

B.Sc. Applied Statistics & Analytics

Syllabus

Semester I

Program: B. Sc. Applied Statistics & Analytics					Semester : I	
Course : Descriptive Statistics - I					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks - 50 (Theory) in Question Paper)	
3h	2h	-	4	50 (Theory) & 50 (Practical)	50 (Theory)	
Pre-requisite:						
Objectives: The main objective of this paper is to provide the background of data type, data collection methods, describing the data graphically, including its central tendency and dispersion.						
Outcomes: After completion of the course, students would be able to : A student should be able to prepare the data and select appropriate methods to represent data graphically and derive the basic descriptive statistics of the data.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Types of Data and Data Condensation a) Concept of population and sample. Different types of scales: nominal, ordinal, interval and ratio. b) Collection of Primary data: concept of a questionnaire and a schedule, Secondary data c) Types of data: Qualitative and quantitative data; Time series data and cross section data, discrete and continuous data. d) Tabulation & Diagrammatic representation using bar diagrams, Line diagram and pie chart. e) Univariate frequency distribution of discrete and continuous variables. Cumulative frequency distribution. f) Graphical representation of frequency distribution by Histogram, frequency polygon, Stem and leaf diagram and Cumulative frequency curve.					15+10
2	Measures of central tendency (a) Concept of central tendency of data. Requirements of good measure (b) Mean, Median, Mode: Arithmetic mean (Simple, weighted mean, combined mean), Geometric mean, Harmonic mean, Median, Mode, Empirical relation between mean, median and mode (c) Partition Values: Quartiles, Deciles, Percentiles. (d) Merits and demerits of using different measures & its applicability					15+10
3	Measures of Dispersion, Skewness & Kurtosis - (a) Concept of dispersion. Requirements of good measure. (b) Absolute and Relative measures of dispersion: Range, Quartile Deviation, Mean absolute deviation, Standard deviation.					15+10

	(c) Variance and Combined variance, raw moments and central moments and relations between them. (d) Concept of Skewness and Kurtosis: Measures of Skewness: Karl Pearson's, Bowley's and Coefficient of skewness based on moments. (e) Measure of Kurtosis (f) Box Plot	
	Total	45+30

Text Books:

1. S.C. Gupta, V.K. Kapoor (2013) - Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand & Sons.
2. Welling, Khandeparkar, Pawar, Naralkar (2015) -Descriptive Statistics, Third edition, MananPrakashan

Reference Books:

1. Levin and Rubin (2012) – Statistics for Management, Seventh Edition, Pearson India
2. D. R. Anderson (2012) – Statistics for Business and Economics, Eleventh Edition, South Western. Cengagelearning .
3. Amir D. Aczel (2012) -Complete Business Statistics, Seventh edition,McGraw Hill Education(I) Pvt. Ltd.
4. Resendes Keith (2015) - Excelling with Data: Descriptive Statistics using MS Excel, 1st edition,CreateSpace Independent Publishing Platform.
5. V.R. Pawagi and Saroj A. Ranade (2010) - Statistical methods using R software, Nirali Publications
6. S.G. Purohit, S.D. Gore and S.R. Deshmukh (2008) - Statistics using R, Narosa Publishing House
7. Kothari C.R (2014) - Research Methodology, Third Edition, Wiley Eastern Limited

Program: B. Sc. Applied Statistics & Analytics					Semester : I	
Course : Introduction to Probability Theory					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite: None						
Objectives: This paper aims at introducing fundamentals of probability theory, random variable and its distribution. This will provide students basic grounding in probability theory, its properties, random variable, various generating functions and its applications to real life situations.						
Outcome: Students will be able to understand basic elements of probability theory and apply them to solve real life problems.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Concepts of Probability & Properties: <ul style="list-style-type: none"> • Random Experiment: Sample space, event, operation of events, concepts of independent, mutually exclusive and exhaustive events. • Classical (Mathematical), Empirical, Axiomatic definitions of Probability, and their properties. Theorems and properties based on Axiomatic definition of probability • Conditional probability, Theorems on Addition and Multiplication of probabilities. • Bayes' theorem and its applications. 					25
2	Random Variable & Distribution: <ul style="list-style-type: none"> • Definition of discrete and continuous random variables, Probability mass function (pmf), Probability density function (pdf), and their properties, cumulative distribution function and its properties • Expectation and variance of a random variable and its properties. 					20
3	Generating Functions - <ul style="list-style-type: none"> • Moments and Moment generating function (m.g.f.) and its properties • Cumulant generating function (c.g.f.) and its properties • Characteristic function and its properties 					15
	Total					60
Text Books:						
<ol style="list-style-type: none"> 1. S.C. Gupta, V.K. Kapoor (2013) - Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand & Sons. 2. J.N. Kapur, H.C. Saxena - Mathematical Statistics, Fifteenth Edition, Sultan Chand & Company Ltd. 3. Welling, Khandeparkar, Pawar, Naralkar (2015) Statistical Methods Manan Publications. Third edition. 						

Reference Books:

1. Spiegel M. R. (2007) - Theory and Problems of Statistics, 3rd edition, Schaum's Publications series. Tata McGraw-Hill
2. Statistical methods using R software (2010): V.R. Pawagi and Saroj A. Ranade; Nirali publications
3. S.G. Purohit, S.D. Gore and S.R. Deshmukh (2010), Statistics using R , Narosa Publishing House

Any other information:

Numerical examples are expected to be covered in theory class.

Program: B. Sc. Applied Statistics & Analytics					Semester : I	
Course : Discrete Mathematics					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite: None						
Objectives: The purpose of the course is to familiarize the prospective learners with mathematical structures that are fundamentally discrete. This course introduces sets and functions, forming and solving recurrence relations and different counting principles.						
Outcome: Student should be able to study or describe objects or problems in computer algorithms and programming languages.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Sets and Functions: Sets, subsets, operations on sets, De Morgan's Laws, Equivalence relations, partitions of sets. Definition of function. Domain, co domain and the range of a function. Direct and inverse images. Injective, surjective and bijective functions. Composite and inverse functions. Graph of standard functions such as absolute value function, inverse function, logarithmic and exponential functions, flooring and ceiling functions, trigonometric functions over suitable intervals.					20
2	Counting Principles: Sum and Product Rules, Two-way counting, Tree diagram for solving counting problems, Pigeonhole Principle (without proof); Simple examples, Inclusion Exclusion Principle (Sieve formula) (Without proof). Partition and Distribution of objects, Permutation with distinct and indistinct objects, Binomial numbers, Combination with identities: Pascal Identity, Vandermonde's Identity, Pascal triangle, Binomial theorem, Combination with indistinct objects. Principle of finite induction and generating functions					20
3	Recurrence Relations, Graphs and Trees: Recursive definition and examples, Recursive Algorithms. Applications of Recurrence Relations, Solving Linear Recurrence Relations using generating functions, Divide-and-Conquer Algorithms and Recurrence Relations, Huffman Coding and decoding					20

	Definition and elementary results of Graphs. Definition and elementary results of Trees. Ordered rooted tree, Binary trees, Complete and extended binary trees, representing binary trees in memory, traversing binary trees, binary search tree	
	Total	60
Text Books: <ol style="list-style-type: none">1. Discrete Mathematics and Its Applications, Seventh Edition by Kenneth H. Rosen, McGraw Hill Education (India) Private Limited. (2011)		
Reference Books: <ol style="list-style-type: none">1. L Biggs (2002), Discrete Mathematics, Oxford University Press2. Richard A. Brualdi (2008), Introductory Combinatorics, 5th Edition, Pearson Education, Inc.		
Any other information: Numerical examples are expected to be covered in theory class.		

Program: B. Sc. Applied Statistics & Analytics					Semester : I	
Course : Calculus & Differential Equations					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: The objective of the course is to introduce basic abstract ideas like limit, continuity and derivatives. The treatment of the course is to familiarize the student without much rigor, but through real life examples and graphs.						
Outcome: Students will have understanding of mathematical calculus through visualizations. Will have strong foundations for theory of probability and Statistics						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Limit and Continuity: Limits -an intuitive approach, computing limits, continuity: definition and its applications, continuity in an interval, properties of continuous functions. Sequence & Series- in determinant forms					20
2	Derivative and its applications: Tangent lines and rate of change, definition, derivatives of standard functions. Increasing and decreasing functions, concavity, points of inflexion, relative maxima and minima, first and second derivative tests (without proof), absolute maxima and minima.					20
3	Differential Equation: Solutions of equations of first order and first degree, Homogeneous and non homogeneous equations of first degree, Exact equations, Integrating factors, solution of differential equations with the help of given integrating factors. Application of First Order Differential Equations.					20
	Total					45+30
Text Books:						
1. Calculus: Early transcendentals (10 th Edition): Howard Anton, IrlBivens, Stephen Davis, John Wiley & sons, 2012.						
2. Differential Equations with boundary value problems (8 th edition): Dennis G Zill, Warren S Wright, Brooks/Cole, Cengage Learning, 2012						

Reference Books:

1. George B Thomas, Ross L Finney (2010), Calculus and analytic geometry, 9th edition, Dorling Kindersley Pvt Ltd.
2. Paul Blanchard, Robert L Devaney, Glen R Hall (2011), Differential Equations 4th Edition, Cengage Learning

Any other information:

Numerical examples are expected to be covered in theory class.

Program: B.Sc. (Applied Statistics & Analytics)				Semester : I	
Course: Functional Programming				Course Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 25 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks - 25 (Theory) in Question Paper)
2h	2h	-	3	25 (Theory) & 50 (Practical)	25 (Theory)
Pre-requisite: None					
Objectives: A student will receive basic knowledge about <ol style="list-style-type: none"> the ability of reading with understanding programs saved in an imperative programming language, symbolic execution of simple programs for verification, writing and running simple programs of the size of the order of 50 lines of the code in Python language (object oriented). 					
Outcomes: After completion of the course, students would be able to implement basic programs of python language.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	<p>Fundamentals of algorithms: Notion of an algorithm. Pseudo-code conventions like assignment statements and basic control structures. Analysis of algorithms: Running time of an algorithm, worst and average case analysis.</p> <p>Introduction to Programming: Program Design, Program Quality, Pseudocode, Flowcharts, Version Control, Basics of Computer Organization (Input and Output), Hello World Code Example</p> <p>Data Types and Operators: Constants and Variables, Identifier Names (std formats for nomenclature), Data Types, Integer Data Type, Floating-Point Data Type, String Data Type, Boolean Data Type, Nothing Data Type (NULL)</p> <p>Operators: Order of Operations, Assignment, Arithmetic Operators, Integer Division and Modulus, Unary Operations, Data Type Conversions, Input-Process-Output Model (Temperature conversion from °F to °C)</p> <p>Strings: Strings, String Functions, String Formatting</p>				15+15
2	<p>Functions: Modular Programming, Hierarchy or Structure Chart, Function Examples, Parameters and Arguments, Call by Value vs Call by Reference, Return Statement, Void Data Type, Scope, Programming Style, Standard Libraries</p> <p>Conditions: Structured Programming, Selection Control Structures, If Then Else, Code Blocks, Relational Operators, Assignment vs Equality, Logical Operators, Nested If Then Else, Case Control Structure, Condition Examples</p> <p>Loops: Iteration Control Structures, While Loop, Do While Loop, Flag Concept, For Loop, Branching Statements, Increment and Decrement Operators, Integer Overflow, Nested Loops, Loop Examples</p>				15+15
	Total				30+30

Text Books:

1. Programming Fundamentals - A Modular Structured Approach, Kenneth Leroy Busbee and Dave Braunschweig, 2nd Ed., (Available under Creative Commons License) (Web Book)
2. Programming in Python 3: A Complete Introduction to the Python Language, Mark Summerfield, Addison-Wesley Professional, 2nd Ed., 2009

Reference Books:

1. Thomas H. Cormen, Charles E. Leiserson (2010), Introduction to Algorithms, Third edition, Cengage Learning
2. Learning Python: powerful object-oriented programming, Mark Lutz, O'Reilly Media, 2013
3. Python Programming: An Introduction to Computer Science, John M. Zelle, Franklin Beedle & Associates, 2003
4. Fundamentals of Python: First Programs, Kenneth A. Lambert, Cengage Learning 2011

Any other information:

Total Marks of Internal Continuous Assessment Practical (ICA Practical): 50 Marks

Distribution of ICA Practical Marks:

Description of ICA	Marks
One test / Quiz	25 marks
One test on IDE	25 Marks
Total Marks :	50 Marks

Program: B. Sc. Applied Statistics & Analytics					Semester : I	
Course : Micro Economics					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h		-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: The main objective of this course is to provide students with an understanding of the theories, principles and analytical techniques in Microeconomics. To illustrate how Microeconomic concepts can be applied to analyze real life situations						
Outcome: Student should be able to describe, compare and correlate the important Economic phenomena of production, consumption, exchange and distribution with the help of Statistics.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Introduction to Microeconomics <ul style="list-style-type: none"> The scope and Method of Economics Scarcity , Choice and Opportunity cost - Production Possibility Frontier Firms, Households and the Circular flow- Input and output markets. 					4
2	Consumer Behaviour: Demand, Determinants of demand, Elasticity of demand, Demand forecasting, Choice under uncertainty					12
3	Supply: Determinants of supply, Elasticity of supply					5
4	Production Theory & costs: Cost analysis, Cost in short run and long run, Production function - short run and long run.					12
5	Price Determination under different market structures: Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly, Game theory					17
6	Government and its role: Market failure, Public goods, Externalities and Asymmetric information					10
	Total					60
Text Books:						
1. Mankiw, Gregory N (2013), Principles of Microeconomics, Cengage Learning						
2. Dominick Salvatore (2013), Micro Economics Theory and Application, 5 th edition, Oxford University Press						

