understand the basic concepts of Econometrics, methodology and limitations of using Econometric theory	K1,K2
2	Derive Generalized Least square estimators and its properties	K2-K3
3	Address the problem of violation of basic assumptions of GLS	K2-K4
4	Find the solution for structural and reduced form models	K2-K5
5	Obtain viable, reliable and optimal solution under simultaneous equation models	K2-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Econometrics and Generalized Linear Models**	18 hours

Nature and Scope of Econometrics - Single Equation Regression Models – Generalized Linear Model (GLM) and its existence - Ordinary least square (OLS) Method of Estimation and Prediction. Precision of OLS Estimates – Properties of Estimates under Normality Assumption - Dummy Variables: Nature and Use – Caution - Generalized least square (GLS) Method of Estimation and Prediction..

Unit:2		**Homoscadasticity and Heteroscedasticity**	18 hours

Nature – OLS Estimation and Its Consequences – Detection: Informal and Formal Methods – Remedial Measures – Method of GLS. Concept of Multicollinearity: Effects, Detection and Remedial Measures - Problem of Aggregation.

Unit:3		**Concept of Autocorrelation**	18 hours

OLS Estimation – BLUE - Consequences of Using OLS – Tests for Detection – Remedial Measures – GLS. Ridge Regression - Autoregressive and Distributed Lag Models: Estimation of Models – Method of Instrumental Variables – Autocorrelation in Autoregressive Models – Durbin *h* test.

Unit:4		**Simultaneous Equation Model**	16 hours

Nature and Illustrations - Simultaneous Equation Bias - Problem of Identification – Under and Over Identification - Rules for Identification: Order and Rank Conditions of Identifiability. Test of Simultaneity – Test for Exogeneity.

Unit:5		**Simultaneous Equation Model**	18 hours

Approaches to Estimation – Recursive Models and OLS – Estimation of an Identified Equation:

Method of Indirect Least Squares. Estimation of an Overidentified Equation: Method of Two-stage and Three-stage Least Squares Estimation – Method of Maximum Likelihood Estimation. Monte Carlo studies and simulation for Model specification.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars - webinars		

	Total Lecture hours	90 hours

Text Book(s)

1	Gujarathi, N. D., and Porter, D. C. (2009). Basic Econometrics, Fifth Edition, McGraw-Hill/Irwin, NY..
2	Koutsoyiannis, A. (2001). Theory of Econometrics, Second Edition, Palgrave Macmillan, UK.

Reference Books

1	Theil, H. (1971). Principles of Econometrics, John Wiley & Sons, NY.
2	Johnston, J. and DiNardo, J. (1997). Econometric Methods, Fourth Edition, McGraw-Hill, US.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://swayam.gov.in/nd2_cec20_hs14/preview
2	https://nptel.ac.in/courses/111/104/111104072/
3	https://nptel.ac.in/courses/110/105/110105053/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	S	M	S	L	M	L
CO2	S	S	M	L	S	M	S	L	L	M
CO3	S	S	M	L	S	M	S	M	S	M
CO4	S	S	M	L	S	M	S	L	L	S
CO5	S	S	M	L	S	M	S	L	S	M

*S-Strong; M-Medium; L-Low
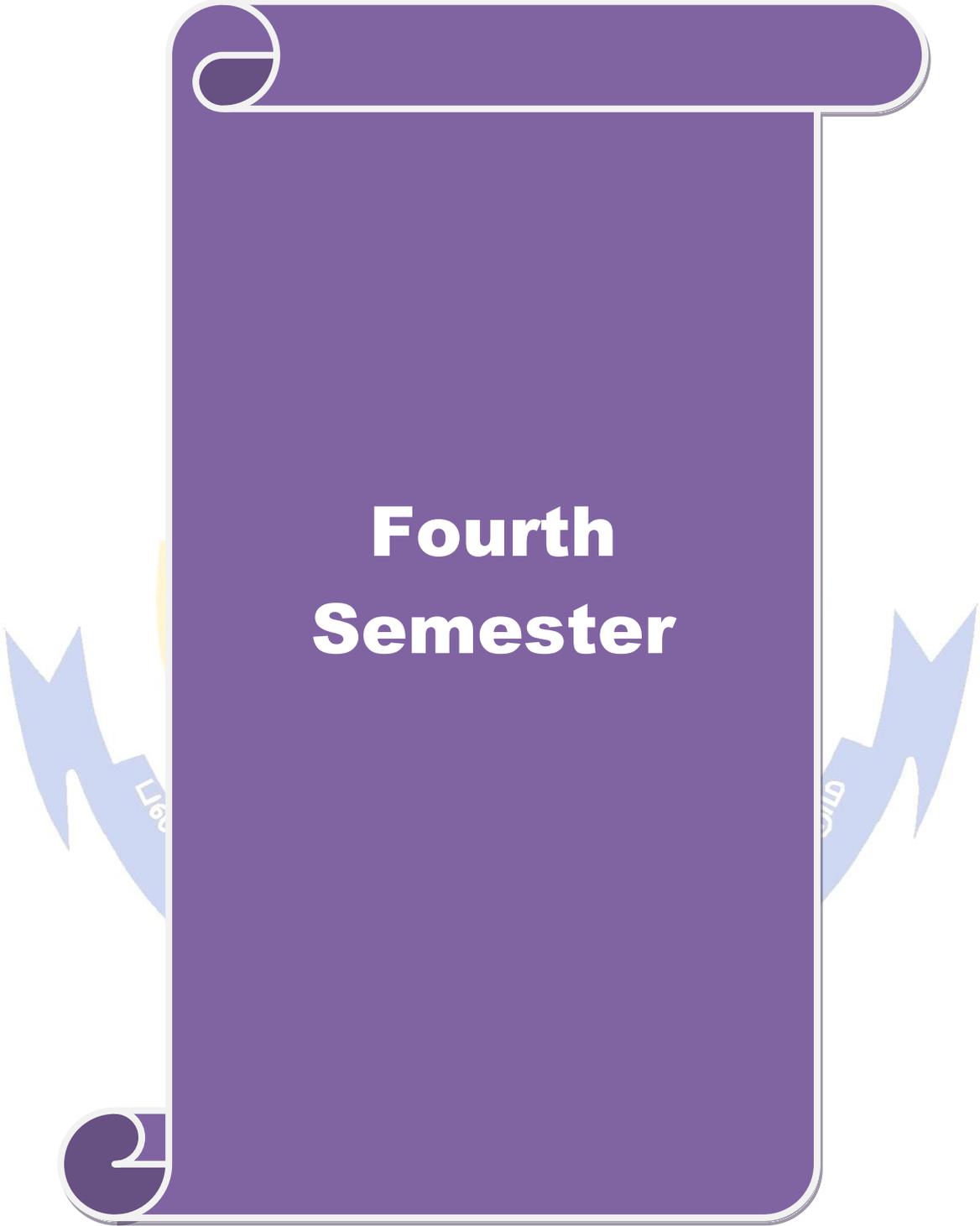
Fourth Semester

Course Code		Title of the Course	L	T	P	C
Core		**Linear Models and Design of Experiments**	6	-	-	4
Pre-requisite		Knowledge on Analysis of Variance and Basics of Design of Experiments	**Syllabus Version**		**2020-21**	

Course Objectives

The main objectives of this course are to:
1. Provide knowledge on ithe theoretical concepts of the general linear model and its types.
2. Introduce the concepts of analysis of variance and experimental designs with illustrations.
3. Encourage the student to formulate the designs for various situations and to construct mathematical models for carrying out analysis.

