BHARATHIDASAN UNIVERSITY TIRUCHIRAPPALLI-620 024.

B.Sc. DATA SCIENCE

CHOICE BASED CREDIT SYSTEM –

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-2023 onwards)

Sem.	Part	Course	Title	Ins. Hrs	Credit	Exam Hours	Marks		Total
							Int.	Ext.	
I	I	Language Course – I Tamil $ / Other Languages + #		6	3	3	25	75	100
	II	English Course - I		6	3	3	25	75	100
	III	Core Course – I (CC)	Programming in C and Data Structures	5	5	3	25	75	100
		Core Practical – I (CP)	Programming in C Lab	4	4	3	40	60	100
		First Allied Course – I (AC)		4	4	3	25	75	100
		First Allied Practical (AP)		3	-	-	-	-	-
	IV	Value Education		2	2	3	25	75	100
	TOTAL			**30**	**21**	**-**	**-**	**-**	**600**
II	I	Language Course - II Tamil $ / Other Languages + #		6	3	3	25	75	100
	II	English Course - II		6	3	3	25	75	100
	III	Core Course – II (CC)	Python Programming	5	5	3	25	75	100
		Core Practical – II (CP)	Python Programming – Lab	4	4	3	40	60	100
		First Allied Practical (AP)		3	2	3	40	60	100
		First Allied Course – II (AC)		4	4	3	25	75	100
		Add on Course – I ##	Professional English I	6*	4	3	25	75	100
	IV	Environmental Studies		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Language Proficiency for Employability - Effective English	-	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**900**

III	I	Language Course – III Tamil $ / Other Languages + #		6	3	3	25	75	100
	II	English Course - III		6	3	3	25	75	100
	III	Core Course – III (CC)	Database Systems	5	5	3	25	75	100
		Core Practical - III (CP)	Database Systems Lab	4	4	3	40	60	100
		Second Allied Course – I (AC)		4	4	3	25	75	100
		Second Allied Practical (AP)		3	-	-	-	-	-
		Add on Course – II ##	Professional English II	6*	4	3	25	75	100
	IV	Non-Major Elective I @ - Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level **or** b) Special Tamil if Tamil language was studied upto 10^{th} & 12^{th} std.		2	2	3	25	75	100
	TOTAL			**30**	**25**	**-**	**-**	**-**	**700**
IV	I	Language Course –IV Tamil $ / Other Languages + #		6	3	3	25	75	100
	II	English Course – IV		6	3	3	25	75	100
	III	Core Course - IV (CC)	Big Data Analytics with NoSQU Database	5	5	3	25	75	100
		Core Practical - IV (CP)	Big Data Analytics Lab	4	4	3	40	60	100
		Second Allied Practical (AP)		3	2	3	40	60	100
		Second Allied Course – II (AC)		4	4	3	25	75	100
	IV	Non-Major Elective II Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level or b) Special Tamil if Tamil language was studied upto 10^{th} & 12^{th} std.		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Digital Skills for Employability	-	2	3	25	75	100
	TOTAL			**30**	**25**	**-**	**-**	**-**	**800**

V	III	Core Course - V (CC)	Data Mining, Data Warehousing and Data Visualization	5	5	3	25	75	100
		Core Course – VI (CC)	Network Security	5	5	3	25	75	100
		Core Course – VII (CC)	Cloud Computing	5	5	3	25	75	100
		Core Practical -V (CP)	Data Mining, and Data Visualization Lab	4	4	3	40	60	100
		Major Based Elective – I (Any one)	1. Internet of Things 2. Block Chain Technology	5	4	3	25	75	100
	IV	Skill Based Elective I	Shell Programming	4	2	3	25	75	100
		Soft Skills Development		2	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**700**
VI	III	Core Course - VIII (CC)	R Programming	6	5	3	25	75	100
		Core Course - IX (CC)	Machine Learning	6	5	3	25	75	100
		Core Practical – VI (CP)	Machine Learning Lab	4	4	3	40	60	100
		Major Based Elective – II (Any one)	1. Computing Technologies for Data Science 2. Augmented Reality and Virtual Reality	5	4	3	25	75	100
		Project		4	3	-	20	80	100
	IV	Skill Based Elective – II	Web Technology	4	2	3	25	75	100
	V	Gender Studies		1	1	3	25	75	100
		Extension Activities **		-	1	-	-	-	-
	VI	Naan Mudhalvan Scheme (NMS) @@		-	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**800**
GRAND TOTAL				**180**	**154**	**-**	**-**	**-**	**4500**

List of Allied Courses

First Allied Course	**Second Allied Course**
Mathematics	Statistics

$ For those who studied Tamil upto 10th +2 (Regular Stream).

+ Syllabus for other Languages should be on par with Tamil at degree level.

Those who studied Tamil upto 10th +2 but opt for other languages in degree level under Part- I should study special Tamil in Part – IV.

The Professional English – Four Streams Course is offered in the 2nd and 3rd Semester (only for 2022-2023 Batch) in all UG Courses. It will be taught apart from the Existing hours of teaching / additional hours of teaching (1 hour /day) as a 4 credit paper as an add on course on par with Major Paper and completion of the paper is must to continue his / her studies further. (As per G.O. No. 76, Higher Education (K2) Department dated: 18.07.2020).

* The Extra 6 hrs / cycle as per the G.O. 76/2020 will be utilized for the Add on Professional English Course.

@ NCC Course is one of the Choices in Non-Major Elective Course. Only the NCC cadets are eligible to choose this course. However, NCC Course is not a Compulsory Course for the NCC Cadets.

** Extension Activities shall be outside instruction hours.

@@ Naan Mudhalvan Scheme.

SUMMARY OF CURRICULUM STRUCTURE OF UG PROGRAMMES

Sl. No.	Part	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	I	Language Courses	4	12	400
2.	II	English Courses	4	12	400
3.	III	Core Courses	8	40	800
4.		Core Practical	7	29	700
5.		Allied Courses I & II	4	16	400
6.		Allied Practical	2	4	200
7.		Major Based Elective Courses	2	8	200
8.		Add on Courses	2	8	200
9.		Project	1	3	100
10.	IV	Non-Major Elective Courses (Practical)	2	4	200
11.		Skill Based Elective Courses	2	4	200
12.		Soft Skills Development	1	2	100
13.		Value Education	1	2	100
14.		Environmental Studies	1	2	100
15.	V	Gender Studies	1	1	100
16.		Extension Activities	1	1	--
17.	VI	Naan Mudhalvan Scheme	3	6	300
	Total		**46**	**154**	**4500**

PROGRAMME OBJECTIVES:

- Graduates will be able to comprehend the basic concepts learnt and apply in real life situations with analytical skills.
- Graduates with acquired skills and enhanced knowledge will be employable / become entrepreneurs or will pursue higher Education.
- Graduates with acquired knowledge of modern software tools will be able to contribute effectively as data scientist.
- Graduates will be able to comprehend the related concepts to Data Science with Allied papers
- Graduates will be imbibed with ethical values and social concerns to ensure peaceful society.

PROGRAMME OUTCOMES:

After successful completion of B.Sc. Data Science programme the students will be able to

- Apply the computing knowledge to analyze real world applications.
- Solve the complex problems in the field of data science with an understanding of different types and formats of data
- Understand the concepts and ability to apply appropriate models.
- Develop programs and models for the various domain specific problems.
- The ability to exposure, identify and 3nalyse big data, adjust and adapt with the dynamic technical environment for the growth of IT industry.

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First Year **CORE COURSE I** **Semester I**

PROGRAMMING IN C AND DATA STRUCTURES

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To know about the basics of C Programming, Control and Looping Structures and programming with it.
- To understand Arrays, Pointers and String Processing in C language
- To know about the basic concepts in Data Structures.

