B.Sc. DATA SCIENCE

DEGREE COURSE

CBCS PATTERN

(With effect from 2022 - 2023)

The Course of Study and the Scheme of Examinations

S. No.	Part	Study Components Course Title		Ins. Hrs / week	Credit	Title of the Paper	Maximum Marks		
		SEMESTER I					**CIA**	**Uni. Exam**	**Total**
1.	I	Language	Paper-1	6	4	Tamil/Other Languages	25	75	100
2.	II	English (CE)	Paper-1	6	4	**Communicative English I**	25	75	100
3.	III	Core Theory	Paper-1	6	4	Programming in C	25	75	100
4.	III	Core Practical	Practical-1	3	2	Programming in C Lab	25	75	100
5.	III	Allied -1	Paper-1	7	3	Discrete Mathematics	25	75	100
6.	**III**	**PE**	**Paper 1**	**6**	**3**	**Professional English I**	**25**	**75**	**100**
7.	IV	Environmental Studies		2	2	Environmental studies	25	75	100
		Sem. Total		**36**	**22**		**175**	**525**	**700**
		SEMESTER II					**CIA**	**Uni. Exam**	**Total**
8.	I	Language	Paper-2	6	4	Tamil/Other Languages	25	75	100
9.	II	English (CE)	Paper-2	4	4	**Communicative English II**	25	75	100
10.	**II**	**NMSDC I : Language Proficiency for Employability**	**Paper-1**	**2**	**2**	**Effective English**	**25**	**75**	**100**
11.	III	Core Theory	Paper-2	5	4	Java Programming	25	75	100
12.	III	Core Practical	Practical-2	2	2	Java Programming Lab	25	75	100
13.	III	Allied-1	Paper-2	7	5	Operations Research	25	75	100
14.	**III**	**PE**	**Paper 1**	**6**	**3**	**Professional English II**	25	75	100
15.	IV	Value Education		2	2	Value Education	25	75	100
16.	IV	Soft Skill		2	1	Soft Skill	25	75	100
		Sem. Total		**36**	**27**		**200**	**600**	**800**

S.NO.	Part	Study Components Course Title		Ins. hrs /week	Credit	Title of the Paper	Maximum Marks		
SEMESTER III							**CIA**	**Uni. Exam**	**Total**
17.	I	Language	Paper-3	6	4	Tamil/ Other Languages	25	75	100
18.	II	English	Paper-3	6	4	English	25	75	100
19.	III	Core Theory	Paper-3	3	3	Python for Data Science	25	75	100
20.	III	Core Practical	Practical-3	3	3	Python for Data Science Lab	25	75	100
21.	III	Allied II	Paper-3	4	3	Statistical Methods and Their Applications I	25	75	100
	III	Allied II	Practical	3	0	Statistics Practical	0	0	0
22.	IV	Skill Based Subject	Paper-1	3	2	Digital Logic Design & Computer Organization	25	75	100
23.	IV	Non-Major Elective	Paper-1	2	2	Introduction to Information Technology	25	75	100
		Sem. Total		**30**	**21**		**175**	**525**	**700**
SEMESTER IV							**CIA**	**Uni. Exam**	**Total**
24.	I	Language	Paper-4	6	4	Tamil/Other Languages	25	75	100
25.	II	English	Paper-4	6	4	English	25	75	100
26.	III	Core Theory	Paper-4	3	3	Advanced Python for Data Science	25	75	100
27.	III	Core	Practical-4	3	3	Advanced Python for Data	25	75	100
28.	III	Allied II	Paper-4	4	3	Statistical Methods and their Applications II	25	75	100
29.	III	Allied II	Practical	3	2	Statistics Practical	25	75	100
30.	**IV**	**NMSDC II : Digital Skills for Employability**	**Paper-2**	**2**	**2**	**Office Fundamentals**	**25**	**75**	**100**
31.	IV	Non-Major Elective	Paper-2	2	2	Internet Technology	25	75	100
		Sem. Total		**30**	**23**		**200**	**600**	**800**

