CHRIST
(DEEMED TO BE UNIVERSITY)
DELHI - NCR , INDIA

School of Sciences, Delhi NCR

Syllabus for
Bachelor of Science (Data Science and Artificial Intelligence Honours)
Academic Year(2022)

Department Overview

The Department of Computational Sciences at CHRIST (Deemed to be University) Delhi- NCR has created a niche in the realm of higher education in India through its programmes. Currently, the Department offers a wide array of undergraduate courses with multiple specializations in the disciplines of Computer Science, Statistics & Mathematics. A dedicated research block with all the latest research facilities boosts the morale of the faculty and research scholars alike. This is an ideal place for students with a research blend of mind to explore his/her passion. Apart from academics, students are moulded holistically through various co-curricular and extracurricular activities.

To promote the holistic development of the students and to sustain the academic creativity and inventiveness of the faculty the department engages in numerous workshops, seminars, industrial interfaces, faculty development programmes and many such endeavours. It is equipped with the highly committed team of instructors having versatile experience in teaching and research. The department also provides opportunities to work on collaborative projects with industry and international universities.

VISION

The Department of Computational Sciences endeavours to imbibe the vision of the University "Excellence and Service". The department is committed to this philosophy which pervades every aspect and functioning of the department.

MISSION

"To develop a computational scientist with ethical and human values". To accomplish our mission, the department encourages students to apply their acquired knowledge and skills towards professional achievements in their career. The department also moulds the students to be socially responsible and ethically sound.

INTRODUCTION TO THE PROGRAMME

BSc Data Science and Artificial Intelligence (Honours)

Bachelor of Science (BSc) in Data Science & Artificial Intelligence (Honours) integrates two major areas, Data Science and Artificial Intelligence, in a collaborative manner. It is a 3-year course designed to prepare graduates who can conduct data-driven investigations using statistical techniques and utilising Artificial Intelligence on different algorithmic techniques. This course will empower the graduates to develop an in-depth knowledge focusing on data science and the techniques for analysing the quantitative and qualitative data and developing a cutting-edge solution. Students will be able to apply the concepts for identifying the patterns and trends in the data from various sectors such as banking, production, manufacturing, finance, retails, healthcare etc. The comprehensive curriculum is a blend of core and advanced specialist subjects. The emphasis of the curriculum is based on the principle that the subjects get more and more

specialised as you go ahead through the program. The course structure starts with general courses comprising the basics of Mathematics, Statistics, Computer programming, Databases. It then gradually specialised into Artificial Intelligence and Data Science domain which shall include Machine learning, Deep Learning, Database, Algorithms etc. exposing students to unlock the power of automation, Artificial Intelligence and Analytics. Upon successful completion of course the graduates shall be able to understand and apply the Data Science and AI concepts for solving real-world problems.

Programme Objective

1. To strengthen the theoretical knowledge in the foundational subjects of computational sciences, such as Mathematics, Statistics and Computer Science.
2. To achieve practical experience in various programming languages and statistical tools applicable to the area of data science and artificial intelligence.
3. To strengthen analytical and problem-solving skills by developing real-time applications.
4. To provide a comprehensive understanding of Data Science and AI applications.

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 from other sources is strictly discouraged since it impairs development of programming skills.

3. Unique Practical (Domain based) exercises ensure that the students don't get involved 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 and its design enforce the practice of good referencing technique to improve the sense of integrity.

9. Courses involving group discussions and debates on ethical practices and human values are designed to sensitize the students in dealing with customers and members within the organization.

Programme Outcomes

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

PO1. Understand and apply 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 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

1. To understand a strong conceptual foundation in Mathematics, Statistics and Computer Science
2. To address the challenging requirements in Data Science and AI domain
3. To apply theoretical concepts to design and develop applications of industry standard.
4. To develop industry-focused skills to lead a successful career

Semester 1

Course Code	Course Title	Course Type	Hrs/week	Credits	Marks
BDA121N	Professional English	AECC	3	3	100
BDA191N	Discrete Mathematics	IDC	3	3	100
BDA132N	Descriptive Statistics and Probability	Core	4	4	100
BDA133N	Digital Computer Fundamentals	Core	3	3	100
BDA134N	Principles of Data Science	Core	4	4	100
BDA135N	Python Programming	Core	4	4	100
BDA151N	Descriptive Statistics Using Excel Lab	PC	2	1	50
BDA152N	Python Lab	PC	4	2	100
HOL111N	Holistic Education	SEC	1		
	TOTAL		**28**	**24**	**750**

Semester 2

Course Code	Course Title	Course Type	Hrs/week	Credits	Marks
BDA221N	Communicative English	AECC	3	3	100
BDA291N	Differential Calculus	IDC	3	3	100
BDA232N	Random Variables and Probability Distributions	Core	4	4	100
BDA233N	Operating System	Core	3	3	100
BDA234N	Data Structures	Core	4	4	100
BDA251N	Data Structures Lab	PC	4	2	100
BDA271N	R Programming and Statistical Modelling Lab (No ESE)	PC	2+4	4	100

HOL211N	Holistic Education	SEC	1	2	
EVS 221N	Environmental Studies	AECC		2	
	TOTAL		**28**	**27**	**700**

Semester 3

Course Code	Course Title	Course Type	Hrs/week	Credits	Marks
BDA391N	Linear Algebra	IDC	3	3	100
BDA332N	Statistical Inference	Core	4	4	100
BDA333N	Introduction to Machine Learning and Artificial Intelligence	Core	4	4	100
BDA334N	Object Oriented Programming Using Java	Core	4	4	100
BDA351N	Statistical Inference Lab	PC	2	1	50
BDA352N	Machine Learning and AI Lab	PC	4	2	100
BDA353N	Java Programming Lab	PC	4	2	100
BDA312N	Entrepreneurial Development	SEC	2	2	50
HOL311N	Holistic Education	SEC	1		
	TOTAL		**28**	**22**	**700**

Semester 4

Course Code	Course Title	Course Type	Hrs/week	Credits	Marks
BDA491N	Optimization Techniques	IDC	3	3	100
BDA432N	Applied Regression	Core	4	4	100
BDA433N	Database Management Systems	Core	3	3	100
BDA434N	Data Analytics and Visualization	Core	3	3	100
BDA451N	Database Management Systems Lab (DBMS)	PC	2	1	50

BDA452N	Data Analytics and Visualization Lab	PC	4	2	100
BDA471N	Web Technology Lab (NO ESE)	PC	2+4	4	100
BDA412N	Personality Development – I	SEC	2	2	50
HOL411N	Holistic Education	SEC	1	2	
	TOTAL		**28**	**24**	**700**

Semester 5

Course Code	**Course Title**	**Course Type**	**Hrs/week**	**Credits**	**Marks**
BDA531N	Artificial Neural Networks and Deep learning	Core	4	4	100
BDA532N	Big data Programming using Hadoop and Spark	Core	4	4	100
BDA561A	German	GE	4	4	100
BDA561B	French				
Elective 1					
BDA541AN	IOT	DSE	4	4	100
BDA541BN	Cyber Security				
BDA541CN	UI/UX Design				
BDA541DN	Simulation and Modelling				
BDA541EN	Digital Image Processing				
BDA541FN	Computer Networks and WSN				
Elective-2					
BDA542AN	Time Series and Forecasting	DSE	4	4	100
BDA542BN	Operations Research				
BDA542CN	Stochastic Process				

BDA542DN	Multivariate Analysis				
BDA551N	Artificial Neural Networks and Deep Learning Lab	PC	4	2	100
BDA552N	Big Data Programming with Hadoop and Spark Lab	PC	4	2	100
BDA581N	Summer Internship	SEC		2	
BDA511N	Personality Development- II	SEC	2	2	50
	TOTAL		**30**	**28**	**750**

Semester 6

Course Code	**Course Title**	**Course Type**	**Hrs/week**	**Credits**	**Marks**
BDA671N	Cloud Analytics	Core	3+3	5	150
	Elective-3				
BDA671AN	Software Engineering and Testing	DSE	3+3	5	150
BDA671BN	Machine Learning Techniques				
BDA671CN	Data Warehousing and Mining				
BDA671DN	Information Security				
BDA681N	Major Project		16	10	300
IC611N	Indian Constitution Law	SEC		1	Grade
	TOTAL		**28**	**21**	**600**

Semester 1

Professional English (BDA121N)

Total Teaching Hours for Semester:45 **Credits:03**
Maximum Marks: 100

Course Objectives:
This course focuses on preparing students to communicate verbally and non-verbally in an effective manner. The aim is to introduce students to communication in a professional environment. It is instrumental in learners comprehending the role of technical English in communication.

Course Outcomes:
Upon completion of the course the student should be able to
CO1: Understand how to engage with texts from various countries, historical, cultural specificities and politics.
CO2: Understand and develop the ability to reflect upon and comment on texts with various themes.
CO3: Develop the ability to communicate both orally and in writing for various purposes.
CO4: Develop an analytical and critical bent of mind to compare and analyse the various literature they read, listen and discuss in class.

Unit - 1 **Teaching Hours:06**
B
1.1. The Happy Prince by Oscar Wilde
1.2. Shakespeare Sonnet 18
Language
Common Errors- Subject-Verb Agreement- Punctuation- Tense Errors.