UNIT - I:

Basic of C: History of C and its importance – Structure of a C program – Data Types – Constants and Variables – Operators and Expressions – Order of Precedence, Evaluating of Arithmetic Expressions – Type Conversion- Decision Statements: if, if-else, and nested if statements.

UNIT - II:

Loops Structures: For Loop, While, Do-while loop – Arrays: - One Dimensional Array, Two-dimensional Arrays, Character Arrays and Strings – Functions: Function with arrays- Function with decision and looping statements - Recursion.

UNIT - III:

Pointers: Introduction – Pointer Expressions – Chain of Pointers – Pointers and Arrays – Array of Pointers – Pointers as function arguments – Functions returning Pointers – Pointers to Functions – Function pointer – Structures - declaration, initialization, Array of Structures – Pointer to structures, Structures and functions – Typed of Enumerated data types, Unions.

UNIT - IV:

Strings Processing, Standard string library functions – Files: introduction and files functions – Writing and reading in Text mode – Simple application: Display the contents of a file. Write data to a file. Append data to an existing file – File IO – Reading and writing structures.

UNIT - V:

Stack: LIFO concept, Stack operations, Array implementation of stack – Queue: FIFO concept, Queue operations, Array implementation of queue – Singly Linked List: concepts, operations – Doubly Linked List: concepts, operations – Trees: General trees, Binary trees.

UNIT - VI CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. E. Balagurusamy, "Programming in ANSI C", Tata McGraw Hill, New Delhi, Seventh Edition, 2016.
2. E. Horowitz, S. Sahni and Susan Anderson Freed, "Fundamental Data Structures in C", 2ed, Orient Black Swan Publisher, 2009.
3. Byron S. Gottfried, "Programming with C", Schaum's Outline Series, Tata- McGraw Hill Edition, New Delhi, 1991.
4. E. Karthikeyan, "A Textbook on C Fundamentals, Data Structures and Problem Solving", Prentice-Hall of India Private Limited, New Delhi, 2008.
5. Yashavant Kanetkar, "Let us C", BPB Publications, Tenth Edition, New Delhi, 2010.
6. Szuhay, Jeff, and Szuhay, Jeff, "Learn C Programming: A Beginner's Guide to Learning C Programming the Easy and Disciplined Way", Packt Publishing, 2020.
7. Jena, Sisir Kumar, and Jena, Sisir Kumar, "C Programming: Learn to Code", CRC Press, 2021.
8. https://www.tutorialspoint.com/cprogramming/index.htm
9. https://www.w3schools.in/data-structures/intro

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Summarize the basic knowledge to develop C programs
- Manipulate Looping, arrays and functions
- Apply and write programs for solving real world problems
- Create open, read, manipulate, write and close files.
- Understand the basic concepts in data structures.

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First Year **CORE PRACTICL I** **Semester I**

PROGRAMMING IN C LAB

Code: **(Practical)** **Credit: 4**

COURSE OBJECTIVES:

- To understand the programming fundamentals of C language.
- To impart writing skill of C programming and data structures for a list ofproblems.
- To impart hands on training for writing a C program using computers.

1. Write a Program
   (i) To convert temperature from degree Centigrade to Fahrenheit,
   (ii) Find whether given number is Even or Odd,
   (iii) Find the greatest of three numbers.
2. Write a Program to display Monday to Sunday using switch statement
3. Write a Program to display first Ten Natural Numbers and their sum.
4. Write a Program to perform Multiplication of Two Matrices.
5. Write a Program
   (i) To find the maximum number in an Array using pointer.
   (ii) To reverse a number using pointer.
   (iii) To add two numbers using pointer.
6. Write a Program to solve Quadratic Equation using functions.
7. Write a Program to find factorial of a number using Recursion.
8. Write a Program to demonstrate Call by Value and Call by Reference.
9. Write a Program to create a file containing Student Details.
10. Write a program to implement a stack using singly linked list, Implement Queue using Linked List.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Relate the use of language constructs to solve simple programs
- Develop programs for various concepts in C language
- Understand and trace the execution of the list of programs
- Understand the usage of file handling in C programming
- Solve data problems related to data structures

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First Year **CORE COURSE II** **Semester II**

PYTHON PROGRAMMING

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To provide a platform to learn the fundamentals of Object Oriented Programming
- To understand the syntax of the Python and apply the concepts to write programs
- To implement file concepts and data analysis in Python

UNIT - I:

Object Oriented Programming: Procedural and Object-Oriented Programming – Classes – Working with instances – techniques for designing classes. – Inheritance: introduction to inheritance – Polymorphism

UNIT - II:

Python: Installing python- The python Interpreter – Interactive mode – Writing and running programs in script mode- IDLE programming environment – Input, processing and output – Displaying output with print function –Strings and String literals- Comments – variables – Reading input from the Keyboard - Operators- more about output – Decision structures and Boolean logic – Repetition Structures

UNIT - III:

Lists, Tuples, Strings, Dictionaries and Set: Sequences – Introduction to Lists – List slicing – 'in' operator – list methods and built-in-functions – copying lists – processing lists – Two Dimensional Lists – Tuples. Strings**:** Basic String Operations – String Slicing Testing, Searching and manipulating strings – Dictionaries and Set: Dictionaries – Set – Serializing Objects.

UNIT - IV:

Functions, Modules and File Handling: Functions: introduction to functions – Defining and calling functions – designing a program to use functions – Local variables – passing arguments to functions – Global variable and Global Constants- –Value returning functions: generation – user defined value returning functions – Modules: math module- Storing functions in modules - Files: Introduction to File Input and Output – Using Loops to process files – processing records - Exceptions – Python Standard Library - Regular Expression..

UNIT - V:

Data Analysis using Python: Load data into a Data Frame - Fundamentals of Data Manipulation with Python.

UNIT - VI Current Contours (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. Allen B. Downey, ***"Think Python: How to Think Like a Computer Scientist"***, 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
2. Satyanarayana, Radhika Mani, Jagadesh***,"Python Programming",*** Universities Press (India) Pvt. Ltd 2018
3. Wesley Chun **"Core python Programming"** Pearson Education, 2006,
4. Al Sweigart, **"Invent your own computer games with python",** 2nd edition, 2008
5. Bill Lubanovic, **"Introducing Python"**, O"Reilly, First Edition-Second Release, 2014.
6. Tony Gaddis, **"Starting out with python",** 2nd edition, Addison Wesley, Pearson
7. Michael Dawson, "**Python programming for the absolutebeginner"**, Premier press, 2003.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Interpret and manipulate the OOPs Concepts
- Install python and write programs to solve simple problems
- Explain basic data structures in Python
- Store and manipulate data using file system
- Implement Python packages and libraries

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First Year **CORE PRACTICAL II** **Semester II**

PYTHON PROGRAMMING LAB

Code: **(Practical)** **Credit: 4**

COURSE OBJECTIVES:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- To represent compound data using Python lists, tuples, and dictionaries.