S.NO.	Part	Study Components Course Title		Ins. hrs /week	Credit	Title of the Paper	Maximum Marks		
SEMESTER V							**CIA**	**Uni. Exam**	**Total**
32.	III	Core Theory	Paper-5	6	4	Relational Database Management System	25	75	100
33.	III	Core Theory	Paper-6	6	4	Data Visualization Techniques	25	75	100
34.	III	Core Theory	Paper–7	4	3	Natural Language Processing	25	75	100
35.	III	Core Practical	Practical-5	4	3	Relational Database Management System Lab	25	75	100
36.	III	Core Practical	Practical-6	4	3	Data Visualization Techniques Lab	25	75	100
37.	III	Internal Elective	Paper-1	3	3	Tensor Flow	25	75	100
38.	IV	Skill Based Subject	Paper-2	3	2	Machine Learning	25	75	100
				30	**22**		**175**	**525**	**700**
SEMESTER VI							**CIA**	**Uni. Exam**	**Total**
39.	III	Core Theory	Paper-8	4	4	Big Data Analytics	25	75	100
40.	III	Core Theory	Paper-9	4	4	R for Analytics	25	75	100
41.	III	Core Practical	Practical-7	4	3	Big Data Analytics Lab	25	75	100
42.	III	Core Practical	Practical-8	4	2	R for Analytics Lab	25	75	100
43.	III	Project		5	5	Project Work (Group/Individual Project)	25	75	100
44.	III	Internal Elective	Paper - 2	3	3	Artificial Intelligence	25	75	100
45.	III	Internal Elective	Paper - 3	3	3	Operating System	25	75	100

46.	**III**	**NMSDC III : Data Analytics with Advanced Tools for Employabilit**	**Paper – 3**	**2**	**2**	**Project based learning III**	**25**	**75**	**100**
47.	V	Extension Activities		0	1		100	0	100
		Sem. Total		**30**	**27**		**300**	**600**	**900**
					142				**4600**

Part	Subject	Papers	Credit	Total Credits	Marks	Total Marks
Part I	Languages	4	4	16	100	400
Part II	Communicative English & English	4	4	16	100	400
Part II	Effective English	1	2	2	100	100
Part III	Allied (Odd Semester)	2	3	6	100	200
	Allied (Even Semester)	2	5	10	100	200
	Allied Practical	1			100	100
	Electives	3	3	9	100	300
	Core	10	(3-5)	36	100	900
	Core practical	8	(2-3)	21	100	800
	Professional English	2	3	6	100	200
	Compulsory Project (Group/Individual Project)	1	5	5	100	100
Part IV	Environmental Science	1	2	2	100	100
	Soft skill	1	1	1	100	100
	Value Education	1	2	2	100	100
	Lang. & Others /NME	2	2	4	100	200
	Skill Based	4	2	8	100	400
Part V	Extension Activities	1	1	1	100	100
	Total	**46**		**142**		**4700**

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(B.Sc., Data Science) – 2022-2023 onwards

Programme Objectives:

1. PO1: To produce agile and skilled professionals to understand, collect, extract, analyze and predict the given set of data.
2. PO2: To solve the major problems through real-time data analysis.
3. PO3: This course is designed in such a way that graduates can perform and conduct data-driven investigations by managing and visualizing all types of data.
4. PO4: Students will understand the concept and develop an in-depth understanding of data science and data analytics.
5. PO5: To teach students the basic techniques and procedures to analyze quantitative and qualitative data to arrive at solutions by identifying the pattern, predict trends and analyze data sets from different sectors.

Programme Outcomes:

1. PO1: Data Science knowledge: Application of Data Science knowledge in various fields of science, engineering and management etc.
2. PO2: Nature of Data Science: Understand the concise, precise and rigorous nature of Data Science.
3. PO3: `Critical thinking: Develop the skill to think critically on abstract concepts of Data Science.
4. PO4: Problem analysis: Develop the ability to analyze a problem logically and dissect into micro-parts and thus resolving the problem to accessible components.
5. PO5: Presentation skill: Develop the skill to pleasant exposition for successful presentation for any career interview with confidence.
6. PO6: Data Science logic: Formulates and develops data analysis arguments in logical manner.
7. PO7: Team Work: Work as a team player and strive for self-excellence.
8. PO8: Ethics: Realize and understand professional, ethical and cultural responsibilities.
9. PO9: Communication: Communicate effectively with an elite audience.
10. PO10:Life-long learning: Engage in life-long learning towards enduring professional development.

Programme Educational Objectives:

1. PEO1: Prepare professionals conversant with current and advanced technological tools to carry out Investigation, analysis and synthesis by identifying various compute oriented solutions.
2. PEO2: To develop positive attitude and skills which enable them to become a multi facet personality.
3. PEO3: To prepare students in such a way so that they perform excellently in national label entrance examinations conducted by various well known institution like IIT's/ central Universities/other academic institutes etc. to pursue their PG/MS/Dual PG and Ph. D. programs.

4. PEO4: To make them aware of effective machine learning and Artificial Intelligence based data analytics and inference required for Industrial Application.
5. PEO5: To inculcate passion for lifelong learning by introducing principles of group dynamics, public policies, environmental and societal context.

