CHRIST
(DEEMED TO BE UNIVERSITY)
PUNE LAVASA CAMPUS
The Hub of Analytics

Department of Data Science

Pune Lavasa Campus

Syllabus

BSc (Economics and Analytics)

Academic Year 2020-21

Batch 2020-2023

DEPARTMENT OVERVIEW

The Department of Data Science at CHRIST (Deemed to be University), Pune Lavasa Campus was established to shape students into outstanding Data Scientists and Analytics professionals with ethical and human values. The department offers various undergraduate and postgraduate programmes viz., Bachelor of Science in Data Science, Master of Science in Data Science, Bachelor of Science in Economics & Analytics, and Doctor of Philosophy in the area of Computer Science and Engineering. The department has rich expertise in faculty resources who are trained in various fields like Data Science, Data Security, Data Analytics, Artificial Intelligence, Machine Learning, Networking, Data Mining, Big Data, Text Mining, Knowledge Representation, Soft Computing, and Cloud Computing. The department has a wide variety of labs set up, namely the Machine Learning Lab, Data Analytics Lab, Open Source Lab, etc., which are exclusively for students' hands-on training for their lab-oriented courses and research.

The department intermittently organizes hands-on workshops on recent technologies like Machine Learning, Cloud Computing, Hadoop, etc. for the students to make them ready for the industry. The department aims to equip students with a holistic education to make them better citizens.

VISION

“Enrich Ethical Scientific Excellence”

MISSION

“To develop Data Science professionals with ethical and social values.”

”To divulge state-of-the-art knowledge in the area of Data Science and Analytics.”

“To encourage research and innovation.”

“To accustom the students with current industry practices, teamwork, and entrepreneurship.”

INTRODUCTION TO THE PROGRAMME

BSc (Economics and Analytics)

The objective of the BSc (Economics & Analytics) course is to introduce students to an understanding of the domain of economics as a social theory. This course is designed to introduce you to the fundamentals of economic analysis and reasoning. Subsequent and more specialized economic courses are based upon this course. BSc (Economics & Analytics) also attempts to introduce students to the main conclusions derived from economic analysis and to develop a student's understanding of their organizational and policy implications.

The course provides an introduction to the fundamental tools of economics, mathematics, and statistics, which forms a strong base for understanding and analyzing economic concepts. The curriculum introduces the students to multiple analytical tools which are used in economic analysis and also facilitates the use of econometrics to examine relevant policy issues at the micro and macro level. In their final year, students explore application based subjects like international and monetary economics. They are trained in advanced mathematical tools to aid any further studies or research projects that they undertake.

Programme Objective

- To acquire an in-depth understanding of the theoretical concepts in statistics, data analysis, data mining, machine learning, and other advanced data science techniques.
- To gain practical experience in programming tools for data sciences, database systems, machine learning, and big data tools.
- To strengthen analytical and problem-solving skills by developing real-time applications.
- To empower students with tools and techniques for handling, managing, analyzing, and interpreting data.

Ethics and Human Values

1. Only proprietary or open-source software would be used for academic teaching and learning purposes.

2. Copying of programs from the internet, friends or other sources is strictly discouraged as it impairs the development of programming skills.

3. Unique Practical (Domain-based) exercises are given to ensure that the students don't involve in code plagiarism.

4. Projects undertaken by students during the course are done in teams to improve collaborative work and synergy between team members.

5. Projects involve modularization, which initiates students to take individual responsibility for common goals.

6. Passion for excellence is promoted among the students, be it in software development or project documentation.

7. Giving due credit to sources during the seminar and research assignment is promoted among the students

8. The course is designed so that it enforces the practice of proper referencing techniques to improve the sense of integrity.

9. The course involves group discussions and debates on ethical practices and human values, which sensitize the students in dealing with customers and members within the organization.

Programme Eligibility

- The programme's basic eligibility is a pass at the +2 level (Maharashtra HSC / ISC / CBSE / NIOS / State Boards) from any recognized examination in India.
- Candidates writing the +2 examinations in March-May may apply with their class X and XI marks.
- It is compulsory to have studied (Mathematics) at the Class XII level.

Programme Outcomes

On successful completion of the BSc Programme, the students will be able to

PO1. Understand and apply the fundamental principles, concepts, and methods in critical areas of science and multidisciplinary fields.

PO2. Demonstrate problem-solving, analytical, and logical skills to provide solutions for scientific requirements.

PO3. Develop critical thinking with a scientific temper.

PO4. Communicate the subject effectively.

PO5. Understand the importance and judicious use of technology for the sustainable growth of humanity in synergy with nature.

PO6. Understand professional, ethical, and social responsibilities.

PO7. Enhance research culture and uphold scientific integrity and objectivity.

PO8. Engage in continuous reflective learning in the context of technological and scientific advancements.

Programme Specific Outcomes (PSO)

PSO1: Abstract Thinking: To develop the ability to understand abstract concepts that lead to various data science theories in Mathematics, Statistics, and Computer Science.

PSO2: Problem Analysis and Design Ability: To identify, analyze and design solutions for problems using the fundamental principles of Mathematics, Statistics, Computing Sciences, and relevant domain disciplines.

PSO3: Modern Software Tool Usage: To acquire the skill of handling data science programming tools for problem-solving and solution analysis for domain-specific problems.

PSO4: Professional Ethics: To understand and commit to professional ethics, cyber regulations, responsibilities, and norms of professional computing practices.

PSO5: Conduct investigations of complex computing problems: Use research-based knowledge and research methods including design of experiments, analysis, interpretation of data, and synthesis of the information to provide valid conclusions.

PSO6: Individual and Teamwork: To function effectively as an individual, as a member or as a leader in diverse teams and multidisciplinary environments.

PSO7: Applications in Multidisciplinary domains: To understand the role of statistical approaches and apply the same to solve the real-life problems in the fields of data science.

PSO8: Project Management: To apply research-based knowledge to analyze and solve advanced problems in data science.

EVALUATION PATTERN

CIA - 70%
ESE - 30%

Curriculum Structure for BSc (Economics and Analytics)
2020-2023

SEM	SUBCODE	SUBJECT NAME	Hrs./WEEK	CREDIT	MAX MARKS	TYPE
I	BEA131	Discrete Mathematics	4	4	100	CORE
	BEA132	Fundamentals of Statistics	4	4	100	CORE
	BEA133	Introductory Microeconomics	3	3	100	CORE
	BEA134	Introductory Macroeconomics	3	3	100	CORE
	BEA171	Programming in Python	6	5	150	DSEP
	ENG121	General English I	3	3	100	AECC
	AEN122	Language I	3	3	100	AECC
	BEA112	Applied Excel	2	1	50	SEC
	HOL111	Holistic Education	1	-	Grade	SEC
		Total	**29**	**26**	**800**	
SEM	**SUBCODE**	**SUBJECT NAME**	**Hrs./WEEK**	**CREDIT**	**MAX MARKS**	**TYPE**
II	BEA231	Calculus	4	4	100	CORE
	BEA232	Probability and Distribution Theory	4	4	100	CORE
	BEA233	Introduction to Data Science	4	4	100	CORE
	BEA234	Applied Microeconomics	3	3	100	CORE
	BEA235	Applied Macroeconomics	3	3	100	CORE
	BEA272	R for Analytics	5	4	100	DSEP
	ENG221	English -II	3	3	100	AECC
	AEN222	Additional English – II	3	3	100	AECC
	EVS223	Environmental Studies	-	1	50	AECC
	HOL211	Holistic Education	1	2	Grade	SEC
		Total	**30**	**31**	**850**	
SEM	**SUBCODE**	**SUBJECT NAME**	**Hrs./WEEK**	**CREDIT**	**MAX MARKS**	**TYPE**
III	BEA331	Software Engineering	3	3	100	CORE
	BEA332	Professional Ethics in Computing	2	2	50	CORE
	BEA333	Applied Econometrics -I	3	3	100	CORE
	BEA334	Economic Policy Analysis	3	3	100	CORE
	BEA371	Inferential Statistics	5	4	100	DSEP
	BEA372	Database Management Systems	6	5	150	DSEP
	BEA321-A	French	2	2	50	AECC
	BEA321-B	German	2	2	50	AECC
	HOL311	Holistic Education	1	-	Grade	SEC
	BEA281I	Summer Internship	-	1	50	
		Total	**25**	**23**	**700**	

SEM	SUBCODE	SUBJECT NAME	Hrs./WEEK	CREDIT	MAX MARKS	TYPE
IV	BEA431	Sampling Techniques	4	4	100	CORE
	BEA432	Data Warehousing and Mining	4	4	100	CORE
	BEA433	Applied Econometrics –II	3	3	100	CORE
	BEA434	Monetary Economics	3	3	100	CORE
	BEA435	Introduction to Financial Management	3	3	100	CORE
	BEA471	Linear Algebra	6	5	150	DSEP
	HOL411	Holistic Education	1	2	Grade	SEC
	VAC411	Value Added Courses	2	2	-	SEC
		Total	**26**	**26**	**650**	
SEM	**SUBCODE**	**SUBJECT NAME**	**Hrs./WEEK**	**CREDIT**	**MAX MARKS**	**TYPE**
V	BEA531	Applied Regression	4	4	100	CORE
	BEA532	Economics of Strategy	3	3	100	CORE
	BEA571	Machine Learning	6	5	150	DSEP
	BEA572	NoSQL Databases and Best Practices	6	5	150	DSEP
	BEA541-A	Institutional Economics	3	3	100	DSE
	BEA541-B	Financial Economics	3	3	100	DSE
	BEA541-C	Operations Research	3	3	100	DSE
	BEA573-A	Exploratory Data Analysis	5	4	100	DSEP
	BEA573-B	Data Analysis for Business Economy	5	4	100	DSEP
	BEA561	Financial Statement Analysis	2	2	50	GE
	BEA481I	Summer Internship	-	1	50	
		Total	**29**	**27**	**800**	
SEM	**SUBCODE**	**SUBJECT NAME**	**Hrs./WEEK**	**CREDIT**	**MAX MARKS**	**TYPE**
VI	BEA671	Big Data Analytics	6	5	150	DSEP
	BEA641-A	Public Economics	3	3	100	DSE
	BEA641-B	Industrial Economics	3	3	100	DSE
	BEA641-C	Actuarial Mathematics and Statistics	3	3	100	DSE
	BEA672-A	Introduction to TensorFlow	6	5	150	DSEP
	BEA672-B	Data Visualization Techniques	6	5	150	DSEP
	BEA672-C	Time Series and Forecasting	6	5	150	DSEP
	IC611	Indian Constitutional Law	-	1	Grade	SEC
	BEA661	Human Resource Management	2	2	50	GE
	BEA681P	Project	10	5	300	
		Total	**27**	**21**	**750**	

SEMESTER 1

BEA131 DISCRETE MATHEMATICS

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 **Credits: 4**

Course Objectives

- Formulate and interpret statements by applying the rules and methods of propositional logic
- Demonstrate a working knowledge of set notation and elementary set theory, recognize the connection between set operations and logic
- Prove elementary results involving sets
- Apply the different properties of injections, surjections, bijections, compositions, and inverse functions
- Demonstrate the use of mathematical reasoning by justifying and generalizing patterns and relations
- Determine when a relation is reflexive, symmetric, antisymmetric, or transitive, apply the properties of equivalence relations and partial orderings, and explain the connection between equivalence relations
- Gain enhanced understanding on Boolean algebra and it uses in Circuits

Course Outcomes

After successful completion of the course students will be able to

- Understand the notion of mathematical thinking, mathematical proofs, and algorithmic thinking, and be able to apply them in problem solving.
- Understand the basics of combinatorics, and be able to apply the methods from these subjects in problem solving.
- Be able to use effectively algebraic techniques to analyse basic discrete structures and algorithms.

Unit 1 **Hours: 15**

Foundations of Mathematical Logic-

Propositional Logic: Propositions, Conditional Statements, Truth tables of Compound Statements, Precedence of Logical Operators, Logic and bit operations - **Applications of Propositional Logic**: Translating English sentences, System specifications, Boolean Searches, Logic Puzzles, Logic Circuits - **Propositional Equivalences:** Compound proposition, Logical Equivalences, Using De Morgan's Laws, Constructing new logical equivalences, Propositional Satisfiability, Applications of Satisfiability: A Sudoku Puzzle,

Predicates and Quantifier : Predicates, Quantifiers, Quantifiers with Restricted Domains, Precedence of Quantifiers.

Unit 2 **Hours: 15**

Permutations, Combinations and Functions-

Permutations: permutation, r-permutations, circular r-permutations, permutations with repetitions, permutations with indistinguishable objects, **Combinations:** r-combinations, combinations with repetitions, **Functions:** Definition of a Function, functions in programming languages, One-to-One and Onto functions, One to one correspondence, Inverse functions and compositions of functions, Graphs of functions, Floor, ceiling, greatest Integer and Factorial functions,, partial functions.

Unit 3 **Hours: 15**

Matrices: Matrix, Matrix Arithmetic, Transposes and Powers of Matrices, Zero-One Matrices: Boolean Product, Diagonal Matrix, Inverse of Matrix, System of Linear equations and Matrices **- Relations:**

Relations and Products, Functions as Relations, Relations on a Set, Properties of Relations: reflexive, irreflexive, symmetric, asymmetric, antisymmetric, transitive, inverse and complementary relations, Combining Relations, **n-ary Relations and their applications:** n-ary Relations, Databases and Relations, Operations on n-ary Relations, SQL.

Unit 4 **Hours: 15**

Boolean Algebra-

Boolean Functions: Boolean Expressions and Boolean Functions, Identities of Boolean Algebra, Duality, The Abstract definition of a boolean algebra, **Representing Boolean Functions:** Sum-of-Products expansions, Product-of-Sums expansions, Functional Completeness, **Logic Gates:** Combinations of Gates, Half Adder, Full Adder, **Minimization of Circuits:** Karnaugh Maps, Don't Care Conditions, The Quine-McCluskey Method.

Text Books

- K. H. Rosen, Discrete Mathematics and its Applications, 7th ed., McGraw – Hill, 2012.

Reference Books

- R.P. Grimaldi and B.V. Ramana, Discrete and Combinatorial Mathematics, An applied introduction, 5th ed., Pearson Education, 2007.
- D. S. Chandrasekharaiah, Discrete Mathematical Structures, 4th ed., India: PRISM Book Pvt. Ltd., 2012.

- J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Application to Computer Science, Reprint, India: Tata McGraw Hill Education, , 2008.

BEA132 STATISTICAL METHODS

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 **Credits: 4**

Course Objectives

- To introduce the historical development of statistics, presentation of data, descriptive measures and fitting mathematical curves for the data.
- To introduce measurement of the relationship of quantitative and qualitative data and the concept of probability.
- To enable the students to understand and apply the descriptive measures and probability for data analysis.

Course Outcomes

After Successful completion of the course students will be able to

- Demonstrate the history of statistics and present the data in various forms.
- Infer the concept of correlation and regression for relating two or more related variables.
- Demonstrate the probabilities for various events.

Unit 1 **Hours: 10**

Organization and Presentation of data: Origin and development of Statistics, Scope, limitation and misuse of statistics. Types of data: primary, secondary, quantitative and qualitative data. Types of Measurements: nominal, ordinal, discrete and continuous data. Presentation of data by tables: construction of frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

Unit 2 **Hours: 15**

Descriptive Statistics Measures of location or central tendency: Arithmetic Mean, Median, Mode, Geometric mean, Harmonic mean. Partition values: Quartiles,

Deciles and percentiles. Measures of dispersion: Mean deviation, Quartile deviation, Standard deviation, Coefficient of variation. Moments: measures of skewness, Kurtosis.

Unit 3 **Hours: 10**

Correlation and Regression: Correlation: Scatter plot, Karl Pearson coefficient of correlation, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only). Regression: Concept of errors, Principles of Least Square, Simple linear regression and its properties.

Unit 4 **Hours: 10**

Association of Attributes: Relation between class frequencies, consistency of data, independence of attributes, criterion of independence, association of attributes: Yule's coefficient of association, Yule'coefficient of colligation

Unit 5 **Hours: 15**

Basics of Probability : Random experiment, sample point and sample space, event, algebra of events. Definition of Probability: classical, empirical and axiomatic approaches to probability, properties of probability. Theorems on probability, conditional probability and independent events, Laws of total probability, Baye's theorem and its applications.

Textbooks

1. Rohatgi V.K and Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015.
2. Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons, New Delhi, 2014.

Reference Books

1. Mukhopadhyay P, Mathematical Statistics, Books and Allied (P) Ltd, Kolkata, 2015.
2. Walpole R.E, Myers R.H, and Myers S.L, Probability and Statistics for Engineers and Scientists, Pearson, New Delhi, 2017.
3. Montgomery D.C and Runger G.C, Applied Statistics and Probability for Engineers, Wiley India, New Delhi, 2013.
4. Mood A.M, Graybill F.A and Boes D.C, Introduction to the Theory of Statistics, McGraw Hill, New Delhi, 2

BEA 133 INTRODUCTORY MICRO ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The Course enables Students to

- Understand that economics is about the allocation of scarce resources and how that results in trade-offs.
- Understand the role of prices in allocating scarce resources in market
- economies and explain the consequences of government policies in the form of price controls.
- Appreciate positive as well as normative view points on concepts of market failure and the need for government intervention.