Reference Books:

- 1.** Pindyck, Robert S. & Rubinfeld, Daniel L. (2012): Microeconomics, 8th edition, Prentice Hall
- 2.** Lipsey and Chrystal, Principles of Economics, 11th edition, Oxford University Press

Program: B. Sc. Applied Statistics & Analytics					Semester : I	
Course : Effective Communication					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- NA in Question Paper)	
2h		-	2	Marks Scaled to 50	Marks Scaled to NA	
Pre-requisite:						
Objectives: To develop confidence and a positive attitude, To fine tune the ability to listen, To express ideas coherently and cohesively in spoken and written English, To cultivate reading skills-silent and loud reading.						
Outcome: Awareness about self and community. Understanding different ways of communication.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Conversational etiquette - Importance, cultural influence Stage presence and Gestures - Speech, speaking in public Communication in Business - Essence of communication Barriers to communication - Causes of failure Voice Modulation - Nuances, Effect, meanings Intonation - Nuances, Effect, meanings Listening I & II - Importance, Causes of failure methods Positive Presentation - Essentials, Structure of a Good Speech - method Reading - Fundamentals Comprehension - Principles, Essentials, Business Writing I & II - Principles, Essentials, E-mails - Essentials, Letter Writing - Essentials, Essentials of Grammar - Importance in communication, Usage & Idiom - Importance in communication, Computer presentations - Fundamentals and Format Group Discussion - Format and Importance					30
	Total					30
Text Books:						
<ol style="list-style-type: none"> 1. Newspapers, Magazines. 2. Raymond V. Lesikar (1996), Basic Business Communication, 12th Edition, Irwin Professional Publishing 3. Stephen Covey(2004), Seven habits of highly effective people – Pocket Books 4. Shirley Taylor (2012), Communication for Business, Pearson Longman 5. Lynne Truss (2009), Eats Shoots and Leaves, Profile Books 6. What not to write (2014) –Viva Books Pvt Ltd 7. Fowler (2015) ,Modern English Usage, 4th edition, Oxford University Press 						

B.Sc. Applied Statistics & Analytics

Syllabus

Semester II

Program: B. Sc. Applied Statistics & Analytics					Semester : II	
Course : Descriptive Statistics - II					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks - 50 (Theory) in Question Paper)	
3h	2h	-	4	50 (Theory) & 50 (Practical)	50 (Theory)	
Pre-requisite:						
Objectives: The main objective of this paper is to introduce the concept of relationship between two qualitative and/ or quantitative variables. The topics include association, correlation, regression, index numbers. It also aims at introducing the vital statistics which themselves are a critical national information resource for understanding public health and examining key indicators such as fertility, mortality, and causes of death, and the factors associated with them.						
Outcomes: 1. Understand the concepts of Vital Statistics, Index Numbers 2. Applying them in policy making. 3. Solving the practicals using Excel and R						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Theory of Attributes: Dichotomous classification, Association of attributes: Yule's coefficient of association Q. Odds Ratio, Gamma coefficient					10+6
2	Correlation & Regression: Correlation Analysis: Scatter Diagram, Product moment correlation coefficient and its properties. Spearman's rank correlation coefficient, Spurious correlation. (b) Regression Analysis: Principle of least squares. Fitting a straight line by method of least squares, Concept and use of coefficient determination (r^2), Fitting of curves reducible to linear form by transformation, Fitting a quadratic curve by method of least squares.					15+12
3	Index Numbers: Index numbers as comparative tool. Stages in the construction of Price Index Numbers. Measures of Simple and Composite Index Numbers. Laspeyre's, Paasche's, Marshal-Edgeworth's, Drobisch and Bowley's and Fisher's Index Numbers formulae Quantity Index Numbers and Value Index Numbers, Time reversal test, Factor reversal test, Circular test. Fixed base Index Numbers, Chain base Index Numbers. Base shifting, splicing and deflating. Cost of Living Index Number. Concept of Real Income based on Wholesale Price Index Number					15+10

4	Vital Statistics: <ul style="list-style-type: none"> • Death Rate: Crude Death Rate, Specific Death Rate, Standardised Death Rate • Birth Rate: Crude Birth Rate, Age Specific Fertility Rate, General Fertility Rate, Total Fertility Rate. • Growth Rate: Gross Reproduction Rate and Net Reproduction Rate 	10+6
	Total	45+30

Text Books:

1. S.C. Gupta, V.K. Kapoor (2013) - Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand & Sons.
2. Alan Agresti (2012) - Categorical Data Analysis, Third Edition, Wiley Publications

Reference Books:

1. Levin and Rubin (2012) - Statistics for Management, Seventh Edition, Pearson India
2. D. R. Anderson (2012) - Statistics for Business and Economics, Eleventh Edition, South Western
3. Kothari C. R. (2014) - Research Methodology, Third Edition, Wiley Eastern Limited

Program: B. Sc. Applied Statistics & Analytics					Semester : II	
Course : Discrete Probability Distributions					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
3h	-	-	3	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite: Basic understanding of Probability and random variables.						
Objectives: The objective of this paper is to introduce various univariate and bivariate discrete probability distributions, their properties and applications in real life.						
Outcomes: The course will enable the students to describe the data with the help of specific distributions and understand its behaviour.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Standard Univariate Distributions: Uniform, Bernoulli, Binomial, Poisson, Geometric, Negative Binomial & Hypergeometric distributions. The following aspects of the above distributions (wherever applicable) to be discussed: Mean, Mode and Standard deviation. Moment Generating Function, Cumulant Generating Function, Additive property, Moments, Skewness and Kurtosis (without proof), Limiting distribution. Fitting of Distribution. Truncated Binomial and Truncated Poisson Distribution					30
2	Bivariate Distributions: Joint Probability mass function for discrete random variables, their properties. Marginal and conditional Distributions. Independence of Random Variables. Conditional Expectation & Variance. Coefficient of Correlation. Transformation of Random Variables. Trinomial distribution, Marginal & Conditional distributions. Their Means & Variances. Correlation coefficient. Extension to Multinomial distribution.					15
	Total					45
Text Books:						
1. S.C. Gupta, V.K. Kapoor (2013) - Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand & Sons.						
2. J. N. Kapur, H.C. Saxena - Mathematical Statistics, Fifteenth Edition, Sultan Chand & Company Ltd.						
Reference Books:						
1. Levin and Rubin (2012) – Statistics for Management, Seventh Edition, Pearson India						
2. D. R. Anderson (2012) – Statistics for Business and Economics, Eleventh Edition, South Western						
3. Sanjay Arora and Bansilal (1989) - New Mathematical Statistics, Satya Prakashan						

Any other information:

Numerical examples are expected to be covered in theory class.

Program: B. Sc. Applied Statistics & Analytics					Semester : II	
Course : Continuous Probability Distributions					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h		-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: The objective of this paper is to introduce various univariate and bivariate discrete probability distributions, their properties and applications in real life.						
Outcomes: The course will enable the students to describe the data with the help of specific distributions and understand its behaviour.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	<p>Standard Univariate Distributions: Rectangular, Triangular, Exponential, Cauchy (with Single & Double parameters), Gamma (with Single & Double parameters), Beta (Type I & Type II).</p> <p>The following aspects of the above distributions (wherever applicable) to be discussed: Mean, Median, Mode & Standard deviation. Moment Generating Function, Additive property, Cumulant Generating Function. Skewness and Kurtosis (without proof).</p> <p>Fitting of Distribution. Interrelation between the distributions.</p> <p>Normal Distribution: Mean, Median, Mode, Standard deviation, Moment Generating function, Cumulant Generating function, Moments & Cumulants (up to fourth order). Skewness & kurtosis, Mean absolute deviation.</p> <p>Distribution of linear function of independent Normal variables. Fitting of Normal Distribution, q-q plot.</p> <p>Log Normal Distribution: Derivation of mean & variance.</p>					40
2	<p>Bivariate Distributions: Joint Probability density function for Continuous random variables, Their properties. Marginal and conditional Distributions. Independence of Random Variables. Conditional Expectation & Variance. Regression Function. Coefficient of Correlation.</p> <p>Transformation of Random Variables, Jacobian of transformation</p> <p>(b) Bivariate Normal distribution, Marginal & Conditional distributions. Their Means & Variances.</p>					20
	Total					60
Text Books:						
<ol style="list-style-type: none"> S.C. Gupta, V.K. Kapoor (2013) - Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand & Sons. J. N. Kapur, H.C. Saxena - Mathematical Statistics, Fifteenth Edition, Sultan Chand & Company Ltd. 						

Reference Books:

1. Levin and Rubin (2012) – Statistics for Management, Seventh Edition, Pearson India
2. D. R. Anderson (2012) – Statistics for Business and Economics, Eleventh Edition, South Western
3. Sanjay Arora and Bansilal (1989) - New Mathematical Statistics, Satya Prakashan

Any other information:

Numerical examples are expected to be covered in theory class.

Program: B. Sc. Applied Statistics & Analytics					Semester : II	
Course : Linear Algebra					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4	-	-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: The main objective of this course is to acquaint students with basic concepts and applications of Linear Algebra, such as vector spaces, basis, linear transformations, projections, least squares method, eigen values, and eigen vectors. This subject is crucial for many high-demand lucrative career fields such as Computer Science, Actuarial Science, Financial Mathematics, Economics etc. and will enable students to grasp the basic computations associated with linear operations on finite dimensional vector spaces and be able to solve simple problems using linear algebra.						
Outcomes: Understanding of the various fundamental concepts of Linear algebra. Understanding its wide applications in Statistics and Analytics. Solving theoretical and application based problems						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	A) System of Linear Equations and Matrices: <ul style="list-style-type: none"> • Introduction to system of linear equations and their solutions, • Relationship between solutions of non-homogeneous and homogenous linear systems. • Elementary row operations on matrices, Row echelon form • Applications of System of Linear Equations <ul style="list-style-type: none"> i. Hyper matrix associated to an internet network ii. Stochastic matrices iii. Balancing chemical equations iv. Economics Input-Output models v. Electric circuits B) Vectors in Euclidean Spaces: <ul style="list-style-type: none"> • Vectors in 2d and 3d planes, vectors in R^n. • Vector addition, scalar multiplication and their properties • Dot product, cross product and their applications • Orthogonality • Applications to area, volume and some standard results in geometry. 					20

2	<p>A) Vector Space:</p> <ul style="list-style-type: none"> • Definition of vectors spaces over real numbers and some examples • Subspaces of a vector space • Linear span of vectors, linear dependence and linear independence • Basis and dimension of vector spaces • Applications to differential Equations <p>B) Linear Transformations:</p> <ul style="list-style-type: none"> • Definition and example of linear transformations • Null space and range space • Matrix representations of a linear transformation • Row space and column spaces • Rank-nullity theorem • Applications to computer graphics such as translation, scaling, shearing, rotation etc¹⁰ 	20
3	<p>A) Eigen values and Eigenvectors:</p> <ul style="list-style-type: none"> • Definitions of eigen values, eigen vectors • Eigen values and eigenvectors of linear operators • Cayley-Hamilton theorem and its application to find inverse and higher power of matrices • Diagonalization • Application: Solving system of linear differential equations, Markov chains, predator-prey models etc. <p>B) Inner Product Spaces:</p> <ul style="list-style-type: none"> • Definition and examples of inner product spaces over real numbers • Norm of vectors, distance between two vectors and their properties • Cauchy-Schwarz inequality and its applications • Orthogonality • Applications: Linear least square problems, QR-decomposition and Singular Value Decomposition and their applications 	20
	Total	60

Text Books:

1. S. Kumaresan – Linear Algebra : A Geometric Approach, PHI
2. David C. Lay, Steven R. Lay, Judi J. McDonald – Linear Algebra and Its Applications, Pearson Education, 5th Ed.

Reference Books:

1. Howard Anton, Chris Rorres – Elementary Linear Algebra with Applications, 10th Ed., Wiley
2. James DeFranza, Daniel Gagliardi – Introduction to Linear Algebra, McGraw-Hill
3. Carl D. Meyer – Matrix Analysis and Applied Linear Algebra, SIAM
4. James E. Gentle – Matrix Algebra: Theory, Computations, and Applications in Statistics, Springer

Any other information:

Numerical examples are expected to be covered in theory class.