Programme Specific Outcomes:

1. PSO1: Abstract Thinking: To develop the ability to understand abstract concepts that lead to various data science theories in Mathematics, Statistics, and Computer Science.
2. PSO2: Problem Analysis and Design Ability: To identify, analyze and design solutions for problems using the fundamental principles of Mathematics, Statistics, Computing
   Sciences, and relevant domain disciplines.
3. PSO3: Modern Software Tool Usage: To acquire the skill of handling data science programming tools for problem-solving and solution analysis for domain-specific problems.
4. PSO4: Professional Ethics: To understand and commit to professional ethics, cyber regulations, responsibilities, and norms of professional computing practices.
5. PSO5: Conduct investigations of complex computing problems: Use research-based knowledge and research methods including design of experiments, analysis, interpretation of data, and synthesis of the information to provide valid conclusions.
6. PSO6: Individual and Teamwork: To function effectively as an individual, as a member or as a leader in diverse teams and multidisciplinary environments.
7. PSO7: Applications in Multidisciplinary domains: To understand the role of statistical approaches and apply the same to solve the real-life problems in the fields of data science.
8. PSO8: Project Management: To apply research-based knowledge to analyze and solve advanced problems in data science.
9. PSO9: Data-based models: To develop the ability to build and assess data-based models.
10. PSO10: Statistical analysis: To enable the students to execute statistical analyses with professional statistical software.

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: I **Paper type: Core Theory – Paper 1**

Paper code: **Name of the Paper: Programming in C** **Credit: 4**

Total Hours per Week: 6 Hrs. Lecture Hours: 78 Hrs. Tutorial Hours: - **Practical Hours: -**

……

Course Objectives

1. To learn the syntax and semantics of the C++ programming language.
2. To learn how to design C++ classes for code reuse.
3. To learn how to implement copy constructors and class member functions.
4. To understand the concept of data abstraction and encapsulation.
5. To learn how to overload functions and operators in C++.

Course Outcomes

1. After studied unit-1, the student will be able to understand basic concepts like constants, variables, operators and expressions.
2. After studied unit-2, the student will be able to understand the need of input output operations and decision making.
3. After studied unit-3, the student will be able to understand the insights of arrays, character arrays and strings.
4. After studied unit-4, the student will be able to carry out operations on structures, unions and pointers.
5. After studied unit-5, the student will be able to understand the essential information regarding fundamental algorithms and factoring problems.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT – I OVERVIEW OF C **Teaching Hours: 16 Hrs**

History – Importance – Sample Programs – Basic Structure – Programming Style – Executing – Unix System – MS-DOS System - **Constants, Variables, and Data Types:** Character Set – C Token – Keyword and Identifiers – Constants – Variables – Data Types – Declaration of Storage Class – Assigning Values to Variables – Defining Symbolic Constants – Declaration – Overflow and Underflow of Data - **Operators and Expressions:** Arithmetic, Relational, Logical, Assignment, Increment and Decrement, Conditional, Bitwise, Special Operators – Arithmetic Expressions, Evaluation of Expressions – Precedence of Arithmetic Operators – Some Computational Problems – Type Conversions in Expressions – Operator Precedence

and Associativity – Mathematical Functions .

UNIT – II MANAGING INPUT AND OUTPUT OPERATIONS Teaching Hours: 15 Hrs

Reading, Writing a Character – Formatted Input, Output - **Decision Making and Branching:** Decision Making with If statement – Simple If Statement – The If…Else Statement – Nesting of If…Else Statements – The Else If Ladder – The Switch Statement- The ?: Operator – The Goto Statement - **Decision Making and Looping:** The while Statement – The do Statement – The for Statement – Jumps in Loops – Concise Test Expressions.

UNIT – III ARRAYS Teaching Hours: 16 Hrs

One-Dimensional Arrays - Declaration, Initialization of One-Dimensional Arrays – Two-Dimensional Arrays - Initializing Two-Dimensional Arrays – Multi-Dimensional Arrays – Dynamic Arrays - **Character Arrays and Strings:** Declaring and Initializing String Variables – Reading Strings from Terminal – Writing Strings to Screen – Arithmetic Operations on Characters – Putting String Together – Comparison of Two Strings –String-Handling Functions – Table of Strings – Other Features of Strings - **User Defined Functions**: Need for User-Defined Functions – A Multi-Function Program – Elements of User-Defined Functions – Definition of Functions – Return Values and Their Types – Function Calls – Function Declaration – Category of Functions – No Arguments and No Return Values – Arguments but no return values – Arguments with Return Values – No Arguments but Returns a value – Functions that Return Multiple Values – Nesting of Functions – Recursion - Passing Arrays, Strings to Functions – The Scope, Visibility and Lifetime of Variables – Multi file Programs.