Course Outcomes

After Successful completion of the course students will be able to

- Acquaint students with the basic principles of microeconomic theory.
- Describe the market structure.

UNIT 1 **Hours: 9**

Exploring the subject matter of Economics

Why study economics? Scope and method of economics; the economic problem: scarcity and choice; the question of what to produce, how to produce and how to distribute output; science of economics; the basic competitive model; prices, property rights and profits; incentives and information; rationing; opportunity sets; economic systems; reading and working with graphs.

UNIT 2 **Hours: 9**

Supply and Demand:

How Markets Work, Markets and Welfare Markets and competition; determinants of individual demand/supply; demand/supply schedule and demand/supply curve; market versus individual demand/supply; shifts in the demand/supply curve, demand and supply together; how prices allocate resources; elasticity and its application; controls on prices; taxes and the costs of taxation; consumer surplus; producer surplus and the efficiency of the markets.

UNIT 3 **Hours: 9**

The Households

The consumption decision - budget constraint, consumption and income/price changes, demand for all other goods and price changes; description of preferences

(representing preferences with indifference curves); properties of indifference curves; consumer ‘s optimum choice; income and substitution effects; labour supply and savings decision - choice between leisure and consumption.

UNIT 4 **Hours: 9**

The Firm and Perfect Market Structure

Behaviour of profit maximizing firms and the production process; short run costs and output decisions; costs and output in the long run.

UNIT 5 **Hours: 9**

Imperfect Market Structure

Monopoly and anti-trust policy; government policies towards competition; imperfect competition.

Text Books

1. C. Snyder and W. Nicholson (2011).Fundamentals of Microeconomics (11th ed.).Cengage Learning India.
2. Hal R. Varian. (2014).Intermediate Microeconomics, a Modern Approach (9th ed.). W.W. Norton and Company/Affiliated East-West Press(India)
3. Bernheim, Douglas B & B. Michael, Whinston D. (2009). Microeconomics. Tata McGraw-Hill India.

Reference Books

1. Henderson, J. M.& Quandt R. E. (2003). Microeconomic Theory: A Mathematical Approach, New Delhi: McGraw Hill.
2. Koutsoyiannis, A. (1979). Modern Microeconomics. London:Macmillan Press.
3. Kreps, David M., (1990). A Course in Microeconomic Theory. Princeton: Princeton University Press.
4. Lipsey, R.G. and K.A. Chrystal (1999). Principles of Economics. (9th ed.). Oxford University Press. Oxford.
5. Mas-Colell, A., Whinston, M. D., & Green, J. R. (1995). Microeconomic theory (Vol. 1). New York: Oxford university press.
6. Pindyck, Robert & Rubinfeld, Daniel (2013). Micro Economics. (8th ed.). New York: Pearson Education.
7. Samuelson, Paul A and William D Nordhaus (2010). Economics, (19th ed.). McGraw-Hill Companies.
8. Sen, Anindya, (2007). Microeconomics: Theory and Applications. New Delhi: Oxford University Press.

BEA134 INTRODUCTORY MACRO ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The Course enables Students

- To introduce to the students, the basic principles of macroeconomic theory.
- To enable the students to understand the characteristics of major macroeconomic variables.
- To provide a vivid understanding to students on the evolution of macroeconomic thought.
- To equip students to analyse the dynamic interactions between the major macroeconomic variables.

Course Outcomes

After Successful completion of the course students will be able to

- Enable students to analyse the macroeconomic performance of various countries using formal analytical tools.
- Evaluate important macroeconomic policies and their implications.

UNIT 1 **Hours: 9**

Introduction to Macroeconomics and National Income Accounting

Basic issues studied in macroeconomics; measurement of gross domestic product; income, expenditure and the circular flow; real versus nominal GDP; price indices; national income accounting for an open economy; balance of payments: current and capital accounts.

UNIT 2 **Hours: 9**

The labour market

Wage determination; wages, prices and employment; natural rate of unemployment; from employment to output

UNIT 3 **Hours: 9**

Aggregate demand and aggregate supply curves

Derivation of aggregate demand and aggregate and supply curves; interaction of aggregate demand and supply to determine equilibrium output, price level and employment

UNIT 4 **Hours: 9**

Inflation

Inflation, unemployment and expectations Phillips curve; adaptive and rational expectations; policy ineffectiveness debate

UNIT 5 **Hours: 9**

Microeconomic foundations Consumption

Keynesian consumption function; Fisher's theory of optimal intertemporal choice; lifecycle and permanent income hypotheses; rational expectations and random walk of consumption expenditure Investment: determinants of business fixed investment; residential investment and inventory investment Demand for money.

Text Books

1. Abel, A., Bernanke, B. (2016). Macroeconomics, 9th ed. Pearson Education.
2. Blanchard, O. (2018). Macroeconomics, 7th ed. Pearson Education.
3. Branson, W. (2013). Macroeconomics: Theory and policy, 3rd ed, East West Press.
4. Dornbusch, R., Fischer, S., Startz, R. (2018). Macroeconomics, 12th ed. McGraw-Hill.
5. Jones, C. (2016). Macroeconomics, 4th ed. W. W. Norton.
6. Mankiw, N. (2016). Macroeconomics, 9th ed. Worth Publishers.

Reference Books

1. Paul R. Krugman, Maurice Obstfeld and Marc Melitz, International Economics, Pearson Education Asia, 9 th edition, 2012.

BEA171 PROGRAMMING IN PYTHON

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week:6**

Max Marks: 150 **Credits: 5**

Course Objectives

- Provide comprehensive knowledge of paradigms of python programming language.

Course Outcomes

After successful completion of the course students be able to

- Demonstrate the use of built-in objects of Python
- Apply the programming concepts of Python for data science applications.
- Implement GUI and Web based programming concepts.

Unit 1 **Hours: 12**

Introduction to Python, Underlying mechanism of Module Execution- Whitespace Formatting, Operators, Control Statements, Arithmetic Functions and String functions. Sequences, Mapping and Sets- Dictionaries- Functions - Lists and Mutability- Problem Solving Using Lists and File handling.

Unit 2 **Hours: 12**

Classes: Classes and Objects, Inheritance—Polymorphism- Abstract classes-Exceptional Handling, Types of exception-Inbuilt, User defined, Regular Expressions using "re" module.

Unit 3 **Hours: 12**

Introduction-Tkiner module-Root window-Widgets-Button-Label-Message-Text-Menu-ListboxesSpinbox-Creating tables

Unit 4 **Hours: 12**

Introduction-Web framework-creating model to add database service-python application shell-Django administration application-input-forms and models

Unit 5 **Hours: 12**

Introduction to Numpy, Computation on NumPy-Aggregations-Computation on Arrays-Comparisons, Masks and Boolean Arrays-Fancy Indexing-Sorting Arrays-Structured Data: NumPy's Structured Array.
Introduction to Pandas, Data Series, Data Frames, Data Wrangling, Data indexing and SelectionOperating on Data in Pandas-Handling Missing Data-Hierarchical Indexing. Visualizing DataMatplotlib, Bar Charts, Line Charts, Scatterplots, Linear Algebra, Vectors, Matrices.

Text Books

1. Wesely J.Chun,Core Python Application Programming ,Prentice Hall,third edition 2015. 2. T.R.Padmanabhan, Programming with Python,Springer Publications,2016.

Reference Books

1. Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372
2. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", 1st Edition, O'Reilly Media, 2016. ISBN-13: 978-1491912058
3. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd, 2015. ISBN-13: 978-8126556014
4. Wesley J Chun, "Core Python Applications Programming", 3rd Edition, Pearson Education India, 2015. ISBN-13: 978-9332555365

Lab Programs **Hours: 30**

1. Implement the concepts of variables and operators.
2. Implement the concepts of Strings.
3. Demonstrate the concept of Sets using real world scenario.
4. Demonstrate the concept of Lists using real world scenario.
5. Demonstrate the concept of Tuples using real world scenario.

6. Demonstrate the concept of Dictionaries using real world scenario.
7. Demonstrate the concept of File operations.
8. Implement the concept of Inheritance.
9. Implement the concept of Exception handling using predefined and user defined exceptions.
10. Demonstrate usage of basic and advance Regular expressions.
11. Demonstrate the concept of building a GUI using Tkiner.
12. Demonstrate the concept of building a web framework using Django.
13. Implement the concepts of aggregation, Indexing and sorting using Numpy Arrays.
14. Implement the concept of data series and data frames using Pandas.
15. Demonstrate the concept of data visualization using Matplotlib.

ENG121 GENERAL ENGLISH I

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

- To help learners understand the relationship between the world around them and the text/literature
- To help improve their communication skills for larger academic purposes and vocational purposes and teach them logical sequencing of content and process information
- To enable learners to be able to speak for various purposes and occasions using context specific language and expressions and to listen to audio content and infer contextual meaning.
- To enable learners to develop the ability to write for various purposes using suitable and precise language.

Course Outcomes

After successful completion of the course students be able to

- Understand how to engage with texts from various countries, historical, cultural specificities and politics
- Understand and develop the ability to reflect upon and comment on texts with various themes
- Develop the ability to communicate both orally and in writing for various purposes

- Develop an analytical and critical bent of mind to compare and analyze the various literature they read, listen and discuss in class.

Unit 1 **Hours: 6**

BEAUTY

1.1. The Happy Prince by Oscar Wilde

1.2. Shakespeare Sonnet 18

Language

Common Errors- Subject-Verb Agreement, Punctuation, Tense Errors

Unit 2 **Hours: 6**

TRAVEL

2.1. Why We Travel by Pico Iyer

2.2 What Solo Travel Has Taught Me About the World – and Myself by Shivya Nath- Blog post

Language

Sentence Fragments, Dangling Modifiers, Faulty Parallelism

Unit 3 **Hours: 6**

ENVIRONMENT

3.1. Thinking like a Mountain by Aldo Leopold

3.2. Short Text: On Cutting a Tree by Gieve Patel

Language

Note Making

Unit 4 **Hours: 6**

RELIGION

4.1. Violence in the name of God is Violence against God by Rev Dr Tveit

4.2. Leave this Chanting From Gitanjali by Rabindranath Tagore

Language

Paragraph writing

Unit 5 **Hours: 6**

CRIME

5.1. The Story of B24 by Sir Arthur Conan Doyle

5.2. Short Text: Aarushi Murder Case

Language

Newspaper report

Unit 6 **Hours: 6**

HEALTH

6.1. Long text: My Story by Nicole DeFreece
6.2. Short text: Why You Should Never Aim for Six Packs
Unit-6
Language
Essay Writing
Unit 7 **Hours:6**

SPORTS
7.1. Long Text: Sir Ranjth Singh Essay by Sourav Ganguly
7.2. Short text: Casey at the Bat by Ernest Lawrence Thayer
Unit-7
Language
Paraphrasing and interpretation skills
Unit 8 **Hours:3**

8.1 Visual Text
Visual text- Before the Flood

Text Books

- Englogue – I : A textbook for First Year Undergraduate Students

Reference Books

- Wren and Martin's English Grammar and Composition
- English Grammar and Composition by NK Narayan
- Master your English Grammar by I. Jayakaran

AEN122 LANGUAGE I

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

- To expose students to the rich literary and cultural diversity of Indian literatures
- To sensitise students on the social, political, historical and cultural ethos that has shaped the nation- INDIA
- To enable to grasp and appreciate the variety and abundance of Indian writing, of which this compilation is just a passing glance
- To learn and appreciate India through association of ideas in the texts and the external contexts (BhashaUtsav will be an intrinsic help in this endeavour)

Course Outcomes

After successful completion of the course students be able to

- The students will become sensitive to cultural, social, religious and ethnic diversities and help them engage with their peers and all around them in a more understanding and 'educated' manner.
- It will also enable them through the activities conducted to become more proactive citizens/participants in society.
- Awareness of the dynamics of gender, identity, communalism and politics of this vast nation through its literature.

Unit 1 **Hours: 10**

Poetry

1. Keki N Daruwala "Migrations"
2. Kamala Das "Forest Fire"
3. Agha Shahid Ali "Snow on the Desert"
4. Eunice D Souza "Marriages are Made"

Unit 2 **Hours: 15**

Short Stories

1. Rabindranath Tagore "Babus of Nayanjore"
2. Ruskin Bond "He said it with Arsenic"
3. Bhisham Sahni "The Boss Came to Dinner"
4. N. Kunjamohan Singh "The Taste of Hilsa"
5. Mohan Thakuri "Post Script"

Unit 3 **Hours: 20**

Essays

1. Mahatma Gandhi "What is True Civilization?" (Excerpts from *Hind Swaraj)*
2. Ela Bhatt "Organizing for Change"
3. Sitakant Mahapatra "Beyond the Ego: New Values for a Global Neighbourhood
4. B. R Ambedkar "Waiting for A Visa"

Text Books

1. Reading Diversity –Additional English Textbook

Reference Books

1. Hind Swaraj-Mahatma Gandhi
2. Annihilation of Caste- B.R Ambedkar
3. My Story- Kamala Das
4. Lone Fox Dancing- Ruskin Bond

BEA112 APPLIED EXCEL

Total Teaching Hours for Semester: 30 **No of Lecture Hours/Week: 2**

Max Marks: 50 **Credits: 1**

Course Objectives

The Course enables Students to

- Provide students with the fundamental knowledge of the use of computers in business
- Provide exposure to the students on MS Office Excel.
- Apply MS, excel functions in business.

Course Outcomes

After Successful completion of the course students will be able to

- Apply their knowledge in excel for creating useful spreadsheets
- Create their own spreadsheet containing formulas that helps in calculations
- Create spreadsheet that contains data visualization using various charts
- Create spreadsheets that contain useful functionalities like lookups and pivot charts.

Unit 1 **Hours: 6**

Introduction to Excel

Basic Excel functions: Structure of an excel function, functions such as SUM (), MIN (), MAX (), AVERAGE (), COUNT (), AUTOSUM, AUTOFILL. **Working with an Excel List:** Understanding Excel List Structure, Sorting a List Using Single Level Sort, Sorting a List Using Multi-Level Sorts, Using Custom Sorts in an Excel List, Filter an Excel List Using the AutoFilter, Creating Subtotals in a List, Format a List as a Table, Using Conditional Formatting to Find Duplicates, Removing Duplicates. **Excel Data Validation:** Understanding the Need for Data Validation, Creating a Validation List, Adding a Custom Validation Error, Dynamic Formulas by Using Validation Techniques

Unit 2 **Hours: 6**

Conditional Functions and Working with Large Excel Data Sets

Conditional Functions: Working with Excel Name Ranges, Using Excel's IF () Function, Nesting Functions, Using Excel's COUNTIF () Function, Using Excel's SUMIF () Function, Using Excel's IFERROR () Function.

Working with Large Sets of Excel Data: Using the Freeze Panes Tool, Grouping Data (Columns and/or Rows), Consolidating Data from Multiple Worksheets.

Unit 3 **Hours: 6**

LookUp and Text Based Function

Excel's Lookup Functions: Using Excel's VLOOKUP() Function, Using Excel's HLOOKUP() Function, Using Excel's INDEX() and MATCH() Functions. **Excel's Text Based Functions:** Using Excel's functions such as LEFT(), RIGHT() and MID(), LEN(), SEARCH(), CONCATENATE().

Unit 4 **Hours: 12**

Excel PivotTables:

Understanding Excel PivotTables, Creating an Excel PivotTable, Modifying Excel PivotTable Calculations, Grouping PivotTable Data, Formatting PivotTable Data, Drilling Down into PivotTable Data, Creating Pivot Charts, Filtering PivotTable Data, Filtering with the Slicer Tool.

Unit 5 **Hours: 12**

Visualization using Pivot Charts

Column Chart, Combo Chart, Scatter Plot chart, Heatmap, Stacked area chart & animating chart over time, Building an interactive dashboard in excel using a combination of techniques learn

Reference Books

1. Alexander, Kusleika, & Walkerbach ; Excel 2019 Bible;Wiley,2018
2. John Walkenbach; Excel Charts, Wiley,2016

SEMESTER II

BEA231 CALCULUS

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 **Credits: 4**

Course Objectives

This course will help the learner to,

- Gain familiarity with the concepts of limit, continuity and differentiability.
- Analyse and interpret the different versions of mean value theorems.
- Learn successive differentiation and n_{th} derivative of product of two functions.
- Find derivative of functions of more than one variable.
- Be familiar with curve tracing

Course Outcomes

After successful completion of the course students be able to

- Understand and use the notion of Derivative of the function of one variable
- Demonstrate a working knowledge of vectors and vector functions
- Determine partial derivatives of the functions of two or more variables and illustrate the computational skills in finding the directional derivatives, Gradient vectors and differentials

Unit 1 **Hours: 20**

Limits, Continuity, Differentiability and Mean Value Theorems

Definition of the limit of a function (ε-δ) form – Continuity, Uniform Continuity – Types of discontinuities – Properties of continuous functions on a closed interval – Differentiability – Mean Value Theorems: Rolle's theorem – Lagrange's and Cauchy's First Mean Value Theorems – Taylor's theorem (Lagrange's form and Cauchy's forms of remainder) –Maclaurin's theorem and expansions - Indeterminate forms. Maxima and Minima

Unit 2 **Hours: 20**

Successive and Partial Differentiation

– First and higher order derivatives – Differentiation of homogeneous functions – Euler's theorem – Taylor's theorem for two variables (only statements and problems)- Maxima and Minima of functions of two variables.