Program: B. Sc. Applied Statistics & Analytics				Semester : II	
Course : Numerical Methods				Code:	
Teaching Scheme			Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 25 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks- 25 (Theory) in Question Paper)
2h	2h	-	3	Marks Scaled to 25 (Theory) & 50 (Practical)	Marks Scaled to 25 (Theory)
Pre-requisite: Basic understanding of mathematics.					
Objectives: Numerical methods course will demonstrates different techniques to solve transcendental Equations, Interpolation methods for polynomial approximation and solving techniques of integration.					
Outcomes: To solve transcendental equations, polynomial approximations and integrations by different techniques. Solving the problems by writing the programs on the relevant software.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Measures of Error and Solution of Transcendental Equations: Errors, Types of errors- Round off and Inherent error, Measures of errors- absolute and relative error, Relative error test. Iterative methods for simple roots: (i) Bisection method, (ii) Secant method, (iii) Regula-Falsi method, (iv) Newton -Raphson method, (v) Simple iteration method. Condition of convergence and rate of convergence of (i) Bisection method, (ii) Secant method, (iii) Regula-Falsi method, (iv) Newton Raphson method, (v) Simple iteration method.				10+10
2	Interpolation by polynomial approximations: Taylor's series Lagrange's Linear, Quadratic and higher order Interpolation. Iterated Interpolation. Interpolation error for Lagrange's Interpolation formula. Spline Interpolation Finite Differences and Difference operators: Forward and backward difference operator, Shift, Central and Average operators, Divided differences. Newton's divided difference Interpolation.				10+10
3	Solving system of linear equations and Numerical Integration: Solving system of linear equations: Gauss-Jacobi, Gauss Seidel methods, LU Decomposition, SOR. System of non-linear equations. Numerical Integration: Method based on interpolation- Trapezoidal rule, Simpson's rule, Errors associated with these rules. Method based on				10+10

	undetermined coefficients – Gauss Legendre integration method (one point formula and two point formula)	
	Total	30+30

Text Books:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain (2010), Numerical methods for Scientific and Engineering Computation, 6th Edition, New Age International Publishers

Reference Books:

1. B.S. Grewal (2010), Numerical methods in Engineering and Science, Khanna publishers

Any other information:

Total Marks of Internal Continuous Assessment Practical (ICA Practical): 50 Marks

Distribution of ICA Practical Marks:

Description of ICA	Marks
First test	25 marks
Second test	25 Marks
Total Marks :	50 Marks

Program: B.Sc. (Applied Statistics & Analytics)				Semester : II	
Course: Python Programming				Course Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- NA in Question Paper)
-	2h	-	1	Marks Scaled to 50	Marks Scaled to NA
Pre-requisite: Datatypes, Conditions, Loops, Strings					
Objectives: The objective of this paper is to use python to read and write files, work with the python standard libraries and explore python's object-oriented features.					
Outcomes: After completion of the course, students would be able to process the data and plot different charts.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Data structures: lists, tuples, dictionaries, sets Arrays (using Numpy): Arrays and Lists, Index Notation, Displaying Array Members, Arrays and Functions, Math Statistics with Arrays (implementing statistical measures like sum, mean), Searching Arrays, Sorting Arrays, Parallel Arrays, Multidimensional Arrays, Dynamic Arrays				15
2	Files: File Input and Output, Error Handling, loading an Array from a Text File, Pandas dataframe, reading files using dataframe. Visualization (using Matplotlib): 2D Plots, 3D Surface Plots Object-Oriented Programming: Objects and Classes, Encapsulation, Inheritance and Polymorphism				15
	Total				30
Text Books:					
1. Programming Fundamentals - A Modular Structured Approach, Kenneth Leroy Busbee and Dave Braunschweig, 2nd Ed., (Available under Creative Commons License) (Web Book)					
2. A Python Book: Beginning Python, Advanced Python, and Python Exercises, Dave Kuhlman, Open Source MIT License, Rev 1.3a, 2013					
Reference Books:					
1. Beginning Python: From Novice to Professional, Magnus Lie Hetland, Apress publishing 2017					
2. Computational Physics - Problem Solving with Python, Rubin H. Landau, Cristian C. Bordeianu, Manuel J Páez, wiley-VCH, 2015					
3. Fluent Python: Clear, Concise, and Effective Programming, Luciano Ramalho, O'Reilly Media, 2015					
Any other information: At least one ICA test must be conducted on IDE.					

Program: B. Sc. Applied Statistics & Analytics					Semester : II	
Course : Macro Economics					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: This course aims to introduce the students to the working of the economy with reference to the domestic economy. To provide the students with analytical skills which will assist them in calculating, analyzing and interpreting different types of macroeconomic data to extract useful information for optimal decision-making.						
Outcomes:						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Introduction to Macroeconomics: Background, Macroeconomic Policies – objectives, functions and tools					4
2	GDP, General Price and related concepts: Concepts and measurement- Analysis of Indian National Income Statistics Money- Money supply and banking- Money supply measures in India Interest rates- Nominal and Real interest rates, Key interest rates in India General Price levels-Measurement of CPI, WPI & GDP deflator ,Types of inflation Exchange rate -The basics: Supply and demand for foreign exchange, Nominal and real exchange rate, Real effective exchange rate as a measure of international competitiveness , Fixed, Flexible exchange rates & Managed Float system					20
3	Income determination model : Simple Classical – Say's Law and full employment model Simple Keynesian model Consumption, saving & investment Multiplier 3 sector & 4 sector model Unemployment, full employment & wage PP flexibility Goods market and money market equilibrium in closed and open market					20
4	Fiscal Policy					8
5	Monetary Policy					8
	Total					60

Text Books:

1. Mankiw, G : Macroeconomics, 6th Edition, Worth Publishers

Reference Books:

1. Dornbusch, Fischer Dornbusch, R, G. Fischer and R. Statrz (2013), Macroeconomics, 11th edition, Tata McGraw Hill Education Private Limited
2. Roy, Shyamal (2013): Macroeconomic Policy Environment 2nd edition, Tata McGraw Hill Education Private Limited

Program: B. Sc. Applied Statistics & Analytics					Semester : II	
Course : Environmental Studies					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
3h	-	-	3.5	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: Environmental studies explore the impacts of natural, manmade and legislative events on the natural world and its inhabitants.						
Outcomes: 1. Understanding of the working of ecosystem. 2. Exploring the impacts of natural, manmade and legislative events on the natural world and its inhabitants.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Multidisciplinary nature of environmental studies: Definition, scope and importance Need for public awareness.					2
2	Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.					8
3	Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem :-Forest ecosystem, Grassland ecosystem, Desert ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)					6

4	<p>Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values Biodiversity at global, National and local levels. India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.</p>	8
5	<p>Environmental Pollution: Cause, effects and control measures of : Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.</p>	8
6	<p>Social Issues and the Environment: From Unsustainable to Sustainable development Urban problems related to energy Water conservation, rain water harvesting, watershed management Resettlement and rehabilitation of people; its problems and concerns, case studies Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act Wildlife Protection Act Forest Conservation Act Issues involved in enforcement of environmental legislation. Public awareness</p>	7
7	<p>Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.</p>	6
8	<p>Field work Visit to a local area to document environmental assets - river/ forest/grassland/hill/mountain Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.</p>	5
	Total	50

Text Books:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p

Reference Books:

1. Clark R.S., Marine Pollution, Clarendon Press Oxford (TB)
2. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
3. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
4. Down to Earth, Centre for Science and Environment (R)
5. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
6. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
7. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment, Cambridge Univ. Press 1140p.
8. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws, Himalaya Pub. House, Delhi 284 p.
9. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
10. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
11. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
12. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
13. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
14. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
15. Survey of the Environment, The Hindu (M)
16. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
17. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)
18. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
19. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

Any other information : 0.5 credit is for EVS field trip.

B.Sc. Applied Statistics & Analytics

Syllabus

Semester III

Program: B. Sc. Applied Statistics & Analytics					Semester : III	
Course : Sampling Theory					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 25	Term End Examinations (TEE) (Marks- 25 in Question Paper)	
2h	-	-	2	Marks Scaled to 25	Marks Scaled to 25	
Pre-requisite:						
Objectives: The main objective of this paper is to understand various probability and non-probability sampling techniques. It also aims at providing an understanding of estimating sample size and population characteristics.						
Outcomes: Students will understand theory of various Sampling Techniques used in real life situations. To able to apply various sampling techniques while conducting sample survey in many instances.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Basic Concepts and Simple Random Sampling: (a) Population, Population unit, Sample, Sample unit, Parameter, Estimator, Bias, Unbiasedness, Mean square error (MSE) & Standard error. Steps in conducting a sample survey, Sampling and Non-sampling errors, Probability and non-probability sampling methods. (b) Description and Method of selecting SRS with & without replacement (WR/WOR) (c) Estimation of population mean & population total. (d) Expectation & Variance of the estimators, unbiased estimator of variance of these estimators. (e) Estimation of Sample size.					12
2	Stratified Random Sampling: (a) Estimation of population mean & total in case of Stratified Random Sampling. (b) Expectation & Variance of the unbiased estimators, Unbiased estimators of variances of these estimators. (c) Proportional allocation, Optimum allocation, Neyman's allocation. (d) Comparison of Simple Random Sampling with Stratified Random Sampling.					9

3	Ratio & Regression Estimators assuming SRSWOR: (a) Regression Estimators for population Mean & Total. Expectation & Variance of the Estimators. Comparison of Ratio, Regression & mean per Unit estimators. (b) Concepts of Systematic, Cluster, Two-stage and Probability Proportional to Size sampling methods.	9
	Total	30

Text Books:

1. Des Raj, Chandhok Pramod (1999): Sample Survey Theory, Narosa Publishing House.
2. M. N. Murthy (1967): Sampling Theory and Methods, Statistical Publishing Society.

Reference Books:

1. Cochran William G. (1999): Sampling Techniques, 3rd Ed., Wiley India.
2. S.C. Gupta and V. K. Kapoor (2014) - Fundamentals of Applied Statistics, Fourth Edition, Sultan Chand & Sons
3. Daroga Singh, F. S. Chaudhary (2013) - Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd.

Any other information:

Numerical examples to be covered in the theory lectures.

Program: B. Sc. Applied Statistics & Analytics					Semester : III	
Course : Sampling Distributions & Applications					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 25 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks- 25 (Theory) in Question Paper)	
2h	2h	-	3	Marks Scaled to 25 (Theory) & 50 (Practical)	Marks Scaled to 25 (Theory)	
Pre-requisite: Understanding of discrete and continuous probability distributions.						
Objectives: The main objective of this paper is to make the students understand various sampling distributions and their applications.						
Outcomes: Understand various sampling distributions and their applications. Solve real life problems in practical.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Introduction: Problem of testing of hypothesis. Definitions - Simple hypothesis, Composite hypothesis, Null Hypothesis, Alternative Hypothesis, Test of hypothesis, Critical region, Type I and Type II errors, Level of significance, p-value, Size of the test, Power of the test.					5+0
2	Central Limit theorem for i.i.d. random variables and its applications Sampling distribution of sample mean and sample proportion, Tests for single population mean, single population proportion, difference between two population means, equality of two population proportions.					7+5
3	Exact Sampling Distributions: (a) Chi-Square Distribution: Mean, Median, Mode & Standard deviation. Moment generating function, Cumulant generating function. Additive property, Distribution of the sum of squares of independent Standard Normal variables, Concept of degrees of freedom. Sampling distributions of sample mean and sample variance, independence of sample mean & variance for a sample drawn from Normal distribution (without proof). Applications of Chi-Square:					18+25

	<p>Test of significance for specified value of variance of a Normal population. Test for goodness of fit, Test for independence of attributes. Yates' correction.</p> <p>(b) t - Distribution: Mean, Median, Mode & Standard deviation. Distribution of ratio of a Standard Normal variable to the square root of an independent Chi-square divided by its degrees of freedom. Asymptotic properties. Student's t.</p> <p>Applications of t: Test of significance of: mean of a Normal population, difference in means of two Normal populations based on: (i) independent samples (ii) paired samples</p> <p>(c) F-distribution: Mean, Mode & Standard deviation. Distribution of Reciprocal of an F variate, Ratio of two independent Chi-squares divided by their respective degrees of freedom. Interrelationship of F with: t-distribution, Chi-square distribution & Normal distribution.</p> <p>Applications of F: Test for equality of variances of two independent Normal populations.</p>	
	Total	30+30

Text Books:

1. Rohatgi V.K. & Saleh A.K. Md. Ehasanes (2001): An Introduction to Probability and Statistics, 2nd Ed., Wiley India.
2. S. C. Gupta, V.K. Kapoor (2010) - Fundamentals of Mathematical Statistics a Modern Approach, Tenth Edition, Sultan Chand & Sons
3. Casella G., Berger R. L. (2008): Statistical Inference, 2nd Ed., Duxbury press

Reference Books:

1. Hogg R V and Craig A (2005): Introduction to Mathematical Statistics, 6th Ed., Pearson Education
2. Rao , Tanis , Hogg (2011): Probability and Statistical Inference, 7th Edition, Pearson India
3. J.N. Kapur, H.C. Saxena - Mathematical Statistics, Fifteenth Edition, Sultan Chand & Company Ltd.
4. J. Medhi (2007): Statistical Methods- An Introductory Text, 2nd Ed., New Age International
5. Sanjay Arora and Bansilal (1989) - New Mathematical Statistics, Satya Prakashan
6. Namita Srivastava , Manoj Kumar Srivastava , Abdul Hamid Khan (2014): Statistical Inference : Theory of Estimation, PHI

Any other information :

Practical need to be conducted with the help of relevant software.