UNIT – IV STRUCTURE AND UNIONS Teaching Hours: 15 Hrs

Defining a Structure – Declaring Structure Variables – Accessing Structure Members – Structure Initialization and Copying and Comparing Structure Variable – Operations on Individual Members – Arrays of Structures – Arrays within Structures – Structures within Structures – Structures and Functions – Unions – Size of Structures – Bit Fields **Pointers:** Understanding Pointers – Accessing the Address of Variable – Declaring, Initialization of Pointer Variables – Accessing a Variable through its pointer – Chain of Pointers – Pointer Expression – Pointer Increments and Scale Factor – Pointers and Arrays – Pointers and Character Strings – Array of Pointers – Pointers as Function Arguments –

Functions Returning Pointers – Pointers to Functions – Pointers and Structures – Troubles with Pointers **File Management in C**: Defining and Opening a File – Closing a File – Input/Output Operations on File – Error Handling During I/O Operations – Random Access to Files – Command Line Arguments.

UNIT – V FUNDAMENTAL ALGORITHMS **Teaching Hours: 16 Hrs**

Exchanging the values of Two Variables- Counting- Summation of a Set of Numbers- Factorial Computation -Sine Function Computation –Generation of the Fibonacci Sequence- Reversing the Digits of an Integer- Base Conversion – Character to Number Conversion **- Factoring Methods:** Finding the square Root of a Number –The Smallest Divisor of an Integer-The Greatest Common Divisor of the two integers-Generating Prime Numbers- Computing the Prime Factors of an integer –Generation of Pseudo-random Numbers-Raising a Number to a Large Power-Computing the nth Fibonacci Number

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
- For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
-

TEXTBOOKS:

1. Programming in ANSI C, E. Balagurusamy, Tata McGrawhill Education, 6th Edition, 2013. (Unit I to IV)
2. How to Solve it by Computer, R.G.Dromey, PHI International (Unit V)

REFERENCE BOOKS:

1. The C Programming Language (ANSI C), Kernighan, B.W. and Ritchie, D.M., PHI.
2. C by Discovery , Foster & Foster , Penram International Publishers, Mumbai.

Mapping with Programme Outcomes

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

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: I **Paper type: Core Practical – 1**

Paper code: **Name of the Paper: Programming in C Lab** **Credit: 2**

Total Hours per Week: 3 Hrs. Lecture Hours:… Tutorial Hours:….. Practical Hours: 39 Hrs.

……

Course Objectives

1. To learn the syntax and semantics of the C++ programming language.
2. To learn how to design C++ classes for code reuse.
3. To learn how to implement copy constructors and class member functions.
4. To understand the concept of data abstraction and encapsulation.
5. To learn how to overload functions and operators in C++.

Course Outcomes

1. To understand basic concepts like constants, variables, operators and expressions.
2. To understand the need of input output operations and decision making.
3. To understand the insights of arrays, character arrays and strings.
4. To carry out operations on structures, unions and pointers.
5. To understand the essential information regarding fundamental algorithms and factoring problems.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

Control Statements:

1. Print n Fibonacci numbers – (using for)

2. Print n Prime numbers – (using while)

3. Simple arithmetic on two numbers – (using switch/case)

Functions:

4. Swap two values using call by value / call by reference.

Recursion:

5. To compute NcR and NpR

6. To Compute GCD and LCM

String Manipulation:

7. Operations on string such as length, concatenation, reverse, counting, and copy of a string to another.

Matrices:

8. Matrix Addition, Subtraction, Multiplication, Transpose of n x m matrices.

9. Inverse of a square matrix.

Searching:

10. Binary Search

Sorting:

11. Bubble Sort

12. Insertion Sort

Structures:

13. Students Mark statement

Pointers:

14. Arithmetic operations on pointers.

Files:

15. Creating/ Reading/ Writing a text/binary file.

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.

- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
- For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: I **Paper type: Allied**

Paper code: **Name of the Paper: Discrete Mathematics** **Credit: 3**

Total Hours per Week: 7 Hrs. Lecture Hours: 91 Hrs. Tutorial Hours: ….. Practical Hours: …..

……

Course Objectives

1.
2.
3.
4.
5.

Course Outcomes

1.
2.
3.
4.
5.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: RECURRENCE RELATIONS AND GENERATING FUNCTIONS

Teaching Hours: 19 Hrs.

Recurrence - Polynomials and their Evaluations - Recurrence Relations - Solution of Finite Order Homogeneous [linear] Relations - Solutions of Non-homogeneous Relations.

Unit-2: MATHEMATICAL LOGIC **Teaching Hours: 18 Hrs.**

TF Statements - Connectives - Atomic and Compound Statements - Well-formed [Statement Formulae] - Parsing - Truth Table of a Formula - Tautology - Tautological Implications and Equivalence of Formulae.

Unit-3: MATHEMATICAL LOGIC **Teaching Hours: 18 Hrs.**

Replacement process - Functionally complete sets of connectives and Duality law – Normal Forms - Principal Normal Forms.