Expected Course Outcomes:

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

1	Remember and understand the theoretical underpinning of the linear model, analysis of variance and design of experiments.	K1,K2
2	Understand the type of any given experiment and the type of design apt for its analysis.	K2
3	Apply various designs of experiments in several practical situations and evaluate its results.	K3,K5
4	Make further analyses which are specific to the objectives of any experiment.	K4
5	Create new types of designs as per the requirements and study their behaviour while proceeding to the research.	K6

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**Linear Models**	16 hours

Model Assumptions on Error Components - Fixed/Mixed and Random Component Models - Gauss-Markov set up and its generalization - Linear estimation - Estimability of parameters - Gauss-Markov theorem – Best Linear Unbiased Estimators (BLUE) - Test for Linear Hypothesis.

Unit:2	**ANOVA and ANACOVA**	18 hours

Review of ANOVA Techniques for One-way and Two-way Classified Data – ANOVA for Orthogonal and Non-orthogonal Data - Multiple Comparison Tests: Duncan's, Student-Newmann-Keuls Tests - Analysis of Covariance (ANACOVA) Method - ANACOVA method with for One and Two Concomitant Variables. Design of Experiments: Principles of Randomization, Replication and Local Control - Basic Designs: CRD, RBD and LSD.

Unit:3	**Factorial Experiments**	18 hours

Greco LSD and its Analysis - Factorial Experiments: Symmetrical and Asymmetrical Factorial Experiments for 2^n, 3^n and S^n Design with Main and Interaction Effects – Construction and their Analysis - Concept of complete, partial and balanced confounding in symmetrical factorial experiments.

Unit:4	**Special Designs**	18 hours

Fractional Replications in Symmetrical Factorial 1/2 and 1/4 in Replicate of 2^n Experiments - Construction and Analysis - Concept of Split-plot and Strip-plot Designs – Simple and Balanced lattice designs - Crossover Designs. Concept of Response Surface Experiments – First and Second Order Rotatable Designs and their Construction.

Unit:5	**Block Designs**	18 hours

Block designs and their Properties - Connectedness, Balance and Orthogonality - Information Matrix C. Incomplete Block Designs – Balanced Incomplete Block Design – Properties and analysis - Parametric Relations - Intra-block and Inter-block Analysis of BIBD. Partially Balanced Block Design with Two Associate Classes - Properties.

Unit:6	**Contemporary Issues**	2 hours

Expert lectures, online seminars – webinars

	Total Lecture hours	90 hours

Text Book(s)

1	Montgomory, D.C. (2012). Design and Analysis of Experiments, Eighth Edition, John Wiley & Sons, NY.
2	Das, M. N., and Giri, N. C. (2011). Design and Analysis of Experiments, Second Edition, New Age International Private Ltd., New Delhi
3	Graybill, F. A. (2000). Theory and Applications of Linear Models, Duxbury Press, First Edition, MA.

Reference Books

1	Panneerselvam, R. (2012). Design and Analysis of Experiments, Prentice- Hall
2	Cochran, W. G., and Cox, G. M. (1992). Experimental Designs, Second Edition, John Wiley and Sons.
3	Myers, R. H., Montgomery, D. C., and Anderson-Cook, C. M. (2011). Response Surface Methodology, Wiley.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/110/105/110105087/
2	Prof.Jhareswar Maiti, Department of Industrial and System Engineering, IIT Kharagpur, 2018, "Design and Analysis of Experiments". (NPTEL) [https://www.classcentral.com/course/swayam-design-and-analysis-of-experiments-9877/ course/swayam-design-and-analysis-of-experiments-9877]

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	L	M	S
CO2	S	S	M	M	S	M	S	M	L	S
CO3	S	S	M	M	S	M	S	M	L	M
CO4	S	S	L	M	S	M	S	M	M	S
CO5	S	S	L	M	S	M	S	M	M	M

*S-Strong; M-Medium; L-Low

Course code		Title of the Course	L	T	P	C
Core		**Stochastic Processes**	**6**	**-**	**-**	**4**
Pre-requisite		Random Variables and Probability	**Syllabus Version**		**2020-21**	

Course Objectives:

The main objectives of this course are to:
1. Provide knowledge on the theoretical aspects of various classifications of stochastic processes.
2. Formulate problems on the structure of a family of random variables which depend on time.
3. Impart the importance of random processes through illustrations and mathematical formulations

Expected Course Outcomes:

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

1	Construct transition probability matrices and compute stationary probabilities	K5
2	Identify the nature of the states of a Markov chain	K1-K2
3	Evaluate extinction probabilities through the concept of branching process	K2-K4
4	Apply the renewal process for industrial problems	K2-K4
5	Construct time series models for forecasting using the concepts of stationary processes.	K1-K6

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**Notions of Stochastic Processes**	**18 hours**

Introduction to Stochastic Processes - Classification of Stochastic Processes, Markov Processes – Markov Chain - Countable State Markov Chain. Transition Probabilities, Transition Probability Matrix. Chapman - Kolmogorov's Equations, Calculation of n - step Transition Probability and its limit.

Unit:2		**Markov Chain and Its Properties**	**18 hours**

Classification of States, Recurrent and Transient States - Transient Markov Chain, Random Walk and Gambler's Ruin Problem. Continuous Time Markov Process: Poisson Processes, Birth and Death Processes, Kolmogorov's Differential Equations, Applications, Properties.

Unit:3		**Branching Processes**	**16 hours**

Branching Processes – Galton – Watson Branching Process - Properties of Generating Functions – Extinction Probabilities – Distribution of Total Number of Progeny. Concept of Weiner Process.

Unit:4		**Renewal Processes**	**18 hours**

Renewal Processes – Renewal Process in Discrete and Continuous Time – Renewal Interval – Renewal Function and Renewal Density – Renewal Equation – Renewal theorems: Elementary Renewal Theorem. Probability Generating Function of Renewal Processes.

Unit:5		**Stationary Processes**	**18 hours**

Stationary Processes: Discrete Parameter Stochastic Process – Application to Time Series. Auto-covariance and Auto-correlation functions and their properties. Moving Average, Autoregressive, Autoregressive Moving Average, Autoregressive Integrated Moving Average Processes. Basic ideas of residual analysis, diagnostic checking, forecasting.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	**90 hours**

Text Book(s)	
1	Karlin, S. and Taylor, H.M. (1975): A First Course in Stochastic Processes, Second Edition,Academic Press, Inc., NY
2	Medhi, J. (2011): Stochastic Processes, Third Edition, New Age International Private Ltd., New Delhi

Reference Books	
1	Parzen, E. (1962): Stochastic Processes, Holden-Day, Oakland, CA. (Latest Edition: 2015: Dover Books on Mathematics, Dover Publications).
2	Bhat, U. N., and Miller, G. K. (2002). Elements of Applied Stochastic Processes, Third Edition, Wiley - Interscience.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/103/111103022/
2	https://nptel.ac.in/courses/111/102/111102098/
3	https://ocw.mit.edu/courses/mathematics/18-445-introduction-to-stochastic-processes-spring-2015/lecture-notes/
Course Designed By:	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	S	M	S	S	M	S
CO2	S	S	M	L	S	M	S	S	M	S
CO3	S	S	M	L	S	M	S	M	M	M
CO4	S	S	M	L	S	S	S	S	S	S
CO5	S	S	M	L	S	S	S	S	S	M