Total Marks of Internal Continuous Assessment Practical (ICA Practical): 50 Marks

Distribution of ICA Practical Marks:

Description of ICA	Marks
First test	25 marks
Second test	25 Marks
Total Marks :	50 Marks

Program: B. Sc. Applied Statistics & Analytics					Semester : III	
Course : Estimation Theory					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
3h	-	-	2	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: This paper gives a theoretical understanding of various concepts like methods of estimation and properties of the estimators.						
Outcomes: To develop estimators for population characteristics using different Estimation Techniques. Study the properties of the developed estimators in sample						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Point Estimation: (a) Introduction: Notion of a parameter, parameter space, general problem of estimating an unknown parameter by point and interval estimation, Definition of an estimator and estimate. (b) Properties of a good estimator: i. Unbiasedness: Definition of an unbiased estimator, biased estimator, positive and negative bias. ii. Consistency: Definition, Theorem: An estimator is consistent if its bias and variance both tend to zero as the sample size tends to infinity (with proof) iii. Sufficiency: Definition, Neymann's Factorization Theorem (without proof). Exponential family of probability distributions and sufficient statistic. iv. Relative efficiency of an estimator.					15
2	Methods of Estimation: (a) Method of Maximum Likelihood Estimation (M.L.E.) Properties of M.L.E (without proof) and Method of Moments (b) Minimum variance unbiased estimator (MVUE), Cramer-Rao inequality and Cramer-Rao Lower Bound (CRLB)					15
3	Bayesian estimation and Confidence Interval: (a) Bayesian Estimation: Prior distribution, Posterior distribution, Loss function, Risk function, Bayes' solution under Squared Error Loss Function (SELF) and Absolute Error Loss function.					15

	(b) Interval Estimation: Concept of Confidence Interval and Confidence Limits. Definition of pivotal quantity and its use in obtaining confidence limits for population mean, population proportion, difference between two population means and proportions. Population variance and ratio of population variances. Confidence Intervals based on asymptotic property of M.L.E.	
	Total	45

Text Books:

1. Rohatgi V.K. & Saleh A.K. Md. Ehasanes (2001): An Introduction to Probability and Statistics, 2nd Ed., Wiley India.
2. S.C. Gupta, V.K. Kapoor (2010) - Fundamentals of Mathematical Statistics a Modern Approach, Tenth Edition, Sultan Chand & Sons
3. Casella G., Berger R. L. (2008): Statistical Inference, 2nd Ed., Duxbury press

Reference Books:

1. Hogg R V and Craig A (2005): Introduction to Mathematical Statistics, 6th Ed., Pearson Education
2. Rao , Tanis , Hogg (2011): Probability and Statistical Inference, 7th Edition, Pearson India
3. J.N. Kapur, H.C. Saxena - Mathematical Statistics, Fifteenth Edition, Sultan Chand & Company Ltd.
4. Sanjay Arora and Bansi Lal (1989) - New Mathematical Statistics, Satya Prakashan
5. Namita Srivastava , Manoj Kumar Srivastava , Abdul Hamid Khan (2014): Statistical Inference : Theory of Estimation, PHI
6. I. Miller, M. Miller (2014): John E. Freund's Mathematical Statistics, 8th Edition; Pearson Education Inc.
7. P.G. Hoel (1984): Introduction to Mathematical Statistics; 5th Edition; John Wiley & Sons Inc.

Any other information :

Numerical examples to be covered in the theory lectures.

Program: B. Sc. Applied Statistics & Analytics					Semester : III	
Course : Operations Research - I					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks- 50 (Theory) in Question Paper)	
3h	2h	-	4	Marks Scaled to 50 (Theory) & 50 (Practical)	Marks Scaled to 50 (Theory)	
Pre-requisite:						
Objectives: The main objective of this paper is to make the students understand the use of optimization techniques in industrial decision making process.						
Outcomes:						
1. Understanding of various optimization techniques.						
2. Solving problems based on the industrial decision making process by using relevant software						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Introduction, Linear Programming Problem: Meaning and scope of Operations Research, Applications in Business, Commerce and Industry, limitations of Operations Research. Linear Programming Problems (LPP): Mathematical Formulation of LPP. Solution to the LPP using Graphical Method, Simplex Method, Big M method and Two-Phase Method. Duality in LPP. Detection of optimum solution to primal using optimum solution to the dual.					20 + 15
2	Transportation Problem, Assignment Problem: Transportation Problem - Description and Formulation of the Transportation Problem, Initial Basic Feasible Solution by i) North West Corner Rule, ii) Least Cost Entry Method (Matrix Minima), iii) Vogel's Approximation Method. Optimum Solution by MODI Method. Existence of Alternative optimum solution. Impact of change in some cost Coefficients on optimum solution. Maximization type and Unbalanced Transportation Problems. Assignment Problem - Description and Formulation of the Assignment Model. Hungarian Method of solving Assignment Problem. Maximization and Unbalanced Assignment Problems.					15+9
3	Decision Theory:					10 + 6

	Decision Environment, Decisions under Uncertainty (Optimistic/ Pessimistic Criterion, Laplace Criterion, Hurwitz Criterion, Savage Criterion), Decisions under Risk (Expected Monetary Value (EMV) Criterion, Expected Opportunity Loss (EOL) Criterion, Expected Value of Perfect Information (EVPI)). Decision Tree Analysis. Bayesian Decision approach.	
	Total	45+30

Text Books:

1. H. A. Taha (2014): Operations Research – An Introduction, 9th Ed., Pearson India.
2. J. K. Sharma (2013): Operations Research: Theory & Applications, 5th Ed., Laxmi Publications
3. V. K. Kapoor (2010): Operations Research-Problems & Solutions, Sultan Chand & Sons.

Reference Books:

1. Ravinderan, Phillips and Solberg (1987): Operations Research - Principles & Practice, 2nd Ed., John Wiley.
2. Richard Bronson (1997): Theory & Problems of Operations Research Schaum's outline series, 2nd Ed.
3. Prem Kumar Gupta, Comboj D. S. Hira Aarti (2012): Introduction to Operations Research, S. Chand
4. Shenoy, Shrivastava & Sharma (2011): Quantitative Techniques, 3rd Ed., New Age International.
5. Frederick S. Hillier, Gerald J. Lieberman (1995): Introduction to Operations Research, 2nd Ed., Tata McGraw Hill Education.
6. N. D. Vohra (2009): Quantitative Techniques, 4th Ed., McGraw Hill.

Any other information :

Program: B. Sc. Applied Statistics & Analytics				Semester : III	
Course : Multivariate Calculus				Code:	
Teaching Scheme			Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (weightage)	Term End Examinations (TEE) (weightage)
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite: Understanding of Calculus of single variable.					
Objectives: The main objective of this course is to acquaint students with basic concepts and applications of Multivariate calculus such as limits, continuity & differentiability. It explores different aspects of differentiability such as partial derivatives, total derivatives & directional derivatives. The concept of extreme values is also introduced in order to equip the learner to appreciate the applications of multivariate calculus in different domains like Economics, Data Sciences, Actuarial Science etc.					
Outcomes: Understanding of the mathematical concepts of limit, continuity in higher dimensions with emphasis on applications.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Limits, Continuity & Differentiability: Limits and Continuity of two and three variables. <ul style="list-style-type: none"> Partial derivatives of a real valued function of two variables, Relationship between continuity and the existence of partial derivatives at a point. Second order partial derivatives, Mixed partial derivatives theorem for two variables (without proof). The increment theorem for two variables (without proof). Differentiability of a function, Chain rule for composite function (without proof). Implicit differentiation of two variables at a point over a disc, linearization of a differentiable function at a point. 				20
2	Directional derivatives and Extreme values: <ul style="list-style-type: none"> Directional derivatives in a plane, interpretation of directional derivatives, gradient vector, relation between directional derivative and gradient. Geometric interpretation of partial derivatives and its relation to the tangent plane at a point. Extreme values of a function of two variables. Local maximum, local minimum and first derivative test for local extreme values (without proof). Critical points, saddle points, second derivative test for local extreme values (without proof). 				20

	<ul style="list-style-type: none"> • Method of Lagrange's Multiplier to obtain extrema of a function of two variables (one constraint only). • Concept of Jacobian matrix. 	
3	Multiple Integrals: <ul style="list-style-type: none"> • Definition of Double and Triple Integrals • Evaluation of Double and Triple Integrals • Fubini's Theorem(Without Proof) • Applications of Double and Triple Integrals 	20
	Total	60

Text Books:

1. Sudhir. R. Ghorpade and Balmohan V. Limaye - A Course in Calculus and Real Analysis, Springer International Edition.

Reference Books:

1. G.B. Thomas and R. L. Finney (1998) - Calculus and Analytic Geometry: Ninth Edition, Addison-Wesley.
2. Howard Anton (1999) - Calculus - A new Horizon, Sixth Edition, John Wiley and Sons Inc.
3. James Stewart, Calculus, Third Edition, Brooks/Cole Publishing Company, 1994.
4. Apostol T.M. (1975) Mathematical Analysis: A modern approach to advanced calculus, (Addison-Wesley).
5. Bartle, R. G. (1976) - Elements of Real Analysis, Wiley
6. Kreyszig, E. (1975) - Advanced Engineering Mathematics, Wiley Eastern
7. Rudin, W. (1985) - Principles of Analysis, McGraw-Hill
8. Williamson R.E. and Tratter H.F. (1996) - Multivariable Mathematics , 3r

Any other information :

Numerical examples are expected to be covered in theory class.

Program: B. Sc. Applied Statistics & Analytics				Semester : III	
Course : Introduction to R				Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- NA in Question Paper)
-	2h	-	1	Marks Scaled to 50	Marks Scaled to NA
Pre-requisite:					
✓ Basic programming knowledge					
Objectives:					
<ul style="list-style-type: none"> • The goal is to give a brief introduction to R working environment. • Understanding the working of different data types in R. • Using R as a programming language. • Using R for Data visualization, Data manipulation 					
Outcomes:					
After completion of the course, students would be able to understand and write functions in R. Perform basic data analysis in R.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Fundamentals of R Programming <ul style="list-style-type: none"> • Introduction to interface (R/ R Studio) • Creating a dataset in R: <ul style="list-style-type: none"> ○ Data Structures: Vector, Matrices, Arrays, Data frames, Factors and Lists ○ Data input: Entering data from keyboard, Importing data from various data sources • R Control Statements, Loops and R functions: User defined & built in functions which are useful for working with data objects. • Operators in R: Arithmetic operators, Relational operators, Logical operators, Miscellaneous operators 				15
2	Data Management in R <ul style="list-style-type: none"> • Importing and Exporting data into R • Manipulating dates and missing values • Understanding data type conversions • Creating and recoding variables • Sorting, merging and subsetting datasets • Selecting and dropping variables 				15

	Data visualization in R <ul style="list-style-type: none"> Creating bar charts, histogram, scatterplot, boxplot, time series plot using ggplot2 package. 	
	Total	30

Text Books:

- Robert I. Kabacoff (2011): R in Action - Data analysis and graphics in R, Manning
- Hadley Wickham (2009): ggplot2: Elegant graphics for Data Analysis, Springer

Reference Books:

- Y Zhao (2013): R and Data mining: Examples and Case studies, Elsevier
- Adler J. (2012): R in a Nutshell, O'reilly
- Grolemund G. (2014): Hands on Programming with R, O'reilly

Any other information: Exam will be conducted on R studio.

Report writing or document submission is to be done with the help of R Markdown.

Total Marks of Internal Continuous Assessment: 50

Distribution of ICA Marks:

Description of ICA	Marks
First test	25
Second test	25
Total Marks :	50

Program: B. Sc. Applied Statistics & Analytics					Semester : III	
Course : Financial Economics					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: The aim of this course is to develop the microeconomic theory relevant to financial transactions. A set of underlying economic principles is applied to the determination of the value of basic financial instruments such as stocks and bonds, as well as to more complicated derivative securities, such as futures and options. Valuation concepts, in turn, allow for the analysis of various issues of interest to policy makers as well as portfolio managers and investors, such as the term structure of interest rates, portfolio theory, the capital structure of the firm, and risk management.						
Outcomes: Student should be understand the microeconomic theory relevant to financial transactions						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Introduction to Financial Markets: Types of Financial markets; Financial market institutions; Regulation of financial Markets					10
2	Risk Aversion and Capital Allocation Risk Aversion and Mean-Variance Criterion; Capital Allocation to Risky and Risk-free Assets Optimal Risky Portfolios, Efficient Frontier of Risky Assets; Test on Risk Aversion and Capital allocation.					10
3	Financial Models Capital Asset Pricing Model; Single-Index and Multifactor Models; Arbitrage Pricing Model Efficient Market Hypothesis					10
4	Equity Markets Institutional features of stock market; Stock pricing					10
5	Bond Pricing and Security Analysis Project Valuation under certainty; Bond Prices and Yields, Interest Rate Uncertainty					10

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	Managing Bond Portfolios; Macroeconomic and Industry Analysis; Equity Valuation Models; Financial Statement Analysis	
6	Derivatives Option Contracts and Option Strategies; Option Valuation; Futures Markets; Futures and Swaps; Risk management; Pricing of derivatives; Relation to spot markets	10
	Total	60

Text Books:

1. Bodie, Z. Kane, A. Marcus, A.J. and P. Mohanty. 2010. Investments. Tata McGraw Hill Education Private Limited. New Delhi. India.
2. Bodie, Z., Merton R.C. and D.L. Cleeton. 2008. Financial Economics. Pearson.