Unit - 2 **Teaching Hours:06**
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 **Teaching Hours:06**
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 **Teaching Hours:06**

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 **Teaching Hours:06**

Crime

5.1. The Story of B24 by Sir Arthur Conan Doyle

5.2. Short Text: Aarushi Murder Case

Language

Newspaper report

Unit - 6 **Teaching Hours:06**

Health

6.1. Long text: My Story by Nicole DeFreece

6.2. Short text: Why You Should Never Aim for Six Packs

Language

Essay Writing

Unit - 7 **Teaching Hours:06**

Sports

7.1. Long Text: Sir Ranjth Singh Essay by Sourav Ganguly

7.2. Short text: Casey at the Bat by Ernest Lawrence Thayer

Language

Paraphrasing and interpretation skills

Unit - 8 **Teaching Hours:03**

8.1 Visual Text

Visual text- Before the Flood

Essential Reading :

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

Recommended Reading :

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

Discrete Mathematics (BDA191N)

Total Teaching Hours for Semester:45
Maximum Marks: 100 **Credits:03**

Course Description:
The purpose of this course is to understand and use (abstract) discrete structures that are backbones of computer science. In particular, this class is meant to introduce logic, proofs, sets, relations, functions and counting, basics of graph theory with an emphasis on applications in computer science.

Course Outcomes:
Upon completion of the course students will be able to
CO1: Understand the notion of Sets, mathematical proofs and relations functions. Students will be able to apply them in problem solving.
CO 2: Understand the basics of combinatorics- and be able to apply the methods from these subjects in problem solving.
CO 3: Write precise and accurate mathematical definitions of basics concepts in graph theory.

Unit 1 **Teaching hours:09**
Set Theory and Counting Principles
Set Theory-Introduction- Combination of sets-Set Identities. Mathematical Induction-inclusion and exclusion- pigeon-hole principle- permutation- combination- summations. Introduction to recurrence relations and generating functions.

Unit 2 **Teaching hours:09**
Relations and functions
Relations and Products- Functions as Relations- Relations on a Set-Properties of Relations: reflexive-irreflexive-symmetric-asymmetric-antisymmetric, transitive- inverse. One-to-One and onto functions-One to one correspondence-Inverse functions and compositions of functions-Graphs of functions-Floor-ceiling-greatest Integer functions.

Unit 3 **Teaching hours:09**
Propositional and Predicate Logic
Propositional Logic, Applications of Propositional Logic, Propositional Equivalences, Predicates and Quantifiers.

Unit 4 **Teaching hours:09**
Methods of Proof
Nested Quantifiers, Rules of Inference, Introduction to Proofs, Proof Methods and Strategy.

Unit 5 **Teaching hours:09**
Graphs

Graphs – introduction – isomorphism – sub graphs-types of graphs-Results related to graphs – walks- paths - circuits – connectedness – components – Euler graphs – Hamiltonian paths and circuits.

Essential Reading:

1. K. H. Rosen- Discrete Mathematics and its Applications- 7th ed.- McGraw – Hill- 2012.
2. Floyd- Thomas L: Digital Computer Fundamentals- 11th Edition- Pearson International- 2015.

Recommended Reading

1. R.P. Grimaldi and B.V. Ramana- Discrete and Combinatorial Mathematics- An applied introduction- 5th ed.- Pearson Education- 2007.
2. R.P. Grimaldi- Discrete and Combinatorial Mathematics- Addison Wesley, 5th ed., 2004.
3. D. S. Chandrasekharaiah- Discrete Mathematical Structures- 6th ed.- India: PRISM Book Pvt. Ltd.- 2019.
4. J. P. Tremblay and R. Manohar- Discrete Mathematical Structures with Application to Computer Science- Reprint- India: Tata McGraw Hill Education- 2008.
5. Liu and Mohapatra- "Elements of Discrete Mathematics"- McGraw Hill, 4th ed., 2017.

Descriptive Statistics and Probability (BDA132N)

Total Teaching Hours for Semester:60
Maximum Marks: 100 **Credits:04**

Course Objectives:

This course is designed to introduce the historical development of statistics- presentation of data- descriptive measures and fitting mathematical curves to the data. This course also introduces measurement of the relationship of quantitative and qualitative data and the concept of probability. This course will enable students to understand and summarize the data, understand and apply the descriptive measures and probability for data analysis, implement theoretical concepts of descriptive measures and probability, study the relationship between variables.

Course Outcomes:

Upon completion of the course the student should be able to

CO1: Demonstrate the history of statistics Identify the type of data and present the data in various forms and summarize it using descriptive statistics.

CO2: Understand and apply the concept of correlation, association, regression analysis and infer its results.

CO3: Understand and apply the concept of probability.

Unit 1 **Teaching Hours:10**

Organization and Presentation of data

Origin and development of Statistics- Scope- limitations and misuse of statistics. Types of data: primary and secondary data- quantitative and qualitative data. Scales of Measurement: nominal-ordinal-ratio and interval. Discrete and continuous data variables. 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 **Teaching 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: Range, Mean deviation- Quartile deviation- Standard deviation- Coefficient of variation. Moments: measures of Skewness- Kurtosis. Box plot.

Unit 3 **Teaching hours:13**

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 **Teaching hours:12**

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.

Unit 5 **Teaching 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’s coefficient of colligation.

Essential Reading:

1. S.C. Gupta and V.K. Kapoor - Fundamentals of Mathematical Statistics- 12th ed.- Sultan Chand & Sons- New Delhi- 2020.
2. P. Mukhopadhyay.- Mathematical Statistics-3rd ed.- Books and Allied (P) Ltd- Kolkata- 2018.

Recommended Reading:

1. R.E. Walpole- R.H. Myers and S.L. Myers - Probability and Statistics for Engineers and Scientists-9th ed. -Pearson- New Delhi- 2017.
2. D.C. Montgomery and G.C. Runger- Applied Statistics and Probability for Engineers-7th ed.- Wiley India- New Delhi-2018.
3. B.L. Agarwal - Basic Statistics- 6th ed.- New Age International Publication- 2015.
4. V.K. Rohatgi and E. Saleh - An Introduction to Probability and Statistics- 3rd ed.- John Wiley & Sons Inc.- New Jersey- 2015.

Digital Computer Fundamentals (BDA133N)

Total Teaching Hours for Semester: 45
Maximum Marks: 100 **Credits:03**

Course Objectives

This is an introductory course that provides the required knowledge about the digital fundamentals of computers. The course covers a few topics like number systems, logic gates, and flips flops. The course starts with an introduction to number systems and its applications in computers. The discussion about the working of devices like encoders and decoders, multiplexers, and demultiplexers are dealt with.

Course Outcomes:
Upon completion of the course the student should be able to
CO1: Use math and Boolean algebra in performing computations in various Number systems.
CO2: Simplify Boolean algebraic expressions.
CO3: Design efficient combinational and sequential logic circuit

Unit 1 **Teaching Hours:10**

Introduction to Number System and Codes

Number systems-Decimal numbers - Binary numbers-Counting in binary- The weighted structure of binary numbers- Octal numbers- hexadecimal numbers and their mutual conversions -Binary arithmetic-Addition- subtraction- multiplication and division of binary numbers- 1‘s and 2‘s complement- signed numbers- arithmetic operations-addition-subtraction with signed numbers- 9‘s and 10‘s complement- BCD numbers- BCD addition-BCD subtraction- Gray code-Binary to Gray code conversion- Gray to Binary conversion-Weighted code-8421 code and Non weighted codes : ASCII and EBCDIC.

Unit 2 **Teaching Hours:08**

Boolean Algebra

Boolean operations and expressions, Laws and rules of Boolean algebra, Demorgan‘s Theorem, Boolean expressions, Simplification of a Boolean expression.

Unit 3 **Teaching Hours:08**

Logic Gates

AND gate, OR gate, NOT gate, NAND gate, NOR gate, X-OR gate, X-NOR gate, The universal property of NAND gate and NOR gate, Realization of basic gates. The Boolean expression for logic circuits, Karnaugh map SOP with examples.

Unit-4 **Teaching Hours:10**

Combinational Logic

Basic Adders: Half adder, Full adder, 4-bit Parallel adders, Subtractor: Half subtractor, Full subtractor Implementation using logic gates, Decoders: 4-bit decoder, BCD to decimal decoder, Encoder: Decimal to BCD encoder, Multiplexer: 4 to 1 multiplexer, Demultiplexer: 1 to 4 demultiplexer.

Unit-5 **Teaching Hours:09**

Flip-flops

Latches: SR latch, Clocked flip-flops: SR flip-flop, D flip-flop, JK flip-flop, Positive edge-triggered flip flops, Timing diagrams, Master-slave JK flip-flop.

Self-Learning

Introduction to RAM- SRAM- DRAM- ROM- PROM- EPROM- EEPROM.

Essential Reading:

1. Floyd- Thomas L: Digital Computer Fundamentals- 11th Edition- Pearson International- 2015.

Recommended Reading:

1. Malvino, Paul Albert, Leach, Donald P,Gautam Saha: Digital Principles And Applications, TMH ,8th Edition, 2015.
2. Bartee,Thomas C: Digital Computer Fundamentals, 6 Edition,TMH, 2010.

Principles of Data Science (BDA134N)

Total Teaching Hours for Semester: 60
Maximum Marks: 100 **Credits:04**

Course Objectives

The Course enables Students to Provide a strong foundation for data science and application areas related to it. They also Understand the underlying core concepts and emerging technologies in data science and learn the process of working with data on large scale. Students also explore the concepts of Data Processing, learn basic concepts of Machine Learning.

Course Outcomes

Upon completion of the course, students will be able to

CO1: Understand the fundamental concepts of data science.

CO2: Evaluate the data analysis techniques for applications handling large data and demonstrate the data science process.

CO3: Understand concept of machine learning used in the data science process.

CO4: Visualize and present the inference using various tools.

CO5: Learn to think through the ethics surrounding privacy, data sharing.

Unit 1 **Teaching 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 **Teaching 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 **Teaching 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 **Teaching 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 **Teaching 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.