*S-Strong; M-Medium; L-Low

EDUCATE TO ELEVATE

Course Code		Title of the Course	L	T	P	C
Core		**Applied Regression Analysis**	6	-	-	4
Pre-requisite		Fundamentals of Linear Regression, Correlation and their Properties	**Syllabus Version**	2020-21		

Course Objectives

The main objectives of this course are to:
1. Understand the notions of regression model building.
2. Impart application of regression models in various domains.
3. Instruct the methodology to test assumptions and conditions involved in regression models

Expected Course Outcomes:

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

1	Identify mature of regression models	K1,K2
2	Construct linear and non-linear regression models	K2,K3
3	Test model assumptions and conditions	K3,K4
4	Identify appropriate test statistic and carryout tests of significance	K3.K5
5	Build logistic regression and generalized linear models	K2,K6

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**Simple Linear Regression Models**	**18 hours**

Simple regression models with one independent variable, assumptions, estimation of parameters, standard error of estimator, testing the significance of regression coefficients, standard error of prediction. Testing of hypotheses about parallelism, equality of intercepts, congruence. Extrapolation, optimal choice of independent variable

Unit:2		**Polynomial and Inverse Regression**	**16 hours**

Diagnostic checks and correction: graphical techniques, tests for normality, uncorrelatedness, homoscedasticity, lack of fit, modifications like polynomial regression, transformations on Y or X. Inverse regression.

Unit:3		**Multiple Regression**	**18 hours**

Multiple regression: Standard Gauss Markov Setup. Least square (LS) estimation, Error and estimation spaces. Variance-Covariance of LS estimators. Estimation of error variance, case with correlated observations. LS estimation with restriction on parameters. Simultaneous estimation of linear parametric functions.

Unit:4		**Nonlinear Regression**	**18 hours**

Non-linear regression: Linearization transforms, their use & limitations, examination of non-linearity initial estimates, iterative procedures for NLS grid search, Newton-Raphson, steepest descent, Marquardt's methods. Logistic Regression: Logic transform, ML estimation, Tests of hypotheses, Wald test, LR test, score test, test for overall regression.

Unit:5		**Multiple Logistic Regression**	**18 hours**

Multiple logistic regressions, forward, backward method. Interpretation of parameters relation with categorical data analysis. Generalized Linear model: link functions such as Poisson, binomial, inverse binomial, inverse Gaussian and gamma.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	**90 hours**

Text Book(s)

1	Draper, N. R. and Smith, H. (1998). Applied Regression Analysis, Third Edition, John Wiley and Sons.
2	Montgomary, D. C., Peck, E. A., and Vining, G. G. (2012). Introduction to Linear Regression Analysis, Fifth Edition, John Wiley & Sons, NY.

Reference Books

1	Hosmer, D.W., Lemeshow, S., and Sturdivant, R. X. (2013). Applied Logistic Regression, Third Edition, John Wiley & Sons, NY.
2	Seber, G.E.F. and Wild, C.J. (2003). Nonlinear Regression, John Wiley & Sons, NY. Neter, J., Wasserman, W., and Kutner, M.H. (1989). Applied Linear Statistical Models,
3	Neter, J., Wasserman, W., and Kutner, M.H. (1989). Applied Linear Statistical Models, Second Edition, Irwin, IL

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/NCSS/Multiple_Regression.pdf
2	https://nptel.ac.in/courses/111/104/111104098/
3	http://people.sabanciuniv.edu/berrin/cs512/lectures/10x-logistic-regression-new.pdf

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	M	M	S	S	M	M
CO2	S	S	M	S	M	M	S	S	M	M
CO3	S	S	M	S	M	L	S	S	M	M
CO4	S	S	M	S	M	L	S	S	M	M
CO5	S	S	M	S	M	L	S	S	M	M

Course code		Title of the Course		L	T	P	C
Core: Practical		**Computer Practical using R**		**-**	**-**	**6**	**4**
Pre-requisite		Basic knowledge in programming languages and statistical comouting		**Syllabus Version**		**2020-21**

Course Objectives:

The main objectives of this course are to:
1. Understand the operations and functions of R Programming
2. Perform statistical analysis using built-in functions
3. Learn and write customized program for mathematical and statistical problems

Expected Course Outcomes:

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

1	Understand the basics of R Language	K2
2	Apply the logical skills for performing statistical analysis	K4
3	Use appropriate plots, charts and diagrams for all kinds of data	K3
4	Perform matrix computations	K3
5	Write and execute the codes for linear models and analysis of variance	K6

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Data Types in R**	**18 hours**

Data types in r - numeric/character/logical; real/integer/complex - strings and the paste command - matrices, dataframes, lists, setwd, read.table, read.csv, write.matrix, write.csv, creation of new variables, categorization, cut, factor; round, apply, creation of patterned variables - saving output to a file; source; print - saving workspace/history.

Unit:2		**Graphics in R**	**18 hours**

Graphics in r - the plot command, histogram, barplot, boxplot - points, lines, segments, arrows, paste - inserting mathematical symbols in a plot, - pie diagram, customisation of plot- setting graphical parameters - text and mtext, the pairs command, colours and palettes, saving to a file; graphical parameters such as mar/mai/mfrow, xlab/ylab/las/xaxp/yaxp/xlim/ylim/cex/axis/tck/srt, main/title/legend/locator, identify.

Unit:3		**Statistical Computation using R**	**18 hours**

Basic statistics - r help-command help, help.search(), r mailing list - contributed documentation on cran - one and two sample t tests, bartletts test for variance, f test for equality of variances, multi sample means, non parametric tests, chi squared tests - randomness, homogeneity, independence, exact tests and confidence intervals, checking the assumptions, distribution fitting.