Reference Books:

Any other information :

Program: B. Sc. Applied Statistics & Analytics					Semester : III	
Course : Research Methods					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- NA in Question Paper)	
2h	-	-	2	Marks Scaled to 50	Marks Scaled to NA	
Pre-requisite:						
Objectives: The objective of this course is to introduce students to quantitative and qualitative methods of conducting effective research studies. They will gain an overview of the important concepts of research intent and design, data collection, statistical and interpretive analysis, and final report presentation.						
Outcomes:						
1. Student should have an overview of the important concepts of research intent and design.						
2. They should be able to understand the process of data collection, statistical and interpretive analysis, and final report presentation.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Overview of research and its methodologies Research process Literature review Selecting and defining a research problem Types of research Developing a research proposal Objectives setting Framing questionnaire and validating Conceptual frame work Data collection and coding Data Analysis – an overview Preparing report and presentation Some do's and don'ts in research					30
	Total					30
Text Books:						
1. Kothari C.R.(2014) Research Methodology: Methods and Techniques, Third edition, New Age International publisher						
Reference Books:						
1. Deepak Chawla, Neena Sondhi (2011), Research Methodology Concepts and cases, Vikas Publishing House						
Any other information :						

B.Sc. Applied Statistics & Analytics
Syllabus
Semester IV

Program: B. Sc. Applied Statistics & Analytics					Semester : IV	
Course : Hypothesis Testing					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite: Basics of distribution theory and Estimation theory						
Objectives: To introduce to the students the fundamental theory of hypothesis testing and its application.						
Outcomes: 1. Students will understand concepts of Statistical hypothesis, developing tests to test the hypothesis. 2. Formulation of Statistical hypothesis is real life situations. Apply appropriate test to validate the hypothesis						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Parametric Tests: Power function of the test and power curve. Problem of testing of hypothesis, Neyman-Pearson fundamental lemma for construction of most powerful test of size α for a simple hypothesis against a simple alternative hypothesis. Uniformly most powerful (UMP) test. Likelihood ratio test.					30
2	Sequential Tests Wald's SPRT of strength (α, β) for testing a simple null hypothesis against a simple alternative hypothesis. Its comparison with fixed sample size (Neyman-Pearson) test.					8
3	Non-parametric Tests (a) Need for non-parametric tests. Distinction between a parametric and a non-parametric test. Concept of a distribution free statistic. (b) Single/ Two/ k-samples non-parametric tests. (i) Sign test (ii) Wilcoxon's signed rank test (iii) Median test (iv) Mann-Whitney test (v) McNemar test (vi) Run test (vii) Fisher's Exact test (viii) Kruskal Wallis test (ix) Friedman's test (x) Cochran Q test Assumptions, justification of the test procedure for small & large samples.					22
	Total					60
Text Books: 1. Rohatgi V.K. & Saleh A.K. Md. Ehasanes (2001): An Introduction to Probability and Statistics, 2 nd Ed., Wiley India.						

2. S.C. Gupta, V.K. Kapoor (2010) - Fundamentals of Mathematical Statistics a Modern Approach, Tenth Edition, Sultan Chand & Sons
3. J.N. Kapur, H.C. Saxena - Mathematical Statistics, Fifteenth Edition, Sultan Chand & Company Ltd.

Reference Books:

1. Hogg R V and Craig A (2005): Introduction to Mathematical Statistics, 6th Ed., Pearson Education
2. Rao , Tanis , Hogg (2011): Probability and Statistical Inference, 7th Edition, Pearson India
3. Casella G., Berger R. L. (2008): Statistical Inference, 2nd Ed., Duxbury press
4. Sanjay Arora and Bansilal (1989) - New Mathematical Statistics, Satya Prakashan
5. Namita Srivastava , Manoj Kumar Srivastava , Abdul Hamid Khan (2014): Statistical Inference : Theory of Estimation, PHI
6. Israel D. (2008) - Data Analysis in Business Research, Sage Publication.
7. W. J. Conover () - Practical Nonparametric Statistics, 2nd Ed., John Wiley & Sons.
8. John A. Rice (2006): Mathematical Statistics and Data Analysis, Duxbury Resource Center.
9. Erich L. Lehman, Joseph P. Romano (2010): Testing Statistical Hypotheses, 3rd Ed., Springer Science & Business Media.

Any other information :

Numerical examples are expected to be covered in theory class.

Program: B. Sc. Applied Statistics & Analytics					Semester : IV	
Course : Designs of Experiment					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 25 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks - 25 (Theory) in Question Paper)	
2h	2h	-	3	25 (Theory) & 50 (Practical)	25 (Theory)	
Pre-requisite:						
Objectives: This course aims at introducing the concept of DOE which is effective for general problem-solving, as well as for improving or optimizing product design and manufacturing processes. On way, two way and three way designs are introduced in this course. Full factorial designs are introduced and studies through examples.						
Outcomes: Students will be able to understand planning and conducting the experiment and analysing the data collected through the experiment.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Analysis of Variance: Introduction, Uses, Cochran's Theorem (Statement only). One way classification with equal & unequal observations per class, Two way classification with one or more observations per cell. Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard Error and Confidence limits for elementary treatment contrasts.					12+12
2	Concepts and Various Designs: Concepts of Experiments, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision. Principles of Design of Experiments: Replication, Randomization & Local Control. Efficiency of design D1 with respect to design D2. Choice of size, shape of plots & blocks in agricultural & non-agricultural experiments. Completely Randomized Design (CRD), Randomized Block Design (RBD) & Latin Square Design (LSD): Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table.					12+12

	Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of RBD relative to a CRD, LSD relative to RBD, CRD. Missing plot technique for one missing observation in case of CRD, RBD & LSD.	
3	Factorial Experiments Definition, Purpose & Advantages. 2^2 , 2^3 Experiments. Calculation of Main & interaction Effects. Yates' method. Analysis of 2^2 & 2^3 factorial Experiments. Confounding in factorial experiments.	6+6
	Total	30+30

Text Books:

1. Douglas C Montgomery (2013): Design and Analysis of Experiments, 8th Ed., Wiley India.

Reference Books:

1. W. G. Cochran and G. M. Cox (1992): Experimental Designs, 2nd Ed., John Wiley and Sons.
2. Dean and Voss (2013): Design and Analysis of Experiments, Springer New York.
3. B. J. Winer (2012): Statistical Principles in Experimental Design, Literary Licensing, LLC

Any other information :

Program: B. Sc. Applied Statistics & Analytics				Semester : IV	
Course : Stochastic Processes				Code:	
Teaching Scheme			Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- 50 in Question Paper)
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite:					
Objectives: This course introduces the concept of time dependent sequence of observations – stochastic processes. Markov chain, a discrete time discrete state space stochastic process and its applications are studied. Applications of this to queuing theory is studied through examples striking a balance between theory and applications.					
Outcomes: 1. Students get introduction to the different stochastic/random processes, theoretical foundations for Stochastic Processes. 2. Applications of Stochastic processes in queuing theory, applied sciences, etc					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Stochastic Process: Definition of stochastic process. Postulates and difference differential equations for : (i) Pure birth process (ii) Poisson process with initially 'a' members, for $a=0$ and $a > 0$ (iii) Yule Furry process (iv) Pure death process (v) Death process with $\mu_n = \mu$ (vi) Death process with $\mu_n = n\mu$ (vii) Birth and death process (viii) Linear growth model. Derivation of $P_n(t)$, mean and variance where ever applicable.				20
2	Application to Queuing Theory: Basic elements of the Queuing model. Roles of the Poisson and Exponential distributions. Derivation of Steady state probabilities for birth and death process. Steady state probabilities and various average characteristics for the following models: (i) (M/M/1) : (GD/ ∞ / ∞) (ii) (M/M/1) : (GD/ N / ∞) (iii) (M/M/c) : (GD/ ∞ / ∞) (iv) (M/M/c) : (GD/ N / ∞) (v) (M/M/ ∞) : (GD/ ∞ / ∞)				20

3	Discrete time discrete state space stochastic process: Markov Chains - Definition and Examples, Transition probability matrix, higher transition probabilities, first passage times. Classification of states and chain - Transience, persistence Periodicity, Ergodic state, ergodic chain. Limiting behaviour of the chain.	20
	Total	60

Text Books:

1. Medhi J: Stochastic Processes, Second edition, Wiley Eastern Ltd.
2. H. A. Taha (2014): Operations Research- An Introduction, 9th Ed., Pearson India.

Reference Books:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third Edition, Wiley Eastern Limited.
2. Kapur J. N., Saxena H. C.: Mathematical Statistics, Fifteenth edition, S. Chand and Company

Any other information :

Numerical examples are expected to be covered in theory class.

Program: B. Sc. Applied Statistics & Analytics					Semester : IV	
Course : Actuarial Science					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- 50 in Question Paper)	
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50	
Pre-requisite:						
Objectives: To introduce to the students the fundamental concepts of Actuarial statistics, life insurance and annuities.						
Outcomes:						
1. Understand the fundamental concepts of the Life tables, Life insurance, Annuities						
2. Apply the learned techniques on real life situations.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Mortality Tables: Various mortality functions. Probabilities of living and dying. The force of mortality. Estimation of μ_x from the mortality table. Laws of mortality: Gompertz's and Makeham's first law. Select and Ultimate mortality tables. Stationary population. Expectation of life and Average life at death.					20
2	Compound Interest and Annuities Certain: Accumulated value and present value, nominal and effective rates of interest. Discount and discounted value. Varying rates of interest. Equation of value. Equated time of payment. Present and accumulated values of annuity certain (immediate and due) with and without deferment period. Present value for perpetuity (immediate and due) with and without deferment period Present and accumulated values of i) increasing annuity ii) increasing annuity when successive instalments form arithmetic progression iii) annuity with frequency different from that with which interest is convertible. Redemption of loan.					20
3	Life Insurance and Assurance Benefits: Present value in terms of commutation functions of Life annuities and Temporary life annuities (immediate and due) with and without deferment period. Present values of Variable and increasing life annuities(immediate and due)					20

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	Present value of Assurance benefits in terms of commutation functions of i) pure endowment assurance ii) temporary assurance iii) endowment assurance iv) double endowment assurance v) whole life assurance vi) increasing whole life assurance vii) deferred whole life assurance viii) Deferred temporary assurance ix) increasing temporary assurance x) special endowment assurance.	
	Total	60
Text Books:		
1. Gupta S. C. & Kapoor V. K. (2014): Fundamentals of Applied Statistics, Fourth edition, Sultan Chand & Sons.		
Reference Books:		
1. Neill A. (1977): Life Contingencies, First edition, Heineman educational books London		
2. Dixit S.P., Modi C.S., Joshi R.V. : Mathematical Basis of Life Assurance, First edition Insurance Institute of India		
Any other information :		
Numerical examples are expected to be covered in theory class.		

Program: B.Sc. (Applied Statistics & Analytics)				Semester : IV	
Course: Data Management				Course Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 25 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks- 25 (Theory) in Question Paper)
2h	2h	-	3	Marks Scaled to 25 (Theory) & 50 (Practical)	Marks Scaled to 25 (Theory)

Pre-requisite: None

Objectives:

To introduce the basic concept of database management system to students.