Unit 3 **Hours: 20**

Curve Tracing

Tangents and Normals, Curvature, Asymptotes, Singular points, Tracing of curves (Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates).

Text Books

1. G.B. Thomas, M. D. Weir and J. Hass, *Thomas Calculus*, 12th ed., Pearson Education India, 2015

Reference Books

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons Inc., 2002.
   F. Ayres and E. Mendelson, *Schaum's Outline of Calculus*, 6th ed. USA: Mc. Graw Hill., 2013.
2. J. Stewart, *Single Variable Essential Calculus: Early Transcendentals*, 2nd ed.: Belmont, USA: Brooks/Cole Cengage Learning., 2013.
3. S. Narayanan & T. K. M. Pillay, *Calculus*, Reprint, India: S. Viswanathan Pvt. Ltd., 2009. (Vol. I & II)
4. M. Spivak, *Calculus*, 3rd ed., Cambridge University Press, 2006.
5. T.M. Apostol, *Calculus, Vol-II*, Wiley India Pvt. Ltd., 2011.
6. J. Edwards, *An elementary treatise on the differential calculus: with applications and numerous examples*, Reprint, Charleston, USA: BiblioBazaar, 2010.
7. N. P. Bali, *Differential Calculus*, New ed. New Delhi, India: Laxmi Publications (P) Ltd., 2012.

BEA232 PROBABILITY AND DISTRIBUTION THEORY

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 **Credits: 4**

Course Objectives

The Course enables Students to

- To teach the basic concepts of random variables and its generation functions.
- To give a brief idea about standard probability distributions and how they are applied in real time situations.
- To enable the students to understand the properties and applications of various probability functions.

Course Outcomes

After Successful completion of the course students will be able to

- Demonstrate the random variables and its functions

- Infer the expectations for random variable functions and generating functions.
- Demonstrate various discrete and continuous distributions and their usage.
- Hypothesis will useful to take decision and Research

Unit 1 **Hours: 10**

Random variables: Definition, Discrete and continuous random variables, Probability Mass function and Probability density function, Distribution function and its properties. Two dimension random variables: Discrete and continuous type, Joint Density function, Marginal and conditional Probability Mass function and Probability Density function, independence of variables with illustration.

Unit 2 **Hours: 10**

Mathematical Expectation and Generating functions: Expectation of single and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications, Conditional expectations

Unit 3 **Hours: 10**

Discrete Probability distributions: Discrete distributions, Mathematical Expectation, Binomial, Poisson, geometric, negative binomial, Hypergeometric distributions along with their properties, limiting/approximation cases and applications.

Unit 4 **Hours: 15**

Continuous Probability distributions: Continuous distributions: Uniform, normal, exponential, Cauchy, beta and gamma distributions along with their properties, limiting/approximation cases and applications.

Unit 5 **Hours: 15**

Continuous Distribution: Univariate continuous distribution Uniform, Normal, Exponential, Cauchy, Gamma, and Beta distributions Mean and Variance and their properties Sampling distributions t, F and Chi-square distribution Derivation and its properties Relationship between t, F and Chi-square distribution.

Text Books

1. Rohatgi V.K and Saleh E, *An Introduction to Probability and Statistics*, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015.
2. Gupta S.C and Kapoor V.K, *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi, 2014.

Reference Books

1 .Mukhopadhyay P, Mathematical Statistics, Books and Allied (P) Ltd, Kolkata, 2015.
2 Walpole R.E, Myers R.H, and Myers S.L, Probability and Statistics for Engineers and Scientists, Pearson, New Delhi, 2017.
3 Montgomery D.C and Runger G.C, Applied Statistics and Probability for Engineers, Wiley India, New Delhi, 2013.
4 Mood A.M, Graybill F.A and Boes D.C, Introduction to the Theory of Statistics, McGraw Hill, New Delhi, 200

BEA233 INTRODUCTION TO DATA SCIENCE

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 **Credits: 4**

Course Objectives

The Course enables Students to

- Provide a strong foundation for data science and application areas related to it.
- Understand the underlying core concepts and emerging technologies in data science.
- Learn the process of working with data on large scale.
- Explore the concepts of Data Processing.
- Learn basic concepts of Machine Learning.
- Prepare students for advanced courses in Data Science.

Course Outcomes

After Successful completion of the course, students will be able to

- Understand the fundamental concepts of data science.
- Evaluate the data analysis techniques for applications handling large data and Demonstrate the data science process.
- Understand concept of machine learning used in the data science process.
- Visualize and present the inference using various tools.
- Learn to think through the ethics surrounding privacy, data sharing.

Unit 1 Data Evolution **Hours: 12**

Data Evolution: Data to Data Science – Understanding data: Introduction – Type of Data, Data Evolution – Data Sources.

Preparing and gathering data and knowledge - Philosophies of data science - data all around us: the virtual wilderness - Data wrangling: from capture to domestication - Data science in a big data world - Benefits and uses of data science and big data - facets of data.

Unit 2 **Hours: 12**

Digital Data-An Imprint: Introduction to Big Data: - Evolution of Big Data - What is Big Data – Sources of Big Data. Characteristics of Big Data 6Vs – Big Data-Challenges of Conventional Systems- -– Data Processing Models – Limitation of Conventional Data Processing Approaches – Big Data. Big Data Exploration - The Big data Ecosystem and Data science.

Overview of the data science process - retrieving data - Cleansing, integrating, and transforming data.

Unit 3 **Hours: 12**

Machine learning – Modelling Process – Training model – Validating model – Predicting new observations –Supervised learning, Unsupervised learning, Semi-supervised learning. Exploratory data analysis.

Unit 4 **Hours: 12**

First steps in big data - Distributing data storage and processing with frameworks - Case study: Assessing risk when loaning money - Join the NoSQL movement - Introduction to NoSQL - Case Study. The rise of graph databases - Introducing connected data and graph databases.

Unit 5 **Hours: 12**

Ethics and Data Science- Doing Good Data Science, Data Ownership, The Five Cs, Implementing the Five Cs, Ethics and Security Training, Developing Guiding Principles, Building Ethics into a Data-Driven Culture, Regulation, Building Our Future, Case Study.

Text Books

1. Introducing Data Science, Davy Cielen, Arno D. B. Meysman and Mohamed Ali, Manning Publications, 2016.
2. Think Like a Data Scientist, Brian Godsey, Manning Publications, 2017.

3. Ethics and Data Science, Mike Loukides, Hilary Mason and D J Patil, O'Reilly, 1st edition, 2018.

Reference Books

1. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015.
2. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O' Reilly, 1st edition, 2013.
3. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Cambridge University Press, 2nd edition, 2014.
4. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013.

BEA234 APPLIED MICRO ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The Course enables Students to

- Train the students of Economics about the basic elements of consumer theory and production theory and the functioning of perfectly competitive market.
- Understand efficiency of markets and the environment where the standard market mechanism fails to generate the desirable outcomes.
- Provide a vivid understanding to students on the evolution of macroeconomic thought.
- Understand issues of market imperfection and market failures

Course Outcomes

After Successful completion of the course students will be able to

- Understand that economics is mainly about the allocation of scarce resources and thereby explain how that results in trade-offs.
- Understand the role of prices in allocating scarce resources in market economies and explain the consequences of government policies.

UNIT 1 **Hours: 09**

Consumer theory

Preference; utility; budget constraint; choice; demand; Slutsky equation; buying and selling; choice under risk and intertemporal choice; revealed preference

UNIT 2 **Hours: 09**

Production, costs and perfect competition

Technology; isoquants; production with one and more variable inputs; returns to scale; short run and long run costs; cost curves in the short run and long run; review of perfect competition.

UNIT 3 **Hours: 09**

General equilibrium, efficiency and welfare

Equilibrium and efficiency under pure exchange and production; overall efficiency and welfare economics.

UNIT 4 **Hours: 09**

Market structure and game theory

Monopoly; pricing with market power; price discrimination; peak-load pricing; two-part tariff; monopolistic competition and oligopoly; game theory and competitive strategy

UNIT 5 **Hours: 09**

Market failure Externalities

Public goods and markets with asymmetric information

Text Books

1. Osborne, M. (2004). An introduction to game theory. Oxford University Press.
2. Snyder, C., Nicholson, W. (2010). Fundamentals of microeconomics. Cengage Learning.
3. Varian, H. (2010). Intermediate microeconomics: A modern approach, 8th ed. W. W. Norton.

Reference Books

2. Henderson, J. M.& Quandt R. E. (2003). Microeconomic Theory: A Mathematical Approach, New Delhi: McGraw Hill.
3. Koutsoyiannis, A. (1979). Modern Microeconomics. London: Macmillan Press.
4. Kreps, David M., (1990). A Course in Microeconomic Theory. Princeton: Princeton University Press.
5. Bergstrom, T., Varian, H. (2014). Workouts in intermediate microeconomics. W. W. Norton.

BEA235 APPLIED MACRO ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The Course enables Students

- To enhance the understanding of closed and open macro-economy modelling.
- To critically reflect on the dynamics of macroeconomic policies in the present economic conditions.
- To understand and critically evaluate the current developments in the field of macroeconomic policy.

Course Outcomes

After Successful completion of the course students will be able to

- Understand the working of the macro economy with long run economic phenomena like economic growth, technological progress, R&D and innovation.
- Enable students to understand business cycles and the concomitant role of policies.

UNIT 1 **Hours: 9**

Business cycles

Real business cycle theory; new Keynesian models of sticky prices

UNIT 2 **Hours: 9**

Open economy models

Short-run open economy models; Mundell-Fleming model; exchange rate determination; purchasing power parity; asset market approach; Dornbusch's overshooting model; monetary approach to balance of payments; international financial markets

UNIT 3 **Hours: 9**

Fiscal and monetary policy Active or passive; monetary policy objectives and targets; rules versus discretion: time consistency; the government budget constraint; government debt and Ricardian equivalence.

UNIT 4 **Hours: 9**

Open-Economy Macroeconomics and Exchange Rates

National Income accounting and balance of payment; Exchange Rates and the Foreign Exchange Market; Money, Interest Rates, and Exchange Rates; Price Levels and the Exchange Rate in the Long Run; Output and the Exchange Rate in the Short Run; Fixed Exchange Rates and Foreign Exchange Intervention.

UNIT 5 **Hours: 9**

International Macroeconomic Policy: International Monetary Systems: An Historical Overview; Financial Globalization: Opportunity and Crisis; Optimum Currency Areas and the Euro; Developing Countries: Growth, Crisis, and Reform

Text Books

1. Abel, A., Bernanke, B. (2016). Macroeconomics, 9th ed. Pearson Education.
2. Blanchard, O. (2018). Macroeconomics, 7th ed. Pearson Education.
3. Branson, W. (2013). Macroeconomics: Theory and policy, 3rd ed, East West Press.
4. Dornbusch, R., Fischer, S., Startz, R. (2018). Macroeconomics, 12th ed. McGraw-Hill.
5. Jones, C. (2013). Introduction to economic growth, 2nd ed. W. W. Norton.
6. Jones, C. (2016). Macroeconomics, 4th ed. W. W. Norton. 7. Mankiw, N. (2016). Macroeconomics, 9th ed. Worth Publishers

Reference Books

1. Feenstra, R., Taylor, A. (2014). International economics, 3rd ed. Worth Publishers.
2. Krugman, P., Obstfeld, M., Melitz, M. (2018). International economics: Theory and policy, 11th ed. Pearson Education.
3. Pugel, T. (2015). International Economics, 16th ed. McGraw-Hill Education

BEA272 R FOR ANALYTICS

Total Teaching Hours for Semester: 75 **No of Lecture Hours/Week: 5**

Max Marks: 100 **Credits: 4**

Course Objectives

The Course enables Students to

- Understand the environment R and the R preliminaries.
- Apply the R objects for statistical computations.
- Analyze and model data using various statistical packages.

Course Outcomes

After Successful completion of the course students will be able to

- Handle data using statistical tool
- Perform graphical representation of data using R
- Use R packages for introductory statistics.

Unit 1 **Hours: 9**

Introduction

Introduction and preliminaries-The R environment, R and statistics, R commands, Data permanency and removing objects, Simple manipulations, Numbers and Vectors, Objects- modes and attributes, Ordered and unordered Factors, Arrays and Matrices

Unit 2 **Hours: 9**

Lists and Data Frames

Constructing and modifying lists, Making Data frames, attach( ) and detach( ), Working with data frame, Reading data from files using read.table( ), scan( ), Grouping, Conditional execution: if statements, Repetitive execution: for loops, repeat and while loops, Functions.

Unit 3 **Hours: 9**

Data Exploration for Univariate and Bivariate Data

Univariate Data - Handling categorical data and numerical data using R, Bivariate Data -Handling bivariate categorical data using R, Categorical vs. Numerical, Numerical vs. Numerical

Unit 4 **Hours: 9**

Data Exploration for Multivariate Data

Multivariate Data **-**Storing multivariate data in R data frames, Accessing and manipulating data in R data frames, view multivariate data, apply( ) family functions -

apply( ), sapply(), lapply( ), tapply( ), *dplyr* package- select( ), filter( ), arrange( ), rename( ), mutate( ), group_by( ), %>%, summarize( ).

Unit 5 **Hours: 9**

Correlation and Data Visualization

Pearson correlation, Spearman rank correlation
lattice package in R - 1D, 2D, 3D plots using lattice
ggplot2 package in R- 1D, 2D, 3D plots using ggplot2

Lab Programs **Hours:30**

1. Demonstrate the usage of Numbers and Vectors in R
2. Simple manipulations on Numbers and Vectors, Objects- modes and attributes, Ordered and unordered Factors
3. Implement the concepts of Arrays and Matrices
4. Demonstrate the usage of Data Frames and Lists and its attributes -attach, detach, scan and importing a file
5. Implement the concept of grouping and conditional execution on Data Frames and Lists
6. Demonstrate repetitive executions on Data Frames
7. Use a Dataset to handle the Categorical and numerical data
8. Use a Dataset to handle the Bi-variate categorical data
9. Use a Dataset to handle the Multivariate categorical data
10. Demonstrate the usage of apply() functions.
11. Implement the usage of dplyr package
12. Utilize a lattice package to plot 1D, 2D and 3D plots for a given dataset.
13. Utilize ggplot2 package to plot 1D, 2D and 3D plots for a given dataset.
14. Demonstrate Pearson correlation and Spearman rank correlation.

Text Books

1. W. N. Venables, D. M. Smith, *An Introduction to R*, R Core Team, 2018.
2. John Verzani, *simpleR – Using R for Introductory Statistics*, CRC Press, Taylor & Francis Group, 2005.

Reference Books

1. Seema Acharya, *Data Analytics Using R*, CRC Press, Taylor & Francis Group, 2018.
2. Michael Lavine, *Introduction To Statistical Thought*, Orange Grove Books, 2009.
3. Paul Teetor, *R Cookbook,* O'Reilly, 2011

ENG221 ENGLISH - II

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

- To help learners understand the relationship between the world around them and the text/literature
- To help improve their communication skills for larger academic purposes and vocational purposes and teach them logical sequencing of content and process information
- To enable learners to be able to speak for various purposes and occasions using context specific language and expressions and to listen to audio content and infer contextual meaning.
- To enable learners to develop the ability to write for various purposes using suitable and precise language.

Course Outcomes

- Understand how to engage with texts from various countries, historical, cultural specificities and politics.
- Understand and develop the ability to reflect upon and comment on texts with various themes.
- Develop the ability to communicate both orally and in writing for various purposes.
- Develop an analytical and critical bent of mind to compare and analyze the various literature they read, listen and discuss in class.