Unit-4: LATTICES **Teaching Hours: 18 Hrs.**

Lattices [omit example 15 Pp No.10.6) - Some properties of Lattices - New Lattices (omit remarkPp 10.14) - Modular and Distributive Lattices (omit theorem 10 and 17, Example 4 - Pp 10.23,Example 11 - Pp 10.24)

Unit-5: BOOLEAN ALGEBRA **Teaching Hours: 18 Hrs.**

Boolean Algebra - Boolean Polynomials - Karnaugh Maps

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research

reports like assignment, seminar papers, case study reports, etc.

Text book:

1. P.Duraipandian and S.Udayabaskaran,(1997) *Allied Mathematics,* Vol. I & II.Muhil Publishers, Chennai.

Reference Books:

1. P.Balasubramanian and K.G.Subramanian,(1997) *Ancillary Mathematics.* Vol. I & II. Tata McGraw Hill, New Delhi.
2. S.P.Rajagopalan and R.Sattanathan,(2005) *Allied Mathematics* .Vol. I & II. VikasPublications, New Delhi.
3. P.R.Vittal (2003) *Allied Mathematics* .Marghan Publications, Chennai
4. P.Kandasamy, K.Thilagavathy (2003) Allied Mathematics Vol-I, II S.Chand& company Ltd., New Delhi-55.
5. Isaac, Allied Mathematics. New Gamma Publishing House, Palayamkottai.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: II **Paper type: Core – Paper 2**
Paper code: **Name of the Paper: Programming in Java** **Credit: 4**

Total Hours per Week: 5 Hrs. Lecture Hours: 39 Hrs. Tutorial Hours: Practical Hours: …..

……

Course Objectives

1. To know about a General-purpose and Purely object-oriented programming language including data types.
2. To understand the concept of garbage collection and operators
3. To know about the concept of Array and string
4. To know about the concept of Files
5. To understand the concept of Applets

Course Outcomes

1. After studied unit-1, the student will be able to understand the concept of General-purpose and Purely object-oriented programming language including data types and classes
2. After studied unit-2, the student will be able to understand the concept of loops

3. After studied unit-3, the student will be able to understand the concepts of Arrays

4. After studied unit-4, the student will be able to understand the concepts of Files

5. After studied unit-5, the student will be able to understand the concept of internet programming using applets and GUI-based

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: INTRODUCTION **Teaching Hours: 13 Hrs.**

Declarations and Access Control: Identifiers and Keywords: Oracle‘s Java Code Conventions. Define Classes: Import Statements and the Java API - Static Import Statements. Use Interfaces: Declaring an Interface-Declaring Interface Constants. Declare Class Members: Access Modifiers - Non access Member Modifiers - Constructor Declarations - Variable Declarations. Declare and Use enums: Declaring enums. Object Orientation: Encapsulation - Inheritance and

Polymorphism- Polymorphism - Overriding / Overloading: Overridden Methods -Overloaded Methods.

Unit-2: OBJECT ORIENTATION **Teaching Hours: 13 Hrs.**

Casting - Implementing an Interface - Legal Return Types: Return Type Declarations - Returning a Value. Constructors and Instantiation: Overloaded Constructors - Initialization Blocks. Statics: Static Variables and Methods. Assignments: Stack and Heap - Literals, Assignments, and Variables: Literal Values for All Primitive Types. Scope - Variable Initialization - Passing Variables into Methods: Passing Object Reference Variables - Passing Primitive Variables. Garbage Collection. Operators: Java Operators - Assignment Operators
- Relational Operators – instance of Comparison - Arithmetic Operators - Conditional Operator - Logical Operators.

Unit-3: WORKING WITH STRINGS, ARRAYS, AND ARRAY LISTS:
Teaching Hours: 13 Hrs.

Using String and StringBuilder: The String Class - The StringBuilder Class - Important Methods in the StringBuilder Class. Using Arrays: Declaring an Array -Constructing an Array - Initializing an Array. Using ArrayList:ArrayList Methods in Action - Important Methods in the ArrayList Class. Flow Control and Exceptions: Using if and switch Statements -Creating Loops Constructs - Handling Exceptions - Catching an Exception Using try and catch - Using finally. String Processing, Data Formatting Resource Bundles: String, StringBuilder, and StringBuffer - Dates, Numbers, Currencies,and Locales.

Unit-4: I/O and NIO **Teaching Hours: 13 Hrs.**

File Navigation and I/O: Creating Files Using the File Class - Using FileWriter and FileReader. File and Directory Attributes -DirectoryStream - Serialization. Generics and Collections: toString(), hashCode(), and equals(): The toString() Method - Generic Types -Generic Methods - Generic Declarations. Inner Classes: Method – Local. Inner Classes - Static Nested Classes - Threads: Defining, Instantiating, and Starting Threads - Thread States and Transitions - Synchronizing Code, Thread Problems - Thread Interaction. Concurrency: Concurrency with the java.util.concurrent Package - Apply Atomic Variables and Locks - Use java.util.concurrent Collections - Use Executors and ThreadPools.