1. Write Python programs for the following: (using Basics of Python)
   a. Purposefully raise Indentation Error and correct it.
   b. Compute distance between two points taking input from the user (use Euclidean distance formula).
   c. To takes numbers as command line arguments and print its sum
2. Write Python programs for implementing the following: (using Control Flow)
   a. Finding the factorial of a number.
   b. Print the prime numbers below 100
3. Write Python programs for implementing the following: (using Strings)
   a. Count the numbers of characters in the string and store them in a dictionary data structure
   b. Using split and joins methods in the string and trace a birthday with a dictionary data structure.
4. Write Python programs for the following: (using List)
   a. Finding mean, median, mode for the given set of numbers in a list.
   b. Function dups to find all duplicates in the list.
5. Write Python programs to do the following (using Methods)
   a. Create a Python class named Circle constructed by a radius and two methods which will compute the area and the perimeter of a circle.
   b. Create a Python class named Rectangle constructed by a length and width and a method which will compute the area of a rectangle.
6. Write Python programs to implement
   a. Constructors to assign the PI_VALUE.
   b. Polymorphism to print area of square/rectangle depending upon the number of parameters passed.
7. Write Python programs to implement
   a. Inheritance
   b. Method overloading and overriding
8. Write a python program (using files)
   a. to open and write “Hello World” into a file.
   b. to write the content “Hi Python Programming” for the existing file.
   c. To import values from a CSV file to create Pandas Data Frame
9. Write a Python program to create an Email slicer.
10. Write a Python program to generate password.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Write simple programs using control structures, functions and strings
- Develop programs using tuples, lists, sets and dictionary
- Write simple programs using Constructors, Method overloading and inheritance
- Develop programs using files and regular expressions
- Write simple programs using packages and exception handling

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Second Year	CORE COURSE III DATABASE SYSTEMS	Semester III
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

- To impart the basic database concepts, applications, data models, schemas and instances.
- To familiarize Entity Relationship model for a database.
- To demonstrate the use of constraints and relational algebra operations.

UNIT - I:

Databases and Database Users: Introduction - characteristics of data base approach - intended uses of a DBMS- advantages and implication of database approach. Database Systems Concepts and Architecture: Data models- schemas and instances- DBMS architecture and data independence- database languages and interfaces- database system environment- classification of data base management systems

UNIT - II:

Data Modelling :High level conceptual data models for database design- Entity types- entity sets- attributes and keys- Relationships- relationship types- roles and structural constraints - Weak entity types- ER diagrams and design issues.

UNIT - III:

Relational Data Model and Relational Algebra: Brief discussion on CODD rules- relational model concepts- constraints and schemas- Update operation on relations- basic and additional relational algebra operations- queries in relational algebra

UNIT - IV:

Structured Query Language (SQL): Data definition in SQL- Basic and complex queries- SQL Insert- delete- update statements and views in SQL- embedded SQL. Database Design: Design guidelines for relational schemas- functional Dependencies - normalization -1st, 2nd, 3rd, 4th and 5th normal forms- Database design process- factors influencing physical database design guidelines and guidelines for relational systems.

UNIT - V:

Record Storage and Primary File Organizations: Secondary storage devices- buffering of blocks- placing file records on disk- operations on files- heap files and sorted files – hashing techniques. Index Structure of Files: Single – level and multilevel ordered indexes- dynamic multi-level indexes using B-trees and B+ trees.

UNIT VI: Current Contours (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. Ramez Elmasri and Shamkanth B. Navathe, "Fundamentals of Database Systems", Pearson Education, 5th Edition, 2008, ISBN: 978– 81– 317 – 1625-0.
2. Raghu Ramakrishnan, "Database Management System", McGraw Hill, 3rd Edition, 1997, ISBN: 0071230572.
3. Gary W. Hansen and James V. Hansen, "Database Management and Design" PHI Pvt. Ltd., 2nd Edition, 1995 ISBN: 81-203-1465-4.
4. Date C J, Kanna A, "Database Systems", Pearson Education, 8th Edition, 2006, ISBN: 978- 81-775-8556-8.
5. H G Molina, J D Ullman, J Widom, "Database Systems – The Complete Book" , Pearson; 2nd edition (4 September 2008).
6. Abraham Silberschatz, Hendry F. Korth, S Sudharshan," Database System Concepts", 6th Edition, McGraw Hill International, 2019.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the basic concepts of database systems
- Understand the relational data model.
- Apply the concepts of data base design.
- Design and create database with normalization
- Analyse the storage and file organization concepts.

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Second Year	CORE PRACTICAL III DATABASE SYSTEMS LAB	Semester III
Code	(Practical)	Credit: 4

1. To understand the basic concepts and the applications of database systems using MYSQL.
2. To create and perform basic operation with MYSQL.
3. To interact with MYSQL by using nested queries, set of aggregate operations and views.

1. Perform the following using SQL:
   a. Viewing all databases,
   b. Creating a Database,
   c. Viewing all Tables in a Database.
2. DDL: Creating Tables (With and Without Constraints)
   a. Primary key, Foreign Key,
   b. Unique, Default
   c. Null, Not null
   d. Enable Constraints, Disable Constraints Drop Constraints
3. DML: Inserting/Updating/Deleting Records in a Table
4. TCL: Saving (Commit) and Undoing (rollback)
5. Perform the following:
   a. Altering a Table,
   b. Dropping a Table
   c. Truncating a Table
   d. Renaming a Table
   e. Backing up / Restoring a Database.
6. For a given set of relation schemes, create tables and perform the following
   a. Simple Queries,
   b. Simple Queries with Aggregate functions,
   c. Queries with Aggregate functions (group by and having clause),
7. For a given set of relation schemes, create tables and perform the following
   a. Queries involving- Date Functions
   b. Queries involving -String Functions
   c. Queries involving - Math Functions
8. Perform the following with creating necessary tables.
   a. Join Queries- Inner Join
   b. Outer Join
   c. Subqueries
9. Perform the following with creating necessary tables
   a. With IN clause
   b. With EXISTS clause
10. For a given set of relation tables perform the following
    a. Creating Views (with and without check option),
    b. Dropping views,
    c. Selecting from a view

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

1. Write queries to manipulate data.
2. Demonstrate the aggregate functions and set operations.
3. Apply the join operations.
4. Know about usage of nested subqueries
5. Understand the method to create views

Second Year **CORE COURSE IV** **Semester IV**

BIG DATA ANALYTICS WITH NoSQL DATABASES

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To explain big data concepts.
- To identify the hadoop eco systems.
- To experience on various NoSQL Databases.

UNIT - I:

Introduction: Introduction to big data– sources of big data – real time application of big data – challenges in collecting and validating big data.

UNIT - II:

Hadoop**:** Hadoop – Hadoop ecosystem for processing big data –Hadoop cluster- Hadoop distributed file system – working with files in HDFS – map reduce technique for big processing – Joining data from different sources using map reduce.

UNIT - III:

Hive and Pig: Hive and pig – need for high-level tools in big data processing – unstructured and structured data – Not Only SQL (NOSQL) commands – use of Hive as an interface to Hadoop – Use of pig as a programming Tool for big data processing

UNIT - IV:

Introduction to NoSQL: An Overview of NoSQL - Defining NoSQL - What NoSQL is and what it is not - List of NoSQL Databases - Characteristics of NoSQL -RDBMS approach – Challenges

UNIT - V:

NoSQL Storage Types: NoSQL Storage Types - Column-oriented databases - Document store – Key value store -Multi-storage type databases - Advantages and Drawbacks - Transactional application - Computational application - Web-scale application

Unit VI: Current Contours (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned

REFERENCES:

1. Gaurav Vaish, “Getting Started with NoSQL”, Published by Packt Publishing Ltd., 2013, ISBN 978-1-84969-4-988

2. “Big data analysis for Dummies”, Dummies press, 2011.
3. Hadoop Fundamentals, packet Publications, 2012.
4. Bart Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Wiley, 2014
5. Soumendra Mohanty, Madhu Jagadeesh, and Harsha Srivatsa, “Big Data Imperatives: Enterprise Big Data Warehouse, BI Implementations and Analytics”, Published by Apress Media, 2013.
6. Ankam, Venkat, Big Data Analytics. India, Packt Publishing, 2016.
7. Prabhu, C.S.R., Big Data Analytics: Systems, Algorithms, Applications, Springer, 2019.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Apply big data concepts in various domains
- Understand hadoop ecosystems
- Apply the concepts of pig and hive
- Implement NoSQL Databases
- Explain various NoSQL storage types

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Second Year	**CORE PRACTICAL IV**	**Semester IV**
	BIG DATA ANALYTICS LAB	
Code	**(Practical)**	**Credit: 4**

COURSE OBJECTIVES:

- To install Hadoop Distributed File System.
- To install Hadoop Ecosystems.
- To implement hive queries.