Unit 1 **Hours: 9**

FOOD

1.1. Long text: Witches' Loaves by O Henry

1.2. Short text: Portion size is the trick!!! by Ranjani Raman

Language

1.1.1. Presentation Skills

1.1.2. Listening skills

Unit 2 **Hours: 7**

FASHION

2.1. Long text: In the Height of Fashion by Henry Lawson

2.2. Short text: Crazy for Fashion by Babatunde Aremu

Language

2.1.1. Report Writing

2.1.2. Listening skills

Unit 3 **Hours: 8**

MANAGEMENT

3.1. Long Text: The Amazing Dabbawalas of Mumbai by Shivani Pandita

3.2. Short Text: If by Rudyard Kupling

Language

3.1.1. Interview Skills and CV Writing

3.1.2. Listening skills

Unit 4 **Hours: 9**

HISTORY

4.1. Long text: Whose Ambedkar is he anyway? by KanchaIlaiah

4.2. Short text: Dhauli by Jayanta Mahapatra

Language

4.1.1. Developing Arguments- Debating

4.1.2. Listening skills

Unit 5 **Hours:8**

WAR

5.1. Long text: An Occurrence at Owl Creek Bridge by Ambrose Bierce

5.2. Short text: Strange meeting by Wilfred Owen

Language

5.1.1. Letter Writing

5.1.2. Listening skills

Unit 6 **Hours: 4**

VISUAL TEXT

6.1 BBC Documentary- Dabbawalas

Text Books

1. Englogue – I : A textbook for First Year Undergraduate Students

Reference Books

1. Shivani Pandita, *The story of Mumbai Dabbawalas,* BBC Documentary,2008.
2. I.Jayakaran, *Master your English Grammar*, 2M Publishing International,2004.
3. Wren & Martin, *English and Grammar Composition*, Blackie ELT Books,2016.
4. https://www.youtube.com/watch?v=M7hOpT0lPGI, TED Talk, 2018.
5. https://www.youtube.com/watch?v=lmyZMtPVodo, TED Talk, 2014.
6. Rudyard Kipling, *Something of myself*, Macmillan and Co Limited ,1937

AEN222 ADDITIONAL ENGLISH - II

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

- To expose students to the rich literary and cultural diversity of Indian literatures
- To sensitise students on the social, political, historical and cultural ethos that has shaped the nation- INDIA
- To enable students to express and appreciate the variety and abundance of Indian writing, of which this compilation is just a passing glance
- To analyse and learn about India through association of ideas in the texts and the external contexts.

Course Outcomes

- The students will be able to identify the cultural, ethical, social and political situations that exists in India
- The course will sensitize students towards cultural, social, religious and ethnic diversities and help them engage with their peers and all around them in a more understanding and 'educated' manner.
- It will enable students to critically analyse the Indian culture and societal structure through the activities conducted to become more proactive citizens/participants in society.
- Students will be able to explain the dynamics of gender, identity, communalism and politics of the nation through its literature.

Unit 1 **Hours: 10**

Poetry

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s of Sense"
us"
r"

Unit 2 **Hours: 15**

Short Stories

6. Temsula Ao "The Journey"
7. A. K Ramanujan "Annaya's Anthropology"
8. Sundara Ramswamy "Waves"
9. Ashfaq Ahmed "Mohsin Mohalla"

10. T.S Pillai "In the Floods"

Unit 3 **Hours: 20**

Essays

5. Salman Rushdie "Gandhi Now"
6. Amartya Sen "Sharing the World"
7. Suketu Mehta "Country of the No"
8. Rahul Bhattacharya "Pundits From Pakistan" (An Excerpt)

Text Books

1. Reading Diversity –Additional English Textbook

Reference Books

1. A.K Ramanujan, *Is there an Indian way of Thinking*?, Oxford University Press, 2004.
2. *A. Roy, The Doctor and the Saint*, Penguin Books, 2017.
3. A. Sen*, The Argumentative Indian*, Penguin Books, 2006.
4. C. Macrae*, Sri Lanka's Killing Fields*, BBC Documentary, 2011.
5. M.K. Gandhi*, Hind Swaraj,* 13ed, Cambridge texts in Modern Politics, 2009.

Recommended Books

1. Henderson, J. M.& Quandt R. E. (2003). Microeconomic Theory: A Mathematical Approach, New Delhi: McGraw Hill.
2. Lipsey, R.G. and K.A. Chrystal (1999). Principles of Economics. (9th ed.). Oxford University Press. Oxford.
3. Pindyck, Robert & Rubinfeld, Daniel (2013). Micro Economics. (8th ed.). New York: Pearson Education.
4. Samuelson, Paul A and William D Nordhaus (2010). Economics, (19th ed.). McGraw-Hill Companies.
5. Sen, Anindya, (2007). Microeconomics: Theory and Applications. New Delhi: Oxford University Press.

SEMESTER III

BEA331 SOFTWARE ENGINEERING

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The course is designed to

- Introduce to the concepts and best practices for Agile and Scrum.
- Know different life cycle models.
- Be an expert in Scrum, thus enhancing the ability to develop and deliver high-quality products, and apply Scrum concepts to the organization.
- Provide practical exposure of Agile methodologies through hands-on projects on JIRA, also maximize business value while mitigating potential risks.

Course Outcomes

After Successful completion of the course students will be able to

- Gain knowledge of difference software development lifecycle and tradeoff among them.
- Become proficient in requirement gathering, estimation, and testing techniques
- Develop understanding of Agile methodologies and its various implementations
- Attain applied knowledge of Scrum methodology using JIRA cloud
- Capable of producing different scrum artifacts, including product backlog, sprint backlog, definition of ready, and definition of done.
- Facilitate different Scrum ceremonies, including product backlog grooming, sprint planning, daily stand-up, sprint reviews, and sprint retrospective.

Unit 1 **Hours: 12**

Software Process

Introduction –S/W Engineering Paradigm – life cycle models (water fall, incremental, spiral, WINWIN spiral, evolutionary, prototyping, object oriented) - system engineering – computer based system – verification – validation – life cycle process – development process –system engineering hierarchy - Requirements and Estimation – Testing Basis.

Unit 2 **Hours: 10**

Agile Project Management

Why Agile - Agile Manifesto - Principles behind Agile Manifesto - History of Agile – Agile Methods and Examples - Project Engineering: Then & Now - Traditional Approach & Agile Approach - Some Agile Facts and Figures

Unit 3 **Hours: 8**

Overview of SCRUM

What is SCRUM - Overview of SCRUM - Key Aspects of SCRUM – Product Owner, Planning Poker, the Team, The Sprint, Scrum Master, Manager in Scrum and Product Backlog - Scrum Pre-Planning meeting – Roadmap – Estimation - Backlog

Unit 4 **Hours: 7**

Sprint in Agile

Scrum Pre-Planning Meeting - Sprint Planning meeting - A typical Sprint Calender - Defining DONE - Getting to DONE – Definition of Ready - Good and BAD Ways.

How Sprint Works: Daily Scrum Meeting - Updating Sprint Backlog - Burndown Chart – TaskBoard - Sprint Review - Sprint Retrospective

Unit 5 **Hours: 8**

Scrum and Metrics

Principles of Agile metrics – Reflections: – Reflection of each iteration - Business value Delivered – Velocity – BurnDown - Code Coverage – Pairing - Defects Caried Over. Release Planning and Estimation in Scrum: Velocity – Based on historical Data - How to plan a release in Scrum - Scrum dis-advantages

Text Books

1. The Scrum Essential Scrum: A Practical Guide to the Most Popular Agile Process (Addison-Wesley Signature Series (Cohn)) - Free downloadable pdf link
2. Essential Scrum: A Practical Guide to the Most Popular Agile Process (Addison-Wesley Signature Series (Cohn)) : Link
3. Agile Methodologies - free ebook : Link

Reference Books

1. Roger S. Pressman, *Software engineering- A Practitioner's Approach*, McGraw-Hill International Edition, 9th Edition 2020.
2. Ian Sommerville, *Software engineering,* Pearson education Asia, 10th Edition 2016.

BEA332 PROFESSIONAL ETHICS IN COMPUTING

Total Teaching Hours for Semester: 30 **No of Lecture Hours/Week: 2**

Max Marks: 50 **Credits: 2**

Course Objectives

The Course enables Students

- To create an awareness on Engineering Ethics
- To instil Moral and Social Values and Loyalty.
- To appreciate the rights of Others

Course Outcomes

After Successful completion of the course students will be able to

- Apply the Ethical values in their professional life
- Implement the moral and social values pertaining to the personal and social life
- Understand how to tackle the rights issue in their professional life.

Unit 1 **Hours: 7**

Engineering Ethics

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas – moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories.

Unit 2 **Hours: 7**

Engineering as Social Experimentation

Engineering as experimentation - engineers as responsible experimenters - codes of ethics – a balanced outlook on law - the challenger case study

Unit 3 **Hours: 8**

Safety, Responsibilities and Rights

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the Three Mile Island and Chernobyl case studies.

Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.

Unit 4 **Hours: 8**

Global Issues

Multinational corporations - Environmental ethics - computer ethics – weapons development - engineers as managers-consulting engineers-engineers as expert

witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE),India, etc.

Text Books

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York 1996.
2. 2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

Reference Books

1. Charles D. Fleddermann, "Engineering Ethics", Pearson Education / Prentice Hall, NewJersey, 2004 (Indian Reprint)
2. 2. Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics –Concepts and Cases", Wadsworth Thompson Learning, United States, 2000 (Indian Reprintnow available)
3. 3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi,2003.
4. 4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.

BEA333 APPLIED ECONOMETRICS -I

Total Teaching Hours Semester:45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The course aims at providing students with:

- Provide a comprehensive introduction to basic econometric concepts and techniques,
- To develop the ability to apply econometric techniques in the investigation of economic relationships and processes.
- To provide the understanding of the specific econometric problems associated with economic statistics.

Course Outcomes

Undergoing the course, the students will have the knowledge and skills required:

- For the construction and estimation of simple and multiple regression models.
- To perform econometric analysis and estimation, by understanding their application in economics.
- To analyse each economic problem in depth, and
- To do not only the estimation of the model and testing of the hypotheses, but also perform post-estimation diagnostics and see how well the model performs.

Unit 1 **Hours: 9**

Introduction

Definition and scope of econometrics – the methodology of econometric research – the historical origin of the term regression and its modern interpretation – statistical vs deterministic relationship – regression vs causation – regression vs correlation – terminology and notation – the nature and sources of data for econometric analysis.

Unit 2 **Hours: 9**

Two-Variable Case Estimation of model by OLS method – Assumptions – Properties of Least Square Estimators: Gauss-Markov Theorem; Testing of regression coefficient; Test for regression as a whole, Coefficient of determination.

Unit 3 **Hours: 9**

Multiple Linear Regression

Model Multiple Regression Analysis: The problem of estimation – notation and assumptions – meaning of partial regression coefficients the multiple coefficient of determination – R2 and the multiple coefficient of correlation R – R2 and adjusted R2 – partial correlation coefficients – interpretation of multiple regression equation.

Unit 4 **Hours: 9**

Relaxing the Assumptions of CLRM

Introduction to multicollinearity, heteroscedasticity, autocorrelation; the nature of the problem, its detection and corrective measures.

Unit 5

Model Specification Errors **Hours: 9**

Omitted Variables and test – Irrelevant Variables – Misspecification of the functional form – Alternative functional forms - Errors of Measurement – Outliers, Leverage and Influence data. , The Nature of Dummy Variables – Dummy Variable Trap – ANOVA –

Use of Dummy variables: Structural Break, Seasonal Adjustment, and Interaction effects – Nature of Qualitative response models – Linear Probability Model – Logit Model – Probit Model.

Textbooks

1. Gujarati, D. N., Porter, D.C., & Gunasekar, S. (2017). Basic Econometrics. (5th ed.). McGraw-Hill.
2. Studenmund, A. H. (2016). Using Econometrics: A Practical Guide. (7th ed.). New Delhi: Pearson.

Reference Books

1. Dougherty, C. (2016). Introduction to Econometrics (5th ed.). Oxford University Press.
2. Koutsoyiannis, A. (1973). Theory of Econometrics. New York: Harper & Row.
3. Wooldridge, J. M. (2014). Introductory Econometrics: A Modern Approach (4th ed.). New Delhi: Cengage Learning

BEA334 ECONOMIC POLICY ANALYSIS

Total Teaching Hours Semester:45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The purpose of this course is to evaluate the effectiveness of public policy in promoting efficiency and equity in our economy. Microeconomics and welfare economics provide a theoretical base, and regression and cost-benefit analyses serve as the primary empirical tools of analysis. A number of selected policies will be studied and evaluated. In addition to being of interest in their own right, the outcomes of these policies can inform future social decision-making, by revealing responses to incentive effects and potential unintended consequences, and by providing examples of effective and ineffective means of attaining social and economic goals.

Course Outcomes

- The main objective is to understand the public policy design and implementation process along with monitoring and evaluation techniques.

- Increase their knowledge of public policy theories, ideologies and contexts, positioning public policy as an important subfield of social science.
- Course will develop the necessary analytical skills among students to contribute to future policy investigation and study.

Unit 1 **Hours: 11**

The Meaning Of Policy Analysis

Basic concepts of public policy, including underlying normative and positive theories, political ideologies, policy determinants, and contextual influences, The goals and steps in policy analysis, A review of markets and rational behaviour.

Unit 2 **Hours: 11**

Efficiency, Imperfect Markets and Governments

Pareto optimality, Other efficiency concepts, The competitive market and Pareto optimality, Market imperfections and inefficiency, The minimum role of government, Taxes in competitive markets, Other forms of government involvement.

Unit 3 **Hours: 11**

Tools For Analyzing Public Policy

The process of benefit–cost analysis, Decision criteria for benefit–cost analysis, Types of policy decisions, Policy analysis involving risk and uncertainty, The expected utility model, Risk aversion and the willingness to pay for insurance

Unit 4 **Hours: 12**

Public Policy Cases

Urban transportation policy: Highway congestion, Highway construction and congestion; Pollution control policy: Economic views of nature and pollution, The benefits of pollution control, Direct regulation vs. Incentive approaches comparison; Labour Market Policies: Issues skills and the labor market, Evaluating training programs, The minimum wage debate, Policy analysis of MGNREGS.

Textbooks

1. The economics analysis of public policy, William K bellinger, Routledge publication.
2. Theory and Practice in Policy Analysis, Granger Morgan, Cambridge, 2017

Reference Books

1. How an Economy Grows and Why It Crashes by Peter D Schiff, Andrew J, Schiff. Wiley; edition (May 3, 2010)
2. A practical guide for policy analysis. CQ Press. Fourth edition. Part II, Bardach, E. (2012)
3. Policy Analysis and Economics Developments, Tensions, Prospects by Weimer, David L. (Ed.) Springer Netherlands (1991).

BEA371 INFERENTIAL STATISTICS

Total Teaching Hours for Semester: 75 **No of Lecture Hours/Week: 5**

Max Marks: 100 **Credits: 4**

Course Objectives

The Course enables Students to

- To introduce the concepts of theory of estimation and testing of hypothesis
- To enable the students to give inference about the population based on sample statistics.
- To deal with the concept of parametric tests for large and small samples.
- To provide knowledge about non-parametric tests and its applications.

Course Outcomes

After Successful completion of the course students will be able to

- Demonstrate the concepts of point and interval estimation of unknown parameters and their significance using large and small samples.
- Apply the idea of sampling distributions of difference statistics in testing of hypotheses.
- Infer the concept of nonparametric tests for single samples and two samples.
- Solving the Industrial and real world problems

Unit 1 **Hours: 9**

Introduction: Introduction of Inferential statistics, Population and sample, Finite and Infinite Population, Parameter and statistic, difference between population and sample, sampling distribution, standard error, overview of inferential statistics, Estimation, type of estimates, Criteria of a good estimator, Unbiasedness, Consistency, Efficiency, Sufficiency.

Unit 2 **Hours: 9**

Estimation Theory-I: Practical questions to proof, Consistent estimator, Some Important remarks about consistency, sufficient condition for consistency.

Unit 3 **Hours: 9**

Estimation Theory II: Efficient Estimator, Minimum Variance Unbiased Estimator (MVUE), Practical questions, Cramer Rao Inequality and their conditions, sufficient estimator, Fisher-Nyman Factorization theorem and their application, Black Rao Theorem, Method of Maximum Likelihood, properties of Maximum likelihood estimators, Method of moment, Method of Moment, Properties of Moment of estimators, drawback of Moment of estimators. Method of least square

Unit 4 **Hours: 9**

Hypothesis I: Introduction of hypothesis and their types, Critical and acceptance region, Types of error, Level of significance, Power function of a test, p value and it use, procedure of testing a hypothesis, unbiased test, Neyman-Pearson lemma.

Unit 5 **Hours: 9**

Hypothesis II: Test of significance, test static and critical value, test of significance of large sample, and small sample, Test of significance for attributes (large samples), test of significance for difference in proportions, test of significance in single mean, test of significance of difference of mean, test of significance based on chi square distribution, test of significance based on t- distribution, test for difference of two population mean, Paired t test for difference of mean, Test of Significance based on F- Distribution.

Lab Programs **Hours: 9**

1. Introduction to R: How to download Cran and R studio their commands
2. Basics of R: Small operations of R software
3. Probability: existence of probabilities like binomial, Poisson etc.
4. Foundations for inference: Sampling distributions etc.
5. Foundations for inference: Confidence intervals
6. Inference for numerical data and their applications
7. Hypothesis: applications and analysis.

Text Books

1. Rohatgi V.K an Saleh E, *An Introduction to Probability and Statistics*, 3rd edition, John Wiley & Sons Inc, New Jersey, 2015.
2. Gupta S.C and Kapoor V.K, *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi, 2014.