Essential Reading:

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.

Recommended Reading:

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.

Python Programming (BDA135N)

Total Teaching Hours for Semester: 60
Maximum Marks: 100 **Credits:04**

Course Objectives:

This course covers the programming paradigms associated with python. It explores the programming language concepts like Data Types- Loops- Functions; Python Lists- Strings- Tuples- Dictionaries of python with help of built in modules. The objective of this course is to provide comprehensive knowledge of python programming paradigms.

Course Outcomes:

Upon completion of the course the student should be able to
CO1: To know the basics of algorithmic problem solving
CO2: To develop Python programs with conditionals and loops.
CO3: To use Python data structures - lists- tuples- dictionaries.
CO4: To do input/output with files in Python.

Unit 1 **Teaching hours:10**

Introduction to Python

Python Introduction- Technical Strength of Python- Introduction to Python Interpreter and program execution- Using Comments- Literals- Constants- Python's Built-in Data types- Numbers (Integers- Floats- Complex Numbers- Real- Sets)- Strings (Slicing- Indexing- Concatenation- other operations on Strings)- Accepting input from Console- printing statements- Simple 'Python' programs.

Unit 2 **Teaching hours:10**

Algorithm Problem Solving

Algorithms- building blocks of algorithms (statements- state- control flow- functions)- notation (pseudo code- flow chart- programming language)- algorithmic problem solving- simple strategies for developing algorithms (iteration- recursion).

Unit 3 **Teaching hours:13**

Operators- Expressions and Python Statements

Assignment statement- expressions- Arithmetic- Relational- Logical- Bitwise operators and their precedence- Conditional statements: if- if-else- if-elif-else; simple programs- Notion of iterative computation and control flow –range function- While Statement- For loop- break statement- Continue Statement- Pass statement- else- assert.

Unit 4 **Teaching hours:13**

Sequence Data Types

Lists: list operations- list slices- list methods- list loop- mutability- aliasing- cloning lists- list parameters-Slicing- Indexing- Concatenation- other operations on Sequence data type;
Tuples: tuple assignment- tuple as return value;
Dictionaries: operations and methods; advanced list processing – list comprehension;
Examples to include finding the maximum- minimum- mean; linear search on list/tuple of numbers- and counting the frequency of elements in a list using a dictionary

Unit 5 **Teaching hours:14**

File Processing

Concept of Files- File opening in various modes and closing of a file- Reading from a file- Writing onto a file- File functions-open()- close()- read()- readline()-readlines()-write()- writelines()-tell()-seek()- Command Line arguments.

Introduction to Packages

Introduction to NumPy – Ndim – Shape – Size – Dtype – Itemsize - Reshape - Introduction to Pandas, series objects, Data frame Objects, Panel Objects , various functions.

Essential Reading:

1. Python Programming using problem solving Approach by Reema Thareja, Oxford University, Higher Education Oxford University Press; First edition 2017.
2. Y Daniel Liang "Introduction to Programming using Python" Pearson

Recommended Reading:

1. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python” Pearson.
2. Mrak Litz, “Learning Python”, O’ Reilly.

Descriptive Statistics using Excel (BDA151N)

Total Teaching Hours for Semester: 30
Maximum Marks: 50 **Credits: 01**

Course Objectives:
The course is designed to provide a practical exposure to the students in basic concepts of Excel and different ways of representation and exploratory data analysis in excel.

Course Outcomes:
Upon completion of the course the student should be able to
CO1: Perform calculations in excel and apply excel functions.
CO2: Represent data using charts and diagrams
CO3: Perform exploratory data analysis using Data Analysis Pack(DAP)

List of Programs

1. Excel worksheets: add worksheet- rename- save and delete- record worksheet and various operations on worksheet, freezing panes and splitting window.
2. Cell referencing, Linking, and conditional formatting.
3. Apply Text to column, Data validation and checks using excel.
4. Creating Pivot table and Pivot chart.
5. Apply formulas like financial, look up, maths, statistics, engineering etc.
6. Apply filter and advanced filter, sorting.
7. Diagrammatic representation and Graphical representation.
8. Descriptive statistics using statistical functions and Data Analysis Pack (DAP).
9. Exercise on correlation, Correlation matrix, partial and multiple correlation coefficient.
10. Draw a scatter plot and fit trend line for a bivariate data set.

Python Lab (BDA152N)

Total Teaching Hours for Semester: 60
Maximum Marks: 100 **Credits:02**

Course Objectives:
The course is designed to provide a practical exposure to python and its applications.

Course Outcomes:

Upon completion of the course the student should be able to

CO1: Understand and develop Computational Thinking concepts.

CO2: Describe python programs that appropriately utilize built-in functions and control flow statements

CO3: Represent compound data using Python lists- tuples- dictionaries

CO4: Be able to do input/output with files in Python.

List of Programs

1. Write a program to demonstrate basic data type in python.
2. Write a program to implement various operators in python.
3. Write a program to implement various conditional statements in python.
4. Write a program to implement various looping statements in python.
5. Write a program to implement various string operations.
6. Write a program to demonstrate list & related functions in python.
7. Write a program to demonstrate tuple & related functions in python.
8. Write a program to demonstrate Dictionary & related functions in python.
9. Write a program to read and write from a file, and copy a file
10. Write a program to implement numpy and pandas packages.
11. Apply scaling mechanism by considering the employee data (based on the given data set).
12. Demonstrate the normalization process and implement the same with customer data of bank.
13. Apply at least 3 sampling techniques to get the best data from the population.
14. Demonstrate the missing value imputations.
15. Demonstrate the usage of outlier detection.
16. Apply various data summarization techniques in student data.
17. Demonstrate the techniques to handle the imbalanced data sets.

Essential Reading:

1. Python Programming using problem solving Approach by Reema Thareja- Oxford University- Higher Education Oxford University Press; First edition 2017.
2. John M. Sewart- “Python for Scientist”- Cambridge Universities Press.

Recommended Reading:

1.Robert Sedgewick- Kevin Wayne- Robert Dondero- “Introduction to Programming in Python” Pearson.

2.Mrak Litz- “ Learning Python”-O’ Reilly.

Semester 2
Communicative English (BDA221N)

Total Teaching Hours for Semester: 45
Maximum Marks: 100 **Credits:03**

Course Objectives:
This course will help the learner to help learners understand the relationship between the world around them and the text/literature and improve their communication skills for larger academic purposes and vocational purposes and teach them logical sequencing of content and process information.

Course Outcomes:
Upon completion of the course the student should
CO1: Understand how to engage with texts from various countries, historical, cultural specificities and politics.
CO2: Understand and develop the ability to reflect upon and comment on texts with various themes.
CO3: Develop the ability to communicate both orally and in writing for various purposes.
CO4: Develop an analytical and critical bent of mind to compare and analyse the various literature they read, listen and discuss in class.

Unit 1 **Teaching Hours:09**
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 **Teaching Hours:07**
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 **Teaching Hours:08**
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 **Teaching Hours:09**

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 **Teaching Hours:08**

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 **Teaching Hours:04**

Visual Text

6.1 BBC Documentary- Dabbawalas**.**

Essential Reading:

1. Englogue – I : A textbook for First Year Undergraduate Students
2. Shivani Pandita, The story of Mumbai Dabbawalas, BBC Documentary,2008.

Recommended Reading:

1. Jayakaran, Master your English Grammar, 2M Publishing International,2004.
2. Wren & Martin, English and Grammar Composition, Blackie ELT Books,2016.
3. Rudyard Kipling, Something of myself, Macmillan and Co Limited ,1937

Differential Calculus (BDA291N)

Total Teaching Hours for Semester: 45
Maximum Marks: 100 **Credits:03**

Course Objectives:
This course aims at enabling the students to know various concepts and principles of differential calculus and its applications. Sound knowledge of calculus is essential for the students of mathematics for the better perceptions of the subject and its development.

Course Outcomes:
Upon completion of the course the student should be able to
CO1: Understand and use the notion of Derivative of the function of one variable.
CO2: Demonstrate a working knowledge of vectors and vector functions.
CO3: Determine partial derivatives of the functions of two or more variables.
CO4: Illustrate the computational skills in finding the directional derivatives- Gradient vectors and differentials.

Unit 1 **Teaching Hours:09**
Functions of single variable: 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.

Unit 2 **Teaching Hours:09**
Mean Value Theorems: 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 3 **Teaching Hours:09**
Successive and Partial Differentiation: Successive differentiation – nth derivatives of functions – Leibnitz theorem and its applications – Partial differentiation –First and higher order derivatives – Differentiation of homogeneous Functions.

Unit 4 **Teaching Hours:09**
Functions of two variables: Partial derivatives- Total derivative- Lagrange's multipliers for two variables- Euler's theorem – Taylor's theorem for two variables - Maxima and Minima of functions of two variables.

Unit 5 **Teaching Hours:09**
Tangents and Normal- 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).

Essential Reading:

1. G.B. Thomas- M. D. Weir and J. Hass- *Thomas Calculus*- 14th ed.- Pearson Education India- 2018

Recommended Reading:

1 F. Ayres and E. Mendelson- *Schaum's Outline of Calculus*- 10th ed. USA: Mc. Graw Hill.- 2015.
2 J. Stewart- *Single Variable Essential Calculus: Early Transcendentals*- 2nd ed.: Belmont-USA: Brooks/Cole Cengage Learning.- 2013.
3 M. Spivak- *Calculus*- 4th ed.- Cambridge University Press- 2008.
4 T.M. Apostol- *Calculus*- *Vol-II*- Wiley India Pvt. Ltd.- 2011.linear

Random Variables and Probability Distributions (BDA232N)

Total Teaching Hours for Semester: 60
Maximum Marks: 100 **Credits:04**

Course Objectives:
This course is designed to introduce the basic concepts of random variables and its generation generating functions. It gives a brief idea about standard probability distributions and how they are applied in real time situations. It introduces the concept of laws of large number and the Central Limit theorem. The course will enable the students understands the concept of random variables, probability distributions and generating functions, the assumptions, properties and applications of various probability distributions, laws of large numbers, central limit theorem and their importance.