Unit:4		**Matrix Evaluation using R**	**18 hours**

Vector matrix operations - matrix operations - addition,subtraction,multiplication, linear equations and eigenvalues, matrix decomposition - lu, qr and svd and inverse, the linear model and qr decomposition, determinant, g inverse, finding a basis, orthonormalisation, finding rank, the lm function; fitting a linear model; anova /ancova/regression.
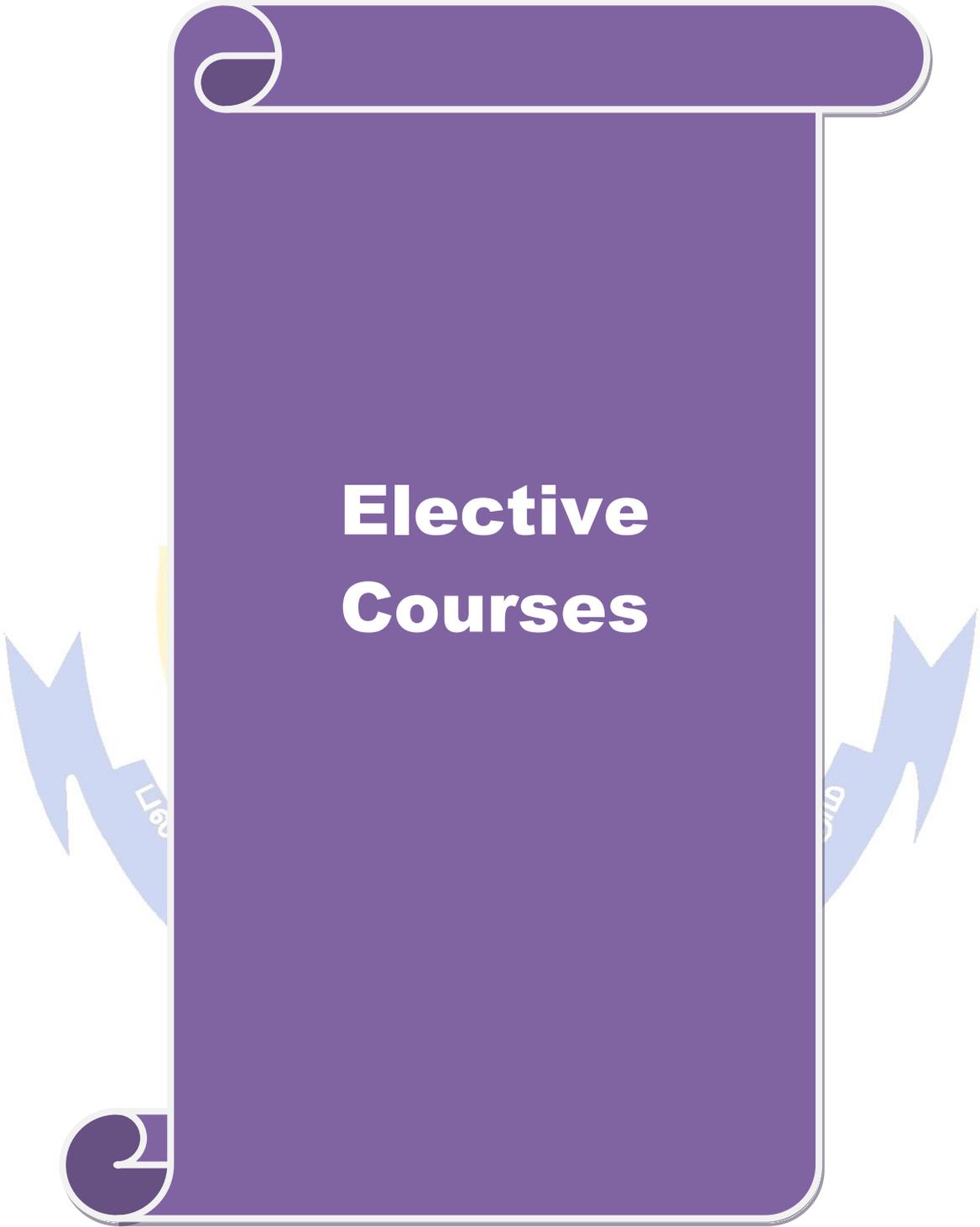
Unit:5	Linear Models using R	18 hours
Linear models - models, the summary function, goodness of fit measures, predicted values and residuals; residual plots, the anova table, testing nested models, confidence intervals and confidence ellipsoids, multiple testing, manipulating data; creating factors - r functions - random no. generation & simulations - r libraries – Case studies practical problems.		

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		

		Total Lecture hours	90 hours

Text Book(s)

1	Quick, J. M. (2010). Statistical Analysis with R, Packt Publishing Ltd., UK.
2	Purohit, S. G., Gore, S. D., and Deshmukh, S. R. (2009). Statistics Using R, Narosa Publishing House, New Delhi.
3	Dalgaard, P. (2008). Introductory Statistics with R, Second Edition, Springer

Reference Books

1	Everitt, B. S., and Hothorn, T. (2010). A Handbook of Statistical Analyses Using R, Second Edition, Chapman and Hall, CRC Press.
2	Crawley, M, J. (2007). The R Book, John Wiley and Sons Private Ltd., NY.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://swayam.gov.in/nd1_noc19_ma33/preview
2	https://swayam.gov.in/nd2_aic20_sp35/preview
3	https://nptel.ac.in/courses/111/104/111104100/

Course Designed By:

Note

 The maximum marks for continuous internal assessment and end semester University examination for Computer Practical using R shall be fixed as 25 and 75, respectively. The continuous internal assessment shall involve test and record work. The question paper at the end semester examination shall consist of five questions with internal choice. A candidate shall attend all the five questions, each of which shall carry 15 marks. The examination shall be conducted at the end of Semester IV. Problems relating to the above topics shall form the basis for setting the question paper.

Mapping with Programme Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	S	S	S	S	M	M	M
CO2	S	S	L	S	S	S	S	M	M	M
CO3	S	S	L	S	S	S	S	M	M	M
CO4	S	S	L	S	S	S	S	M	M	M
CO5	S	S	L	S	S	S	S	M	M	M

*S-Strong; M-Medium; L-Low

Elective Courses

Course code			Title of the Course	L	T	P	C
Elective			**Official Statistics**	**6**	**-**	**-**	**4**
Pre-requisite			Basic notions of health, social and economic sectors	**Syllabus Version**		2020-21	

Course Objectives:

The main objectives of this course are to:
1. Acquaint with the functioning of government department and policies.
2. Encourage people to know about the importance of official statistics
3. Perform the data handling tasks from various government records

Expected Course Outcomes:

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

1	Understand the importance of official statistics	K1-K2
2	Distinguish the data types in sectors such as economics, sociology, health, etc.	K2-K3
3	Comprehend the meaning of crop estimation, inflation, foreign trade, etc.	K2
4	Compute price and quantity index numbers, cost of living index number	K2-K5
5	Know the significance of national income	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Statistical System in India**	**18 hours**

Central and State Government Organizations, Functions of Central Statistical Organization (CSO), National Sample Survey Organization (NSSO). Organization of large scale sample surveys. General and special data dissemination systems.

Unit:2		**Official Statistics**	**18 hours**

Meaning, methods of collection, limitations and reliability. Principal publications containing data on the topics such as population, agriculture, industry, trade, prices, labour and employment, transport and communications - Banking and finance.

Unit:3		**Agricultural and Social Statistics**	**18 hours**

System of Collection of Agricultural Statistics - Crop forecasting and estimation - Productivity, fragmentation of holdings - Support prices - Buffer stocks - Impact of irrigation projects. Statistics related to industries, foreign trade - Balance of payment - Inflation - Social statistics.

Unit:4		**Index Numbers**	**18 hours**

Index Numbers: Price, Quantity and Value indices. Price Index Numbers: Construction, Uses, Limitations, Tests for index numbers, Chain Index Number. Consumer Price Index, Wholesale Price Index and Index of Industrial Production – Construction of index numbers and uses.

Unit:5		**National Income**	**16 hours**

National Income – Measures of national income - Income, expenditure and production approaches - Applications in various sectors in India. Measurement of income inequalit y: Gini's coefficient, Lorenz curves, Application of Pareto and Lognormal as income distribution.

Unit:6		**Contemporary Issues**	**2 hours**

Expert lectures, online seminars – webinars			
		Total Lecture hours	**90 hours**

	Text Book(s)
1	Allen R. G. D. (1975). Index Numbers in Theory and Practice, Macmillan.
2	C. S. O. (1990). Basic Statistics Relating to the Indian Economy.
3	C.S.O. (1995). Statistical System in India.
4	C. S. O. (1999). Guide to Official Statistics.
5	Mukhopadhyay, P. (2011). Applied Statistics, Second Edition, Books & Allied Ltd, India.
	Reference Books
1	Bhaduri, A. (1990). Macroeconomics: The Dynamics of Commodity Production, Macmillan India Limited, New Delhi.
2	Branson, W. H. (1992). Macroeconomic Theory and Policy, Third Edition, Harper Collins Publishers India (P) Ltd., New Delhi.
3	Goon A. M., Gupta M. K., and Dasgupta. B. (2001), Fundamentals of Statistics, Vol. 2, World Press, India.
4	Panse, V. G. (1964). Estimation of Crop Yields (FAO), Food and Agriculture Organization of the United Nations.
	Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
1	https://www.classcentral.com/course/swayam-macro-economics-19942
2	https://www.classcentral.com/course/swayam-economics-of-health-and-health-care-14023
	Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	L	S	M	M	L	L	L
CO2	S	S	L	L	S	M	M	L	L	L
CO3	S	S	L	L	S	M	M	L	L	L
CO4	S	S	L	L	S	M	M	L	L	L
CO5	S	S	L	L	S	M	M	L	L	L

*S-Strong; M-Medium; L-Low

Course code		Title of the Course	L	T	P	C
Elective		**Financial Mathematics**	**6**	**-**	**-**	**4**
Pre-requisite		Basic Skills in Mathematical Computation	**Syllabus Version**		**2020-21**	

Course Objectives:

The main objectives of this course are to:
1. Know the significance of mathematics in financial management.
2. Inculcate knowledge in computation of measures such as interest, discount, inflation, etc.
3. Understand the notions of financial mathematics.