Reference Books

1. Walpole R.E, Myers R.H and Myers S.L, *Probability and Statistics for Engineers and Scientists*, 9th edition, Pearson, New Delhi, 2017.
2. Mukhopahyay P, *Mathematical Statistics*, Books and Allied (P) Ltd, Kolkata, 2015
3. Rajagopalan M and Dhanavanthan P, *Statistical Inference*, PHI Learning (P) Ltd, New Delhi, 2012.
4. Conover W.J, *Practical Nonparametric Statistics*, 3rd edition, Wiley International, 1999.

BEA372 DATABASE MANAGEMENT SYSTEMS

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week: 6**

Max Marks: 150 **Credits: 5**

Course Objectives

The Course enables Students to

- To learn the fundamentals of data models and to conceptualize and depict a database system using ER diagram
- To make a study of SQL and relational database design
- To implement the design of the tables in DBMS
- To construct queries to get optimized outputs
- To gather an introductory knowledge about the emerging trends in the area of distributed database

Course Outcomes

After Successful completion of the course students will be able to

- Apply the fundamental concepts of databases and Entity-Relationship (E-R) model.
- Apply E-R Model and Normalization principles to create relational databases for the given problems.
- Compare and contrast different file organization concepts for data storage in Relational databases.
- Apply the transaction management principles on relational databases.
- Apply the current trends such as object-oriented databases, distributed data storage in database technology.

Unit 1 **Hours: 12**

Introduction & DBMS Architecture

Introduction- Data, Database, Database management system, Characteristics of the database approach, Role of Database administrators, Role of Database Designers, End Users, Advantages of Using a DBMS and When not to use a DBMS.
DBMS Architecture – Data Models – Categories of Data models, Schemas, Instance, and Database states, DBMS Architecture and Data Independence – The Three schema architecture, Data Independence. DBMS language and interface, Classifications of Database Management Systems.

Unit 2 **Hours: 12**

Data Modelling Using Entity-Relationship Model

Using high level conceptual Data models for Database Design, Example Database Applications. Entity types, Entity Sets, Attributes and Keys. Relationships, Relationship types, Roles and Structural constraints. Weak Entity Types and Drawing E- R Diagrams. measures

Unit 3 **Hours: 12**

Database Design
Functional dependencies and Normalization for Relational Databases - Normalization on concepts, first, second, third normal forms. Introduction to SQL.

Unit 4 **Hours: 12**

SQL
SQL data definition and data types, specifying constraints in SQL, schema change statements, Basic queries, Views – Concept of a view in SQL.

The Relational Algebra and Relational Calculus

Relational Algebra: Unary relational operations; Binary relational operations; Examples of queries in relational algebra, Relational calculus: The Tuple relational calculus; The Domain relational calculus

Unit 5 **Hours: 12**

Transaction Processing Concepts and Concurrency Control
Transaction and System concepts – Desirable properties of Transactions – Schedules and Recoverability. Lock-Based Protocols – Locks, Granting of Locks, and Two- phase locking protocol.
Distributed Databases
Distributed database concepts, Data fragmentation, Replication, and Allocation Techniques for Distributed database design, Types of Distributed database systems.

Lab Programs **Hours: 30**

Data Definition Language (DDL)
- Create, Drop Alter
- Tables
- Column
- Views
- Alter table

Data Manipulation Language (DML)
- Insert,
- Update
- Delete

SQL Functions
- The Concatenation Operator
- Column Aliases
- String Functions
- Arithmetic Functions
- Date Function

Advanced SQL Functions
- Select with Minus, Union and Intersect
- Handling NULL

Filtering Data Using Where
- Where Operators
- Where with Keywords and Logical Operators

Group by and Group by having
- Group Function Examples
- Group Function with Having

Integrity Constraints
- Types of constraint
- Referential Integrity
- Defining Constraints

Text Books

1. Elmasri Ramez and Navathe Shamkant B, Fundamentals of Database Systems, Addison- Wesley, 6th Edition, 2010

Reference Books

1. Silberschatz, Korth, Sudarshan, Database System Concepts, 5 Edition, McGraw Hill, 2006.
2. O`neil Patricand, O`neil Elizabeth, Database Principles, Programming and Performance, 2nd Edition, Margon Kaufmann Publishers Inc, 2008.
3. Raghu Ramakrishnan, “Database Management System”, Tata McGraw-Hill Publishing Company, 2003

SEMESTER IV

BEA431 SAMPLING TECHNIQUES

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 **Credits: 4**

Course Objectives

This course is designed to introduce students about official statistical system in India and to understand basic concepts of Sampling and surveys. Through the course student will be able

- To enable the students to understand various sampling techniques and their application in various research studies.
- To Identify the circumstances the make sampling unnecessary and the reason they re rare.
- To Describe the concept of sampling error and explain how its size is affected by the number of cases sampled, the heterogeneity of the population, and the fraction of population included in the sample.

Course Outcomes

After Successful completion of the course students will be able to

- Demonstrate the official Statistical System in India.
- Demonstrate various sampling techniques and their application
- Infer various sampling error and non-sampling error.
- solving the Industrial and real world problems

Unit 1 **Hours: 10**

Sampling Method : Concept of population, sample, parameter and statistic, sampling versus census, advantages of sampling methods, role of sampling theory, sampling and non-sampling errors, bias and its effects, probability sampling.

Unit 2 **Hours: 15**

Simple Random sampling with and without replacement, use of random number tables in selection of simple random sample, estimation of population mean and proportion. Derivation of expression for variance of these estimates. Estimates of variance. Sample size determination.

Unit 3 **Hours: 10**

Stratified random sampling. Problem of allocation, proportional allocation, optimum allocation. Derivation of the expression for the standard errors of the usual estimators

when these allocation are used. Gain in precision due to stratification.

Unit 4 **Hours: 10**

Systematic sampling : estimation of population mean and population total, standard errors of these estimators

Unit 5 **Hours: 15**

Cluster sampling with equal clusters. Estimation of population mean and their mean square error.

Text Books

1. Cochran, W.G., Sampling Techniques, Wiley Eastern Ltd. ,New Delhi
2. Sukhatma P.v., Sampling Theory of Survey with Applications, Piyush Publications, New Delhi

Reference Books

1. Murthy M.N. Sampling Theory and Methods- Statistical Publishing Society, Calcutta.
2. Raj D. , Sampling Survey Theory, Narasa Publication House, New Delhi
3. Daroga Singh and F.S. Chaudhary, Sampling Survey Design, Wiley Eastern Ltd. New Delhi.

BEA432 DATA WAREHOUSING AND MINING

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 **Credits: 4**

Course Objectives

The Course enables Students to

- Explore the concepts of Data Warehousing.
- Posses in depth understanding of data mining tasks like constructing Decision trees, finding Association Rules, Classification and Clustering.
- Provide broad understanding of data mining algorithms.

Course Outcomes

After Successful completion of the course students will be able to

- Design a Data Warehouse system and perform business analysis with OLAP tools
- Apply data pre-processing techniques for data analysis.

- Apply the different association algorithms or classification techniques for data analysis.
- Apply the different clustering algorithms based on their accuracy for solving the real world problems

Unit 1 **Hours: 12**

Data Warehouse- The Need for an Operational Data Store, Operational Data Store, Data Warehouse, Data Marts, Data Warehouse versus OLTP, Data **Warehouse Schema**- Introduction to Data Warehouse Schema, Star Schema, Snow flake schema, Fact Constellation Schema, Online Analytical Processing- Introduction, Data Cube, Type of OLAP Servers, OLAP Operations

Unit 2 **Hours: 12**

Introduction to Data Mining: What is Data mining? Data Mining Tasks, Data Preprocessing- Types of data, Data Quality, Data Preprocessing, Similarity & Dissimilarity measures

Unit 3 **Hours: 12**

Classification: Introduction, Applications Decision Tree based Algorithms, Model Overfitting, Performance Evaluation of a classifier, Comparison Classifiers. **Classification Alternative Techniques-**Rule Based Classifier, Nearest Neighbor Classifier, Bayesian Classification.

Unit 4 **Hours: 12**

Association Rule Mining: Introduction, Applications, Market-Basket Analysis, Frequent Itemsets, Apriori Algorithm, Alternative Methods.

Unit 5 **Hours: 12**

Clustering: Introduction, Applications, Partitioning Algorithms, Hierarchical Algorithms, Density based Algorithms, Cluster Evaluation.

Text Books

1. Tan P. N., Steinbach M & Kumar V. "Introduction to Data Mining" Pearson Education, 2006.
2. Prateek Bhatia, "Data Mining and Data warehousing", Cambridge University Press, 2019.

Reference Books

1. Han J & Kamber M, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Second Edition, 2006
2. Dunhum M.H. & Sridhar S. "Data Mining-Introductory and Advanced Topics", Pearson Education, 2006.

BEA433 APPLIED ECONOMETRICS -II

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Description/ Objectives

The course assumes that students have a basic knowledge of statistics, mathematics as well as basic econometric theory. It builds on the compulsory Introductory Econometrics course and teaches students a broad set of commonly used econometric methods. These include estimating models with limited dependent variables and the use of instrumental variables to estimate models with endogenous repressors.

Course Outcomes

After Successful completion of the course

- Students will learn the theoretical basis for techniques widely used in empirical research and consider their application in a wide range of problems.
- To develop theoretical understanding of Econometrics specification, estimation method and interpretation.
- To Learn skills to carry out independent econometric analysis of real world data

UNIT-1 **Hours: 9**

Basics of Econometrics

Introduction, Review of Multiple Regression, Hypothesis testing, Bias and Inconsistency in Linear Regression

UNIT -2 **Hours: 09**

The linear regression model

Estimation, specification and diagnostic testing: estimation, specification and inference.

UNIT -3 **Hours: 09**

Advanced Topics in Regression Analysis

Selected Topics: dynamic econometric models, instrumental variable estimation, measurement errors.

UNIT -4 **Hours: 09**

Panel Data Models

Panel data models and estimation techniques: pooled regression, fixed and random effects models

UNIT -5 **Hours: 09**

Limited dependent variables

Logit and probit models for binary responses, to bit models for truncated data.

Text Books

1. Gujarati, D. (2014). Econometrics by example, 2nd ed. Palgrave Macmillan
2. Wooldridge, J. (2014). Introduction to econometrics: A modern approach, 5th ed. Cengage Learning
3. Gujarati, D., Porter, D. (2012). Basic econometrics, 5th ed. McGraw-HillJeffrey M. Wooldridge, Econometrics, Cengage Learning, India Edition, 2009.

Reference Books

1. Christopher Dougherty, Introduction to Econometrics, Oxford University Press, 3rd edition, Indian Edition, 2007.
2. Jan Kmenta, Elements of Econometrics, Indian Reprint, Khosla Publishing House, 2nd edition, 2008

BEA434 - MONETARY ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Description/ Objectives

- Develop understanding of the theories that relate to the existence of money, explaining why it is demanded by individuals and used in the trading process
- Develop an understanding of the monetary transmission mechanism, whereby decisions made by the monetary authorities concerning money supplies or interest rates can have real effects on the economy
- Develop a number of macroeconomic models through which monetary policy can be evaluated.
- Develop understanding of the uncertainties policy-makers face and how policy makers may deal with these

Course Outcome

After Successful completion of the course the students will

- Explain and discuss why people hold money and why it is used in the trading process
- Solve macroeconomic models and assess the role and efficacy of monetary policy for various types of models in both the Classical and Keynesian set-ups.
- Describe and explain the main channels of the monetary transmission mechanism, through which monetary policy can have real effects on the economy
- Discuss the merits and disadvantages of different monetary policies used by Central Banks

UNIT -1 **Hours: 09**

Definition of Money: Nature, functions, types and evaluation of money The debate relating to the definition of money Liquidity theory Gurley and Shaw Hypothesis Alternative money stock measures The quantity and components of money stock in India and broad trend in them

UNIT -2 **Hours: 09**

Supply of Money and Money Transmission Mechanics

Base money, money multipliers, and role of financial intermediaries Factors affecting money supply Balance sheet of Reserve Bank of India

UNIT -3 **Hours: 09**

Demand for Money: Quantity theory of money Demand for money Keynesian theory of demand for money Baumol-Tobin theory Issues regarding endogenous and exogenous supply of money.

UNIT -4 **Hours: 09**

Theories of the Interest Rate: Real and monetary theories of the interest rate Keynesian theory, Wicksellian theory, Fisher's theory, Hicksian theory Credit market imperfections adverse selection and moral hazard

UNIT -5 **Hours: 09**

Monetary Institutions & Monetary Policy: Monetary transmission mechanism and targeting Inflation Money growth and interest rates Interest rate rules Taylor rule Rules versus discretion Central Bank autonomy.Develop .

Text Book

1. Mishkin Frederic (2007), The Economics of Money Banking and Financial Markets, 8th ed Addison Wesley Longman Publishers.
2. Bain, Keith & Howells,Peter (2009), Monetary Economics: Policy and Its Theoretical Basis, Palgrave.

Recommended Reading

1. Blinder Alan (1998), Central Banking in Theory and Practice, The MIT Press
2. Langdana Farrokh (2009), Macroeconomic Policy: Demystifying Monetary and Fiscal Policy, 2nd Edition, Springer.
3. Friedman, Ben & Hahn F.H. (Eds.), (1990), Handbook of Monetary Economics, Vols. 1, 2, & 3, North Holland Publishers.

BEA435 – INTRODUCTION TO FINANCIAL MANAGEMENT

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

- To give understanding and perspective on the finance function in the company and its relation to the domestic economy.
- To develop the knowledge on the type and characteristics of problems and the possibility of the occurrence of the financial management problems and to increase the ability to handle the problems through reliable approach and problem solving strategy development.

Course Outcome

After Successful completion of the course the students will be able to

- Understand students with the basics and scope of financial management.
- Employ alternative mechanisms for raising capital at different points in the firm's growth cycle

- Understand the process and methods of evaluating a long term project using capital budgeting techniques and appreciate the risks and benefits involved
- Appreciate the recent advances in corporate finance and their relevance for cost of capital and raising capital.

UNIT-1 **Hours: 09**

Introduction to financial management

Meaning of finance and financial management, Types of finance – public and private finance, classification of private finance – personal finance, business finance and finance of non-profit organization Importance and Scope of financial management. Approaches to finance function Relationship of finance with other business functions, Objectives of financial management – profit maximization and wealth maximization - merits and criticisms Financial decisions, Internal relation of financial decisions, Factors influencing financial decisions Functions areas of financial management, Functions of a finance manager.

UNIT-2 **Hours: 09**

Sources of finance

Ownership securities – Equity shares , Preference shares, Deferred shares, No par stock/shares, Shares with differential rights, Sweat Equity Creditorship securities – Debentures – Zero coupon bonds, Zero interest bonds, Callable bonds, Deep discount bonds Internal financing or ploughing back of profit – factors affecting ploughing back of profits – merits and demerits Loan financing – short term and long term sources.

UNIT-3 **Hours: 09**

Capitalisation: Meaning of capitalization – Theories of capitalization – cost theory and earnings theory. Over capitalization and under capitalization – causes – effects and remedies, Watered stock, over trading and under trading

UNIT-4 **Hours: 09**

Capital Structure : Meaning of capital structure and financial structure, principles of capital structure, optimum capital structure, determinants of capital structure, capital structure and EPS – practical problems. Point of indifference, capital gearing

UNIT-5 **Hours: 09**

Cost of capital: Meaning of cost of capital, significance of cost of capital, components of cost of capital – computation of cost of capital – practical problems. Meaning of leverage, types of leverages – operating, financial and combined leverage, risk and leverage – practical problems.

Essential Reading:

1. C. Snyder and W. Nicholson (2011).Fundamentals of Microeconomics (11th ed.).Cengage Learning India.
2. Hal R. Varian. (2014).Intermediate Microeconomics, a Modern Approach (9th ed.). W.W. Norton and Company/Affiliated East-West Press (India)
3. Bernheim, Douglas B & B. Michael, Whinston D. (2009). Microeconomics. Tata McGraw-Hill India.

Recommended Reading:

1. Henderson, J. M.& Quandt R. E. (2003). Microeconomic Theory: A Mathematical Approach, New Delhi: McGraw Hill.
2. Koutsoyiannis, A. (1979). Modern Microeconomics. London: Macmillan Press.
3. Kreps, David M., (1990). A Course in Microeconomic Theory. Princeton: Princeton University Press.
4. Lipsey, R.G. and K.A. Chrystal (1999). Principles of Economics. (9th ed.). Oxford University Press. Oxford.
5. Pindyck, Robert & Rubinfeld, Daniel (2013). Micro Economics. (8th ed.). New York: Pearson Education.
6. Samuelson, Paul A and William D Nordhaus (2010). Economics, (19th ed.). McGraw-Hill Companies.

BEA471 LINEAR ALGEBRA

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week: 6**

Max Marks: 150 **Credits: 5**

Course Objectives

This course will help the learner to

- Understand the algebra of matrices, concepts in vector spaces and Linear Transformations
- How to Analyze and solve a linear system of equations
- Gain problems solving skills in solving systems of equations using matrices, finding eigenvalues and eigenvectors, vector spaces and linear transformations.