Unit 5: APPLET **Teaching Hours: 13 Hrs.**

Applets: Applet fundamentals - Applet class - Applet life cycle - Steps for developing an applet program - Passing values through parameters - Graphics in an applet - Event-handling. GUI Applications - Part 1: Graphical user interface - Creating windows - Dialog boxes - Layout managers - AWT component classes - Swing component classes. GUI Applications - Part 2: Event handling - Other AWT components - AWT graphics classes - Other swing controls.

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.

b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Text books:

1. Kathy Sierra, Bert Bates — OCA/OCP Java SE 7 Programmer I & II Study Guide, Oracle Press. (Unit I,II,III,IV).

2. Sagayaraj, Denis, Karthik and Gajalakshmi, 2018, Java Programming - For Core and Advanced Learners, University Press (India) Private Limited, Hyderabad.(Unit V).

Reference Books:

1. Hebert Schild, 2002, The Complete Reference Java2, [Fifth Edition]. Tata McGraw-Hill, New Delhi.

2. John Hubbard, R.2004. Programming with Java. [Second Edition]. Tata McGraw-Hill,New Delhi.

3. Debasish Jana. 2005. Java and Object-Oriented Programming Paradigm, [Second Printing]. Prentice-Hall of India, New Delhi.

4. Sagayaraj, Denis, Karthik and Gajalakshmi 2018, Java Programming for core and advanced Learners, University Press India Pvt. Ltd., Hyderabad.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: II **Paper type: Core – Practical - 3**

Paper code: **Name of the Paper: Programming in Java Lab** **Credit: 2**

Total Hours per Week: 2 Hrs. Lecture Hours: Tutorial Hours: .. Practical Hours: 26 Hrs.

……

Course Objectives

1. To understand the concepts of classes and objects.
2. To know about layout managers.
3. To gain knowledge of frames and menus.
4. To understand the concept of RMI.
5. To learn how to handle exceptions.

Course Outcomes

1. After studied unit-1, the student will be able to understand the concept of purely object-oriented programming language including data types and classes.
2. After studied unit-2, the student will be able to implement layout managers.
3. After studied unit-3, the student will be able to develop an application using frames.
4. After studied unit-4, the student will be able to understand the concepts of RMI.
5. After studied unit-5, the student will be able to handle exceptions in program.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

LIST OF PRACTICAL EXCERCISES

1. Implementation of Classes and Objects
2. Implementation of Inheritance and Polymorphism
3. Implementation of Interface and Package concepts

4. Implementation of Flow, Border ,Grid Layouts

5. Implementation of Tic-Tac Toe Application Using Applets

6. Implementation of Frames, Menus, Dialog

7. Implementation of Swing concepts

8. Implementation of Exception Handling

9. Implementation of Multi Threading

10. Implementation of I/O Streams

11. Implementation of Java Networking concepts

12. Implementation of Java Servlets (Connecting Database)

13. Implementation of RMI

14. Implementation of Java Beans

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: II **Paper type: Allied**

Paper code: **Name of the Paper: Operations Research** **Credit: 5**

Total Hours per Week: 7 Hrs. Lecture Hours: 91 Hrs. Tutorial Hours:….. Practical Hours:..

……

Course Objectives

1.

2.

3.

4.

5.

Course Outcomes

1.

2.

3.

4.

5.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT-1: **Teaching Hours: 18 Hrs.**

Linear programming problem - Mathematical formulation of the problem - Graphical solution method - Simplex method - The Big-M method -Duality - Dual simplex method (Simple Problems).

UNIT-2: Partial Differential Equations **Teaching Hours: 18 Hrs.**

Definitions of the transportation model - Formulation and solution of transportation Models_ Finding an initial basic feasible solution (NWCM - LCM -VAM) - Degeneracy in Transportation Problem - Transportation Algorithm (MODI Method)

UNIT-3: **Teaching Hours: 19 Hrs.**

Definition of Assignment models - Mathematical representation of assignment models – Comparison with the transportation models - Solution of the assignment model - The Hungarian methods for solution of the assignment models - variation of the assignment problem .Travelling salesman problem.

UNIT-4 : Vector Analysis **Teaching Hours: 18 Hrs.**

Games and Strategies - Two person zero sum - Some basic terms - the maximin-minimax principle – saddle points - Games without saddle points-Mixed strategies - graphic solution 2xn and mx2 games.

UNIT-5: Vector Analysis (continued) **Teaching Hours: 18 Hrs.**

Simulation - application - advantages and disadvantages - Monte Carlo method - simple problems.