Expected Course Outcomes:	
On the successful completion of the course, student will be able to:	
1	Compute interest rates	K2-K3
2	Determine and interpret net present value	K2-K5
3	Adopt cash flow techniques	K2-K4
4	Find net present value	K2-K3
5	Comprehend the methods of arbitrage free pricing	K1-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Notions of Cash Flow, Interest and Discount**	**18 hours**

Generalized Cash Flow model for financial transaction, making allowance for the probability of payment, Time value of money using the concepts of compound interest and discounting, Interest rates or discount rates in terms of different time periods..

Unit:2		**Net Present Value**	**18 hours**

Calculation of the present value and the accumulated value of a stream of equal or unequal payments using specified rates of interest and the net present value at a real rate of interest, assuming a constant rate of inflation.

Unit:3		**Compound Interest and discounted Cash Flow**	**18 hours**

Use of compound interest function, Equation of value, Repayment by regular installments of interest and capital, Discounted cash flow techniques.

Unit:4		**Investments and Risk Factors**	**18 hours**

The investments and risk characteristics of the following types. Simple compound interest problems, The delivery price and the value of the forward contract using arbitrage free pricing methods.

Unit:5		**Interest Rates**	**16 hours**

Structure of interest rates, Simple Stochastic interest rate models

Unit:6		**Contemporary Issues**	**2 hours**

Expert lectures, online seminars – webinars

		Total Lecture Hours	**90 hours**

Text Book(s)
1	Mecutcheon, J. J., and Scott, W. F. (1986). An Introduction to the Mathematics of Finance, Published for the Institute of Actuaries and the Faculty of Actuaries by Heinemann, UK.
2	Zima, P. and Brown, R. L. (1996). Mathematics of Finance, Second Edition, Schaum's Outline Series, McGraw-Hill Co., Inc., New York.
3	Buchanan, R. J. (2006). Introduction to Financial Mathematics, World Scientific Publishing Co., Pvt., Ltd, Singapore.

Reference Books
1	Bowers, N. L. (1997). Actuarial Mathematics, Society of Actuaries, Second Edition.
2	Promislow, S. D. (2011). Fundamentals of Actuarial Mathematics, John Wiley and Sons, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
1	https://nptel.ac.in/courses/112/107/112107260/
2	https://onlinecourses.nptel.ac.in/noc19_ma26/preview
3	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ma26/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	S	S	S	S	L	L	M
CO2	S	S	L	S	S	S	S	M	M	M
CO3	S	S	L	S	M	S	S	M	M	M
CO4	S	S	L	S	M	M	S	L	L	M
CO5	S	S	L	S	M	S	S	M	M	M

Course code		Title of the Course	L	T	P	C
Elective		**Data Mining**	**6**	**-**	**-**	**4**
Pre-requisite		Basics of data and data structure	**Syllabus Version**		**2020-21**	

Course Objectives:

The main objectives of this course are to:
1. Understand the meaning of database for decision making.
2. Introduce data mining techniques
3. Instill the importance of data mining and web data mining

Expected Course Outcomes:

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

1	Implement tools for data warehousing and data mining	K1-K2
2	Apply data mining techniques in real world situations	K2-K3
3	Apply the methodology to build decision tree	K2-K4
4	Perform cluster analysis	K2-K5
5	Apply tools for web mining	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**Data Warehousing**	**18 hours**

Introduction to Data Warehousing - Characteristics. Data Mart – Types of data marts. Meta data – Data Model for a Data Mart. Online Analytical Processing - Introduction- OLTP and OLAP systems. Developing a Data Warehouse – How to build – Tools for Data Warehousing.

Unit:2		**Basic of Data Mining**	**18 hours**

Introduction to Data Mining – From data warehousing of Data mining – Steps of Data Mining. Data mining algorithm – Data base segmentation – Predictive modelling – Link analysis. Tools for data mining.Data mining applications.Data mining techniques.

Unit:3		**Classification Rules and Cluster Analysis**	**18 hours**

Classification – Introduction - decision tree – Building a decision tree. Over fitting and Pruning – Decision tree rules. Estimating predictive – Accuracy of classification method. Cluster analysis – Introduction – Measuring distance between two clusters – Hierarchical clustering – Non Hierarchical clustering – K-means algorithm

Unit:4		**Association Rules**	**18 hours**

Association rules – Introduction - Discovering association rules in Transaction rule. Direct Hashing and Pruning (DHP) – Dynamic Itemset Counting (DIC). Performance Evaluation of Algorithm. Software for association rule mining .

Unit:5		**Web Data Mining**	**16 hours**

Web data Mining – Introduction .Web technology and characteristics.Locality and hierarchy in the web.Web content mining. Web document clustering – Web usage mining – Web mining software.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture Hours	**90 hours**

Text Book(s)

1	Adriaans, P., and Zantinge, D. (1996). Data Mining, First Edition, Addison Wesley Professional, London
2	Agneswaran, V. S. (2014). Big Data Analytics Beyond Hadoop, First Edition, Pearson FT Press.
3	Gupta, G. K. (2014). Introduction to Data Mining with Case Studies, Third Edition, PHI Learning Private Limited, New Delhi.

Reference Books

1	Delmater, R., and Hancock, M. (2001). Data Mining Explained, Digital Press, MA.
2	Hand, D., Mannila, H., and Smyth, P. (2001). Principles of Data Mining, MIT Press, London.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://swayam.gov.in/nd1_noc20_cs92/preview
2	https://swayam.gov.in/nd2_cec19_cs01/preview
3	https://nptel.ac.in/courses/106/105/106105174/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	S	S	S	S	S	S	S
CO2	S	S	L	S	S	S	S	S	S	S
CO3	S	S	L	S	M	S	S	S	M	M
CO4	S	S	L	S	M	M	S	S	M	M
CO5	S	S	L	S	M	S	S	S	M	M

*S-Strong; M-Medium; L-Low

Course code		Title of the Course	L	T	P	C
Elective		**Survival Analysis**	**6**	**-**	**-**	**4**
Pre-requisite		Basics of Biostatistics	**Syllabus Version**		**2020-21**	

Course Objectives:

The main objectives of this course are to:
1. Inculcate knowledge on survival analysis
2. Introduce survival models and the methods of constructing such models
3. Provide theoretical and applications aspects of survival analysis

Expected Course Outcomes:

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

1	Construct survival models	K1-K3
2	Apply the tools for constructing the survival models	K1-K5
3	Construct Cox model effectively	K1-K5
4	Interpret the outcomes of the analyses meaningfully.	K1-K5
5	Formulate problems on survival analysis	K1-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**Outline of Survival Analysis**	18 hours

Introduction – censor data – outline of survival analysis-goals- basic data layout- examples Kaplan Meler survival curves – general features. The Log-Rank test-for two groups, several groups to the alternatives to the log rank test.