Outcomes:

1. Students will be able to design and draw ER and EER diagram for the real life problem.
2. Students will be equipped to create database through Relational Database concepts and retrieving the data. The SQL queries are implemented using Oracle.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Relational Model Integration: Overview of database management system, limitations of data processing environment, database approach, instance and schema, three level of abstraction, DBMS structure, ACID Properties Entity Relation Model: Entity, attributes, keys, relations, cardinality, participation, weak entities, ER diagram, Generalization, Specialization and aggregation, conceptual design with ER model, entity versus attribute, entity versus relationship, binary versus ternary relationship, aggregate versus ternary relationship.	10+10
2	SQL commands: Integration Creating and altering tables: CREATE statement with constraints like KEY, CHECK, DEFAULT, TRUNCATE, ALTER and DROP statement. Handling data using SQL: selecting data using SELECT statement, FROM clause, WHERE clause, HAVING clause, ORDER BY, GROUP BY, DISTINCT and ALL predicates, Adding data with INSERT statement, changing data with UPDATE statement, removing data with DELETE statement, Views	10+10
3	SQL Functions and Joining Tables Integration: Functions: Aggregate functions, Date functions, String functions, Numeric functions. Joining tables: (inner) join, left (outer) join, right (outer) join, full (outer) join, self-join, union	10+10
	Total	30+30

Text Books:

1. Raghunath Ramakrishnan and Johannes Gehrke (2003), Database Management Systems, 3rd Edition, McGraw Hill Publications
2. Abraham Silberschatz, Henry F. Korth & S. Sudarshan (2010), Database System concepts, 6th Edition, McGraw Hill Publications

Reference Books:

1. Ramez Elmasri, Shamkant B. Navathe (2015), Fundamentals of Database Systems, 7th Edition, Pearson
2. Michael Abbey, Michael J. Corey, Ian Abramson (1999), Oracle 8i – A Beginner's Guide, Tata McGraw-Hill

Any other information:

Total Marks of Internal Continuous Assessment Practical (ICA Practical): 50 Marks

Distribution of ICA Practical Marks:

Description of ICA	Marks
First test	25 marks
Second test	25 Marks
Total Marks :	50 Marks

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Program: B. Sc. Applied Statistics & Analytics				Semester : IV	
Course : Applied Economics				Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- 50 in Question Paper)
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite:					
Objectives: To provide an introduction to the application of economic theory to data by imparting an ability to understand and interpret results both statistically and economically. This course focuses on microeconomics, with some topics from macroeconomics and international trade.					
Outcomes: After completion of the course student should be able to integrate the theory, data and judgment in the analysis of corporate decisions and public policy.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Introduction to Games and Strategy: Normal form game-dominant strategy equilibrium-Nash equilibrium-mixed strategy Nash equilibrium-extensive form games-sub game perfect Nash equilibria, Dynamic consistency (credibility), Cournot, Bertrand and Stackleberg models and their applications, Collusive Oligopoly- Cartels- Profit sharing and market sharing cartels.				10
2	Asymmetric Information and Contracts: Optimal contracts under symmetric information-contracts under moral hazard-Bayesian Nash equilibria – adverse selection and signalling-pooling and separating equilibria-applications in labour and capital markets				10
3	State and Markets: First and second fundamental theorems of welfare economics- externalities-public goods- regulation of monopolies –public utility pricing-models of interest group behavior.				10
4	Macroeconomics: The IS-LM model, impact of monetary and Fiscal policy- Long run and short run Phillips curve, rational expectations and policy ineffectiveness. Policy implications of quota and price restrictions.				10
5	International Trade: Comparative advantage, Heckscher-Ohlin Theorem, Comparative advantage vs. Protectionism; Trade barriers; Open economy with flexible exchange rates- Mundell Fleming model. International trading arrangements (WTO/ Regional Blocks)				10

6	Economic Growth in developing economies: Growth vs Development, Models of Economic growth (Harrod- Domar and Solow) -Growth and Inequality- Poverty measures and policies (Illustrative Policy like MNREGA) -Growth versus the Environment debate (CRZ/ Eco-sensitivity) - Indian economic policy examples.	10
	Total	60

Text Books:

1. Games of Strategy by Avinash Dixit, Susan Skeath, and David H. Reiley, Jr., 3 edition, W. W. Norton & Company
2. Robert Gibbons : Game Theory for the Applied Economist
3. R. Varian : Intermediate Microeconomics
4. N. Gregory Mankiw : Macroeconomics
5. Ray Debraj : Development Economics
6. Eric Rasmusen : Games & Information

Reference Books:**Any other information :**

Program: B. Sc. Applied Statistics & Analytics				Semester : IV	
Course : Research Writing				Code:	
Teaching Scheme			Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks- NA in Question Paper)
2h	-	-	2	Marks Scaled to 50	Marks Scaled to NA
Pre-requisite:					
Objectives: This course introduces students to the basic essentials of formulating, conducting, and delivering a robust research project. Students will get a comprehensive understanding of the major aspects of how to manage a research study from beginning to end, and will learn to identify and use a variety of research tools and techniques to efficiently and effectively conduct research and deliver the findings.					
Outcomes: Getting an basic understanding essentials of formulating, conducting, and delivering a robust research project					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Identifying the topic, references, library and other resources Preparing the draft outline of the research Case Study: Classroom practice for draft outline Developing the research proposal Presentation for research proposal, skills and methods Writing the research report, notes, references, annexures, main body Presenting the research				30
	Total				30
Text Books: 1. Base Book: Research Methods in Applied Economics, Don E Ethridge, Blackwell Publishing, 2004					
Reference Books:					
Any other information :					

B.Sc. Applied Statistics & Analytics

Syllabus

Semester V

Program: B. Sc. Applied Statistics & Analytics					Semester : V	
Course : Time Series & Forecasting					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial	Credit	Internal Continuous Assessment (ICA) (Marks - 50 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks- 50 (Theory) in Question Paper)	
3h	2h	-	4	Marks Scaled to 50 (Theory) & 50 (Practical)	Marks Scaled to 50 (Theory)	
Pre-requisite:						
Objectives: Following are the objectives: <ul style="list-style-type: none"> To gain insights about the forecasting techniques To understand the regression framework and the basic assumptions of ordinary least squares To estimate, interpret and validate multiple regression models. To understand Time Series decomposition and its components To forecast time series data with the appropriate forecasting model 						
Outcomes: Students should be able to: <ul style="list-style-type: none"> Perform Regression analysis on the given dataset using appropriate software. Check and validate all the assumptions of regression analysis. Decompose a time series and estimate its component. Fit an appropriate forecasting model on the given data. 						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Simple Linear Regression: Estimation of the model parameters. Least-squares estimates and their properties. Maximum likelihood estimation. Hypothesis testing in simple linear regression. Tests for significance of regression, tests on individual regression coefficients. Confidence intervals in simple linear regression and prediction of new observation. Extension to Multiple linear regression, Residual Analysis, Multicollinearity, Variable selection methods					20+15
2	Time Series as a forecasting technique, Time Series Components, Principle of Decomposition, Moving Average Exponential Smoothing Methods: Simple exponential smoothing, Holt linear method, Holt -Winter's seasonal method and Pegels classification.					15+10
3	The Box-Jenkins Methodology for ARIMA Models: Examining Correlation in Time Series Data, Examining Stationarity in Time Series Data, ARIMA Models for Time Series Data, Parameter Estimation for ARIMA models, Diagnostic Checking of ARIMA models, Forecasting with ARIMA models.					10+5

	Total	45+30
Text Books: <ol style="list-style-type: none">1. Montgomery D. C, Peck E. A, Vining G. G. (2012). <i>Introduction to Linear Regression Analysis</i>, 5th Edition, Wiley2. Spyros G. Makridakis, Steven C. Wheelwright, Rob J Hyndman (2015). <i>Forecasting: Methods and Applications</i>, 3rd Edition, Wiley3. Box George E. P, Jenkins G. M., Reinsel G. C. (2009): <i>Time Series Analysis-Forecasting and Control</i>, 3rd Ed., Pearson Education.		
Reference Books: <ol style="list-style-type: none">1. Draper, N. R. and Smith, H. (1998). <i>Applied Regression Analysis</i>, 3rd Ed, Wiley.2. Paul S.P., Cowpertwait, Andrew V. Metcalfe (2009): <i>Introductory Time Series with R (Use R!)</i>, Springer.3. James D. Hamilton (2012): <i>Time Series Analysis</i>, Levant Books		
Any other information:		

Program: B. Sc. Applied Statistics & Analytics					Semester : V	
Course : Operations Research - II					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial	Credit	Internal Continuous Assessment (ICA) (Marks - 50 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks- 50 (Theory) in Question Paper)	
3h	2h	-	4	Marks Scaled to 50 (Theory) & 50 (Practical)	Marks Scaled to 50 (Theory)	
Pre-requisite:						
Objectives: The main objective of this paper is to learn the techniques used for industrial resource management.						
Outcomes: 1. To introduce to the optimization techniques used in industrial resource management. 2. Solve real life optimization problems by using relevant software						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Project Analysis: Basic concepts and Definitions, Gantt Charts and its weaknesses, CPM and PERT networks, Numbering of Events, Contractual Obligation Time, Earliest occurrence time, Latest allowable occurrence Time and Slack Time for Events, Different types of floats for activities. Critical Path Calculations, Probability Assessment in PERT Networks. Time Cost Trade - Off Analysis for CPM Networks.					15 + 12
2	Integer Linear Programming Introduction. Types of Integer Programming problems. Gomory's Cutting Plane Method. Mixed Integer Cutting Plane Method, Branch and Bound Method.					10+6
3	Inventory Models Terms in inventory management - Costs, lead time, buffer stock, order cycle time. Deterministic Inventory Models- EOQ Model with Instantaneous Replenishment and Constant Rate of Demand assuming that shortages are not allowed, Price break model. Calculation of buffer stock when lead time is constant / variable. EOQ models with instantaneous/uniform rate of replenishment and constant rate of demand assuming shortages are allowed/ not allowed. Probabilistic Inventory models - Instantaneous / uniform demand (discrete/ continuous variable) without setup cost.					20+12
	Total					45+30

Text Books:

1. J.K.Sharma (2013): Operations Research: Theory & Applications, 5th Ed., Laxmi Publications
2. V. K. Kapoor (2010): Operations Research-Problems & Solutions, Sultan Chand & Sons.
3. Shenoy, Shrivastava & Sharma (2011): Quantitative Techniques, 3rd Ed., New Age International.

Reference Books:

1. L. S. Srinath (2001): PERT & CPM - Principles and Applications, 3rd Ed., Affiliated East-West Press Pvt. Ltd.
2. Ravinderan, Phillips and Solberg (1987): Operations Research - Principles & Practice, 2nd Ed., John Wiley.
3. Richard Bronson (1997): Theory & Problems of Operations Research Schaum's outline series, 2nd Ed.
4. H.A.Taha (2014): Operations Research - An Introduction, 9th Ed., Pearson India.
5. Prem Kumar Gupta, Comboj D. S. Hira Aarti (2012): Introduction to Operations Research, S. Chand
6. Frederick S. Hillier, Gerald J. Lieberman (1995): Introduction to Operations Research, 2nd Ed., Tata McGraw Hill Education.
7. N. D. Vohra (2009): Quantitative Techniques, 4th Ed., McGraw Hill.
8. Gupta and Manmohan (2014): Operations Research, Sultan Chand & Sons.

Any other information :

SVKM's Narsee Monjee Institute of Management Studies

Sunandan Divatia School of Science, Mumbai

Program: B. Sc. Applied Statistics & Analytics				Semester : V	
Course : Statistics in Life Sciences				Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- 50 in Question Paper)
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite:					
Objectives: Introduce the students to concepts of Bioassays, Clinical trials and repeated measurement designs.					
Outcomes: Student should be able to understand and analyze the data obtained from Bioassays, Clinical trials. Also the student should be able to analyze the data from repeated measurement designs.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Bioassays: Meaning and scope of bioassays, Relative potency, Direct assays, Fieller's theorem. Quantal Response assays, Tolerance distribution, Median effective dose ED50 and LD50, Probit analysis. Indirect assays, Dose-response relationship, Condition of similarity and Monotony, Linearizing transformations, Parallel line assays, Symmetrical (K, K) point parallel line and slope ratio assays (with K=2,3), Validity tests using orthogonal contrasts, Point Estimate and Interval Estimate of Relative potency.				20
2	Clinical Trials: The need and ethics of clinical trials, Over view of phases (I-IV) Study Protocol, Randomized controlled, Study Designs, Types of Trials, Concept of odds ratio, Sample size estimation. Bioequivalence: Definitions of Generic Drug product. Bioavailability, Pharmacokinetic (PK) parameters and their estimation, Designs in Bioequivalence, Analysis of Parallel design using logarithmic transformation, Confidence Interval approach to establish bioequivalence (80/125 rule).				20
3	Analysis of repeated measurement designs: Introduction to repeated measurements, Analysis using univariate methods for one sample and multiple samples, unstructured multivariate approach for one sample and two sample repeated measurement, multivariate ANOVA (IV), repeated measures ANOVA for one sample and multiple samples.				20
	Total				60

Text Books:

1. Charles Davis (2002): Statistical Methods for the Analysis of Repeated Measurements, Springer
2. Friedman L. M., Furburg C., Demets D. L. (1998): Fundamentals of Clinical Trials, First edition, Springer Verlag.

Reference Books:

1. Wayne W Daniel (2014): Biostatistics : Basic concepts & methodology for health Sciences- 10th Edition, John Wiley & Sons Inc ,UK
2. Sanford Bolton, Charles Bon (2009): Pharmaceutical Statistics, Practical and Clinical applications 5th Ed., Routledge, New Delhi.

Any other information:

Numerical examples to be solved in theory class.