Course Outcomes:
Upon completion of this course the students will be able to
CO1: Demonstrate the random variables, its generating functions and infer its expectation.
CO2: Demonstrate various discrete and continuous distributions and their usage.
CO3: Understand and apply laws of large numbers and Central Limit Theorem.

Unit 1 **Teaching Hours:12**
Random variables
Definition- Discrete and Continuous random variables- Probability Mass function and Probability Density function- Distribution function and its properties. Two dimensional 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 **Teaching Hours:12**
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 **Teaching Hours:12**

Discrete Probability distributions

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

Unit 4 **Teaching Hours:12**

Continuous Probability distributions

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

Unit 5 **Teaching Hours:12**

Limiting Theorems

Chebyshev's inequality- Week Law of Large numbers- Strong Law of Large numbers and their applications- Central Limit Theorem for i.i.d variates and its application- De-Moivre Laplace theorem.

Essential Reading:

1. S. Ross- A First Course in Probability- 10th ed.- Pearson Education- US- 2019.
2. S.C. Gupta and V.K. Kapoor- Fundamentals of Mathematical Statistics- 12th ed.- Sultan Chand & Sons- New Delhi- 2020.

Recommended Reading:

1. P. Mukhopadhyay - Mathematical Statistics-3rd ed. -Books and Allied (P) Ltd- Kolkata- 2018.
2. V.K. Rohatgi and E. Saleh - An Introduction to Probability and Statistics- 3rd ed.- John Wiley & Sons Inc.- New Jersey- 2015.
3. D.C. Montgomery and G.C. Runger- Applied Statistics and Probability for Engineers-7th ed.- Wiley India- New Delhi- 2018.
4. A.M. Mood-F.A. Graybill and D.C. Boes- Introduction to the Theory of Statistics-3rd ed.- McGraw Hill- New Delhi-2017.

Operating System (BDA233N)

Total Teaching Hours for Semester:45

Maximum Marks: 100 **Credits:03**

Course Objectives:
This course is an introduction to the concepts behind modern computer operating systems. Topics will include what an operating system does (and doesn't) do- system calls and interfaces- processes- resource scheduling and management (of the CPU- memory- etc.)- Virtual memory. To acquire the fundamental knowledge of the operating system architecture and its components.

Course Outcomes:
Upon completion of the course the student should be able to
CO1: Understand the basic working process of an operating system.
CO2: Understand the importance of process and scheduling.
CO3: Understand the issues in synchronization and memory management.

Unit 1 **Teaching hours:09**

Introduction
Categories of Operating Systems- Computer-System Organization- Computer-System Architecture- Operating-System Structure- Operating-System Operations.

System Structures
Operating-System Services- User Operating-System Interface- System Calls- Types of System Calls- System Programs.

Process Management
Process Concept- Process Scheduling- Operations on Processes: process creation and termination - zombie and orphan process- Cooperating Processes- Inter-process Communication- Process related commands.

Unit 2 **Teaching hours:09**

Scheduling and Synchronization
CPU Scheduling- Basic Concepts- Scheduling Criteria- Scheduling Algorithms- Thread Scheduling- Multiple-Processor Scheduling - The Critical-Section Problem - Peterson's Solution - Synchronization Hardware - Semaphores - Classic problems of Synchronization - Multithreading models - threading issues.

Unit 3 **Teaching hours:10**

Memory Management Strategies and Deadlocks
System Model- Deadlock Characterization- Methods for handling Deadlocks -Deadlock Prevention- Deadlock avoidance- Deadlock detection- Recovery from Deadlocks - Swapping- Contiguous Memory allocation- Paging- Structure of the Page Table- Segmentation.

Unit 4 **Teaching hours:09**

Virtual Memory Management
Demand Paging- Copy-on-Write- Page Replacement- page replacement algorithms- Allocation of frames- Thrashing.

File System: File Concept- Access Methods- Directory and Disk Structure- File System Mounting- File Sharing- Protection.

Unit 5 **Teaching hours:08**

Implementing File Systems
File System Structure- File System Implementation- Directory Implementation- allocation Methods- Free-space Management.

Secondary Storage Structure

Disk Structure- Disk Attachment- Disk Scheduling- Disk Management and Swap-Space Management. Case study.

Essential Reading:

1. Silberschatz- P.B. Galvin and G. Gagne- Operating System Concepts.9th Edition- New Delhi: Wiley India- 2011.

Recommended Reading:

1. Stalling William- Operating Systems: Internals and Design Principles. 7th Edition - Prentice Hall-2011.

Data Structures (BDA234N)

Total Teaching Hours for Semester:60
Maximum Marks: 100 **Credits:04**

Course Objectives:
This course will introduce the concepts of Abstract data type (ADTs), linear data structures which includes lists, stacks, and queues. The course covers various sorting, searching and hashing algorithms and applications of linear data structures.

Course Outcomes:
Upon completion of the course the student should
CO1: Understand the need for Data Structures when building applications.
CO2: Design and develop algorithms using relevant data structure operations.
CO3: Appreciate the need for an optimized algorithm.

Unit 1 **Teaching Hours:11**
Introduction
Introduction to data structures - Algorithms - Analysing algorithms - Complexity of algorithms- Growth of functions - Asymptotic Notations - Performance measurements - Arrays and Structures: Abstract Data Type- Dynamically Allocated Arrays- Structures- Unions- Polynomial Representation and Additions.

Unit 2 **Teaching Hours:12**
Linear Data Structures – List
Linear Lists: Abstract Data Types (ADTs) – List ADT – array-based implementation linked list implementation — singly linked lists- circularly linked lists- doubly-linked lists – applications of lists –Polynomial Manipulation – All operations.(Insertion, Deletion, Merge, Traversal)

Unit 3 **Teaching Hours:12**
Linear Data Structures – Stacks, Queues

Stack ADT – Operations – Applications – Evaluating arithmetic expressions-Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue- Priority Queue – deQueue – applications of queues.

Unit 4 **Teaching Hours:11**

Searching, Sorting and Hashing Techniques

Searching- Linear Search – Binary Search. Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort – Radix sort. Hashing- Hash Functions – Separate Chaining- Open Addressing – Rehashing – Extendible Hashing.

Unit 5 **Teaching Hours:14**

Non-Linear Data Structures – Trees

Tree ADT – tree traversals – Binary Tree ADT – expression trees – applications of trees binary search tree ADT –Threaded Binary Trees- AVL Trees – B-Tree -B+ Tree – Heap– Applications of heap.

Non-Linear Data Structures -Graphs

Definition – Representation of Graph – Types of graph – Breadth-first traversal –Depth-first traversal – Topological Sort – Bi-connectivity – Cut vertex – Euler circuits-Applications of graphs.

Essential Reading:

1. Rance D. Necaise. "Data Structures and Algorithms Using Python" Hamilton Printing Company-2011.
2. Thomas H. Coreman- Charles E. Leiserson and Ronald L. Rivest- "Introduction to Algorithms"- Printice Hall of India, 2001.

Recommended Reading:

1. Aho- Hopcraft- Ullman- "The Design and Analysis of Computer Algorithms" Pearson Education- 2008.
2. Horowitz- Sahni- Rajasekaran- Fundamentals of Computer Algorithms-Silicon Pr- 2nd Edition- November 2012.

Data Structures Lab (BDA251N)

Total Teaching Hours/Semester: 60
Maximum Marks: 100 **Credits:02**

Course Objective

The course is designed to provide a practical exposure to data structures and its applications.

Course Outcomes

Upon completing this course the student will be able to

CO1: Acquire the knowledge to build the logic and develop solution for a problem statement.

List of Programs:

1. Implement creation, insertion, deletion, update in an array.
2. Implement concatenation of arrays , find the length of the arrays.
3. Implementation of Single Linked List performing the following operations
   (i)Creation (ii) insertion (iii) deletion (iv) traversal
4. Array implementation of Stacks.
5. Array Implementation of queues.
6. Implementation of Stack using Linked list.
7. Implementation of Queue using Linked list.
8. Implementation of linear search.
9. Implementation of Binary Search.
10. Implementation of Insertion sorting.
11. Implementation of selection sorting.
12. Implementation of merge sort.
13. Implementation of Sorting Algorithm - Separate chaining and Open Addressing Hashing Technique
14. Implementation of Binary Search Tree
    a. Create a binary search tree.
    b. Traverse the above binary search tree recursively in pre-order, post-order and in- order
    c. Count the number of nodes in the binary search tree. LIST
15. Write Python programs to create a tree and implement the following graph traversal Algorithms a. Depth first search. b. Breadth first search

R programming and Statistical Modelling Lab (BDA271N)

Total Teaching Hours for Semester: 30+60
Maximum Marks: 100 **Credits: 04**

Course Objectives: This course is used to provide an introduction to R programming language and environment. The course covers the basics of R for statistical computation, exploratory

analysis, and modelling. This course also enables students to understand and develop programs in the R environment.

Course Outcomes:
Upon completion of the course the student should be able to
CO1: Perform data handling in R.
CO2: Perform exploratory data analysis using R.
CO3: Perform statistical modelling using R.