Unit:2	**Survival Models**	16 hours

Cox PH model ML estimation of the Cox PH model Hazard Ratio adjusted survival curves PH assumptions Cox likelihood

Unit:3	**Methods of Evaluation of Hazards**	18 hours

Evaluating the proportional Hazards – Background – checking the PH Assumptions. Overview – graphical approach – log-log plots – observed versus expected plots – goodness of fit testing approach – time - dependent covariates.

Unit:4	**Stratified Cox Model**	18 hours

The stratified Cox procedure – general stratified Cox model – no interaction assumption - several stratification variables. Time dependent variables – extended Cox model for time dependent variables Hazard ratio formula – assessing time dependent variables – extended cox likelihood.

Unit:5	**Parametric Survival Models**	18 hours

Parametric survival models – Probability density function in relation to the hazard and survival function- Accelerated failure time assumption - Exponential, Weibull and log logistic.

Unit:6	**Contemporary Issues**	2 hours

Expert lectures, online seminars – webinars

		Total Lecture Hours	**90 hours**

Text and Reference Book	
1	Cox D. R., and Oakes, D. (1984). Analysis of Survival Data, Chapman and Hall, London.
2	Lee, E. T. and Wang, J. W. (2003). Statistical Methods for Survival Data Analysis, 3rd Edition, John Wiley & Sons, NJ.
3	Kleinbaum, D. G., and Klein, M. (2012): Survival Analysis: A Self-Learning Text, Third Edition, Springer – Verlag, NY.
4	Hosmer D.W., Limeshow, S., and May, S. (2008).Applied Survival Analysis, John Wiley & Sons, NY.
5	Kalbfleisch J. D., and Prentice, R. L. (2002). The Statistical Analysis of Failure Time Data, John Wiley & Sons, NY.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://www.ms.uky.edu/~mai/sta635/Survival%20AnalysisWMC2.pdf
2	http://www.math.ucsd.edu/~rxu/math284/slect1.pdf
3	file:///C:/Users/Admin/AppData/Local/Temp/make-01-00058-v2.pdf
Course Designed By:	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	L	M	S	S	M	S	S	S
CO2	S	S	L	M	S	S	M	S	S	S
CO3	S	S	L	M	S	S	M	S	M	M
CO4	S	S	L	M	S	S	M	S	M	M
CO5	S	S	L	M	S	S	M	S	M	M

Course code		Title of the Course	L	T	P	C
Elective		**Actuarial Statistics**	**6**	**-**	**-**	**4**
Pre-requisite		Basic Skills in Mathematical and Statistical Computations	**Syllabus Version**		**2020-21**	

Course Objectives:

The main objectives of this course are to:
1. Explain the significance of statistics in insurance sector
2. Introduce notions of actuarial science
3. Provide methods of computing annuities and premium for insurance policy

Expected Course Outcomes:

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

1	Comprehend the meaning of insurance and insurance risk	K1-K2
2	Construct life tables	K1-K3
3	Compute annuities and premium for an insurance policy	K2-K4
4	Analyze and interpret risk models	K2-K4
5	Construct multiple decrement table	K5-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	**Actuarial Science**	18 hours

Insurance Business   - Introduction - Role of Statistics in Insurance Concept of risk – characteristics of insurable risks - Expected value principle – Notion of utility – risk models – individual risk model and collective risk model.
Life time distributions and life tables: Life time random variable – distribution of the time until death – Curtate future-life time – survival functions, life tables and its relationship. .

Unit:2	**Life Insurance**	18 hours

Theory of compound interest – force interest - discount factor – major types – Term life insurance – endowment insurance –whole life insurance – variations of these insurances - level benefit insurance – deferred insurance - varying benefit insurance – Insurance payable at the moment of death and Insurance payable at the end of year of death for a variety of insurance models.

Unit:3	**Life-Annuities**	16 hours

Annuity certain – life annuity – continuous annuity – discrete annuity – deferred annuity – Continuous life annuities – Discrete life annuities – Life annuities with monthly payments – varying annuities.

Unit:4	**Premiums**	18 hours

Principle of premium calculation – Fully continuous premiums – Fully discrete premiums – true month payment premiums – Gross premiums. Reserves: Introduction – Fully continuous reserves– Fully discrete reserves - – retrospective reserve – reserve for a semi-continuous basis.

Unit:5	**Multiple Life Functions**	18 hours

Multiple Life functions: Joint distribution of future life times – joint life status – last survivor

status – Gompertz's and Makeham's law and their evaluations – theory of multiple decrement models and its applications – construction of multiple decrement table.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars - webinars		
	Total Lecture hours	**90 hours**

Text and Reference Books

1	Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., and Nesbitt, C. J. (1997). Actuarial Mathematics, Second Edition, Society of Actuaries, Ithaca, Illinoid, US.
2	Spurgeon E.T. (1972): Life Contingencies, Cambridge University Press.
3	Neill, A. (1977): Life Contingencies, Heineman, London, UK.
4	Dinius, J. B., Hassett, M. J., Ratlift, M. I., Garcia, T. C., and Steeby, A. C. (2017). ACTEX Exam FM Study Manual, Actex Learning, New Hartford, Connecticut.
5	Wahidudin, A. N. (2011). Financial Mathematics and Its Applications, Ventus Publishing.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.edx.org/course/introduction-to-actuarial-science
2	https://www.classcentral.com/course/edx-introduction-to-actuarial-science-3875
3	https://nptel.ac.in/courses/112/107/112107260/
4	http://www1.maths.leeds.ac.uk/~jitse/math1510/notes-all.pdf

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	M	S	S	M	L	M	S
CO2	S	S	L	M	S	S	M	L	M	S
CO3	S	S	L	M	S	S	M	L	M	S
CO4	S	S	L	M	S	S	M	L	M	S
CO5	S	S	L	M	S	S	M	L	M	S

Course code		Title of the Course	L	T	P	C
Elective		**Programming in C**	**6**	**-**	**-**	**4**
Pre-requisite		Basics of Computer Languages	**Syllabus Version**		2020-21	

Course Objectives:
The main objectives of this course are to:

1. Develop skills to write codes in C language.
2. Develop an understanding of the compilation process.
3. Develop skills to design programs using a variety of data structures

Expected Course Outcomes:	
On the successful completion of the course, student will be able to:	
1	Write inline functions for efficiency and performance	K1-K6
2	Overload functions and operators in C	K1-K6
3	Design and implement generic classes with C templates	K1-K6
4	Design C classes for code reuse.	K1-K6
5	Identify syntax and semantics of the C programming language.	K1-K6
K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create	

Unit:1		**Title of the Unit (Capitalize each Word)**	**16 hours**

Overview of C: Introduction - Importance of C – Basic structure of C programs – programming style – executing a C program. Constants, Variables, Data types: character set - C tokens – keywords and identifiers – constants – variables – data types – declaration of variables – assigning values to variables – defining symbolic constants.

Unit:2		**Title of the Unit (Capitalize each Word)**	**18 hours**

Operators and expressions: Arithmetic operators - relational and logical operators – assignment operators – increment and decrement operators – conditional operators – bitwise operators - C expressions – evaluation of expressions - Hierarchy of operators precedence and order of evaluation – type conversion in expressions. Managing input and output operators: reading and writing character – formatted input and output.