Program: B. Sc. Applied Statistics & Analytics				Semester : V	
Course : Principles of Marketing				Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- 50 in Question Paper)
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite:					
<ul style="list-style-type: none"> ✓ Curious about playing with data ✓ Familiar with the basic math and statistic concepts ✓ Know the fundamentals of programming and database 					
Objectives:					
Introduction to the principle of marketing with specific reference to customer behavior and marketing strategy.					
Outcomes:					
After completion of the course, students would be able to : Basic understanding of the key concepts of marketing, use of internal and external data/ information needed for marketing decisions					
Detailed Syllabus: (unit wise plan)					
Unit	Description				Duration
1	Principles of Customer Behavior and Marketing strategy <ul style="list-style-type: none"> • 4 P's of Marketing • STP (Segmentation, Targeting and Positioning) • Principles of customer Behaviour and Marketing Strategy • Marketing Channels • Porter 5-point analysis • Creating a Brand 				15
2	Key Aspects of the Marketing Process <ul style="list-style-type: none"> • Marketing Environment- Demography, Socioeconomic environment • Marketing Information- Assessing Information Needs, Developing Information • Marketing Technology- Assessing technological needs, choosing the right technology, channels • Principles of digital marketing • Model of consumer behavior- buyer decision process, types of buyer behavior, Role of pricing and promotion • Nudge framework and power of habit creation 				15
3	What do my market looks like? (modeling interrelationship techniques) Segmentation: Tools and Techniques Key metrics in marketing				15

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	Relationship between marketing and other business units	
4	Introduction to Market Research Role of Market Research in Business decision making Principles of survey design Statistical Techniques- Factor analysis, discriminant analysis	15
	Total	60

Text Books:

1. Philip Kotler, Kevin Lane Keller : (2016): Marketing Management , 15th edition , Pearson Education Limited
2. Philip Kotler: (1998): Marketing Management - Analysis Planning Implementation and Control, 9th edition , Prentice-Hall of India Pvt. Ltd.
3. Peter Fader- Customer Centricity: Focus on the Right Customers for Strategic Advantage, (Wharton Executive Essentials), (2012)

Reference Books:

1. Anderson, Sweeney & Cochran : (2010) : Statistics for Business and Economics , 11th edition , South-Western Cengage Learning Inc.
2. Rajendra Nargundkar: (2003) : Marketing Research (Text & Cases) , 2nd edition, Tata McGraw Hill Education

Any other information

Program: B. Sc. Applied Statistics & Analytics				Semester : V	
Course : Fundamentals of Financial Risk				Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- 50 in Question Paper)
4h	-	-	4	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite:					
<ul style="list-style-type: none"> • Basic should have general understanding of Finance • Basic understanding of various types of Financial risks that business faces 					
Objectives:					
The objective of this course is to establish the context for Financial Risk and its management, significantly enhance the understanding of the financial risks faced by businesses in various industries including Banking & Financial Services. Establish a strong foundation for application of statistical tools and concepts to finance, to quantify, assess, mitigate and monitor risk.					
Outcomes:					
After completion of the course, students would be able to :					
<ul style="list-style-type: none"> • Understand and evaluate complex dimensions of the financial risks • Quantify risks • Map statistical concepts and techniques to finance for risk assessment, mitigation and monitoring • Develop basic financial risks models 					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	<u>Risk Management Process- Overview and Introduction</u> <ul style="list-style-type: none"> • Introductory concepts of the securities market • Basics of Financial risk management • Introduction to Statistical tools and techniques applicable for Financial Risk Management 				5
2	<u>Risk Measurement and Analysis</u> <ul style="list-style-type: none"> • Quantification of Risk • Probabilistic foundations of financial modelling and pricing • Evaluating loss data, Analysis of distribution of loss data • Duration Analysis • VaR and Non-VaR measurements and analysis • Copulas 				20

3	<p><u>Detailed insight into Individual Types of Risks</u></p> <ul style="list-style-type: none"> ○ Credit Risk ○ Market Risk ○ Operational Risk ○ Interest rate risk ○ Currency Volatility ○ Cash Flow Cycle ○ Liquidity ○ Asset Liability Management ○ Maturity Mismatch ○ Re-pricing ○ Acturial Risk 	10
4	<p><u>Risk Modelling – Principles and Practice</u></p> <p>Emphasis on calibrating and validating various models for managing risk</p> <ul style="list-style-type: none"> ● Discounted Cash Flow Modeling <ul style="list-style-type: none"> ○ Certain / Un-Certain Cash flows ○ Risks and its impact on the cash flows ○ Impact of risk on expected return and discounting factors ○ Other key factors impacting risk profile of the business ● Overview Various Model adopted for different types of risk. <ul style="list-style-type: none"> ○ Market Risk <ul style="list-style-type: none"> ▪ VAR model ○ Credit Risk: <ul style="list-style-type: none"> ▪ Implied probability of default ▪ Transition matrix, ▪ LGD, EAD ▪ Credit Scoring ○ Operational Risk: <ul style="list-style-type: none"> ▪ Loss Data analysis ▪ Catastrophic modelling ● Project Risk analysis <ul style="list-style-type: none"> ○ Project risk evaluation tools and techniques ● Insurance & finance risk modelling <ul style="list-style-type: none"> ○ Risk based Product pricing and underwriting ○ Risk measurement, Loss data analysis ○ Catastrophic loss modelling ● Credit and other financial ratings – models and implications 	22
5	<ul style="list-style-type: none"> ● Detailed Example in Financial Risk Management <ul style="list-style-type: none"> ○ Financial Services Company ○ Non-Financial Services Company ○ Insurance 	3
	Total	60

Text Books:

1. Financial Risk Management: A Practitioner's Guide to Managing Market and Credit Risk- Steve L. Allen
2. Identifying and Managing Project Risk--Book by Tom Kendrick

3. The essentials of risk management- Book by Michel Crouhy
4. Risk Management and Financial Institutions – John C Hull

Reference Books:

1. Risk Management for Insurers: Risk Control, Economic Capital and Solvency II-Book by René Doff
2. Fundamentals of Enterprise Risk Management: How Top Companies Assess Risk- Book by John J. Hampton
3. Risk Management in Banking- Book by Joel Bessis

Any other information : NA

Program: B. Sc. Applied Statistics & Analytics				Semester : V	
Course : Visual Analytics				Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical(Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- NA in Question Paper)
-	2h	-	1	Marks Scaled to 50	Marks Scaled to NA
Pre-requisite:					
Objectives: This course aims at exploring data and building reports using the concepts and principles of Visual Analytics. Students will learn to build queries in Visual Data Builder, Explorations in explorer and Reports in visual designer. It also helps to learn the basics of Visual Analytics Administrator.					
Outcomes: Students should be able to:					
<ul style="list-style-type: none"> • interact with the environment via the Visual Analytics Hub • access and prepare data for exploration, analysis, and reporting • explore data using the Visual Analytics Explorer • create reports with the Visual Analytics Designer • use the Visual Data Builder and understand the capabilities of the Visual Analytics Administrator • View reports using the Visual Analytics Viewer and Mobile BI App. 					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Getting Started with Visual Analytics <ul style="list-style-type: none"> • exploring Visual Analytics concepts • using the Visual Analytics home page • discussing the course environment and scenario Administering the Environment and Managing Data <ul style="list-style-type: none"> • exploring Visual Data Builder • exploring Visual Analytics Administrator 				6
2	Using Visual Analytics Explorer <ul style="list-style-type: none"> • examining Visual Analytics Explorer • selecting data and defining data item properties • creating visualizations • enhancing visualizations with analytics • interacting with visualizations and explorations 				10

3	Designing Reports with Visual Analytics <ul style="list-style-type: none"> • examining the Visual Analytics Designer interface • creating a simple report • creating data items and working with graphs • working with filters and report sections • establishing interactions, links, and alerts • working with gauges and display rules • working with tables • working with other objects 	10
4	Viewing Visual Analytics Reports <ul style="list-style-type: none"> • viewing reports on the Web • viewing reports on a mobile device • viewing reports with SAS Office Analytics 	2
5	Case Study: Creating Analyses and Reports with Visual Analytics	2
	Total	30

Text Books:

1. Visual Analytics: Standard Training Material (Global Certification Material : Visual Analytics Fast Track)
2. Visual Analytics: User Guide

Reference Books:

1. [Expanding the Frontiers of Visual Analytics and Visualization](#)
John Dill, Rae Earnshaw, David Kasik - 2012
2. [Innovative Approaches of Data Visualization and Visual Analytics](#)
Huang, Mao Lin - 2013
3. [Visual Analytics and Interactive Technologies: Data, Text and Web ...](#)
Zhang, Qingyu - 2010

Any other information :

SVKM's Narsee Monjee Institute of Management Studies

Sunandan Divatia School of Science, Mumbai

Program: B.Sc. Applied Statistics & Analytics					Semester : V	
Course/Module : Employability Skills					Module Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- __NA__ in Question Paper)	
2h	-	-	2	Marks Scaled to - 50	Marks Scaled to - NA	
Pre-requisite:						
Objectives: To make the students self-aware, help them to build confidence and to adopt best practices to become responsible citizens. To prepare the students for the corporate environment.						
Outcomes: After completion of the course, students would be able to: Identify and use appropriate words for communication, choose proper tools to communicate, use positive body language while communicating, maintain proper eye contact to build trust and confidence.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Behavioural Skills - Self -awareness and confidence building, Display Professionalism at the institute and work place, Increased social initiations relationships and networks. Acceptance of peers from different cultures and social groups and work with them. Collaboration with team to prioritize the common goal and compromise individual priorities. Characteristic of a responsible citizen Adopting best practices and aspire to follow success stories of individual for personal development.					10
2	Communication Skills - Campus to Work Time Management and Planning Skills, Interview skills- its phases & ways to crack interview, Handling setbacks/rejection and recover from it with an action plan, Developing strong professional contacts/ network to gain support in learning process and career as a whole.					10
3	Preparation to the world of work Identify the difference between job and career Job roles available in respective trades Awareness of industries, and the respective professional pathways Awareness of higher education / up skilling (short-term) options Steps involved in online application for Instructor course, Apprenticeship and different jobs in popular site.					10
	Total					30

Text Books:

1. Steven A. Beebe, Timothy P. Mottet and K. David Roach (2012) – Training and Development: Enhancing Communication and Leadership Skills.
2. Amos, Julie (2004) - Ann. Handling Tough Job Interviews, Jaico Publishing.
3. Neuliep, James W. (2003) – Intercultural Communication: A Contextual Approach. Boston: Houghton Mifflin Co.
4. Prasad, H. M. (2001) – How to Prepare for Group Discussion and Interview, New Delhi: Tata McGraw-Hill Publishing Company Limited.

Reference Books:

1. Fred Luthans (2013) – Organizational Behavior: An Evidence Based Approach, 13th Ed., McGraw Hill.
2. Robbins, Stephens (2007) – Organizational Behavior (cd) 12e Paperback

Any other information:

The syllabus should be covered through role plays, activity, group discussion, scenario, project, storytelling, skit.

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Evaluation is through assignments, presentation, group discussion and projects.

Description of ICA	Marks
Assignments	20
Presentations	20
Group Discussions	10
Total Marks :	50

B.Sc. Applied Statistics & Analytics
Syllabus
Semester VI

Program: B.Sc. (Applied Statistics & Analytics)				Semester : VI	
Course: Introduction to Data Science				Course Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- 50 in Question Paper)
3h	-	-	3	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite:					
<ul style="list-style-type: none"> • Curious about playing with data • Familiar with the basic math and statistic concepts • Know the fundamentals of programming and data base 					
Objectives:					
Introduction to the theoretical foundations, algorithms, and methods of deriving valuable insights from data. Data mining techniques and algorithms; machine learning techniques such as supervised learning.					
Outcomes:					
After completion of the course, students would be able to: Basic understanding of the key concepts, algorithms and models relevant to data science, understand the data patterns to be mined, data mining algorithms, and machine learning techniques.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Introduction to Data and Data Mining: Data Information, Knowledge, Role of data mining in taking Strategic and tactical decision, users involved in taking decisions, Types of attributes, Data Patterns learned through Data mining. Naïve Bayes Classifier Association Rule Mining: A Pattern-Growth Approach for Mining Frequent Itemsets (FP Tree), Mining Frequent Itemsets Using the Vertical Data Format k-Nearest Neighbor Classifier, Support Vector Machines				10
2	Artificial Neural Networks for Classification and Prediction: Biological Neuron, Artificial Neural Networks, MP NEURON, Types of learning, Activation functions, Neural network architectures, Single layer Perceptron Learning, Self-Organizing Map, Introduction to Fuzzy logic, Properties and operations of fuzzy sets and fuzzy relations, Lambda cuts for fuzzy sets and relations, Fuzzification methods(Intuition, Inference and Rank Ordering), Defuzzification methods (Max - Membership, Centroid, Weighted Average method, Mean-Max Membership, Center of Sums, Center of Largest Area, First of Maxima)				20
3	Decision Tree: CART (Classification and Regression Trees) using Gini Index, ID3 (Iterative Dichotomiser) using Entropy and Information gain, Dimensionality Reduction, Singular value decomposition. Ensemble Learning: Random Forest, Bagging, K-fold cross validation				15
	Total				45
Text Books:					
1. Jiawei Han, Jian Pei, Micheline Kamber (2012): Data Mining: Concepts and Techniques, Third Edition, Elsevier					

2. Timothy J. Ross (2017), Fuzzy Logic with Engineering Applications, 4th edition Wiley India.

Reference Books:

1. Nong Ye (2014), Data Mining: Theories, Algorithms, and Examples, CRC Press
2. N Burlingame and L Nielsen (2012): A simple introduction to Data Science, New Street Communications
3. Jacek M. Zurada (1992), "Introduction to Artificial Neural Systems," Jaico Publishing House.