Unit-1 **Teaching Hours:10**
Introduction to R- Installation of R- Getting Started with R interface- Entering Input-Evaluation. R objects- Numbers- Attributes- Creating Vectors-Mixing Objects Explicit Coercion- Matrices-Lists- Missing Values-Data Frames- Names- Reading and Writing Data into R- Introduction to read.table().

Unit-2 **Teaching Hours:10**
Managing Data Frames with dplyr package- Data Frames- dplyr package- dplyr grammar-Installing dplyr- functions –select-filter-arrange-rename-mutate-group by. Control Structures-Functions and Debugging- If-else- for loops-Nested for loops-while loops- repeat Loops-next break.

Unit-3 **Teaching Hours:10**
Statistical Modelling using R: Diagrammatic and graphical representation. Exploratory data analysis-generating random numbers-fitting of discrete and continuous distributions.

List of Programs:

1. Creating vectors and performing operations on vectors.
2. Creating Matrices and performing operations on matrix.
3. Usage of select-filter-arrange-rename-mutate-group by functions.
4. Programming using control statements.
5. Diagrammatic and graphical representation.
6. Doing exploratory data analysis.
7. Correlation and Regression analysis
8. Generate random numbers from discrete distributions.

9. Generate random numbers from continuous distributions.

10. Fitting of discrete probability distribution.

11. Fitting of continuous probability distribution.

Essential Reading:

1. W.N. Venables, D.M.Smith, An Introduction to R, R Core Team, 2018.

2. Maria Dolores Ugarte, Ana F. Militino, Alan T. Arnhold. Probability and Statistics with R - 2nd ed.-CRC Press, 2016.

Recommended Reading:

1. John Verzani, simple R - Using R for Introductory Statistics-2nd ed. CRC Press- Taylor & Francis Group - 2018.

2. Bharti Motwani-Data Analytics with R- 1st ed. – Wiley-2019.

Semester 3

Linear Algebra (BDA391N)

Total Teaching Hours for Semester: 45

Maximum Marks: 100 **Credits:03**

Course Objectives:
Linear algebra is one of the basic core disciplines in mathematics, and it connects subjects in pure and applied mathematics. It also has direct applications in Data Science and Artificial Intelligence.

Course Outcomes:
Upon completion of the course the student should be able to
CO1: Apply concepts of matrix algebra for solving simultaneous linear algebraic equations.
CO2: Understand the introduction and application of concepts like vector spaces, inner product spaces and linear transformations.
CO3: To apply the knowledge of linear algebra to deal with data to solve real-world problems.

Unit 1 **Teaching Hours:09**

Matrices and System of linear equations

Matrix- Operation on matrices- Transposes and Powers of Matrices- Zero-One Matrices: Diagonal Matrix- Inverse of Matrix- System of Linear equations and Matrices - System of Homogeneous and non-homogeneous equations - Cayley Hamilton Theorem - Eigenvalues - Eigenvectors - and diagonalization.

Unit 2 **Teaching Hours:09**

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 **Teaching Hours:09**

Linear Transformations

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

Unit 4 **Teaching Hours:09**

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 **Teaching Hours:09**

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).

Essential Reading:

1. M.P. Deisenroth, A. Aldo Faisal and C.H. Ong- Mathematics for Machine Learning- 1st ed. Cambridge University Press- 2020.
2. G. Strang- Linear Algebra and Learning from Data. - 1st ed.- Wellesley-Cambridge Press- 2019.

Recommended Reading:

1. David C. Lay- Linear Algebra and its Applications- 5th ed.-Indian Reprint- Pearson Education Asia- 2018.
2. K. P. Murthy- Machine Learning- a Probabilistic Perspective-1st ed.- MIT Press- 2012.
3. S. H. Friedberg- A. Insel- and L. Spence- Linear algebra- 4th ed.- Pearson- 2015.
4. Gilbert Strang- Linear Algebra and its Applications- 4th ed.- Thomson Brooks/Cole- 2007.

Statistical Inference (BDA332N)

Total Teaching Hours for Semester: 60

Maximum Marks: 100 **Credits: 04**

Course Objectives:

This course is designed to introduce the concepts of estimation and testing of hypotheses. This course also deals with the concept of parametric tests for large and small samples. It also provides knowledge about non-parametric tests and its applications. This course will enable students to understand the concept of estimation, test of hypothesis and to apply appropriate estimation technique and test of hypothesis.

Course Outcomes:

Upon completion of this course students will be able to

CO1: Demonstrate the concepts of point and interval estimation and use point estimators for estimating unknown parameters.

CO2: Use sampling distributions in testing of hypotheses.

CO3: Apply various parametric and nonparametric tests for one sample and two samples and interpret their results.

Unit 1 **Teaching Hours:12**

Introduction

Concept of Population- Sample- Sample Space- Parameter and Statistic- Parameter Space- Sampling distribution of a statistic- Standard error. Derivation of Standard Error of sample mean- variance (without derivation)- proportion and difference between variances. Concept of Order Statistic.

Unit 2 **Teaching Hours:12**

Theory of Estimation

Point Estimation: Concept of Estimator and Estimate- properties of Point estimator – Unbiasedness- Consistency- Efficiency- relative efficiency- Minimum variance unbiased estimators- Sufficiency- Cramer Rao Inequality (Statement only)- Rao Blackwell Theorem (Statement only)- Neyman Factorization Theorem (Statement only). Methods of Estimation: Maximum likelihood- Least Squares and Minimum Variance. Concept of Interval Estimation.

Unit 3 **Teaching Hours:12**

Tests of Significance I
Concept of Statistical hypotheses- Type I and Type II error- Critical Region and power of the test. Neyman-Pearson lemma (Statement only).
Large sample tests: Tests for single mean- equality of two means- single variance and equality of two variances for Normal population- Tests of single proportion and equality of two proportions.

Unit 4 **Teaching Hours:12**
Tests of Significance II
Sampling distributions of Chi-square- t and F statistics: derivation of Mean- variance- M.G.F and properties. Small sample tests: Tests for single mean- equality of two means- single variance and equality of two variance- Tests of proportions based on t and F statistics. ANOVA-test for equality several means. Chi-square tests for independence of attributes and goodness of fit.

Unit 5 **Teaching Hours:12**
Nonparametric Tests
Concept of Nonparametric tests- Run test for randomness- Sign test and Wilcoxon Signed Rank Test for one sample and paired samples. Run test- Median test and Mann-Whitney-Wilcoxon tests for two samples. Kruskal Wallis H test.

Essential Reading:

1. V. K. Rohatgi- Statistical Inference- Dover Publication- New York- 2013.
2. S. C. Gupta and V. K. Kapoor- Fundamentals of Mathematical Statistics-12th ed.- Sultan Chand & Sons- New Delhi- 2017.

Recommended Reading:

1. R. E. Walpole, R. H. Myers and S. L. Myers- Probability and Statistics for Engineers and Scientists- 9th ed.- Pearson- New Delhi- 2017.
2. V. John- Using R for Introductory Statistics- 2nd ed.- CRC Press- Boca Raton- 2014.
3. M. Rajagopalan and P. Dhanavanthan- Statistical Inference-1st ed. - PHI Learning (P) Ltd.- New Delhi- 2012.
4. V. K. Rohatgi and E. Saleh- An Introduction to Probability and Statistics- 3rd ed.- John Wiley & Sons Inc- New Jersey- 2015.

Introduction to Machine Learning and Artificial Intelligence (BDA333N)

Total Teaching Hours for Semester: 60

Maximum Marks: 100 **Credits:04**

Course Objectives:
The main objective of this course is to provide fundamental knowledge of Machine Learning Algorithms and Artificial Intelligence. On successful completion of the course- students will acquire fundamental knowledge of Machine Learning Algorithms such as Supervised- Unsupervised- Ensemble learning along with AI strategies.

Course Outcomes:

Upon completion of the course the student should able to

CO1: Describe Machine Learning fundamentals and various models of Machine Learning.

CO2: Demonstrate various ML techniques of Supervised and Unsupervised learning algorithms.

CO3: Applicability of various techniques of Artificial Intelligence Strategies.

Unit 1 **Teaching Hours: 12**

Machine Learning Basics

Introduction to Machine Learning, AI, ML and Data Science, Training and Testing- Algorithm and Model, ML importance and techniques, Various Application areas of ML, Inferential and Descriptive models with example implementations, performance tuning techniques in the model fit.

Unit 2 **Teaching Hours:12**

Supervised Learning

Supervised Learning approach- Characteristics of Supervised learning- K-fold cross validation- Classification Techniques: KNN- Naive Bayes- Support Vector Machine and Logistic Regression- Regression Techniques: Simple Linear Regression- Multiple Linear Regression- Lasso- Ridge and Elastic Net Regression- Types.

Unit 3 **Teaching Hours:12**

Unsupervised Learning

Unsupervised Learning approach- characteristics of unsupervised learning- Apriori Algorithm- Association Rule generation- Dimensionality Reduction with Principal Component Analysis- Various Clustering Methods-K-means- Hierarchical Regularization and Penalization techniques.

Unit 4 **Teaching Hours:12**

Introduction to AI:

Introduction to Artificial Intelligence, Background and Applications, Turing Test and Rational Agent approaches to AI, Problems, Problem Spaces, Search: State space search – Production Systems – Problem Characteristics – Issues in design of Search.

Unit 5 **Teaching Hours:12**

Problem Solving and Searching Techniques

Problem Characteristics, Production Systems, Control Strategies, Breadth First Search, Depth First Search, Hill climbing and its Variations, Heuristics Search Techniques: Best First Search, Constraint Satisfaction Problem, Means-End Analysis.