Unit:3		**Title of the Unit (Capitalize each Word)**	**18 hours**

Decision making and branching: Simple IF statement – IF ELSE statement – Nesting of IF ELSE statement – ELSE IF ladder – SWITCH statement - ?: operator – GOTO statement. Decision making and looping: WHILE statement – Do statement – FOR statement – Jumps in loop.

Unit:4		**Title of the Unit (Capitalize each Word)**	**18 hours**

Arrays: Introduction – one-dimentional, two-dimensional and multidimensional arrays. Handling of strings: declaring and initializing string variables - reading and writing strings – arithmetic operations on characters – comparisons of two strings – string handling functions. User defined functions: need for user defined functions – form of C functions – return values and their types – calling a function – category of functions – Nesting of functions – recursion – functions with arrays- scope and life time of variables in functions.

Unit:5	Title of the Unit (Capitalize each Word)	18 hours
	Structures: Structures - array of structures – structure and functions – Unions. Pointers – pointer expressions – pointers and arrays – pointers and strings – pointers and functions – pointers and structures – File management in C: Definitions – input and output operations on files – error handling during I/O operations – random access to files – command line arguments.	
Unit:6	Contemporary Issues	2 hours
	Expert lectures, online seminars – webinars	
	Total Lecture Hours	90 hours

Text Book(s)

1	Balagurusamy, E. (1992). Programming in ANSI C, Second Edition, Tata McGraw-Hill Publishing Company Limited.
2	Gottfried, B. S. (1997). Theory and Problems of Programming with C, Schaum's Outline Series, McGraw Hill Publishing Company.
3	Kanetkar, Y. P. (2016). Let Us C, 15th Edition, BPB Publications.

Reference Books

1	Schildt, H. (2000). C - The Complete Reference, 4th Edition, McGraw Hill Publishing Company.
2	Kernighan, B. W., and Ritchie, D. M. (1990). The C Programming Language, Prentice Hall.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://onlinecourses.nptel.ac.in/noc21_cs01/preview
2	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs42/

Course Designed By:

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	M	S	S	M	S	M	M
CO2	S	S	L	M	S	S	M	S	M	M
CO3	S	S	L	M	S	S	M	S	M	M
CO4	S	S	L	M	S	S	M	S	M	M
CO5	S	S	L	M	S	S	M	S	M	M

Course code		Title of the Course	L	T	P	C
Core: Practical		**Statistics Practical I**	**-**	**-**	**6**	**4**
Pre-requisite		Knowledge in Statistical Methods	**Syllabus Version**		2020 -21	

Course Objectives:

The main objectives of this course are to:
1. Impart knowledge on statistical computation using real data sets
2. Instill knowledge to apply theory into practice
1. Understand the theory through practical oriented training

Expected Course Outcomes:

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

1	Generate random samples and study the properties of estimators	K1 - K4
2	Compute ratio and regression estimators	K2 - K4
3	Solve managerial decision making problems	K2 - K4
4	Estimate the parameters of the population based on random samples	K1 - K3
5	Evaluate vital statistics and construct life tables	K1 - K6

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Sampling Theory**	15 hours

Simple Random Sampling – Stratified Random Sampling – Systematic Sampling – Single-stage and Two-stage Cluster Sampling – Ratio and Regression estimates.

Unit:2		**Statistical Inference I**	15 hours

Point Estimation – Methods of Maximum Likelihood, Moments, Minimum Chi-Square - Interval Estimation for mean, variance, ratio of variances and proportions.

Unit:3		**Demographic Methods**	15 hours

Measurements of Mortality: Crude, Specific, Standardized Rates. Construction of life tables. Measurements of Fertility: Gross and Net Reproduction Rate, Construction of Logistic Model.

Unit:4		**Operations Research**	15 hours

Graphical and Simplex Methods of Solving Linear Programming Problems - Artificial Variable – Dual Simplex methods – Integer and nonlinear programming problems – Network Analysis: PERT and CPM techniques – Inventory problems – Replacement Problems.

Unit:5		**Contemporary Issues**	2 hours

Expert lectures, online seminars – webinars

		Total Lecture hours	62 hours

Text and Reference Books	
1	Goon, A. M., Gupta, M. K., and Dasgupta, B. (2008). Fundamentals of Statistics, Vol. II, Ninth Edition, World Press, India.
2	Gupta, S. C., and Kapoor, V. K. (2016). Fundamentals of Applied Statistics, Sultan Chand & Sons Private Limited, New Delhi.

3	Mukhopadhyay, P. (2011): Applied Statistics, Second Edition, Books and Allied (P) Ltd., India.
4	Sharma, S. D. (2017). Operations Research: Theory, Methods and Applications, Kedar Nath, Ram Nath and Co, Meerut.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://www.infocobuild.com/education/audio-video-courses/mathematics/Statistical Inference - IIT- Kharagpur/lecture-25.html
2	https://nptel.ac.in/courses/111/107/111107128/
3	https://nptel.ac.in/courses/111/102/111102112/
Course Designed By:	

Note

The maximum marks for continuous internal assessment and end semester University examination for Statistics Practical I shall be fixed as 40 and 60, respectively. The continuous internal assessment shall involve test and record work. The question paper at the end semester examination shall consist of four questions with internal choice. A candidate shall attend all the four questions, each of which shall carry 15 marks. The examination shall be conducted at the end of Semester II. Problems relating to the above topics which are covered in Semester I and Semester II shall form the basis for setting the question paper.

| **Mapping with Programme Outcomes** | | | | | | | | | |
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	S	S	S	S	M	M	M
CO2	S	S	L	S	S	S	S	M	M	M
CO3	S	S	L	S	S	S	S	M	M	M
CO4	S	S	L	S	S	S	S	M	M	M
CO5	S	S	L	S	S	S	S	M	M	M

Course code			TITLE OF THE COURSE	L	T	P	C
Core: Practical			**Statistics Practical II**	=	-	6	4
Pre-requisite			Knowledge in Statistical Methods	**Syllabus Version**		**2020 - 21**	

Course Objectives:

The main objectives of this course are to:
1. Impart knowledge on statistical computation using real data sets
2. Instill knowledge to apply theory into practice
1. Understand the theory through practical oriented training

Expected Course Outcomes:

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

1	Attempt to classify the sample space as acceptance and rejection regions	K1 - K4
2	Compute test functions for testing the hypotheses	K2 - K4
3	Adopt statistical methods for industrial applications and construct process control charts	K2 - K4
4	Carry out the significance tests based on multivariate data and perform data analysis for multivariable cases	K1 - K3
5	Apply the theoretical knowledge for estimating reliability of components	K1 - K6

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1		**Statistical Inference II**	**15 hours**

Most powerful test – Uniformly Most Powerful test – Likelihood Ratio test – Chi-Square goodness of fit test – Non-parametric Tests – Sequential Probability Ratio Tests.

Unit:2		**Multivariate Analysis**	**15 hours**

Maximum likelihood estimation of population mean vector and covariance matrix - Tests based on Hotelling T^2 and Mahalanobis D^2 Statistics - Principal component analysis – Factor analysis - Classification Analysis - Discriminant Function.

Unit:3		**Statistical Quality Control and Reliability**	**15 hours**

Control charts for mean, range, fraction defective, number of defective, number of defects – OC and AOQ curves of single, double and sequential sampling plans – Problems on reliability.