1. Set up a pseudo-distributed, single-node Hadoop cluster backed by the Hadoop Distributed File System
2. Installation of Hadoop Ecosystem - Pig
3. Installation of Hadoop Ecosystem - Hive
4. Write a hive query to load the data into table from any local file on the system.
5. Write a hive query, which returns the contents of the whole table.
6. Demonstrate the usage of Hive functions.
7. Installation of MongoDB
8. Reading CSV file and loading into MongoDB
9. Reading JSON file and Loading into MongoDB
10. Reading MongoDB and writing into MySQL

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Install Hadoop distributed file system
- Install Hadoop ecosystems
- Write hive queries
- Implement MongoDB for unstructured data
- Use read and write various files in MongoDB

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Third Year **CORE COURSE V** **Semester V**

DATA MINING, DATA WAREHOUSING AND DATA VISUALIZATION

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To explore data mining concepts.
- To identify the data warehouse .
- To experience on various data visualization techniques.

UNIT - I:

Introduction: Introduction to data mining: Datamining process- Applications-Techniques-Examples – Future – Limitations-Software - Data Collection and Pre-processing - Outliers - Mining Outliers - Missing Data - Types of Data - Computing Distance - Data Summarising Using Basic Statistical Measurements - Displaying Data Graphically Multidimensional Data Visualization.

UNIT - II:

Association Rules Mining: Basics - The Task and a Naïve Algorithm - The Apriori Algorithm - Improving the Efficiency of the Apriori Algorithm - Apriori-TID - Direct Hashing and Pruning (DHP) - Dynamic Itemset Counting (DIC) - Mining Frequent Patterns without Candidate Generation (FP–Growth) - Performance Evaluation of Algorithms – Case Study: Mining Customer Value: From Association Rules to Direct Marketing.

UNIT - III:

Classification & Cluster Analysis: Classification: Decision Tree –Building a decision tree-Split algorithm – Rules-Naïve Bayes method – Estimating Predictive Accuracy of Classification Methods - Improving Accuracy of Classification Methods Cluster analysis: Desired Features of Cluster Analysis Types of Cluster Analysis Methods - Partitional Methods - Hierarchical Methods - Density-Based Methods - Quality and Validity of Cluster Analysis Methods.

UNIT - IV:

Data warehousing: Data warehousing – Operational Data Stores - Data Warehouses – Data warehouse Design – Guidelines for Data Warehouse Implementation – OLAP - Multidimensional View and Data Cube - Data Cube Implementations - Data Cube Operations.

UNIT - V:

Data Visualization: A Conceptual Framework for Data Visualization: Data, information, knowledge, and insight - Developments in data visualization - Visualization in decision-making - Visualization fit - Visualization plots - Data Analysis and Visualization: Visualization planning - - Visually representing the results - Perception and presentation methods - best practices for visualization.

UNIT VI: CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. G.K. Gupta, "Introduction to Data mining with case studies", 3rd Edition, PHI Learning Private Limited, Delhi, 2014 (ISBN-978-81-203-5002-1). (Unit1: chapter2: 2.1-2.10, Unit2: chapter 3: 3.1-3.10, Unit3: chapter 4:4.2-4.4,4.9-4.11,Chapter5: 5.2-5.6,5.8, Unit4: chapter8: 8.2-8.5, Chapter9: 9.2, 9.5, 9.6, 9.7)
2. Kirthi Raman, "Mastering Python Data Visualization", Packt Publishing, 2015. (Unit5: Chapter1, Chapter2)
3. S. K. Mourya, Shalu Gupta, "Data Mining and Data Warehousing", Alpha Science International Limited, 2013
4. K.P. Soman & Shyam Diwakar and V. Ajay, "Insight to Data Mining Theory and Practice", Prentice Hall of India, 2006. (ISBN -81-203- 2897-3)
5. 3. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Elsevier, Second Edition, 2007 (ISBN: 81-312-0535-5)
6. Bhatia, Parteek, Data Mining and Data Warehousing: Principles and Practical Techniques, Cambridge University Press, 2019.
7. Wilke, Claus, Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, O'Reilly Media, 2019.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Apply basic concepts of data mining and preprocessing in various domains
- Implement Association Rule.
- Evaluate Classification and clustering
- Explain data warehousing
- Implement various data visualization techniques

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Third Year	CORE COURSE VI NETWORK SECURITY	Semester V
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

- To introduce security mechanisms
- To familiarize the cryptographic techniques and procedures.
- To deliver foundations of system security

UNIT - I:

Introduction: Security Trends – The OSI Architecture – Security Attacks – Security Services – Security Mechanisms – A model for Network Security – Classic Encryption Techniques – Symmetric Cipher Model – Substitution Techniques – Transposition techniques – Rotor Machines – Steganography.

UNIT - II:

Block Ciphers and Data Encryption Standards: Block Cipher - Principles - Data Encryption Standard – The strength of DES – Differential and Linear Cryptanalysis – Block Cipher design principles – Advanced encryption Standard – The AES Cipher

UNIT - III:

Public Key Encryption and Hash functions: Principles of Public Key Crypto Systems – The RSA algorithm – Message Authentication – Authentication Requirements – Authentication Functions – Message Authentication codes – Hash Functions – Security of Hash Functions and MAC – Whirlpool - Digital Signatures – Authentication Protocols – Digital Signature standard

UNIT - IV:

Authentication Applications: Kerberos – X.509 Authentication Service – PKI – Electronic Mail Security - Pretty Good Piracy – S/MIME – IP Security – IP Security Overview – IP Security Architecture – Authentication Header – Key Management – Web Security – Web Security Considerations-SSL and Transport Layer Security

UNIT - V:

System Security: Intruders – Intrusion Detection – Password Management – Viruses – DOS and DDOS Attacks – Firewalls – Firewall Design Principles – Trusted Systems – IT Security Evaluation

UNIT – VI CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. William Stallings, "Cryptography and network Security", Principles and Practices‖, Prentice Hall (Pearson Education), Fourth Edition, 2006. (**Unit 1:** Chapter1, Chapter2; **Unit 2:** Chapter3, Chapter5; **Unit 3:** Chapter9, Chapter11, Chapter12, Chapter13; **Unit 4:** Chapter14, Chapter15, Chapter16, Chapter17; **Unit 5:** Chapter18, Chapter19, Chapter20.
2. Kevin Mitnick (Author), Robert Vamosi Mikko Hypponen, "The Art of Invisibility: The World's Most Famous Hacker Teaches You How to Be Safe in the Age of Big Brother and Big Data Hardcover" , 2017 (ISBN-13: 9780316380522)
3. AtulKahate, "Cryptography and Network Security", Tata McGraw Hill Publications, New Delhi.
4. Stallings, "Data and Computer Communications", Pearson Education 2012, 7th Edition.
5. B. A. Forouzan, "Data Communications and Networking", Tata McGraw Hill 2007, 4th Edition.
6. F. Halsall, "Data Communications, Computer Networks and Open Systems", Pearson Education 2008

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Describe the fundamentals of network security
- Identify the various types of ciphers
- Describe encryption standards
- Ensure authentication applications
- Identify and apply system security

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Third Year	CORE COURSE VII CLOUD COMPUTING	Semester V
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