Essential Reading:

1. O. Theobald- Machine Learning for Absolute Beginners: A Plain English Introduction- Scatterplot Press- 2nd Ed.- 2017.
2. J. D. Kelleher- Fundamentals of Machine Learning for Predictive Data Analytics- MIT Press- 2020.
3. Elaine Rich and Kelvin Knight, Artificial Intelligence, TMH, 2nd Edition, 2018.
4. DAN.W. Patterson, Introduction to A.I and Expert Systems – PHI, 2007.

Recommended Reading:

1. M. J. Paul -Machine Learning (in Python and R) For Dummies- Wiley India Pvt. Ltd- 1st Edition.
2. P. Flach- Machine Learning: The Art and Science of Algorithms that Make Sense of Data- Cambridge University Press- 1st Ed.- 2012.
3. E. Rich and K. Knight- Artificial Intelligence- 3rd Ed.- New York: TMH- 2019.

Object Oriented Programming Using Java (BDA334N)

Total Teaching Hours for Semester: 60

Maximum Marks: 100 **Credits:04**

Course Objectives:

This course teaches students how to develop java applications. Course gives an overview of the difference between C++ and Java. Students will be developing and testing java applications as a practical course work. The course introduces the concept of UI design in java using SWING.

Course Outcomes:

Upon completion of the course the student should able to

CO1: Demonstrate their ability to understand the concepts of Object-oriented programming and will model the real-world applications using Object Oriented Programming concepts.

CO2: Apply the concept of Multithreading in concurrent programming.

CO3: Able to design GUI applications using SWING and Event Handling.

Unit-1 **Teaching Hours:12**

Java basics

Java Fundamentals

Object oriented programming concepts – Benefits of OOPS-The origins of java - java's lineage C and C++ - how java impacted the internet - java bytecode - a first simple program - the java keywords - identifiers in java - the java class libraries.

Introducing data types and operators

Why data types are important - java's primitive types - literals - a closer look at variables - the scope and lifetime of variables - operators - type conversion in assignments - casting incompatible types - operator precedence -expressions.

Program control statements

Input characters from the keyboard - if statement - switch statement - for loop - the enhanced for loop - the while loop - the do-while loop – break – continue - nested loops.

Unit-2 **Teaching Hours:10**

Arrays and classes

Arrays

One dimensional array - multidimensional arrays - irregular arrays - alternative array declaration syntax - assigning array references - using the length member- the for each style for loop – command line arguments.

Class fundamentals - how objects are created - reference variables and assignment - methods returning a value - using parameters - constructors - parameterized constructors - the new operator revisited - garbage collection - this keyword - controlling access to class members -

method overloading -overloading constructors - understanding static - introducing nested and inner classes.

Unit-3 **Teaching Hours:11**

Inheritance, strings and exception handling

Inheritance

Inheritance basic - member access and inheritance - constructors and inheritance - using super to call superclass constructors - using super to access superclass members - creating a multilevel hierarchy - superclass references and subclass objects - method overriding - using abstract classes -using final - the object class.

Strings

Constructing strings - operating on strings - arrays of strings - strings are immutable - using a string to control a switch statement - different string handling functions.

Exception handling

The exception hierarchy - exception handling fundamentals - the consequences of an uncaught exception - using multiple catch statements - catching subclass exceptions - try blocks can be nested - throwing an exception - using finally -using throws - java's built in exceptions - creating exception subclasses.

Unit-4 **Teaching Hours: 09**

Interfaces, using I/O and multi-threading

Packages and Interfaces

Packages - packages and member access - understanding protected members -importing packages - Interfaces - implementing interfaces - using interface references - variables in interfaces - interfaces can be extended - default interface methods - use static methods in an interface.

Using I/O

Java's I/O is built upon streams - byte streams and character streams - the byte stream classes - the character stream classes - the predefined streams using the byte streams - reading and writing files using byte streams - reading and writing binary data, using java's character-based streams - file I/O using character streams.

Multithreaded programming

Multithreading fundamentals - the thread class and runnable interface - creating a thread - creating multiple threads - determining when a thread ends -thread priorities - synchronization - suspending, resuming, and stopping threads.

Unit-5 **Teaching Hours: 09**

Swing

Introducing swing - the origins and design philosophy of swing - components and containers - layout managers - swing event handling - use of JButton -work with JTextField - create a JCheckBox - work with JList.

Self Study

Advanced SWING components.

Unit-6 **Teaching Hours: 09**

Introducing javafx

Javafx basic concepts - the javafx packages - the stage and scene classes - nodes and scene graphs - layouts - the application class and the life-cycle methods - launching a javafx

application - a javafx application skeleton - compiling and running a javafx program - the application thread - a simple javafx control- label - using buttons and events - three more javafx controls-CheckBox – ListView – TextField -introducing effects and transforms.

Essential Reading:

1. S. Herbert- Java: The Complete Reference- Tata McGraw- Hill- 10th Ed.-2017.
2. Dr.Rao-Nageswara -Core Java-An Integrated Approach -New Edition Kongent Solutions Inc.- 2009.

Recommended Reading:

1. S. Herbert- Java ™ A Beginner's Guide- McGraw-Hill Education- 8th Ed.- 2017.

Statistical Inference Lab (BDA351N)

Total Teaching Hours for Semester: 30

Maximum Marks: 50 **Credits:01**

Course Objectives:

This course is designed to give a practical exposure of testing hypotheses by analysing various data sets using R programming.

Course Outcomes:

Upon completion of this course- students will be able to

CO1: Perform the parametric and nonparametric tests for small and large samples using R programming.

List of Programs:

1. Obtain Sampling distribution of various statistic.
2. Verify unbiasedness and consistency of estimator.
3. Verify efficiency of estimator.
4. Test for single mean and equality of two means when variance is known under normality conditions.
5. Test for single mean and equality of two means when variance is unknown under normality conditions.
6. Test for single proportion and equality of two proportions.
7. Test for variance and equality of variances under normality conditions.
8. Test for independence of attributes and goodness fit using Chi-Square test.
9. Test for one sample using Run test and sign test.
10. Test for paired samples using Wilcoxon Signed Rank test.
11. Test for two samples using Run test and Median test
12. Test for two samples using Mann-Whitney-Wilcoxon test.

Machine Learning and AI Lab (BDA352N)

Total Teaching Hours for Semester: 60

Max Marks: 100 **Credits: 02**

Course Objectives:

This course teaches students how to implement various Machine Learning Algorithms. The usage of Supervised and Unsupervised Learning algorithms in the real time scenarios. The AI based strategies and their implementation with the help of algorithms.

Course Outcomes:

Upon completion of the course the student should be able to

CO1: Demonstrate the usage of Supervised Learning Models.

CO2: Apply the concepts Artificial Intelligence.

CO3: Demonstrate the Usage of Unsupervised and Reinforcement Learning Models.

List of Programs:

1. Demonstrate the descriptions observed from the given data set.
2. Implement K-Nearest Neighbour implementation.
3. Demonstrate the implementation of Naive Bayes technique.
4. Apply the linear and multiple regression and justify the results.
5. Apply the logistic regression and justify the results.
6. Implement K-Means clustering algorithm.
7. Implement hierarchical clustering algorithm.
8. Demonstrate the usage of BFS search strategy in AI.
9. Demonstrate the usage of DFS search strategy in AI.
10. Apply the A* algorithm on a data set and justify the results.
11. Apply AO* algorithm on a data set and justify the results.
12. Implement the principal component analysis.
13. Implement the decision tree algorithm.
14. Demonstrate the usage of Random Forest and justify results.

Java Programming Lab (BDA353N)

Total Teaching Hours for Semester: 60

Maximum Marks: 100 **Credits: 02**

Course Objectives:

This course teaches students how to develop java applications. Course gives an overview of the difference between C++ and Java. Students will be developing and testing java applications as a practical course work. The course introduces the concept of UI design in java using SWING.

Course Outcomes:

Upon the completion of this course students will be able to

CO1: Demonstrate their ability to understand the concepts of Object-oriented programming and will model the real-world applications using Object Oriented programming concepts.

CO2: Apply the concept of Multithreading in concurrent programming.

CO3: Able to design GUI applications using SWING and Event Handling.

List of programs:

1. To implement different entry controlled and exit controlled looping statements.
2. To Implement nesting of switch statement.

3. To Implement single and multi-dimensional arrays.
4. To implement constructor overloading and method overloading.
5. To implement static keyword.
6. To Implement multilevel inheritance.
7. To implement super and this keyword.
8. To implement abstract and final keyword.
9. To implement methods of String class.
10. To Implement exception handling and custom exceptions.
11. To implement package and interface.
12. To implement File Stream classes.
13. To Implement multithreading.
14. To implement mouse and keyboard events.
15. To implement different layout managers.
16. To design a customer registration form using advanced swing components.
17. To implement 2D Shapes using JavaFX.
18. To implement CheckBox and ListView events using JavaFX.

ENTREPRENEURIAL DEVELOPMENT (BDA312N)

Total Teaching Hours for Semester: 30

Maximum Marks: 50 **Credits: 02**

Course Objectives:
This course provides the students with an in-depth understanding of key concepts in entrepreneurship and business development. The objective of the course is that the students develop the ability of analysing various aspects of entrepreneurship – especially of taking over the business risk, and the specificities as well as the pattern of entrepreneurship development.

Course Outcomes:
CO1: Analyse the business environment in order to identify business opportunities.
CO2: Identify the features and pitfalls of a business Plan.
CO3: Consider the legal and financial conditions for starting a business venture.

Unit 1 **Teaching Hours: 08**
Introduction to Entrepreneurship
Entrepreneur-Entrepreneurship-Enterprise: Conceptual issues. Entrepreneurship vs Management. Roles and functions of entrepreneurs in relation to the enterprise and in relation to the economy. Entrepreneurship as a interactive process between the individual and the environment. Small business as the seedbed of entrepreneurship.