Unit:4		**Linear Models and Design of Experiments**	**15 hours**

Linear Models and Estimation of BLUE – Analysis of Covariance – Greaco Latin Square Design – Split plot and Strip plot techniques – 2^n and 3^n factorial experiments with and without total and partial confounding - BIBD – PBIBD.

Unit:5		**Contemporary Issues**	**2 hours**

Expert lectures, online seminars – webinars

		Total Lecture hours	**60 hours**

Text and Reference Books

1	Goon, A. M., Gupta, M. K., and Dasgupta, B. (1989). An Outline of Statistical Theory-Vol.II, World Press, Calcutta.

2	Johnson, R. A., and Wichern, D. W. (2013). Applied Multivariate Statistical Analysis Sixth Edition, Pearson New International Edition.
3	Montgomery, D. C. (2009). Introduction to Statistical Quality Control, Sixth Edition, Wiley India, New Delhi.
4	Mukhopadhyay, P. (2011): Applied Statistics, Second Edition, Books and Allied (P) Ltd., India.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://www.infocobuild.com/education/audio-video-courses/mathematics/Statistical Inference - IIT- Kharagpur/lecture-25.html
2	http://www.nptelvideos.in/2012/12/applied-multivariate-analysis.html
Course Designed By:	

Note

The maximum marks for continuous internal assessment and end semester University examination for Statistics Practical II shall be fixed as 40 and 60, respectively. The continuous internal assessment shall involve test and record work. The question paper at the end semester examination shall consist of four questions with internal choice. A candidate shall attend all the four questions, each of which shall carry 15 marks. The examination shall be conducted at the end of Semester IV. Problems relating to the above topics which are covered in Semester III and Semester IV shall form the basis for setting the question paper.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	L	S	S	S	S	S	M	S
CO2	S	S	L	S	S	S	S	S	M	S
CO3	S	S	L	S	S	S	S	S	M	S
CO4	S	S	L	S	S	S	S	S	M	S
CO5	S	S	L	S	S	S	S	S	M	S

*S-Strong; M-Medium; L-Low

Course code	17S4PV	TITLE OF THE COURSE	L	T	P	C
Core		**Project and Viva - Voce**	9	-	-	6
Pre-requisite		Knowledge in statistical theory methods	**Syllabus Version**		2020 -21	

All the admitted candidates shall have to carry out a project/dissertation work during the fourth semester under the supervision of the faculty of the Department of Statistics in the College. Candidates shall have to submit three copies of the report of the project/dissertation work at the end of the fourth semester at least two weeks before the last working day and shall have to appear for a viva-voce examination. The report shall be evaluated and viva-voce examination shall be conducted jointly by an External Examiner and the Project Guide. The maximum marks for the project/dissertation report and viva – voce examination shall be fixed as 150, which would be split with the following components:

Internal Assessment Marks by the Project/Dissertation Guide :   25 marks
Evaluation of Project/Dissertation Report jointly by the   :   100 marks
External Examiner and the Guide
Conduct of Viva-Voce Examination jointly by the   :   25 marks
External Examiner and the Guide
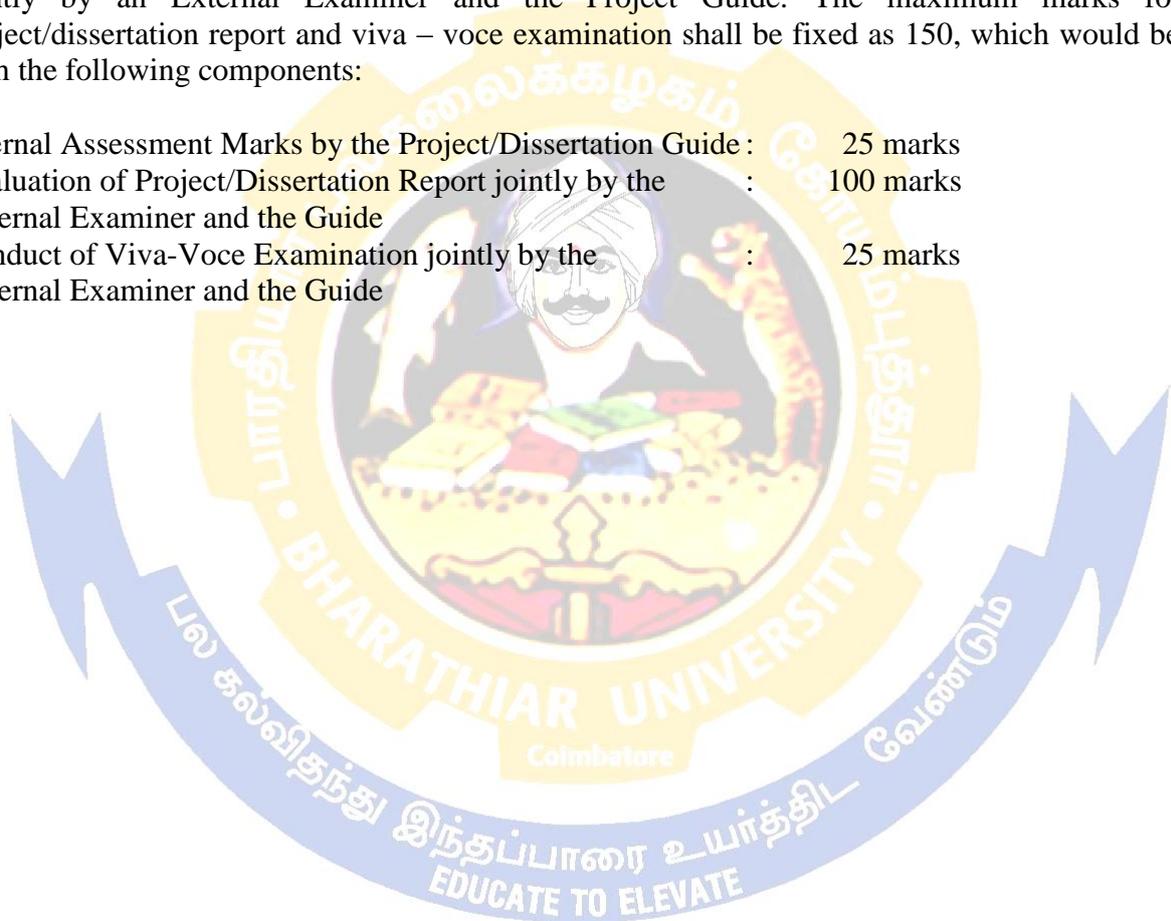
BHARATHIAR UNIVERSITY : : COIMBATORE 641 046
M. Sc. Statistics Curriculum (Affiliated Colleges)
(For the students admitted during the academic year 2020 – 21 onwards)
List of Core/Elective Subjects to be offered

CORE Subjects
1. Real Analysis
2. Linear Algebra
3. Distribution Theory
4. Sampling Theory
5. Probability Theory
6. Statistical Inference I
7. Demographic Methods
8. Operations Research
9. Statistical Inference II
10. Multivariate Analysis
11. Statistical Quality Control and Reliability Theory
12. Econometrics
13. Linear Models and Design of Experiments
14. Stochastic Processes
15. Applied Regression Analysis
16. Computer Practical using R
17. Statistics Practical I
18. Statistics Practical II
19. Project & VIVA-VOCE

ELECTIVE Subjects
1. Official Statistics
2. Financial Mathematics
3. Data Mining
4. Survival Analysis
5. Actuarial Statistics
6. Programming in C