- To describe the concepts in Cloud Computing and its Security
- To explain the cloud modeling and design
- To explore the virtualization and cloud

UNIT - I:

Cloud Computing Foundation: Introduction to Cloud Computing – Move to Cloud Computing – Types of Cloud – Working of Cloud Computing

UNIT - II:

Cloud Computing Architecture: Cloud Computing Technology – Cloud Architecture – Cloud Modeling and Design - Virtualization: Foundation – Grid, Cloud and Virtualization – Virtualization and Cloud Computing

UNIT - III:

Data Storage and Cloud Computing: Data Storage – Cloud Storage – Cloud Storage from LANs to WANs – Cloud Computing Services: Cloud Services – Cloud Computing at Work

UNIT - IV:

Cloud Computing and Security: Risks in Cloud Computing – Data Security in Cloud – Cloud Security Services – Cloud Computing Tools: Tools and Technologies for Cloud – Cloud Mashaps – Apache Hadoop – Cloud Tools

UNIT - V:

Cloud Applications – Moving Applications to the Cloud – Google Cloud Applications – Amazon Cloud Services – Cloud Applications

UNIT - VI Current Contours (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. A. Srinivasan and J.Suresh, "Cloud Computing – A Practical Approach for Learning and Implementation", Pearson India Publications, 2014. **(Unit 1:** Chapter1, Chapter2, Chapter3, Chapter4**; Unit 2:** Chapter5, Chapter6, Chapter7, Chapter8, Chapter9, Chapter10; **Unit 3:** Chapter11, Chapter12, Chapter13, Chapter14, Chapter16, Chapter17; **Unit 4:** Chapter18, Chapter19, Chapter20, Chapter24, Chapter25, Chapter26,Chapter27; **Unit 5:**

Chapter28, Chapter30, Chapter31, Chapter32)
2. Rajkumar Buyya, James Broberg, Andrzej, “Cloud Computing: Principles and Paradigms”, Wiley India Publications, 2011.
3. Anthony T.Velte , Toby J. Velte Robert Elsenpeter, “Cloud computing a practical approach”, TATA McGraw- Hill , New Delhi – 2010
4. Michael Miller, “Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online” - Que 2008
5. Judith Hurwitz , Robin Bloor , Marcia Kaufman ,Fern Halper, “Cloud computing for dummies”, Wiley Publishing, Inc, 2010
6. Comer, Douglas, The Cloud Computing Book: The Future of Computing Explained, CRC Press, 2021.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Describe various types of cloud
- Identify the cloud computing basics and its architecture
- Implement data storage and security
- Explore various cloud applications
- Describe various cloud services.

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Third Year	**CORE PRACTICAL V**	**Semester V**
	DATA MINING AND VISUALIZATION LAB	
Code	**(Practical)**	**Credit: 4**

COURSE OBJECTIVES:

- To learn practical training in Data Mining
- To implement python packages for data Visualization
- To apply data analysis using real time data

Perform the following using Python:

1. Introduction to Python libraries for Data Mining : NumPy, SciPy, Pandas, Matplotlib, Scikit-Learn Write a Python program to do the following operations: (Library: numpy)
   a. Create multi-dimensional arrays and find its shape and dimension
   b. Create a matrix full of zeros and ones
   c. Reshape and flatten data in the array
   d. Append data vertically and horizontally
   e. Apply indexing and slicing on array
2. Write a Python program to do the following operations: (Library: Pandas)
   a. Loading data from CSV file
   b. Compute the basic statistics of given data - shape, no. of columns, mean
3. Write a python program to load the dataset and understand the input data (Library : Scipy)
   a. Load data and describe the given data
   b. Identify missing data items and outlier data items
4. Write a python program to impute missing values with various techniques on given dataset.
   a. Remove rows/ attributes
   b. Replace with mean or mode
5. Write a python program to find rules that describe associations by using Apriori algorithm between different products with appropriate data set. (Libraries: NumPy, SciPy, Matplotlib, Pandas)
   a. Display top 5 rows of data
   b. Find the rules with min_confidence : .2, min_support= 0.0045, min_lift=3, min_length=2
6. Write a python program to (use Iris data set)
   Iris data set consists of 50 samples from each of three species of Iris: Iris setosa, Iris virginica and Iris versicolor. Four features were measured from each sample: the length and the width of the sepals and petals, in centimetres. (Libraries: import numpy as np)
   a. Calculate Euclidean Distance.
   b. Get Nearest Neighbors
   c. Make Predictions
7. Write a python program (use Iris data set)
   a. To build a decision tree classifier to determine the kind of flower by using given dimensions.
   b. Training with various split measures(Gini index, Entropy and Information Gain)
   c. Compare the accuracy

8. Write a Python program to
   a. Generate histogram & describe cumulative property, bins and range.
   b. Generate multiple histograms
9. Write a python program to visualize data using bar chart, line chart, pie chart and Scatter plot
10. Write a python program to understand the data using Boxplot and describe the summary from boxplot.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Handle missing data using python package
- Identify data outliers
- Implement python pandas package for data set handling, classification
- Apply various python packages for data visualization
- Generate histograms

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Third Year	**MAJOR BASED ELECTIVE I**	**Semester V**
	1. INTERNET OF THINGS	
Code	**(Theory)**	**Credit: 4**

COURSE OBJECTIVES:

- To state the basics of Internet of things and protocols
- To define the next generation Internet of Things opportunity
- To describe IoT Architecture

UNIT -1:

Introduction: History of IoT - Importance of Internet of Things – IoT devices, connectivity and system – Technologies behind Internet of Things - IoT applications – benefits of IoT to organizations - pros and cons of IoT – IoT standards and frameworks – IoT security and privacy issues

UNIT - II:

IoT Markets and Trends: Introduction to Internet of Things - Surveying IoT Markets and Trends - Identifying the Wireless Standards That Enable the IoT- The goal: Interoperability - CHIP to the rescue - Ultra-wideband - 5G and Wi-Fi 6/6E

UNIT - III:

IoT Architecture and Technology Protocols: IoT Architecture and Technology Protocols - Digging into the IoT Ecosystem - Examining the IoT Architecture - IoT Protocols

UNIT - IV:

The Smart Home: Surveying Today's Smart Home - The Mesh Network/One Pod Per Room - Overcoming the Challenges – Interoperability - RF interference - Maintaining a seamless, energy-efficient, and reliable connection - Creating an ease-of-use self-management IoT network - Network security and privacy - Power consumption - Importance of Always-on Connectivity

UNIT - V:

Next-Generation IoT Opportunities and Use Cases: Next-Generation Smart Home - Manufacturing/Industry 4.0 – Transportation - Retail - Smart Energy - Healthcare - Smart Cities – Agriculture

REFERENCES:

1. Vijay Madisetti and Arshdeep Bahga, —Internet of Things: (A Hands-on Approach), Universities Press (INDIA) Private Limited 2014, 1st Edition. (Unit1: Chapter1).
2. Gillis, Alexander, "What is internet of things (IoT)?". IOT Agenda, 2021 (Unit1).

3. Cees Link, “Internet of Things For Dummies”, Qorvo 2nd Special Edition, John Wiley & Sons, Inc., 2021 (Unit2: Chapter1; Unit3: Chapter2; Unit4: Chapter3; Unit5: Chapter4).
4. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.
5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
6. David Easley and Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning About a highly Connected World”, Cambridge University Press, 2010.
7. Olivier Hersent, Omar Elloumi and David Boswarthick, “The Internet of Things: Applications to the Smart Grid and Building”, Wiley, 2012.
8. Jamil Y. Khan, Mehmet R. Yuce, Internet of Things (IoT): Systems and Applications. Singapore, Jenny Stanford Publishing, 2019.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Explore the fundamentals of IoT.
- Identify IoT markets and trends.
- Describe IoT Architecture and protocols.
- Understand the challenges in IoT.
- Identify opportunities in IoT.