Unit 2 **Teaching Hours: 08**
Opportunity scouting and idea generation:
Role of creativity & innovation and business research. Sources of business ideas, with case studies.

Unit 3 **Teaching Hours: 07**
Business Plan
Essential Features of Business Plan, Types of Business Plan, Presentation of Business Plan, Pitfalls to be avoided in preparation of Business Plan.

Unit 4 **Teaching Hours: 07**

Issues in small business marketing. Advertising and publicity, sales and distribution. The idea of consortium marketing, competitive bidding.

Essential Reading:

1. Dynamics of Entrepreneurial Development and Management by Vasant Desai, Edition 2000, HP.
2. Fundamentals of Entrepreneurship and Small Business Management by Vasant Desai Edition 2005, HP.

Recommended Reading:

1. Entrepreneurship Need of the Hour- Dr Vidya Hattangadi Edition 2007 HP.

Semester 4

Optimization Techniques (BDA491N)

Total Teaching Hours for Semester: 45

Maximum Marks: 100 **Credits:03**

Course Objectives:

This course is designed to introduce the concepts of different optimization techniques. This paper includes the classical as well as modern optimization techniques. This course will enable the student to have the fundamental knowledge of classical optimization technique, know the basics of different evolutionary algorithms, explain dynamic programming, and apply different optimization techniques to solve various models arising from different areas.

Course Outcomes: After the completion of this course, students will be able to

CO1: Demonstrate the concepts of optimization.
CO2: Understand and apply classical optimization techniques to solve different problems.
CO3: Understand and apply modern optimization techniques to solve different problems.

Unit 1 **Teaching Hours: 15**

Introduction

Introduction to Optimization: Application of Optimization-Optimal Problem formulation-Classification of Optimization problem. Convex sets and convex functions and their properties.
Optimum design concepts: Definition of Global and Local optima- Optimality criteria- Review of basic calculus concepts- Global optimality.

Unit 2 **Teaching Hours: 15**

Optimization algorithms

Optimization algorithms for solving unconstrained optimization problems – Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method. Optimization algorithms for solving constrained optimization problems: direct methods, penalty function methods, steepest descent method.

Unit 3 **Teaching Hours: 15**

Modern methods

Modern methods of Optimization: Genetic Algorithms, Simulated Annealing, Ant colony optimization, Tabu search, Neural-Network based Optimization.

Essential Reading:

1. Rao S. S. – Engineering Optimization, Theory and Practice - 5th ed. -New Age International Publishers – 2020.
2. Deb K. – Optimization for Engineering Design Algorithms and Examples- 2nd ed.– PHI – 2000.

Recommended Reading:

1. Mohan, C. and Deep, K.-Optimization Technique-1st ed.- New Age India Pvt. Ltd-New Delhi-2009.
2. Mittal, K.V. and Mohan, C.-Optimization Methods in System Analysis and Operations Research-1st ed.- New Age India Pvt. Ltd - New Delhi-2016.
3. Ravindran, A., Phillips, D.T. and Solberg, J.J.-Operations Research: Principles and Practice-2nd ed.- John Wiley and Sons, NY- 2007.

Applied Regression (BDA432N)

Total Teaching Hours for Semester: 60

Maximum Marks: 100 **Credits:04**

Course Objective:

This course covers regression analysis, estimation using method of least squares and statistical inference using regression models. Analysis of residuals and variability will be investigated. This course also covers Nonlinear regression model. The course aims to provide deeper understanding about the assumptions and analysis of linear and non-linear regression models.

Course Outcomes:

Upon completion of the course the student should be able to

CO1: Develop a deeper understanding of the linear regression model.

CO2: Understand and apply appropriate regression models and test its assumptions.

CO3: Use appropriate criteria for model selection and evaluate the fitted model.

Unit 1 **Teaching Hours:12**

Simple Linear Regression

Introduction to regression analysis: Modelling a response- overview and applications of regression analysis- major steps in regression analysis. Simple linear regression: Review of Simple linear regression, assumptions- estimation and properties of regression coefficients- significance and confidence intervals of regression coefficients- overall model fit measure. measuring the quality of the fit.

Unit 2 **Teaching Hours:12**

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 **Teaching Hours:12**

Criteria for Model Selection

Mean Square error criteria- R^2 and Adjusted R^2 criteria for model selection; Need of the transformation of variables; Box-Cox transformation; Forward-Backward and Stepwise procedures, AIC-BIC model fit indices.

Unit 4 **Teaching Hours:12**

Residual Analysis

Residual analysis- Departures from underlying assumptions- Effect of outliers- Multi-Collinearity- Non-constant variance and serial correlation- Departures from normality- Diagnostics and remedies.

Unit 5 **Teaching Hours:12**

Nonlinear 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 regressions, Poisson regressions. Prediction and residual analysis.

Essential Reading:

1. D.C Montgomery-E.A. Peck and G.G Vining- Introduction to Linear Regression Analysis- 5th ed.- John Wiley and Sons-Inc.NY- 2012.
2. S. Chatterjee and A. Hadi- Regression Analysis by Example- 5th ed.- John Wiley and Sons-Inc- 2012.

Recommended Reading:

1. I. Pardoe- Applied Regression Modeling- 3rd ed.- John Wiley and Sons- Inc- 2020.
2. P. Mc Cullagh and J.A. Nelder- Generalized Linear Models- 2nd ed.- Chapman & Hall- 2019.

Database Management System (BDA433N)

Total Teaching Hours for Semester: 45

Maximum Marks: 100 **Credits:03**

Course Objectives:

To learn the fundamentals of data models and to conceptualize and depict a database system using ER diagrams, to improve database designing by normalization techniques, to implement the design of the tables in DBMS, to construct queries to get optimized outputs, NOSQL.

Course Outcomes:

Upon completion of the course the student should be able to

CO1: Apply the fundamental concepts of databases and Entity-Relationship (E-R) model.

CO2: Apply query processing techniques to automate the real time problems of database.

CO3: Compare and contrast different file organization concepts and applying the transaction management principles on Relational databases.

Unit 1 **Teaching Hours:10**

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 and limitations 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 **Teaching Hours:09**

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- SQL:DDL- DML- DCL-TCL.

Unit 3 **Teaching Hours:09**

Database Design

Functional dependencies and Normalization for Relational Databases - Normalization on concepts- first, second, third normal forms-BCNF. PL/SQL: Basics - procedures- functions-triggers.

Unit 4 **Teaching Hours:08**

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.

Unit 5 **Teaching Hours:09**

Database Connectivity and NoSQL

Introduction and implementation of database connectivity - Introduction to NoSQL -Advantages and disadvantages-Types.

Essential Reading:

1. E. Ramez and N. Shamkant, Fundamentals of Database Systems- Addison- Wesley, 7th Ed.- 2016.
2. J. R. Groff and P. N. Weinberg, SQL: The Complete Reference- 3rd Edition- 2009.

Recommended Reading:

1. A. Silberschatz, H. F. Korth, S. Sudarshan- Database System Concepts- 6 Ed.- McGraw Hill- 2011.
2. O. Patricand, and O. Elizabeth- Database Principles, Programming and Performance- 2nd Ed.- Margon Kaufmann Publishers Inc.- 2008.
3. R. Ramakrishnan- Database Management System- Tata McGraw-Hill Publishing Comp.- 2003.

Data Analytics and Visualization (BDA434N)

Total Teaching Hours for Semester: 45

Maximum Marks: 100 **Credits:03**

Course Objectives:
The main objective of this course is to provide fundamental knowledge on analytics with R programming. On successful completion of the course- students will acquire fundamental knowledge of various techniques of analysis of the data along with mining and Business Analytics.

Course Outcomes:
Upon completion of the course the student should be able to
CO1: Describe Data Analytics fundamentals and Business Intelligence.
CO2: Demonstrate the usage of data warehousing- mining and importance in analytics.
CO3: Applicability of various exploratory data visualization techniques and various interactive methods.

Unit 1 **Teaching Hours: 08**
Wholeness of the data
Analytics- important of analytics - Business Intelligence- Pattern Recognition- Data Processing Chain- Business Intelligence Concepts and Applications- BI for Better Decisions- BI Tools- BI Skills- BI Applications- Data Analytics Life Cycle- R- Features of R.

Unit 2 **Teaching Hours: 08**
Sources of Analytics
Data warehousing Architecture- Data Sources- ETL process- Data warehouse Best practices- gathering and selecting the data- data cleansing and preparation- data mining best practices- Types of charts- tips for data visualization.

Unit 3 **Teaching Hours: 08**
Exploratory data Analysis
Descriptive Analytics- Prescriptive analytics and Predictive Analytics- Feature Selection- Feature Scaling and Normalization techniques- Confusion Matrix- Area Under Curve- Receiver operating characteristic Curve- Statistical methods for Evaluation- Correlation and Regression.

Unit 4 **Teaching Hours: 11**
Introduction to Data Visualization
Definition – Methodology – Seven Stages of Data Visualization - Data Visualization Tools. Visualizing Data: Mapping Data onto Aesthetics – Visualizing Amounts - Visualizing Distributions: Histograms and Density Plots – Visualizing Propositions: – Visualizing Associations: Among Two or More Quantitative Variables – Visualizing Time Series and Other Functions of an Independent Variable – Trends – Visualizing Geospatial Data.

Unit 5 **Teaching Hours: 10**
Visualization with Tableau

Tableau Software Ecosystem, Toolbar Icons, Data Window and Aggregation, Connect to Data, Sorting Data, Measure Names, Number of Records & Measures, Cross-tabulation, Heat Maps, Tree maps, Bar Chart, Line Chart, Pie Chart, Scatter Plot, Histogram, Boxplot.