Course Outcomes

After the completion of the course students will be able to

- Use properties of matrices, especially invertibility, and matrix algebra.
- Understand concepts of vector space, subspace of a vector space, linear span, linear dependence, linear independence, dimension, basis and formally prove standard results related to these concepts.
- Be familiar with Linear transformations and their corresponding matrices and understand the Rank and nullity concepts

Unit 1 **Hours: 12**

Matrices and System of linear equations

Elementary row operations - Rank - Gaussian elimination, elementary matrices – Inversion of a matrix using row operations - Echelon Forms - Normal Forms - System of Homogeneous and non-homogeneous equations - Cayley Hamilton Theorem - Eigenvalues - Eigenvectors - and diagonalization.

Unit 2 **Hours: 12**

Vector Spaces

Vector space-Examples and Properties, Subspaces-criterion for a subset to be a subspace, linear span of a set, linear combination, linear independent and dependent subsets, Basis and dimensions, Standard properties, Examples illustrating concepts and results.

Unit 3 **Hours: 12**

Linear Transformations

Linear transformations, properties - matrix of a linear transformation, change of basis - range and kernel, rank and nullity, Rank-Nullity theorem.

Unit 4 **Hours: 12**

Norms and Inner Product Spaces

Introduction - Inequalities on Linear Spaces - Norms on Linear Spaces - Inner products-Orthogonality - Unitary and Orthogonal Matrices - norms for matrices

Unit 5 **Hours: 12**

Linear Algebra Application to Data Science

Linear Algebra in Machine Learning - Loss functions - Regularization-covariance Matrix-Support Vector Machine Classification. Linear Algebra in dimensionality Reduction - Principal Component Analysis (PCA) - Singular Value Decomposition (SVD). Linear Algebra in Natural Language Processing - Word Embeddings - Latent Semantic Analysis. Linear Algebra in Computer Vision - Image Representation as Tensors- Convolution and Image Processing.

Lab Programs **Hours:30**

Operations on Matrices

1. Echelon form
2. Inverse of a matrix by Gauss Elimination method
3. Solving system of Equations using various method
4. Eigenvalues and Eigenvectors
5. Expressing a vector as a linear combination of given set of vectors
6. Linear Span, Linear Independence and Linear dependence
7. Linear Transformations and Rank
8. Plotting of Linear transformations

Text Books

1. Amit Saha, *Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More!*, no starch press:San Fransisco, 2015.
2. H P Langtangen, *A Primer on Scientific Programming with Python,* 2nd ed., *Springer*, 2016

Reference Books

1. B E Shapiro, *Scientific Computation: Python Hacking for Math Junkies*, Sherwood Forest Books, 2015.
2. C Hill, Learning Scientific Programming with Python, Cambridge University Press, 2016.

SEMESTER V

BEA531 APPLIED REGRESSION

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 **Credits: 4**

Course Objectives

- This course aims to provide the grounding knowledge about the regression model building of simple and multiple regression.

Course Outcomes

After Successful completion of the course students will be able to

- Develop a deeper understanding of the linear regression model
- Understand the forward, backward and stepwise methods for selecting the variables
- Understand the importance of multicollinearity in regression modelling
- Ability to use and understand generalizations of the linear model to binary and count data
- solving the Industrial and real world problems

Unit 1 **Hours: 10**

SIMPLE LINEAR REGRESSION: Introduction to regression analysis: Modelling a response, overview and applications of regression analysis, major steps in regression analysis. Simple linear regression (Two variables): assumptions, estimation and properties of regression coefficients, significance and confidence intervals of regression coefficients, measuring the quality of the fit.

Unit 2 **Hours: 15**

MULTIPLE LINEAR REGRESSION: Multiple linear regression model: assumptions, ordinary least square estimation of regression coefficients, interpretation and properties of regression coefficient, significance and confidence intervals of regression coefficients.

Unit 3 **Hours: 10**

CRITERIA FOR MODEL SELECTION: Mean Square error criteria, R2 and R 2 criteria for model selection; Need of the transformation of variables; Box-Cox transformation; Forward, Backward and Stepwise procedures.

Unit 4 **Hours: 10**

RESIDUAL ANALYSIS: Residual analysis, Departures from underlying assumptions, Effect of outliers, Collinearity, Non-constant variance and serial correlation, Departures from normality, Diagnostics and remedies

Unit 5 **Hours: 15**

NON LINEAR REGRESSION: Introduction to nonlinear regression, Least squares in the nonlinear case and estimation of parameters, Models for binary response variables, estimation and diagnosis methods for logistic and Poisson regressions. Prediction and residual analysis.

Text Books

1. D.C Montgomery, E.A Peck and G.G Vining, Introduction to Linear Regression Analysis, John Wiley and Sons,Inc.NY, 2003.
2. S. Chatterjee and AHadi, Regression Analysis by Example, 4th Edition, John Wiley and Sons, Inc, 2006.
3. Seber, A.F. and Lee, A.J., Linear Regression Analysis, John Wiley, 2013 [Relevant sections from chapters [3, 4, 5, 6, 7, 9, 10].

Reference Books

1. Iain Pardoe, Applied Regression Modeling, John Wiley and Sons, Inc, 2012.
2. P. McCullagh, J.A. Nelder, Generalized Linear Models, Chapman & Hall, 1989.

BEA532 ECONOMICS OF STRATEGY

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week:3**

Max Marks: 100 **Credit: 3**

Course Objectives

- This course covers the fundamentals of Game Theory and its applications. It is basic to the understanding of market competition among large firms, the designing of incentive contracts, bidding at auctions, bargaining, and other similar problems central to economics and business.
- To train students' strategic thinking
- To provide them with basic tools and concepts to analyse strategic situations and behaviour

Course Outcomes

By the end of this course, students should be able to:

- Demonstrate a basic understanding of game theoretical tools and solution concepts,
- Analyse strategic situations and the incentives of players therein, and to

derive predictions about behaviour,

UNIT-1 **Hours:11**

Introduction: procedures, outlook, basic concepts of game theory

UNIT-2 **Hours:11**

Markets-Markets I: Competition Monopoly: , Oligopoly: Timing, and Commitment Static imperfect competition, Product differentiation

UNIT-3 **Hours:11**

Bargaining and Cooperation- Bargaining: giving, ultimatums and negotiations; Cooperation: dilemmas, common pools and public goods, Limited cognition, infinite games

UNIT-4 **Hours:12**

Topics in Strategy- Coordination, cheap talk, and mixed equilibria, Information: Signaling and cascades

Text Book

1. Avinash K. Dixit, Susan Skeath, David Mcadams, Games of Strategy. Global edition. W.W. Norton and Company, 2020

Reference Books:

1. Avinash K. Dixit and Barry J. Nalebuff: Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life. W. W. Norton &Company, 1993.
2. Adam C. Brandenburger and Barry J. Nalebuff: Co-Opetition : A Revolution Mindset That Combines Competition and Cooperation : The Game Theory
3. Strategy That's Changing the Game of Business. Doubleday Business, 1994.

BEA571 MACHINE LEARNING

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week: 6**

Max Marks: 150 **Credits: 5**

Course Objectives

The Course enables Students to

- To understand basic concepts of machine learning
- Understand how to evaluate models generated from data
- Discover how to build machine learning algorithms, prepare data, and use different techniques using Python

Course Outcomes

After Successful completion of the course students will be able to

- Implement different machine learning algorithm techniques .
- Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
- Apply appropriate data sets to the Machine Learning algorithms.
- Identify and apply Machine Learning algorithms to solve real world problems.

Unit 1 **Hours: 12**

INTRODUCTION TO MACHINE LEARNING : Definition of Machine Learning - Understanding Objectives of Machine Learning - Various Components of Machine Learning – Data Storage – Data Processing – Deriving Variables – Transformation – Generalization - Sampling – Features of Machine Learning - Types of Machine Learning – Supervised – Unsupervised – Reinforcement Learning - Techniques and Predictive Models – Deployment of Solution – Strategic Solution

Unit 2 **Hours: 12**

SUPERVISED LEARNING-Classification and Regression, **Generalization, Overfitting, and Underfitting** : Relation of Model Complexity to Dataset Size . **Supervised Machine Learning Algorithms** : Some Sample Datasets, k-Nearest Neighbours, Linear Models Naive Bayes Classifiers, Decision Trees , Support Vector Machines , **Uncertainty Estimates from Classifiers** :The Decision Function , Predicting Probabilities , Uncertainty in Multiclass Classification.

Unit 3 **Hours: 12**

UNSUPERVISED LEARNING AND PREPROCESSING: Types of Unsupervised Learning, Challenges in Unsupervised Learning**. Reprocessing and Scaling**: Different Kinds of pre-processing , Applying Data Transformations, Scaling Training and Test Data the Same Way, The Effect of Reprocessing on Supervised Learning,

Unit 4 **Hours: 12**

DIMENSIONALITY REDUCTION, FEATURE EXTRACTION, AND MANIFOLD LEARNING: Principal Component Analysis (PCA) , Non-Negative Matrix Factorization (NMF) , Manifold Learning with t-SNE , **Clustering:** k-Means Clustering, Agglomerative Clustering , DBSCAN, Comparing and Evaluating Clustering Algorithms, Summary of Clustering Methods

Unit 5 **Hours: 12**

REPRESENTING DATA AND ENGINEERING FEATURES: **Categorical Variables**: One-Hot-Encoding (Dummy Variables), Numbers Can Encode Categorical, Binning,

Discretization, Linear Models, and Trees , **Automatic Feature Selection** : Univariate Statistics , Model-Based Feature Selection , Iterative Feature Selection, Utilizing Expert Knowledge .

Lab Programs **Hours:30**

1. Loading the **data** from a given csv file into a data frame and print the shape of the data, type of the data, number of rows-columns, feature names and the description.
2. Get the number of observations, **missing values** and nan values for the given data set.
3. Linear regression
4. K Nearest Neighbour
5. ID3 algorithm.
6. Naïve Bayesian classifier
7. Support vector machine
8. Bayesian network
9. PCA
10. k-Means algorithm.

Text Books

1. Andreas C. Müller & Sarah Guido, "Introduction to Machine Learning with Python A Guide For Data Scientists" O'Reilly book, 2017
2. Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005.

Reference Books

1. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd ed)., Springer, 2008.
3. Stephen Marsland, "Machine Learning –An Algorithmic Perspective", CRC Press, 2009.

BEA572 NOSQL DATABASES AND BEST PRACTICES

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week: 6**

Max Marks: 150 **Credits: 5**

Course Objectives

The Course enables students

- To teach the students the installation and operation of NOSQL
- To give students an overview of software like MongoDb, Cassandra, HBASE, Neo4j
- To give students knowledge about replication and shardng
- To give details about HBASE and Riak Operations
- To introduce students to graph NOSQL databases

Course Outcomes

After successful completion of the course the students will be able to

- Install NoSQL in their computers
- Apply replication and sharding methods
- Implement databases using Apache HBASE, Riak and Neo4

Unit 1 **Hours: 12**

Introduction

Overview, and History of NoSQL Databases Definition of the Four Types of NoSQL Database, the Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, the Emergence of NoSQL, Key Points comparison of relational databases to new NoSQL stores, MongoDB, Cassandra, HBASE, Neo4j use and deployment, Application, RDBMS approach, Challenges NoSQL approach, Key-Value and Document Data Models, Column-Family Stores, Aggregate-Oriented Databases.

Unit 2 **Hours: 12**

Replication and Sharding

Replication and sharding, MapReduce on databases. Distribution Models, Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. NoSQL Key/Value databases using MongoDB, Document Databases, What Is a Document Database? Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content

Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure.

Unit 3 **Hours: 12**

Column- oriented NoSQL databases using Apache HBASE

Column- oriented NoSQL databases using Apache HBASE, Column-oriented NoSQL databases using Apache Cassandra, Architecture of HBASE, What Is a Column-Family Data Store? Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Counters, Expiring Usage, When Not to Use.

Unit 4 **Hours: 12**

NoSQL Key/Value databases using Riak

NoSQL Key/Value databases using Riak, Key-Value Databases, What Is a Key-Value Store, Key- Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preferences, Shopping Cart Data, When Not to Use, Relationships among Data, Multi- operation Transactions, Query by Data, Operations by Sets.

Unit 5 **Hours: 12**

Graph NoSQL databases using Neo4

Graph NoSQL databases using Neo4, NoSQL database development tools and programming languages, Graph Databases, What Is a Graph Database? Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data,Routing, Dispatch, and Location-Based Services, Recommendation Engines, When Not to Use.

Lab Programs **Hours: 30**

- Introduction to MongoDB and its Installation
- Description of mongo Shell
- Create database and show database
- Basic queries in MongoDB– Insert, Query, Update, Delete and Projection
- Where Clause equivalent in MongoDB
- To study operations in MongoDB – AND in MongoDB, OR in MongoDB, Limit Records and Sort Records.

- To study operations in MongoDB – Indexing, Advanced Indexing, Aggregation and Map Reduce.
- Practice with ' macdonalds ' collection data for document- oriented database.
- Import operation on database.
- Column oriented databases study, queries and practices

Text Books

1. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence , Pearson Education

Reference Books

1. Redmond, E. & Wilson, Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement ,1st Edition.
2. Gaurav Vaish, Getting started with NoSQL, Packt publishing, 2013

BEA541-A INSTITUTIONAL ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits:3**

Course Objectives:

- To form a detailed view about current development of new institutional theory, about main instruments and approaches
- To develop competences, which allow to implement the methodology of new institutional economics towards solving practical problems.
- Introduce the main concepts that describe the institutional structure of the society
- provide an overview of the recent developments in the field of institutional economics introduce the basic concepts and techniques related to the subject

Course Outcomes

At the end of the course the students would be able to

- Use the concept of transaction costs in the explanation of institutions, business practices and contract types,
- Apply transaction costs economics to explaining the choice of type of contract,
- Analyse the behaviour of the firm based on its property rights structure,
- Use of the neoclassical theory in the explanation of the state,

- Conduct economic analysis of the behaviour of the state.

Unit- 1 **Hours: 13**

Introduction To Institutional Economics-Types of Institutions: formal and informal, Brief history of Marxian Economics, Development of Old & New Institutional Economics ,Core issues in New Institutional Economics, Assumptions of New Institutional Economics, Contribution of Douglas North, Williamson and Ronald Coase.

Unit- 2 **Hours: 12**

Problems Of Information Asymmetry- What is asymmetric Information, Adverse Selection: the problem of lemon in different markets, Moral Hazard, Prisoners dilemma: dominant strategy and nash equilibrium

Unit- 4 **Hours: 10**

Transaction Cost And Bounded Rationality-Issues relating to Transactions costs, Identification and measurement of transaction cost, Coase theorem, Bounded Rationality

Unit- 5 **Hours: 10**

Institution And Economic Growth-International Institutions: WTO, United Nations, World Bank, Institutional Reforms: corruptions and its solution, Institutional indicators

Text Book/s

1. Handbook of New Institutional Economics, by Menard, Claude and Mary M. Shirley, eds, : Springer, 2005.

Reference Book/s:

1. Principle of Economics -by Gregory Mankiw Cengage, 6th edition
2. Microeconomics- by Pindyck & Rubenfled- Pearson, 8th Edition
3. Macroeconomics by Gregory Mankiw, Cengage Learning, 4th Edition (2017)

Reference Articles

1. Coase, Ronald, "The Problem of Social Cost," Journal of Law and Economics, October 1960, pp. 1-44.
2. Williamson, Oliver, "Transaction Cost Economics: The Governance of Contractual Relations," Journal of Law and Economics, 22 (October 1979), pp. 233-261.
3. North, Douglass C., "Institutions," The Journal of Economic Perspectives, 5:1 (Winter 1991), pp. 97-112.
4. North, Douglass C., "New Institutional Economics and Development," 1993 working paper (PDF file).

5. Kedar Vishnu & Alwin Dsouza (2020) " Role of transaction costs in modern food retail chains in Transforming Agriculture" in Mishra, A.K., Kumar, A., & Joshi, P.K. (Eds.).Transforming Agriculture in South Asia: The Role of Value Chains and Contract Farming (1st ed.). (pp. 430-460) Taylore and Francis publication. https://doi.org/10.4324/9781003024996

Articles:

1. New Institutional Economics by Peter G Klein.

2. Kedar Vishnu, "Magnitude of Transaction Costs in Vegetable Markets? Empirical Findings from India", by published at Ronald Coase Institute, USAhttps://www.coase.org/2018bratislavaabstracts.htm#kedar

BEA541-B FINANCIAL ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week:3**

Max Marks: 100 **Credit: 3**

Course Objectives

- This course introduces the functioning of financial markets and mechanism behind the pricing of securities. Using present value techniques, it gives a theoretical treatment of bond and stock valuation including portfolio theory and a development of the Capital Asset Pricing Model.

Course Outcomes

After Successful completion of the course the students will to

- Acquire a thorough grounding in asset pricing and will develop the skills in applying pricing methods to realistic scenarios.
- Develop an understanding of how securities markets operate and understand the research on financial market efficiency.