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Third Year **MAJOR BASED ELECTIVE I** **Semester V**

2. BLOCK CHAIN TECHNOLOGY

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To understand the fundamentals of block chain
- To learn Consensus in block chain
- To describe bit coins

UNIT – I Blockchain Fundamentals:

Tracing Blockchain's Origin - The shortcomings of current transaction systems - The emergence of Bitcoin - The birth of blockchain - Revolutionizing the Traditional Business Network. Blockchains - The Structure of Blockchains - Blockchain Applications - The Blockchain Life Cycle

UNIT – II Consensus:

The Driving Force of Blockchains - Blockchains in Use -Blockchain applications - Picking a Blockchain - Blockchains Substance - determining needs - Defining goal - Choosing a Solution - Drawing a blockchain decision tree Comparing Popular Blockchain Implementations - Making digital currency work - Providing computation control -Scaling to meet enterprise needs

UNIT – III Diving into the Bitcoin Blockchain:

Creating Bitcoin wallet - Generating a Bitcoin vanity address - Transferring vanity address - Making an entry into the Bitcoin blockchain - Reading a blockchain entry in Bitcoin - Using Smart Contracts with Bitcoin - Building your first smart bond -Checking the status of contract - Blockchain For Dummies Building a Private Blockchain with Docker - Preparing your computer - Building your blockchain.

UNIT – IV Beholding the Bitcoin Blockchain:

Getting a Brief History of the Bitcoin Blockchain - Debunking Some Common Bitcoin Misconceptions - Bitcoin: The New Wild West - Fake sites - Mining for Bitcoins - Making First Paper Wallet - The Ten Rules to Never Break on the Blockchain

UNIT – V Blockchain in Action: Use Cases:

Determining How Blockchain Fits in Industry - Identifying Speed Bumps in Business Processes- Determining How Blockchain Can Help - Choosing an Appropriate Use Case - Determining the Goal of Your Blockchain Network - Identifying Dependencies - Choosing a Blockchain Provider and Platform - Developing and Deploying Smart Contracts - Testing and Fine-Tuning Your Application and Network

UNIT VI CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. Manav Gupta, "BlockchainFor Dummies", IBM Limited Edition, John Wiley & Sons, Inc., 2018. (Unit1: chapter1; Unit5: chapter 6)
2. Bashir, Imran, "Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks", 2017.
3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, "Bitcoin and cryptocurrency technologies: a comprehensive introduction" Princeton University Press, 2016.
4. Joseph Bonneau et al, "SoK: Research perspectives and challenges for Bitcoin and cryptocurrency", IEEE Symposium on security and Privacy, 2015.
5. Srinivas Mahankali, Blockchain for Non IT Professionals: An Example Driven, Metaphorical Approach, Notion Press, 2020.
6. Laurence, Tiana., Introduction to Blockchain Technology: The many faces of blockchain technology in the 21st century, Van Haren, 2019.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Explore the fundamentals of block chain
- Explain Consensus in block chain
- Describe bit coins
- Apply abstract models for Blockchain Technology.
- Identify major research challenges and technical gaps.

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Third Year	**SKILL BASED ELECTIVE I SHELL PROGRAMMING**	**Semester V**
Code	**(Theory)**	**Credit: 2**

COURSE OBJECTIVES:

- To learn the types of shells
- To understand the essential commands
- To learn how tots create shell scripts

UNIT – I Introduction:

Types of shells - Creating files – Listing files and directories – Masking file permissions – Directory permissions – access files – Storage of files – Disk related commands - Directory related commands – Miscellaneous commands.

UNIT – II Essential commands:

Introduction – Password – cal is for calendar – The banner command – The touch command – printouts – File compression – I/O redirection and piping

UNIT – III Processes:

Introduction – What`s running right now – Still more processes – Background processes – The nohup command – Killing a processes – Changing processes priorities – Scheduling of processes.

UNIT – IV Shell programming Introduction:

When to use shell scripts – The first shell script – Interactive shell scripts – Shell variables – Shell keywords – Another way of assigning values to variables - The if-then-fi statement – The if-then-else-fi statement – Nested if-else –Use of logical operators – Loops –The break statement – The continue statement.

UNIT – V System administration:

Introduction – Adding and removing users – Starting up the system – Shutting the system down – Disk management – Formatting a disk – Making a file system – Mounting a file system – Unmounting a file system – Using a raw disk – Monitoring system usage – Ensuring system security – Providing assistance to users.

UNIT VI: CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. Yashavant P. Kanetkar, "Unix Shell Programming", BPB Publications, New Delhi, 2003. (Unit-1: Chapter:1,2 Unit-2: Chapter: 4,5 Unit-3: Chapter:7 Unit-4: Chapter: 9,10,11 Unit-5: Chapter 15)
2. Wood, Patrick H., and Kochan, Stephen G. UNIX Shell Programming. United Kingdom, Sams, 2003.
3. Parker, Steve. Shell Scripting Tutorial. United States, Createspace Independent Pub, 2014.
4. Tansley, D. S. W., and Tansley, David V. Linux and UNIX Shell Programming, Addison-Wesley, 2000.
5. Newham, Cameron, and Rosenblatt, Bill. Learning the Bash Shell: Unix Shell Programming, O'Reilly Media, 2005.
6. Wood, Patrick, and Kochan, Stephen G. Shell Programming in Unix, Linux and OS X: The Fourth Edition of Unix Shell Programming. United Kingdom, Pearson Education, 2016.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Write shell scripts
- Create and explore files
- Develop shell scripts to solve problems
- Implement some standard utilities such as ls
- Add/remove users

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Third Year	CORE COURSE VIII R PROGRAMMING	Semester VI
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

- To learn the fundamental concepts of 'R' using RGui and RStudio
- To understand the special data structures of R language viz., Character Vector, Array, Matrix, Data Frame and List
- To provide knowledge for various control structures, functions and packages

UNIT - I:

Introduction: History of R- Benefits of Using R - Working with code Editor: RGui and RStudio - Starting your First R Session - Sourcing a script - Navigating the workspace- Vectors: Creating vectors - Discovering the properties of vector- combing vectors repeating vector - Getting values in and out of vectors- working with logical vectors - Math with Vector functions - working with numbers, infinity and missing values

UNIT - II:

Using character vector for text data - Manipulating text - Factoring in Factors - Working with more dimensions: Adding a second dimension - Using the indices - Naming matrix rows and columns - Calculating with matrices - Adding more dimensions: Creating an array - Combining different types of values in Data Frame - Manipulating values in a Data Frame- List: Creating a list - Extracting elements from lists - Changing elements in lists

UNIT - III:

Control Structures: Conditional control structures: if statement - if..else statement - switch statement - Loops: for, while and repeat loops - break and next statement. Functions: The Function Keyword - Arguments - Return Values- Functions as Arguments - Anonymous Functions-Properties of Functions - Argument Order and Named Arguments. Computing basic statistics: mean, median, mode, correlation and covariance.

UNIT - IV:

Getting data into and out of R: Getting data into R: Entering data in the R text editor - Using clipboard to copy and paste - Reading data in CSV files and excel files- Working with other data types - Getting your data out of R - Working with Files and Folders. Packages: Finding packages, installing packages, loading packages, updating package and unloading packages.

UNIT - V:

Introduction to Graphical Analysis: Box-Whiskers plots - Scatter plots - Pairs plots - Line charts - Pie charts - Cleveland dot charts - Bar charts: single category bar chats and multiple category bar charts. Creating Faceted Graphics with

Lattices: Creating lattice plot - changing plot option.