Essential Reading:

1. A. Maheshwari- Data Analytics made Accessible-Seattle: Amazon Digital Services- 2015.
2. EMC Education Services- Data Science and Big Data Analytics: Discovering- Analyzing- Visualizing and Presenting Data- Wiley- 2015.
3. Ben Fry, "Visualizing Data: Exploring and Explaining Data with the Processing Environment", O'Reilly, 1st Edition, 2008.
4. Dan Murray, Christian Chabot," Tableau Your Data!: Fast and Easy Visual Analysis with Tableau Software", Wiley 2013.

Recommended Reading:

1. V Granville- Developing Analytic Talent: Becoming a Data Scientist- John Wiley & Sons- 2014.

Database Management System Lab (BDA451N)

Total Teaching Hours for Semester: 30

Maximum Marks: 50 **Credits:01**

Course Objectives:

To learn and understand Database Programming Paradigms. To learn and understand PL/SQL Programming Techniques. To learn about Relational Database and to know how it is implemented in Different applications.

Course Outcomes:

Upon completion of the course the student should

CO1: Understanding of Database Programming Languages.

CO2: Execute the basics of database languages and construct queries using SQL, PLSQL.

CO3: Understand how analytics and big data affect various functions now and in the future.

List of Programs:

1. Draw E-R diagram and convert entities and relationships to a relation table for a given scenario. a. Two assignments shall be carried out i.e. consider two different scenarios (eg. bank, college).
2. Design a database schema for the two different scenarios.
3. Design and Develop MySQL DDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence.
4. Write MySQL queries using logical operations and operators.
5. Design MySQL queries for suitable database applications using DML statements: Insert, Select, Update, Delete with operators, functions, and set operators.
6. Design MySQL queries for suitable database application using DML statements: all types of Join, Sub-Query.

7. Create three related tables and perform the following : Simple Queries, Simple Queries with Aggregate functions, Queries with group by and having clause, Queries involving- Date Functions, String Functions , Math Functions.
8. Write a PL/SQL block to calculate the grade of minimum 10 students.
9. Write a PL/SQL block to implement application based commands.
10. Write a PL/SQL block to implement trigger.

Data Analytics and Visualization Lab (BDA452N)

Total Teaching Hours for Semester: 60

Maximum Marks: 100 **Credits:02**

Course Objectives:

This course teaches students how to implement various Analytics Based Algorithms. The usage of Descriptive and Predictive Learning algorithms in the real time scenarios. The Web based data extraction and techniques of scaling and normalizations can be learned.

Course Outcomes:

Upon completion of the course the student should able to

CO1: Demonstrate the usage of Descriptive and Inferential Models.

CO2: To execute and Implement data visualization techniques.

List of Programs:

1. Basic data manipulation operations.
2. Write a program to Implement inferential analytics.
3. Create Vectors and operations on them.
4. Create Lists and perform Operations on them.
5. Create Arrays and perform operations on them.
6. Create 2-D Arrays and perform operations on matrices.
7. Create Data Frames and perform operations on them.
8. Demonstrate the usage of various charts in the visualization.
9. Create Dual Axis Map Charts.
10. Visual Analytics– Grouping, Sorting, ToolTips, Hierarchies, Clustering.
11. Forecasting and Trend Lines.
12. Joining Multiple Datasets with different Join Types and preparing appropriate charts.
13. Enhancing Views with Filters, Groups.
14. Prepare a Story comprising of multiple Dashboards and Convey an appropriate story based on the give dataset.

* preferred tools are R/python/Tableau

Web Technology Lab (BDA471N)

Total Teaching Hours for Semester: 30+60

Maximum Marks: 100 **Credits: 04**

Course Objectives:
This subject will provide basic understanding of WWW- Web Development- Client side and Server-side technologies to develop and deploy Websites on Internet using HTML- Cascading Style Sheet- PHP and JavaScript.

Course Outcomes:
Upon completion of the course the student should able to
CO1: Understand the concepts of Internet basics to design- implement and maintain a typical web page.
CO2: Develop and incorporate dynamic capabilities in Web pages using DOM and JavaScript.
CO3: Learn the importance of server-side scripts for web Interactivity and Web Hosting

Unit-1 **Teaching Hours:08**
Web Essentials And Html5
Clients- Servers- and Communication. The Internet - Basic Internet Protocols -The World Wide Web - HTTP request message - response message - Web Clients - Web Servers – Markup Languages - Introduction to HTML- HTML Syntax- New input element and attribute- New Structure elements - SVG: SVG in HTML - SVG Shapes - SVG Text- Canvas.

Unit-2 **Teaching Hours:07**
CSS
CSS - Introduction to Cascading Style Sheets – Features – Core Syntax – colour and background – Text and font- list and tables – CSS selectors – Cascading and Inheritance.CSS web layout in CSS, Grouping/Nesting , Dimension , Display, Positioning, Navigation bar, Image gallery. CSS 3.0 - CSS Border, Shadows, background - 3D transform - web fonts.

Unit-3 **Teaching Hours:07**
Client-Side Programming
Introduction to JavaScript - Functions, Objects - Arrays - Built - in Objects - JavaScript Debuggers - JS Document Object Model (DOM) -Introduction to the DOM - DOM HTML- DOM CSS - Modifying Element Style - DOM Event Handling - Form validation: validating radio buttons - checkboxes- select menus - Text areas - JS Browser Object Model (BOM) - JS Cookies -JS Windows- JS Location - JS Popups- JS Time.

Unit-4 **Teaching Hours:08**
Server-Side Programming-1
Introduction to PHP - Basic Programming Concepts of PHP: Variables – Data types - Constants - Scope of Variables - Type of Variables - Type Casting – Operators - Operators Precedence – References – Arrays - Control Structures: Branching -If statement - Switch statement - Looping: for Loop - while Loop - do while Loop - for each Loop. Functions: User Defined Functions – Built-in Function- - Functions for Variables - Script Controlling Functions - Array Functions - Date and Time Functions

List of Programs:
1. Write a HTML code to display your education details in a tabular format.
2. Write a HTML code to display your CV on a web page.

3. Write a HTML code to create a Home page having three links: About Us- Our Services and Contact Us also illustrate the usage of various lists.
4. Write a HTML code to create a login form. On submitting the form- the user should get navigated to a profile page.
5. Write a HTML code to create a frameset having header- navigation and content sections.
6. Create separate web pages Design a web page using CSS (Cascading Style Sheets) which includes the Use of different font- styles, setting a background image for both the page and to Control the repetition of the image with the background-repeat property.
7. Write a program to demonstrate the usage of inline CSS, internal CSS, external CSS.
8. Write a CSS program describing the CSS List with the various list-style-type and also the types of borders used.
9. Write a Java script to prompt for the user's name and display it on the screen.
10. Design HTML form for keeping student records and validate it using Javascript.
11. To design the scientific calculator and make event for each button using javascript.
12. Write a javascript program which computes the average marks of the following student and use the average to determine the corresponding grade.
13. Write PHP program to change the image automatically using the switch case and also to calculate current age without using any predefined function.
14. Write a PHP program to upload images to the server using html and PHP.
15. Write a PHP program to upload registration form into the database and also to display the registration form from the database.

Essential Reading:

1. R. W. Sebesta- Programming the World Wide Web- Pearson Education- 4th Ed.- 2014.
2. R. Moseley-Developing Web application - Ralph Moseley-John Wiley & Sons- 2011.

Recommended Reading:

1. J. C. Jackson-Web Technologies-A Computer Science Perspective- Edition 1st, 2011. Pearson Education- 2008.
2. H. M. Deitel, P. J. Deitel et.al -Internet & World Wide Web - How To Program- Pearson Education- 5th Ed.- 2012.
3. Rajkamal- Web Technology- Tata McGraw-Hill- 2001.
4. U. K. Roy-Web Technologies- Oxford University Press- 2011.

Personality Development-I (BDA412N)

Total Teaching Hours for Semester: 30

Maximum Marks: 50 **Credits:02**

Course Objectives:

This course develops the soft skills of the students and in which students can enhance their self to get familiarize with the concept of team building and of Stress Management. Also motivate them to apply time management and multi-tasking.

Course Outcomes:

After completion of this course Students will be able to

CO1: Understand the theoretical concept relating to Team Building.
CO2: Know the concept Stress Management.
CO3: Apply the gained knowledge for Time Management and Multi-Tasking.

Unit-1 **Teaching Hours:08**

Team Building and Art of Negotiation

Nature of the team, Professional goals of the members of the group, Building relation and interpersonal communication, Negotiation and Ways of negotiating, Power of language and non-verbal communication.

Unit-2 **Teaching Hours:08**

Dress for Success and Table Manners

Proper attire as per the situation, one's self-How to project one's self in the right frame and spirit, professional meetings over lunch/dinner, Basics of the table manner.

Unit-3 **Teaching Hours:07**

Organizing Meetings and Stress Management

Call the meeting and organize a meeting in the smooth manner, Design the agenda and prepare minutes of the meeting, Kinds of stress and reason/s of stress, Handling Stressful situation at a workplace.

Unit-4 **Teaching Hours:07**

Telephone etiquettes and Time Management

Telephonic etiquettes and tone and pitch of the voice, Voice mail, Goal setting, Time-schedule.

Essential Reading:

1. Peggy Klaus, The Hard Truth about Soft Skills. Edition 1st, 2007. Collins Publisher.
2. Nitin Bhatnagar, Effective Communication and Soft Skills. Edition 1st, 2011. Pearson Education India.

Recommended Reading:

1. Eric Garner, Team Building. 2012. Eric Garner & Ventus Publishing APS.