Unit-I: **Hours: 05**

Present value calculations; discounting, compounding and the Net Present Value rule; quoted versus effective interest rates; annuities and perpetuities; Fisher separation.

Unit-II: **Hours: 15**

Bond and Stock Valuation- Bond valuation: valuing coupon, and zero coupon, bonds via present value methods; the term structure; yield to maturity; interest rate risk; modelling the term structure of interest rates; Stock valuation: dividend discount models; the Gordon Growth model; earnings, payout ratios and stock prices; company valuation and the Present Value of Growth Opportunities.

Unit-III: **Hours: 12**

Portfolio Theory and the Capital Asset Pricing model-investor preferences; the mathematics of security portfolios; investor portfolio selection; market equilibrium and the CAPM; empirical evaluation of the CAPM and competing models, Efficient security market: Features and empirical evidence

Unit-IV: **Hours: 13**

Derivative pricing- the definition of a derivative contract; how to price derivatives using absence of arbitrage; forwards and futures contracts; pricing forwards on stocks, currencies and commodities; option contracts; practical uses of options contracts; bounds on option premia; option pricing via binomial models and Black-Scholes.

Text Book

1. Brealey, R, Myers, S. and F. Allen Principles of Corporate Finance. 11th edition. (McGraw Hill).

Reference Books:

1. Frank, Fabozzi (2011), Markowitz, Harry, Equity Valuation and Portfolio Management, Wiley.
2. Reilly, Frank K. and Brown, Keith C. (RB) (2002), Investment Analysis and Portfolio Management, 7th Ed. Dryden.

BEA541-C OPERATIONS RESEARCH

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The Course enables Students to

- To provide knowledge of operation research and optimization through different techniques.

- To enhance the skill of optimisation
- To understand the competitive strategy management

Course Outcomes

After Successful completion of the course students will be able to

- Develop a deep understanding of the operation research
- Learn about simplex methods
- Understand application of operation Research
- Understand how to develop mathematical models for future prediction.
- Ability to develop competitive strategies with use of Operation Research
- Solving the Industrial and real world problems

Unit 1 **Hours: 9**

Introduction: Development of operation Research, definition of operation Research, Scientific Methods of operation research, Necessity of operation research, Scope of operation research, operation research and decision making, Models in OR, Character stick of a good model, Advantage and limitation of a model, type of Mathematical Models, Advantages and Limitation of operation Research.

Unit 2 **Hours: 9**

Linear Programming: Application of Linear Programming method, Area of application of linear programming, Advantages and limitations of linear programing, Graphical Method of solution, Theory of simplex method, slack variable, surplus variable, Artificial variable techniques.

Unit 3 **Hours: 9**

Cost Analysis: Introduction to the model, assumptions of transportation model, North west corner method (NWCM), Least cost Method (LCM), Vogel Approximation Method (VAM), Assignment problem, Hungarian Method, travelling salesman problem.

Unit 4 **Hours: 9**

Decision Analysis: Introduction of Game theory, saddle point, pure strategy and mixed strategy, reduce game by dominance, Mixed strategy.

Unit 5 **Hours: 9**

Decision Analysis: Application of queuing models, assumptions of queuing models, classification of queuing models, Model I Single- channel passion arrival, Birth and death model, what is simulation, when to use simulation, advantages and limitations of simulation technique, application of simulations.

Text Books

1. Prem Kumar Gupta & D.S. HIRA . OPERATIONS RESEARCH, S.CHAND & COMPANY PVT. LTD.
2. Kanti Swaroop, Operation research, Sultan Chand and Sons.

Reference Books

1. H.A Taha, Operation Research an introduction, Pearson Prentice Hall
2. Wayne L. Winston,"Operations Research" Thomson Learning,2003
3. R. Panneer Seevam, "Operations Research" PHI Learning, 2008.

BEA573-A EXPLANATORY DATA ANALYSIS

Total Teaching Hours for Semester: 75 **No of Lecture Hours/Week: 5**

Max Marks: 100 **Credits: 4**

Course Objectives

The Course enables Students to

- Apply the R objects for statistical computations.
- Analyse and Describe the idea of exploratory data analysis,
- Describe visualizing, and estimating the correlation between variables
- Apply linear and nonlinear models visually.

Course Outcomes

After Successful completion of the course students will be able to

- Handle data for explanatory analysis
- Perform graphical representation of data
- Applying Techniques in designing the Model

Unit 1 **Hours: 9**

Introduction

Overview, Sources of Data, Process for Making Sense of Data

Describing Data - Observations and Variables, Types of Variables, Central Tendency, Distribution of the Data, Confidence Intervals Hypothesis Tests

Unit 2 **Hours: 9**

Preparing Data Tables

Cleaning the Data, Removing Observations and Variables, Generating Consistent Scales Across Variables, New Frequency Distribution, Converting Text to Numbers,

Converting Continuous Data to Categories, Combining Variables Generating Groups, Preparing Unstructured Data

Unit 3 **Hours: 9**

Understanding the relationships

Visualizing Relationships Between Variables, Calculating Metrics About Relationships

Unit 4 **Hours: 9**

Identifying and Understanding Groups

Clustering, Association Rules, Learning Decision Trees from Data

Unit 5 **Hours: 9**

Building models from data

Linear Regression, Logistic Regression, k-Nearest Neighbours, Classification and Regression Trees

Lab Programs **Hours:30**

1. Managing Data Frames with the dplyr package-Data Frames,The dplyr Package, dplyr Grammar,Installing the dplyr package,select(), filter(),arrange(),rename(), mutate(), group_by(),%>%
2. Understanding Relationships and usage of statistical tools-Show comparisons, Show multivariate data
3. Exploratory Graphs- Getting the Data, Simple Summaries: One Dimension, Five Number Summary, Boxplot, Histogram, Overlaying Features, Barplot, Simple Summaries: Two Dimensions and Beyond, Scatterplots, Scatterplot - Using Color
4. Clustering- Hierarchical clustering, Define Closeness, Prettier dendrograms, Merging points: Complete, Merging points: Average, Using the heatmap() function
5. Familiarization of regression tools and apply Model

Text Books

1. Allen B. Downey - Think Stats, 2nd Edition: Exploratory Data Analysis, , Year:2014, Pages:226, ISBN 13:978-1-49190-733-7
2. Peng, Roger D. (2015). Exploratory Data Analysis with R. Leanpub
3. Glenn J. Myatt -Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining.

Reference Books

1. Glenn J. Myatt, and Wayne P. Johnson -Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications,. Print ISBN:9780470222805 |OnlineISBN:9780470417409 DOI:10.1002/9780470417409.

BEA573-B DATA ANALYTICS FOR BUSINESS ECONOMY

Total Teaching Hours for Semester: 75 **No of Lecture Hours/Week: 5**

Max Marks: 100 **Credits: 4**

Course Objectives

The Course enables Students to

- Understand the importance of measures of descriptive statistics in business.
- Understand the Hypothesis Testing concepts and use inferential statistics- t, F, Z Test and Chi-Square Test
- Understand the practical application of Descriptive and Inferential Statistics concepts and their uses for Business Analytics
- Analyse the concepts of data analysis methods
- Apply hands-on training of Statistical Data Analysis through Python

Course Outcomes

After Successful completion of the course students will be able to

- Handle data using statistical tool
- Perform graphical representation of data using python
- Use python packages for introductory statistics for business data

Unit 1 **Hours: 9**

Introduction

Basic Statistical Terms - Population and Sample (Theory), Understanding Data- Qualitative Vs Quantitative Data / Continuous vs Discrete (Theory) -Measurement Scales - Nominal, Ordinal, Interval & Ratio

Unit 2 **Hours: 9**

Descriptive Statistics

Meaning, Scope, types, functions and limitations of statistics, Measures of Central tendency – Mean, Median, Mode, Quartiles, Measures of Dispersion – Range, Inter quartile range, Mean deviation,
Standard deviation, Variance, Coefficient of Variation, Skewness and Kurtosis.

Unit 3 **Hours: 9**

Correlation & Regression Analysis

Correlation Analysis: Rank Method & Karl Pearson's Coefficient of Correlation and Properties of Correlation. Regression Analysis: Fitting of a Regression Line and Interpretation of Results, Properties of Regression Coefficients and Relationship between Regression and Correlation.

Unit 4 **Hours: 9**

Parametric Tests – Introduction to Univariate Analysis – one sample mean tests/one sample proportion tests/t-tests
Bivariate Analysis – two sample mean tests/two sample proportion tests / t-tests
Chi Square Analysis - Test of Independence - Test of Goodness of fit
Analysis of Variance - One-Way Classification - Two way Classification

Unit 5 **Hours: 9**

Hypothesis Testing& Business Analytics
Hypothesis Testing: Null and Alternative Hypotheses; Type I and Type II errors; Testing of
Hypothesis: Large Sample Tests, Small Sample test, (t, F, Z Test and Chi Square Test)
Concept of Business Analytics- Meaning types and application of Business Analytics, Use of Spread
Sheet to analyse data-Descriptive analytics and Predictive analytics

Lab Programs **Hours:30**

Module 1 - Importing Business Economic Datasets

- Learning Objectives
- Understanding the Domain
- Understanding the Dataset
- Python package for data science
- Importing and Exporting Data in Python
- Basic Insights from Datasets

Module 2 - Cleaning and Preparing the Data

- Identify and Handle Missing Values
- Data Formatting
- Data Normalization Sets

- Binning
- Indicator variables

Module 3 - Summarizing the Data Frame

- Descriptive Statistics
- Basic of Grouping
- ANOVA
- Correlation
- More on Correlation

Module 4 - Model Development

- Simple and Multiple Linear Regression
- Model Evaluation Using Visualization
- Polynomial Regression and Pipelines
- R-squared and MSE for In-Sample Evaluation
- Prediction and Decision Making

Module 5 - Model Evaluation

- Model Evaluation
- Over-fitting, Under-fitting and Model Selection
- Ridge Regression
- Grid Search
- Model Refinement

Text Books

1. G C Beri – Business Statistics, 3rd ed, TATA McGrawHill.
2. Davis , Pecar – Business Statistics using Excel, Oxford
3. Ken Black – Business Statistics, 5th ed., Wiley India

Reference Books

1. Levin and Rubin – statistics for Management, 7th ed., Pearson
2. 6. Lind, Marchal, Wathen – Statistical techniques in business and economics, 13th ed, McGrawHill
3. 7. Newbold, Carlson, Thorne – Statistics for Business and Economics, 6th ed., Pearson.

BEA561 FINANCIAL STATEMENT ANALYSIS

Total Teaching Hours for Semester: 30 **No of Lecture Hours/Week: 2**

Max Marks: 50 **Credits: 2**

Course Objectives

The objective of this class is

- To provide you with a framework for analyzing a firm's past performance, estimating its future performance, and valuing its equity.To introduce the techniques and methods for the accurate (or at least logically consistent) forecasts of a firm's future financial performance, including revenues, earnings, asset balances and free cash flows

Course Outcomes

Upon completion of this course, the student should be able to analyse and interpret the financial statements and related footnotes for publicly traded companies by using the following tools:

- The evaluation of the quality of financial information,
- Vertical and horizontal analysis,
- Ratio analysis of liquidity, solvency, risk, and profitability,
- Strategic analysis, and Prospective analysis

Unit 1 **Hours: 10**

Overview of Financial Reporting, Financial Statement Analysis, and Valuation, Asset and Liability Valuation and Income Recognition, Income Flows versus Cash Flows: Understanding the Statement of Cash Flows, Profitability Analysis, Risk Analysis

Unit 2 **Hours: 10**

Accounting Quality; Financing Activities; Investing Activities; Operating Activities

Unit 3 **Hours: 10**

Forecasting Financial Statements, Risk-Adjusted Expected Rates of Return and the Dividends Valuation Approach, Valuation: Cash Flow Based Approaches, Valuation: Earnings Based Approaches, Valuation: Market Based Approaches

Text Books

1. Ambrish Gupta, Financial Accounting Management An Analytical Perspective, Pearson Education-2007
2. Robert N.Anthony, David F.Hawkins and Kenneth A.Merchant, Accounting –Text and Cases, TMH, 2005

Reference Books

1. Asish K. Bhattacharyya, Financial Accounting for Business Managers-PHI,2006
2. Stice amp; Stice, Financial Accounting Reporting amp; Analysis, Thomson-2007

SEMESTER VI

BEA671 BIG DATA ANALYTICS

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week: 6**

Max Marks: 150 **Credits: 5**

Course Objectives

The Course enables Students to

- Provide knowledge about big data and big data analytics
- Gain insight on Hadoop and Hadoop file systems
- Understand the applications using Map Reduce Concepts
- Explore about the concepts of NoSQL

Course Outcomes

After Successful completion of the course students will be able to

- Design efficient algorithms for mining the data from large volumes
- Apply the concept of storage and clusters in big data file systems.
- Create applications Hadoop
- Operate NoSQL databases
- Understand the fundamentals of various big data analytics techniques.

Unit 1 **Hours: 12**

Introduction to Big Data: Types of Digital Data-Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data - 3Vs of Big Data - Elements of Big Data, Big data stack - Big data Analytics - Introducing Technologies for handling Big Data: Distributed and Parallel Computing for Big Data - Cloud Computing and Big Data

Unit 2 **Hours: 12**

Big Data Storage Concepts- Clusters - File Systems and Distributed File Systems- NoSQL – Sharding – Replication – Sharding and Replication – CAP Theorem – ACID – BASE Big Data Processing Concepts- Parallel Data Processing – Distributed Data Processing – Hadoop – Processing in Batch Mode – Processing

Unit 3 **Hours: 12**

Introduction to Hadoop: Features – Advantages – Versions. Overview of Hadoop Ecosystem - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL

– RDBMS vs. Hadoop - Hadoop Distributed File System-HDFS Architecture - Features of HDFS - Hadoop Yarn - HBase- Hive – Sqoop – ZooKeeper – Flume – Oozie.

Unit 4 **Hours: 12**

Understanding Map Reduce Fundamentals- Map Reduce Framework- Exploring Features of Map Reduce- Working of Map Reduce- Exploring Map and Reduce Functions- Techniques to optimize Map Reduce- Hardware/ Network Topology Synchronization- File System- Uses of Map Reduce

Unit 5 **Hours: 12**

Big Data Storage Technology – On-Disk Storage Devices – Distributed File Systems, RDBMS Databases, NoSQL Databases, NewSQL Databases – In-Memory Storage Devices: In-Memory Data Grids, In-Memory Databases.

Lab Programs **Hours: 30**

1. Study of Hadoop
2. Study of Hadoop distributed file system (HDFS)
3. Manipulation of data on HDFS
4. Learning Map Reduce Programming
5. Word count problem using Map Reduce Programming
6. Sorting the data using MapReduce.
7. Finding max and min value in Hadoop.
8. NoSQL Database Operations using MongoDB

Text Books

3. DreamTech Editorial Services, “Big Data Black Book”, Dreamtech Press, 2015 Edition
4. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
5. Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publication, 2015.

Reference Books

1. Chandrakant Naikodi, “Managing Big Data”, Vikas Publishing, 2015
2. Michael Frampton, “Big Data Made Easy: A Working Guide to the Complete Hadoop Toolset”, Apress, 2014
3. Tom White “Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012.
4. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2012.
5. Arshdeep Bahga, Vijay Madisetti, “Big Data Science & Analytics: A HandsOn Approach “,VPT, 2016

6. Thomas Erl ,"Big Data Fundamentals Concepts, Drivers and Techniques", Pearson Education First Edition,2016
7. Vijay Srinivas Agneeswaran, "Big Data Analytics beyond HADOOP", Pearson Education(2015)

BEA641-A PUBLIC ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

- To explain why government intervention is needed, how it influences the behaviour of the private sector and what the welfare effects of such influences are
- To introduce the central concepts and basic models of modern public economics
- To develop understanding of key concepts characterising types, properties, and effects of taxes

Course Outcomes

- Use the basic tools, concepts, and models to solve problems in key topics in Public Economics.
- Analyse policy challenges facing governments around the world and learn to find solutions to these challenges, considering obstacles to implementation.
- Apply economic perspectives on activities of the government sector.