UNIT – VI CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. Andrie Devries And Jorismeys , "R Programming For Dummies", Wiley Publications, Isbn:978-81-265-5201-6. (Unit 1 : chapter-2,3,4) (Unit 4: chapter 12,14) (Unit 2 chapter 5,6,7)
2. Dr.Mark Gardener, "Beginning R- The Statistical Programming Language", Wiley Publications, Isbn: 978-81-265-4120-1.
3. Paul Teetor, "R Cook Book",O'relly Publications, First Edition, 2011, Isbn: 978-0-596-80915-7 (Unit 5: Chapter 10)
4. Joseph Adler, "R In Nutshell A Desktop Quick Reference",Isbn:978-0-596-80170-0
5. Tilman M .Davis “The Book of R”, No Starch Press, 2016 (Unit 3: chapter 10,11,3)
6. Roger D. Peng, "R Programming For Data Science", Leanopub, 2015
7. Matloff, Norman, And Matloff, Norman S, The Art Of R Programming: A Tour Of Statistical Software Design, No Starch Press, 2011.
8. Lovelace, Robin, And Gillespie, Colin. Efficient R Programming: A Practical Guide to Smarter Programming, O'reilly Media, 2016.
9. Alex Nordeen, Learn R Programming In 24 Hours: Complete Guide For Beginners, Guru99, 2020.
10. Jeeva Jose, Beginner's Guide For Data Analysis Using R Programming., Khanna Publishing House,2019

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the basics of R programming
- Work with vectors, matrices and data frames
- Acquire the knowledge of various control structures
- Parse data files using built-in functions
- Apply the various statistical functions and produce high quality graphics

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Third Year	CORE COURSE IX MACHINE LEARNING	Semester VI
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

- To facilitate the basics of machine learning concepts.
- To learn building a machine learning model from the scratch
- To understand the evaluation of models.

UNIT - I:

Introduction: Introduction, easy for human hard for machines, a simple predicting machine, classifying is not very different from predicting, training a simple classifier, one classifier is not enough, Types of machine learning, Applications of Machine Learning, Perspectives and issues in machine learning.

UNIT - II:

Probabilistic and Stochastic Models: Bayesian Learning – Bayes theorem, Concept learning, Maximum likelihood, Bayes optimal classifier, Gibbs algorithm, Naive Bayes classifier, Expectation maximization and Gaussian Mixture Models, Hidden Markov models

UNIT - III:

Supervised learning: Introduction, Regression, Linear regression, Classification: Decision trees, k-Nereast Neighbours, Support Vector Machine, Logistic regression, Random Forest. Artificial Neural Network: Introduction, Perceptrons, multi-layer networks and back propagation.

UNIT - IV:

Unsupervised learning: Introduction, Supervised vs Unsupervised Cluster Analysis, K-means clustering, Hierarchical clustering. Dimension reduction: Principal Component Analysis, Linear Discriminant Analysis

UNIT - V:

Modelling and evaluation: Building the model, Training a model, evaluating a model, improving a model. Performance metrics - accuracy, precision, recall, sensitivity, specificity, AUC, RoC, Bias Variance decomposition.

UNIT – VI CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. SaikatDutt, Subramanian Chandramouli, Amit Kumar Das, ―Machine

Learning, Pearson Education, 2018(Unit 1: Chapter1:.4,1. 5,1. 7,1. 9; Unit 2: Chapter6; Unit 3: Chapter7,8,10; Unit 4 Chapter-9 (9.1,9.4), Unit 5: Chapter3;)
2. Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014 (Unit2: Chapter7, Chapter 15)
3. Tariq Rashid, "Make your own neural network", Create Space Independent Publishing Platform, US 2016, ISBN:978-1-5308-2660-5 (Unit1, Part1)
4. Shai Shalev-Shwartz, Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2015
5. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer, 2013
6. Charu C. Aggarwal, "DATA CLUSTERING Algorithms and Applications", CRC Press, 2014.
7. C. Bishop, "Pattern Recognition and Machine Learning", Springer,2006
8. Sebastian Raschka and Vahid Mirjalili, "Python Machine Learning", Packt Publishing, Third Edition, 2019

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Explain machine learning
- Apply machine learning concepts in various domains
- Implement supervised, unsupervised learning techniques
- Differentiate supervised and unsupervised learning techniques
- Create and evaluate models

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Third Year	CORE PRACTICAL VI MACHINE LEARNING LAB	Semester VI
Code	(Practical)	Credit: 4

COURSE OBJECTIVES:

- To learn practical training in machine learning
- To understand various statistical operations using R
- To implement linear regression in R.

1. Write R script for the implementation of
   a. vector data objects operations
   b. matrix, array and factors
   c. data frames in R
2. Write R script to find basic descriptive statistics using summary, str, quartile function on mtcars & cars datasets.
3. Write R script to find Correlation coefficient rank correlation, partial and multiple correlation
4. Write R script to find subset of dataset by using subset (), aggregate () functions on iris dataset.
5. Perform the following using R : Reading and writing different types of datasets
   a. Reading different types of data sets (.txt, .csv) from Web, disk and writing in file in specific disk location.
   b. Reading Excel data sheet in R.
   c. Reading XML dataset in R.
6. Data Manipulation with dplyr package
7. Predicting house prices using simple linear regression (use the Boston dataset, which contains data about the housing and price data in the Boston area)
8. Predicting house prices using multiple features – multiple linear regression (use the Boston dataset, which contains data about the housing and price data in the Boston area)
9. Perform Decision Tree Learning Methods in R
10. Perform Naïve Bayes Learning Methods in R

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Perform various statiscal operations using R
- Write R script to predict unknown values
- Read various data formats in R
- Find correlation using R scripts
- Perform decision tree method

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Third Year **MAJOR BASED ELECTIVE II** **Semester VI**

1. COMPUTING TECHNOLOGIES FOR DATA SCIENCE

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To understand the basic concepts of mobile computing.
- To acquire Knowledge of edge computing and Quantum computing
- To demonstrate automation and distributed ledger technology

UNIT – I Mobile Computing:

Introduction to Mobile Computing — Applications of Mobile Computing- Spread spectrum -MAC Protocols — SDMA- TDMA- FDMA- CDMA - GSM — Services & Architecture — Protocols — Connection Establishment — Frequency Allocation — Routing – GPRS.

UNIT – II Edge Computing Definition and Use Cases:

Introduction to Edge Computing Scenario's and Use cases - Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge platforms, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M.

UNIT – III Quantum Computing:

Introduction to quantum computing – quantum computing need - – Quantum Measurements Density Matrices - Positive-Operator Valued Measure - Fragility of quantum information: Decoherence - Quantum Superposition and Entanglement - Quantum Gates and Circuits - Deutsch's algorithm

UNIT – IV Robotic Process Automation:

RPA Basics: History of Automation, RPA vs Automation, Processes & Flowcharts, Programming Constructs in RPA, processes Types of Bots, Workloads which can be automated - Excel Data Tables: Data Tables in RPA, Excel and Data Table basics, Data Manipulation in excel, Email Automation: Email Automation, Incoming Email automation, Sending Email automation

UNIT – V Distributed Ledger Technology:

Introduction – distributed ledgers in a nutshell - distributed identity – decentralized network – distributed ledger – network consensus – future of DLT

UNIT – VI CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. Prasant Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt. Ltd, New Delhi – 2012.(Unit1)
2. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020, ISBN: 9781839214806.(Unit2)
3. M. A. Nielsen and I. L. Chuang. Quantum computation and quantum information. Cambridge, 2010 (Unit3))

4. Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing Release, 2018, ISBN: 9781788470940.(Unit4)
5. Alexander Lipton and Adrien Treccani, “Blockchain and Distributed Ledgers Mathematics, Technology, and Economics, World Scientific, 2021(.(Unit5)
6. Dharma Prakash Agarval, Qing and An Zeng, "Introduction to Wireless and Mobile systems", Thomson Asia Pvt Ltd, 2005.
7. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, “Principles of Mobile Computing”, Springer, 2003.
8. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana Srirama, wiley publication, 2019, ISBN: 9781119524984.
9. Swan, Melanie. Blockchain: Blueprint for a New Economy. United States, O'Reilly Media, 2015.
10. Jaime Lloret Mauri, M. Bala Krishna, Advances in Mobile Computing and Communications: Perspectives and Emerging Trends in 5G Networks Taylor & Francis, 2016.