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Text book:

1. Gupta P.K.and Hira D.S., (2000) Problems in Operations Research, S.Chand & Co. Delhi

Reference Books:

1. J.K.Sharma, (2001) Operations Research: Theory and Applications, Macmillan, Delhi
2. KantiSwaroop, Gupta P.K. and Manmohan, (1999) *Problems in Operations Research*, Sultan Chand & Sons., Delhi

3. V.K.Kapoor [1989] *Operations Research*, sultan Chand & sons.

Ravindran A., Philips D.T. and Solberg J.J., (1987) *Operations research*, John Wiley & Sons, New York.

4. Taha H.A. (2003) *Operations Research,* Macmillan Publishing Company, New York.
5. S.J.Venkatesan, *Operations Research,* J.S. Publishers, Cheyyar-604 407.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: III Paper type: Core Paper – Paper 3

Paper code: Name of the Paper: PYTHON for Data Science Credit: 3

Total Hours per Week: 3 Hrs. Lecture Hours: 39 Hrs. Tutorial Hours: ….. Practical Hours: …..

……
……

Course Objectives

1. To acquire programming skills in core Python.
2. To acquire Object Oriented Skills in Python.
3. To develop the skill of designing Graphical user Interfaces in Python.
4. To develop the ability to write database applications in Python.
5. To define the structure and components of a Python program.

Course Out Comes

1. After studied Unit I, the student will be able to understand basic concepts, flow control and functions.
2. After studied Unit II, the student will be able to understand the need for lists, strings and tuples and dictionaries.
3. After studied Unit III, To understand the insights of manipulating strings and pattern matching functions.
4. After studied Unit IV, To carry out operations on files and their operations.
5. After studied Unit V, To understand the essential information regarding the object oriented concepts.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT I PYTHON BASICS Teaching Hours: 8 Hrs

Entering Expressions into the Interactive Shell, The Integer, Floating Point and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program. **Flow control:** Boolean Values, Comparison Operators, Boolean Operators, Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules, Ending a Program Early with sys.exit(), F**unctions:** def Statements with Parameters, Return Values and return Statements, The None Value, Keyword Arguments and print(), Local and Global Scope, The global Statement, Exception Handling, A Short Program: Guess the Number.

UNIT II LISTS **Teaching Hours: 8 Hrs**

The List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Example Program: Magic 8 Ball with a List, List-like Types: Strings and Tuples, References. **Dictionaries and Structuring Data:** The Dictionary Data Type, Pretty Printing, Using Data Structures to Model Real-World Things

UNIT III **Teaching Hours: 8 Hrs**

Manipulating Strings: Working with Strings, Useful String Methods, Project: Password Locker, Project: Bullets to Wiki Markup. **Pattern Matching with Regular Expressions:** Finding Patterns of Text Without Regular Expressions, Finding Patterns of Text with Regular Expressions, More Pattern Matching with Regular Expressions, Greedy and Nongreedy Matching, The fiindall() Method, Character Classes, Making Your own Character Classes, The Caret and Dollar Sign Characters, The Wildcard Character, Review of Regex Symbols, Case-Insensitive Matching, Substituting Strings with the sub() Method, Managing Complex Regexes, Combining re.IGNORECASE, re.DOTALL and re.VERBOSE, Project: Phone Number and Email Address Extractor.

UNIT IV **Teaching Hours: 8 Hrs**

Reading and Writing Files: Files and File Paths, The os.path Module, The File Reading/Writing Process, Saving Variables with the shelve Module, Saving Variables with the pprint. pformat() Function, Project: Generating Random Quiz Files, Project: Multiclipboard, **Organizing Files:** The shutil Module, Walking a Directory Tree, Compressing Files with the zipfile Module, Project: Renaming Files with American-Style Dates to European- Style Dates, Project: Backing Up a Folder into a ZIP File, D**ebugging:** Raising Exceptions, Getting the Traceback as a String, Assertions, Logging, IDLE's Debugger.

UNIT V **Teaching Hours: 7 Hrs**

Classes and objects: Programmer-defined types, Attributes, Rectangles, Instances as return values, Objects are mutable, Copying. **Classes and functions:** Time, Pure functions, Modifiers, Prototyping versus planning. **Classes and methods:** Object-oriented features, Printing objects, The init method, The str method, Operator overloading, Type-based dispatch, Polymorphism, Interface and implementation. **Inheritance:** Card objects, Class attributes, Comparing cards, Decks, Printing the deck, Add, remove, shuffle and sort, Inheritance, Class diagrams, Data encapsulation.

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.

- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
- For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

TEXT BOOKS:

1. Al Sweigart, "Automate the Boring Stuff with Python", 1st Edition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/) (Chapters 1 to 18)
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 13, 15, 16, 17, 18) (Download pdf/html files from the above links)

REFERENCE BOOKS:

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

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: III **Paper type: Core – Practical - 3**

Paper code: **Name of the Paper: PYTHON for Data Science Lab** **Credit: 3**

Total Hours per Week: 3 Hrs. Lecture Hours: Tutorial Hours: .. Practical Hours: 39 Hrs.