Unit 1 **Hours: 9**

Basic concepts, Positive versus normative analysis of government action, Pareto-criterion, Theorems of welfare economics, Properties of public goods, Samuelson condition, Private provision of public goods, Externalities-Consumption externalities, Production externalities, Rat race externalities, The commons problem, The Coase theorem

Unit 2 **Hours: 9**

Relationships between markets and government: Competitive Markets: Efficiency and Welfare, Market Failures, Equity and Government, Economic Growth and Government

Unit 3 **Hours: 9**

Public Choice and Individual Values, Public Choice in Practice, Voting : Vote Motive and

Rational Ignorance, Simple Majority and Median Voter Theorem, Alternatives to the Simple Majority Rule , Arrows Impossibility Theorem

Unit 4 **Hours: 9**

Redistribution as a public good, Redistribution as insurance, Political economy of redistribution, Cash versus in-kind transfers, Taxation Tax incidence, Ad valorem & specific taxes, Tax burden and excess burden, Tax progressivity, Tax splitting, Labour income taxation,

Unit 5 **Hours: 9**

Theoretical Approaches to Policy Making: Structure-based models, Institution-based models, Interest-based models; Approaches to the Study of Implementation: Top-Down Approaches, Bottom-Up Approaches, Synthesis: A Third Generation of Implementation Research, Policy Failure, and Learning from It, Types of Learning

Text Books

1. Intermediate public economics, Jean Hendriks, Gareth D. Myles, 2013, MIT Press

Reference Books

1. Public Economics: Principles and Practice, Peter Abelson, 2012
2. Economics of the Public Sector by J Stiglitz (Norton)
3. Public finance and public policy, Jonathan Gruber, 2016, Macmillan Education

BEA641-B INDUSTRIAL ECONOMICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The course aims to provide basic theoretical and empirical analysis of contemporary topics in industrial economics. It uses economic theory to analyze important issues facing firms, and examines the practical challenges of empirical applications of theory. Main objectives of the courses are as follows:

- To provide knowledge to understand theory, models, methods, and concepts of industrial economics t
- To introduce the various aspects of strategic interaction between firms and the determinants of industrial structure.

- To discuss the role of policy in the context of competition and industrial policies and regulation.

Course Outcomes

After Successful completion of the course the students will be able to

- Describe and explain the determinants of the size and structure of firms and the implications of the separation of ownership and control
- Describe and explain the pricing behaviour by firms with market power and its welfare implications
- Recognise and explain the basic determinants of market structure and the key issues in competition policy and regulation.

Unit 1 **Hours: 9**

Theory of the firm

Size and structure of firms: the technological view of the firm, the transaction costs-property rights approach, investment specificity, incomplete contracts and vertical integration, empirical evidence.

Unit 2 **Hours: 9**

Separation of ownership and control:

separation of ownership and control, managerial incentives, the limits to managerial discretion, foundations of the profit-maximisation hypothesis

Unit 3 **Hours: 9**

Firm conduct and market structure

Short-run price competition: the Bertrand model, Bertrand competition with capacity constraints: Dynamic price competition: repeated interaction, collusion and cartel stability, theories of price wars, empirical analysis of market power and collusive behaviour. Entry deterrence and entry accommodation: first-mover advantages and the value of irreversible decisions, strategies to deter entry, strategic substitutability vs. Complementarity, a taxonomy of business strategies predation

Unit 4 **Hours: 9**

Product differentiation and non-price competition: horizontal product differentiation, brand proliferation and entry deterrence, vertical product differentiation, markets with asymmetric information.

Unit 5 **Hours: 9**

Price discrimination:

first-degree, second-degree and third-degree price discrimination, non-linear pricing, tie-in sales.

Competition and industrial policy:

competition policy in India, current issues in competition policy, industrial policy towards R&D.

Text Books

1. Tirole, J. *The Theory of Industrial Organization.* (Cambridge, MA: MIT Press)
2. 2Church, J.R. and R. *Ware Industrial Organization: A Strategic Approach*. (Irwin McGraw-Hill)

Reference Books

1. Mookherjee, D. (1997). Indian Industry: Policies and Performance. Oxford University Press, Edited.

2. Jean Tirole: The Theory of Industrial Organization, (MIT Press) Prentice Hall India. • Oz Shy: Industrial Organization, MIT Press.

3. Stephen Martin: Advanced Industrial Economics, Blackwell.

4. Kaushik Basu: Lectures in Industrial Organization Theory, Blackwell.

BEA641-C ACTUARIAL MATHEMATICS AND STATISTICS

Total Teaching Hours for Semester: 45 **No of Lecture Hours/Week: 3**

Max Marks: 100 **Credits: 3**

Course Objectives

The Course enables Students to

- Analyze the financial consequences of risk.
- Understand uncertain future events, especially those of concern to insurance and pension programs.
- Assess financial risks in the insurance and finance fields, using mathematical and statistical methods.
- Apply the mathematics of probability and statistics to define, analyze, and solve

the financial implications of uncertain future events.

Course Outcomes

After Successful completion of the course students will be able to

- Have sufficient exposure to actuarial and financial mathematics
- Be familiar with the role of insurance in society, basic economic theory, and the basics of how insurance and financial markets operate.
- Have familiarity with several of the technical tools, computer languages or software packages used by actuaries.
- Develop communication, leadership and teamwork skills, and understand their importance in the actuarial industry.
- Be able to apply this knowledge and these skills in new combinations and to new problems.

Unit 1 **Hours: 9**

Introduction:

Introduction of Actuarial science and how its useful to risk analysis. Basic concepts of Actuarial science. Risk definition and Managing risks.

Unit 2 **Hours: 9**

Interest rates and Factors:

Simple interest, compound interest, accumulated value, Present value , future value, rate of discount, Rule 72, Rate of discount, constant force of interest, varying force of interest, discrete changes in interest rates.

Unit 3 **Hours: 9**

Level Annuities:

Annuity-immediate, Annuity due, Deferred Annuities, Continuously payable annuities, Perpetuities, Equation of value.

Unit 4 **Hours: 9**

Varying Annuities:

Increasing annuities- Immediate, increase annuity due, decreasing Annuity due, continuously payable varying annuities, compound increasing annuities, continuously increasing annuities, continuous decreasing annuities

Unit 5 **Hours: 9**

Project Appraisal and Loans:

Discounted Cash flow analysis, Nominal vs. Real Interest rates, Investment funds, Allocation investment income, Loans: the amortization method, sinking fund method,

Text Books

1. CHRIS Ruck Man, Financial Mathematics A practical Guide for Actuaries, Warren center for Actuarial studies and Research.

2. Annamaria Olivieri and Ermanno Pitacco, Introduction to Insurance Mathematics Technical and Financial Feature of Risk Transfer, Springer

Reference Books

1. Mario v. Wuthrich and Michael Merz, Financial Modeling Actuarial Valuation and solvency in insurance, Springer.
2. Dale S Borowiak, Arnold Shapiro, Financial and Actuarial Statistics A introduction, CRC Press, A chapman and Hall Book.
3. Marco Corazza Claudio Pizzi Eds. Mathematical and statistical Methods for Actuarial Sciences and Finance, Springer.

BEA672-A INTRODUCTION TO TENSORFLOW

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week: 6**

Max Marks: 150 **Credits: 5**

Course Objectives

The Course enables Students to

- Understand the fundamentals and current usage of the TensorFlow library for deep learning research and the graphical computational model of TensorFlow.
- Explore the functions available in TensorFlow for deep learning.
- Build and structure models best suited for deep learning projects.

Course Outcomes

After Successful completion of the course students will be able to

- Understand the overview and operations of TensorFlow.
- Apply regression models on given data in a project
- Structure a model and manage research experiments.

Unit 1 **Hours: 12**

Introduction: Overview of Tensorflow: Why Tensorflow? Graphs and Sessions.

Operations: Basic operations, constants, variables, Control dependencies, Data pipeline, TensorBoard.

Unit 2 **Hours: 12**

Linear and Logistic Regression :TensorFlow's Optimizers, tf.data Example: Birth rate - life expectancy, MNIST dataset.

Eager execution
Example: word2vec, linear regression

Unit 3 **Hours: 12**

Variable sharing and managing experiments : Interfaces Name scope, variable scope Saver object, checkpoints, Autodiff Example: word2vec. Introduction to ConvNet.

Unit 4 **Hours: 12**

Convnet in TensorFlow : Example: image classification, **GANs** , **Variational Auto-Encoders, Recurrent Neural Networks**: Example: Character-level Language Modelling

Unit 5 **Hours: 12**

Seq2seq with Attention: Example: Neural machine translation, **Beyond RNNs: Transformer, Tensor2Tensor:** Dialogue agents, Reinforcement Learning in Tensorflow, Keras.

Lab Programs **Hours:30**

1. Implement concepts of Basic operations, constants and variables.
2. Implement concepts of Control dependencies
3. Implement concepts of Data pipeline, TensorBoard
4. Implement concepts of TensorFlow's Optimizers
5. Implement concepts of word2vec
6. Implement concepts of Linear regression
7. Implement concepts of Interfaces Name scope,Saver object, checkpoints
8. Implement concepts of Autodiff Example: word2vec
9. Implement concepts of Image classification
10. Implement concepts of GANs , Variational Auto-Encoders
11. Implement concepts of CovNet image classification
12. Implement concepts of GANs
13. Implement concepts of Variational Auto-Encoders
14. Implement concepts of Recurrent Neural Networks

15. Implement concepts of Seq2seq with Attention: Neural machine translation
16. Implement concepts of Transformer
17. Implement concepts of Tensor2Tensor: Dialogue agents
18. Implement concepts of Reinforcement Learning in Tensorflow, Keras

Text Books

1. Reza Bosagh Zadeh, Bharath Ramsundar, "TensorFlow for Deep Learning", 2018.

Reference Books

1. Giancarlo Zaccone,Md.Rezaul Karim, Ahmed Menshawy" Deep Learning with Tensorflow" , 2017
2. Ian Goodfellow, "Deep Learning", 2016.
3. Francois Chollet, "Deep Learning with Python", 2017.

BEA672-B DATA VISUALISATION TECHNIQUES

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week: 6**

Max Marks: 150 **Credits: 5**

Course Objectives

The Course enables students to

- Analyze and Understand patterns in data
- Visualize data using Tableau to communicate better
- Understand the need to collect and prepare relevant data
- Understand some key case studies in Data Visualization
- Determine the usage of tools for data analysis and visual communication for actionable insights to solve business problems.

Course Outcomes

After Successful completion of the course students will be able to

- Visualize Data Using Tableau
- Create Charts
- Appreciate challenges in visualizing data
- Apply Statistical Functions to get insight from data
- Create reports based on given business requirement

Unit 1 **Hours: 12**

Data Visualization Philosophy: Discussion on Envisioning Information: Information in a London Metro Map, Escaping Flatland (Mountain Region Map, 3D visualization), Layering and Separation (Machine Parts), Color and Information (In Charts, Maps), Narratives of Time and Space (Dance Movement). Tableau Introduction, Installation, Connect and Prepare Data

Unit 2 **Hours: 12**

Tableau I: Build Charts and Analyze Data, Calculated Fields, custom aggregations, chart types and visualizations, Use parameters and input controls to give users control over certain values using filters, highlighters

Chart Types: Line chart, Bar chart, Histogram, Scatterplot, Boxplot, Pareto chart, Pie chart, Area chart, Control chart , Run chart, Stem-and-leaf display, Cartogram, Sparkline, Box Whisker Plot, Spider Plot

Unit 3 **Hours: 12**

Tableau II: Implement advanced geographic mapping techniques and use custom images and geocoding to build spatial visualizations of non-geographic data. Dashboard, Data Story Telling and Animation Techniques.

Unit 4 **Hours: 12**

Case Studies: Minard's Napoleon March; 1854 Cholera Outbreak by John Snow; Causes of Mortality in Crimean War by Florence Nightingale; History Timelines; Human Migration Map; COVID pandemic data analysis; Hans Rosling Story Telling of Global Trends

Unit 5 **Hours: 12**

Statistical Applications: Aggregates and Charts, Correlation and Scatter Plots, Regression and Trend Lines, Descriptive Statistics and Box Whisker Plot.

Key Performance Indicators: Revenue Growth, Gross Margins of Software Projects, Employee Attrition, Gartner's Hype Cycle for emerging technologies, Cricketer Ranking Systems

Text Books

1. Linda Ryan, "Visual Data Storytelling with Tableau", First Edition, Pearson Paperback – 2018
2. Edward R Tufte, "Envisioning Information"

Reference Books

1. "Information Dashboard Design: Displaying Data for At-a-glance Monitoring" by Stephen Few
2. "Beautiful Visualization, Looking at Data Through the Eyes of Experts by Julie Steele, Noah Iliinsky"
3. "The Visual Display of Quantitative Information" by Edward R.Tufte

4. "The Accidental Analyst: Show Your Data Who's Boss" by Eileen and Stephen McDaniel

Lab Programs **Hours: 30**

1. Implement Chart Types, Filters, Highlighters. Demonstrate grasp of Tableau Tool. (10 hours) **Individual (Unit 2,3)**
2. Design a map for a Township or Institution (5 hours) **Teamwork**
3. Create a Dashboard for a self-created dataset which includes calculated fields and aggregate bins (5 hours) **(Pair : Team of 2)**
4. Statistical Analysis of existing dataset (8 hours) (Based on Unit 5) **Individual**
5. Create a KPI for an existing dataset, Visualize key aspects(3 hours) (Unit 5) **Teamwork**

BEA672-C TIME SERIES AND FORECASTING

Total Teaching Hours for Semester: 90 **No of Lecture Hours/Week: 6**

Max Marks: 150 **Credits: 5**

Course Objectives

The Course enables Students to

- To equip students with various forecasting techniques and knowledge on modern statistical methods for analysing time series data.
- To familiarize students with applications of time series in various fields
- To make the students understand various methods used in time series analysis

Course Outcomes

After Successful completion of the course students will be able to

- Understand the fundamental advantage and necessity of forecasting in various situations.
- Choose an appropriate forecasting method in a particular environment
- Apply various forecasting methods, which includes obtaining the relevant data and carrying out the necessary computation (running suitable statistical software, if necessary).
- Improve forecast with better statistical models based on statistical analysis

Unit 1 **Hours: 12**

Introduction to times series data, application of time series from various fields, Components of a times series, Decomposition of time series. Trend: Estimation of trend by free hand curve method, method of semi averages, fitting a various mathematical curve, and growth curves.

Unit 2 **Hours: 12**

Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend

Unit 3 **Hours: 12**

Seasonal Component cont.: Ratio to Moving Averages and Link Relative method, Depersonalization. Cyclic Component: Harmonic Analysis. Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.

Unit 4 **Hours: 12**

Random Component: Variate component method. Forecasting: Exponential smoothing methods, Short term forecasting methods: Brown's discounted regression

Unit 5 **Hours: 12**

Box-Jenkins method and Bayesian forecasting. Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average.

Lab Programs **Hours 30**

1. Fitting and plotting of modified exponential curve
2. Fitting and plotting of Gompertz curve
3. Fitting and plotting of logistic curve
4. Fitting of trend by Moving Average Method
5. Measurement of Seasonal indices Ratio-to-Trend method
6. Measurement of Seasonal indices Ratio-to-Moving Average method
7. Measurement of seasonal indices Link Relative method
8. Calculation of variance of random component by variate difference method
9. Forecasting by exponential smoothing
10. Forecasting by short term forecasting methods.

Text Books

1. Kendall M.G. (1976): Time Series, Charles Griffin, Kogan Page Business Books; Tenth edition (May 1, 2006)
2. Chatfield C. (1980): The Analysis of Time Series an Introduction, Chapman & Hall, Chapman and Hall/CRC, 29 July 2003.

Reference Books

1. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied,
2. Rohatgi V.K an Saleh E, *An Introduction to Probability and Statistics*, 3rd edition, John Wiley & Sons Inc, New Jersey, 2015.

BEA661 HUMAN RESOURCE MANAGEMENT

Total Teaching Hours for Semester: 30 **No of Lecture Hours/Week: 2**

Max Marks: 50 **Credits: 2**

Course Objectives

The Course enables Students to

- This course providing knowledge how to utilize Human resources for organization growth through different techniques.
- To develop the understanding of the concept of human resource management and to understand its relevance in organizations.
- To develop necessary skill set for application of various HR issues.
- To analyse the strategic issues and strategies required to select and develop manpower resources.

Course Outcomes

After Successful completion of the course students will be able to

- Develop a deep understanding of the Human Resource Development with applications
- Define an organizational structure which drives productivity.
- Developing effective coordination and communication within the organization.
- Dedicate time to finding the right staff and developing their skills base.

Unit 1 **Hours: 8**

Introduction to HRM & HRD Concept of HRM, Objectives, Process, HRM vs. Personnel Management, HRM Vs. HRD, Objectives of HRD, focus of HRD System, Structure of HRD System, role of HRD manpower.

Unit 2 **Hours: 7**

Human Resource Policies & Strategies Introduction, role of HR in strategic management, HR policies & Procedures, HR Program, developing HR policies and strategies.

Unit 3 **Hours: 8**

Human Resource Procurement & Mobility Productivity & improvement job analysis & Job design, work measurement, ergonomics. Human Resource planning-objectives, activities, manpower requirement process

Unit 4 **Hours: 7**

Recruitment & Selection, Career planning & development, training methods, basic concept of performance appraisal, Promotion & Transfer.

Text Books

1. Dipak Kumar Bhattacharya, Human Resource Management, Excel Books (1 January 2006)
2. Arun Monappa, Managing Human Resource, Laxmi Publications (1 January 2015)

Reference Books

1. P.SubbaRao, Essential of HRM and Industrial Relations; Himalaya Publishing House, 2010
2. C.B. Memoria, Personnel Management; Himalaya Publishing House, 2014
3. k. Ashwathappa, Human Resource Management; McGraw Hill Education, 2013
4. Michel Armstrong, A Handbook of Human Resource Management Practice, Kogan Page; 13th edition (3 April 2014)