COURSE OUTCOME:

Upon successful completion of this course the students would be able to:

- Explain the basics of mobile telecommunication systems
- Explore edge computing
- Describe quantum computing
- Apply automation concepts
- Illustrate DLT

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Third Year **MAJOR BASED ELECTIVE II** **Semester VI**

2. AUGMENTED REALITY AND VIRTUAL REALITY

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To understand virtual and augmented reality
- To provide knowledge about issues and controllers of VR & AR
- To explore VR & AR use cases

UNIT – I Introduction:

Definition virtual and augmented reality - Introducing virtual reality and augmented reality – Other types of virtual and augmented reality –history – the father of virtual reality – Early virtual reality breaks through – Augmented reality hits the mainstream – Evaluating the technology hype cycle.

UNIT – II State of virtual reality & augmented reality:

Available forms factors – Focusing on features – Considering controllers – Recognizing the current issues with VR – Assessing adoption rates- Recognizing the current issues

UNIT – III Consuming content in virtual reality & augmented reality:

Exploring consumers-Grade virtual reality – identifying near-Future hardware – Comparing current and future options.

UNIT – IV Choosing virtual reality & augmented reality:

Choosing virtual reality, augmented reality – Planning virtual, augmented reality project - Exploring design principles in virtual reality – Definition your social experience - future of virtual and augmented reality - exploring virtual reality & augmented reality use cases.

UNIT – V Industries, mobile app by virtual and augmented reality:

Travel – Museums – Aerospace – Retail – Military – Education – Entertainment Real estate – Advertising and marketing - Google translate – Amazon AR view –AR city – Ingress and pokemon go – Sketch AR – Find your car & car finder AR

UNIT – VI CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCE BOOKS:

1. Paul Mealy, “Virtual & Augmented Reality For Dummies” Published by: John Wiley & Sons, Inc., John Wiley & Sons, Inc., 2018. (Unit 1: chapter 1) (Unit

2:chapter 2,3) (Unit 3: chapter 4,5) (Unit 4:chapter 6,7,8,10,11,12,13) (Unit 5: chapter 15,16)
2. Aguilera, P, “Digital info on the real world”. MIT Technology Review, 2009
3. Arnall, T “The web in the world fabric rblg”, 2008
4. Aron, J. “AR goggles make crime scene investigation a desk job. New Scientist.”, 2012
5. “Virtual Reality and Augmented Reality”, 17th EuroVR International Conference Proceedings, 2020.
6. Bruno Arnaldi, Guillaume Moreau, Pascal Guitton, Virtual Reality and Augmented Reality: Myths and Realities, Wiley, 2018.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Explain virtual and augmented reality
- Identify issues and controllers of VR & AR
- Understand VR & AR use cases
- Apply AR & VR in various industries
- Plan and choose VR & AR projects

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Third Year **PROJECT** **Semester-VI**

Code: **Credit: 3**

The candidate shall be required to take up a Project Work by group or individual and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the students in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT/EVALUATION/VIVA VOCE:

1. PROJECT REPORT EVALUATION (Both Internal & External)

   I. Plan of the Project - 20 marks

   II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc. and presentation of the report. - 45 marks

   III. Individual initiative - 15 marks

2. Viva-Voce / Internal & External - 20 marks

TOTAL **- 100 marks**

PASSING MINIMUM:

	Vivo-Voce 20 Marks	**Dissertation 80 Marks**
Project	40% out of 20 Marks (i.e. 8 Marks)	40% out of 80 marks (i.e. 32 marks)

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.

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Third Year	SKILL BASED ELECTIVE II WEB TECHNOLOGY	Semester VI
Code	(Theory)	Credit: 2

COURSE OBJECTIVES:

- To introduce the technology behind designing dynamic webpage.
- To introduce the client server technology
- To learn HTML and PHP

UNIT - I:

HTML: BasicHTML, TheDocument body, Text, Hyperlinks, Adding more formatting, Lists, Tables, Using colors and images, Images, Multimedia objects, Frames, Forms.

UNIT - II:

Towards interactivity Cascading Style Sheets: Introduction, Using styles: Simple examples, Defining your own styles, Properties and values in styles.

UNIT - II:

Client Side Scripting: JavaScript: JavaScript—The basics, Variables, String manipulation, Mathematical functions, Statements, Operators, Arrays, Functions- Dataand objects in java script, Regularexpressions, Exception Handling, Built in objects,Events.

UNIT - III:

Dynamic HTML with JavaScript: Data validation, Opening a new window, Messages and Confirmations, The status bar, writing to a different frame, Rollover buttons, Moving images, multiple pages in a single download, A text-only menu system, Floating logos.

UNIT - IV:

Server Side Scripting: PHP: evolution of PHP– structure and syntax of PHP and integrating the same with HTML – comments – variables – data types – operators – control structures–passing information between pages–Strings–Arrays and Functions.

UNIT - V:

Integration of Apache, MySQL, PHP to design dynamic webpages: MySQL functions in PHP – Connecting and disconnecting from MySQL – Using tables – form design–editing the database.

UNIT – VI CURRENT CONTOURS (for Continuous Internal Assessment Only):

Contemporary Developments Related to the Course during the Semester Concerned.

REFERENCES:

1. Chris Bates, ***"Web Programming Building Internet Applications"***, Third Edi-tion, Wiley, 2007, ISBN-*10*:0470017759. (Unit1: Chapters: 2,3,4; Unit 2: chapters: 6,7; Unit 3: 8, Unit 4: Chapter 12,13)
2. Timothy Boronczyk, Michael, Elizabeth Naramore, Jason Gerner, Yann Le Scouar-nec, Jeremy Stolz,, Michael K. Glass "**Beginning PHP6, Apache, MySQL Web Development**", Wiley Publishing, 2009 Edition. ISBN-13: 978-8126521227. (Unit 5: Chapter 3,4, 5)
3. Robin Nixon, "**Learning PHP, MySQL & JavaScript With jQuery, CSS & HTML5**" O'Reilly Media, Fourth edition, December2014, ISBN:978-1-491-91866-1.
4. David R. Brooks, "**An Introduction to HTML and JavaScript for Scientists and Engineers**", Springer- Verlag London Limited 2007.
5. Michael K Glass, Yann Le Scouarnec, Elizabeth Naramore, Gary Mailer, Jeremy Stolz, Jason Gerner, "***Beginning PHP, Apache, MySQL Web Development***", Wiley dream tech press, 2004 edition. ISBN: 9780764557446.
6. Rochkind, Marc. Expert PHP and MySQL: Application Design and Development. Netherlands, Apress, 2013.
7. Lockhart, Josh. Modern PHP: New Features and Good Practices, O'Reilly Media, 2015.

COURSE OUTCOME:

Upon successful completion of this course the students would be able to:

- Design a static web page using HTML
- Apply HTML and style sheet
- Develop server side scripts using PHP
- Communicate with MySQL database from PHP
- Validate the HTML form data using JavaScript

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