Any other information:

SVKM's Narsee Monjee Institute of Management Studies

Sunandan Divatia School of Science, Mumbai

Program: B. Sc. Applied Statistics & Analytics					Semester : VI	
Course : Quality Management					Code:	
Teaching Scheme				Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial	Credit	Internal Continuous Assessment (ICA) (Marks - 50 (Theory) & 50 (Practical))	Term End Examinations (TEE) (Marks- 50 (Theory) in Question Paper)	
3h	2h	-	4	Marks Scaled to 50 (Theory) & 50 (Practical)	Marks Scaled to 50 (Theory)	
Pre-requisite:						
Objectives:						
This course aims at providing a thorough understanding of the six sigma process which seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes.						
Outcomes:						
Students should be able to use a set of quality management methods, mainly empirical, statistical methods to improve the process management of a project.						
Detailed Syllabus: (per session plan)						
Unit	Description					Duration
1	Introduction to Lean and Six Sigma: DMAIC, Lean and Six Sigma DMAIC structures, Lean Six Sigma, Define phase of DMAIC, SIPOC, Project Charter, Stakeholder Analysis					15+6
2	Measure Phase: KPI, Lean Measures, Statistic for process "Position" and "Spread", Data Collection, Plans & Sampling, Minimum sample size, Sampling Frequency, Measurement System Analysis, Shapes & Normal Distributions, Process Stability & Short/Long Term Variation, Process Capability Introduction & Route Map. Analyse Phase: The Process Door -Route Map, The Data Door, Hypothesis Testing Overview, Correlation & Regression Overview, DOE - Overview					15+15
3	Improve: Negative Brainstorming and Assumption Busting, Error Proofing & Benchmarking, Chain Letters and Billboards, SCAMPER, Assessment Criteria, Paired Comparison, Prioritization Matrix, Pugh Matrix, Solution Screening & Pilot Studies, One Piece Flow, 5S etc. Control: SPC Overview: I-MR Charts, X-Bar , R -Charts, U & P Charts, Control Plans, Standardize Process, Project Reports and Action Logs					15+9

	Total	45+30
Text Books: 1. Michael L. George, John Maxey, David T. Rowlands, Malcolm Upton (2004): The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to Nearly 100 Tools for Improving Quality and Speed		
Reference Books: 1. Quentin Brook (2006): Six Sigma and Minitab: A Complete Toolbox Guide for All Six Sigma Practitioners, QSB Consulting Ltd, 2 nd Ed. 2. Peter S. Pande, Robert P. Neuman, Ronald R. Cavanagh(2007): The Six Sigma Way, Tata McGraw Hill		
Any other information :		

Program: B. Sc. Applied Statistics & Analytics				Semester : VI	
Course : Statistical Modelling in Marketing Analytics				Code:	
Teaching Scheme				Evaluation Scheme	
Lecture	Practical	Tutorial	Credit	Internal Continuous Assessment (ICA) (weightage)	Term End Examinations (TEE) (weightage)
4	-	-	4	50	50
Pre-requisite:					
<ul style="list-style-type: none"> ✓ Curious about playing with data ✓ Familiar with the basic math and statistic concepts ✓ Know the fundamentals of programming and data base 					
Objectives:					
The objective of this course is to train the students with various statistical techniques, models and metrics that help in providing actionable insights leading to better marketing decisions.					
Outcomes:					
After completion of the course, students would be able to: Analyze and critically interpret data, build statistical models of real situations in marketing.					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Preparing data for Marketing Analytics: Graphical examination of data, treatment of Missing data, Outlier detection				5
2	Dimension Reduction techniques: Factor Analysis - Principal Components Analysis, Summarizing Sample variation by Principal Components, Factor Rotation, Factor Scores Multidimensional Scaling (MDS)				15
3	Segmentation and Clustering- Cluster Analysis - Similarity measures, Hierarchical clustering using single and complete linkages. Non-hierarchical clustering using k-means and k-medoids. RFM Segmentation Discriminant Analysis - Discriminant function, Discriminating between two multivariate populations. Logistic regression - Interpreting parameters in Logistic Regression, Inference for Logistic Regression				25
4	Marketing Research Tools Conjoint Analysis Market Basket and Association Analysis: Apriori algorithm				15
	Total				60
Text Books:					
1. Paul E. Green, Donald S. Tull (2014): Research for Marketing Decisions, Prentice-Hall of India Pvt. Ltd.					

2. Wayne Winston, Marketing Analytics (2013) : Data-Driven Techniques with Microsoft Excel
3. Johnson and Wichern (2012): Applied Multivariate Statistical Analysis, Sixth Ed., PHI

Reference Books:

1. Stephan Sorger (2013): Marketing Analytics: Strategic Models and Metrics, Createspace Independent Publishing Platform
2. Kishore K. Das & Dibyojyoti Bhattacharjee (2014): Statistics for Business and Marketing Research, PHI Learning Pvt. Ltd.

Any other information

Program: B. Sc. Applied Statistics & Analytics					Semester : VI		
Course : Statistical Modelling in Financial Risk					Code:		
Teaching Scheme				Evaluation Scheme			
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) Marks - 50	Term End Examinations (TEE) (Marks - 50 in Question Paper)		
4	-	-	4	Marks Scaled to 50	Marks Scaled to 50		
Pre-requisite:							
<ul style="list-style-type: none"> • Application skills related to various statistical tools and techniques • Basic understanding of various types of Financial risks that business faces 							
Objectives:							
To build a foundation and provide application oriented perspective of Financial Risk. Equip the students with necessary skills to perform statistical modelling for financial risk management							
Outcomes:							
After completion of the course, students would be able to:							
<ul style="list-style-type: none"> • Understand and evaluate complex dimensions of the financial risks • Develop basic financial risk models using statistical techniques 							
Detailed Syllabus: (per session plan)							
Unit	Description					Duration	
1	Review of Financial Risk Management and Related Mathematical Tools					2	
2	European option and American options. Interest rates, continuous compounding, present value analysis, Bond pricing, risk free interest rates, Returns, gross returns, log returns. Portfolio theory mean variance portfolio theory. One risky asset and one risk free asset. Two risky assets. Sharpe's ratio, tangency portfolio, optional mix of portfolio.					6	
3	Market portfolio, beta, security market line, and capital asset pricing model (CAPM) and their assumption. Value at Risk (VAR) Nonparametric and parametric estimation of VAR, VAR for a derivative and for a portfolio of assets delta normal method Simulation of VAR models.					10	
4	Financial derivatives, options, pricing via arbitrage, law of one price. Risk neutral valuation, arbitrage theorem. Convexity of cost of call option, Binomial model single and multi-period binomial model. Modelling returns: lognormal model, random walk model, modelling through geometric Brownian motion process. Ito lemma (without proof). Arbitrage theorem. The Black Scholes formula and assumptions. Properties of the Black Scholes option cost.					10	

5	Black Scholes Merton differential equations and assumptions, the delta hedging arbitrage strategy Volatility and estimating the volatility parameter. Implied volatility. Pricing American options. Pricing of a European option using Monte Carlo and pricing an American option using finite difference methods. Call options on dividend paying securities.	9
6	Implementations of Risk Analysis in Various Areas of Financial Industry <ul style="list-style-type: none"> • Real options: pricing long-term investment projects • Technical analysis in risk management • Performance measures and their applications 	7
7	Insurance and Reinsurance Risks <ul style="list-style-type: none"> • Modelling risk in insurance and methodologies of premium calculations • Risks transfers via reinsurance • Elements of traditional life insurance • Risk modelling and pricing in innovative life insurance 	8
8	Solvency Problem for an Insurance Company <ul style="list-style-type: none"> • Ruin probability as a measure of solvency of an insurance company • Solvency of an insurance company and investment portfolios • Solvency problem in a generalized Cramér-Lundberg model 	8
	Total	60

Text Books:

1. Alexander Melnikov (2011): Risk Analysis in Finance and Insurance, 2nd ed, Chapman & Hall/ CRC Financial Mathematics series.
2. Alexander J., Rudiger & Paul (2010): Quantitative Risk Management, 1st ed, New Age Publishers.
3. Sheldon M. Ross (2003) An elementary introduction to Mathematical finance, Cambridge University Press.
4. Ruppert D. (2004) Statistics and Finance an Introduction – Springer International Edition.
5. John C. Hull (2008) Options, Futures and other derivatives, Pearson Education India.

Reference Books:

1. Michael Miller (2012): Mathematics and Statistics for Financial Risk Management, 1st ed, Wiley Finance.
2. Tiziano Bellini (2016): Stress Testing and Risk Integration in Banks, 1st ed, Academic Press
3. Rüschenendorf & Ludger (2013): Mathematical Risk Analysis, 1st ed, Springer
4. Joel Bessis (2015): Risk Management in Banking, 4th Ed., Wiley.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

SVKM's Narsee Monjee Institute of Management Studies

Sunandan Divatia School of Science, Mumbai

Description of ICA	Marks
Test 1	25
Test 2	25
Total Marks :	50

Program: B. Sc. Applied Statistics & Analytics				Semester : VI	
Course : Data Science using R				Code:	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial	Credit	Internal Continuous Assessment (ICA) (Marks - 100)	Term End Examinations (TEE) (Marks - NA In Question Paper)
-	3	-	1.5	Marks Scaled to 100	Marks Scaled to NA
Pre-requisite:					
<ul style="list-style-type: none"> ✓ Curious about playing with data ✓ Familiar with the basic math and statistic concepts ✓ Know the fundamentals of programming and data base 					
Objectives:					
The goal is to gain a better understanding of the techniques in data science, to get acquainted with the basics of statistics and the R software, and to be able to write R programs to solve machine learning/ data mining/statistical problems.					
Outcomes:					
After completion of the course, students would be able to:					
<ul style="list-style-type: none"> ✓ Learn tools and techniques for Statistical analysis and Data transformation ✓ Understand Data Mining techniques and their implementation ✓ Analyze Data using Machine Learning algorithms in R 					
Detailed Syllabus: (per session plan)					
Unit	Description				Duration
1	Data Preparation & Manipulation in R: Introduction to data manipulation of data frames using <i>dplyr</i> package: filter rows, arrange rows, selecting columns, creating new variable, Grouped summaries of the data. Introduction to data manipulation of strings using <i>stringr</i> package				5
2	Dimension Reduction techniques: Principal component analysis, Factor Analysis, Singular Value decomposition				5
3	Segmentation and Clustering- Cluster Analysis - Similarity measures, Hierarchical clustering using single and complete linkages. Non-hierarchical clustering using k-means and k-medoids. RFM Segmentation Discriminant Analysis - Discriminant function, Discriminating between two multivariate populations. Logistic regression - Interpreting parameters in Logistic Regression, Inference for Logistic Regression Naïve Bayes' Classifier, k - nearest neighbor classifier, Decision tree for classification, k fold cross validation.				20

4	Machine learning techniques Market Basket and Association Analysis: Apriori algorithm Artificial neural network, Support Vector machine, fuzzy set and fuzzy relation operations.	15
	Total	45

Text Books:

4. G Groulemand, H Wickham (2017): R for Data Science, O'reilly
5. Brett Lantz (2015): Machine learning with R, Packt Publishing.
6. Y Zhao (2013): R and Data mining: Examples and Case studies, Elsevier.

Reference Books:

3. Bater Makhabel (2015): Learning Data mining with R, Kindle Edition
4. R B Koushik, S K Ravidran (2016): R Data Science Essential, Kindle Edition
5. Karthik Ramasubramanian, Abhishek Singh (2017): Machine Learning Using R, Apress

Any other information

Exam will be conducted on R studio.

Report writing or document submission is to be done with the help of R Markdown.

Total Marks of Internal Continuous Assessment: 100

Distribution of ICA Marks:

Description of ICA	Marks
First test	30
Second test	30
Assignment	40
Total Marks :	100

SVKM's Narsee Monjee Institute of Management Studies

Sunandan Divatia School of Science, Mumbai

Program: B. Sc. Applied Statistics & Analytics				Semester : VI	
Course : Business Ethics				Code:	
Teaching Scheme			Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks - 50)	Term End Examinations (TEE) (Marks- ___NA___ in Question Paper)
2h	-	-	2	Marks Scaled to - 50	Marks Scaled to - NA

Pre-requisite:

Objectives:

To acquaint students with basic fundamentals of business ethics, apprising them of how this concept has evolved in local and international markets, understanding of how businesses should behave ethically and the benefits that Business Organizations can achieve by implementing the same at workplace.

Outcomes:

Students would be having a better understanding of how businesses devise their strategy to positively engage all their stakeholders including environment, employees, and community at large.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Business Ethics: Basics of business ethics, Growth of Ethics in organizations, Ethical issues faced by organizations today. Stakeholders Perspective in Business: Stakeholders Model, Stakeholder Mapping using Mendelow's Matrix. Values in Business: Values and Vision Statements, Ashridge's Mission Model to analyze Values and Purpose Statements, Instrumental and Terminal Values in Business, Core Values of organizations	15
2	Code of Ethics: Code of professional ethics, Code of Conduct. Ethical Dilemmas: Ethical Issues Intensity Model, Ethical Dilemmas in areas of Finance, Marketing, HRM, and Operations. Contemporary Issues: Corporate Social Responsibility and Corporate Governance: Social Responsibility of Business, Ecology and Business, Carbon Credit, Evolution of Social Audit, Benefits of Social Audit, Social Audit v/s Commercial Audit	15
	Total	30

Text Books:

1. Manuel G. Velasquez (2012): Business Ethics: Concepts and Cases, 7th Ed., Pearson

Reference Books:

2. C.S.V. Murthy (2010): Business Ethics: Text and Cases. 2010 Ed, Himalaya Publishing House
3. Sherlekar S.A. (2014): Ethics in Management, Himalaya Publishing House

Internet References:

- <http://www.nfcgindia.org/>
- <http://www.corporate-ethics.org/>

Any other information :