……

Course Objectives

1. To acquire programming skills in core Python.
2. To acquire Object Oriented Skills in Python.
3. To develop the skill of designing Graphical user Interfaces in Python.
4. To develop the ability to write database applications in Python.
5. To define the structure and components of a Python program.

Course Outcomes

1. To understand basic concepts,flow control and functions.
2. To understand the need for lists, strings and tuples and dictionaries.
3. To understand the insights of manipulating strings and pattern matching functions.
4. To carry out operations on files and their operations.
5. To understand the essential information regarding the object oriented concepts.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

1. Demonstrate the usage of Flow Control Statements.
2. Demonstrate the usage of Functions.
3. Demonstrate the usage of different Data Types
4. Demonstrate the usage of String Functions
5. Demonstrate the usage of Regular Expressions
6. Demonstrate the working of Files.
7. Demonstrate the usage of Exception Handling Techniques.
8. Demonstrate the usage of Classes and Objects

9. Demonstrate the usage of Classes and Functions.

10. Demonstrate the usage of Classes and Methods.

11. Demonstrate the usage of Classes and Objects

12. Demonstrate the working of Inheritance concepts

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: III Paper type: Allied Paper – Paper 3

Paper code: Name of the Paper: Statistical Methods And Their Applications I Credit: 2

Total Hours per Week: 4 Hrs. Lecture Hours: 52 Hrs. Tutorial Hours: ….. Practical Hours: …..

……

Course Objectives

Course Outcomes

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: **Teaching Hours: 8 Hrs.**

Introduction - scope and limitations of statistical methods - classification of data -Tabulation of data - Diagrammatic and Graphical representation of data - Graphical determination of Quartiles ,Deciles and Percentiles.

Unit-2: **Teaching Hours: 8 Hrs.**

Measures of location : Arithmetic mean, median, mode, geometric mean and Harmonicmean and their properties.

Unit-3: **Teaching Hours: 8 Hrs.**

Measures of dispersion: Range, Quartile deviation, mean deviation, Standard deviation,combined Standard deviation, and their relative measures.

Unit-4: **Teaching Hours: 7 Hrs.**

Measures of Skewness Karl Pearson's, Bowley's, and kelly's and co-efficient ofSkewness and kurtosis based on moments.

Unit-5: **Teaching Hours: 8 Hrs.**

Correlation - Karl Pearson - Spearman's Rank correlation - concurrent deviationmethods.Regression Analysis: Simple Regression Equations.

Internal Assessment Methods: (The following items may be brought under test, seminar andassignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods

i. may be implemented in the practices and report can be written for documentation, further discussion and research.

l. Extracurricular activities may be framed through their syllabus content.

m. Bring the industries to the campus. Bring the students to the industry.

n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Text books:

1. Fundamental of Mathematical Statistics - S.C. Gupta & V.K. Kapoor - Sultan Chand
2. Statistical Methods - Snedecor G.W. & Cochran W.G. oxford & +DII
3. Elements of Statistics - Mode . E.B. - Prentice Hall
4. Statistical Methods - Dr. S.P. Gupta - Sultan Chand & Sons

Reference Books:

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: III Paper type: Skill based Subject – Paper 1

Paper code: Name of the Paper: Digital Logic Design and Computer Organization Credit: 2

Total Hours per Week: 3 Hrs. Lecture Hours: 39 Hrs. Tutorial Hours: ….. Practical Hours: …..

……

Course Objectives

1. Introduce the concept of digital and binary systems
2. Represent data in various formats and perform computer arithmetic on them;
3. Demonstrate knowledge and understanding of logic functions, logic diagrams and Boolean algebra;
4. Describe and analyze digital logic circuits.
5. Be able to design and analyze combinational logic circuits.
6. Be able to design and analyze sequential logic circuits.

Course Outcomes

1. After studied Unit I, the student is able to understand the numeric system and its basic conversions.
2. After studied Unit II, the student understands the need for combinatorial arithmetic circuits.
3. After studied Unit III, the student will understand the insights of combinational logic circuits.
4. After studied Unit IV, the student knows about basic operations of computers.
5. After studied Unit V, the student understands the essential information regarding the I/O interface and memory organization.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT-I BINARY NUMBER SYSTEM Teaching Hours: 8 Hrs

Number system and its conversions-. Digital Computers and Digital Systems - Binary Number System – Binary Addition – Binary Subtraction- Binary Multiplication and Division-Number Base Conversion: decimal, binary, octal, hexadecimal. The Basic Gates - Boolean Algebra - Universal Gates - Boolean Laws and Theorem.

UNIT-II SIMPLIFICATION Teaching Hours: 7 Hrs

Sum of products - Product of Sums - K-map simplifications - Don't care conditions-QuineMcclausky tabulation method. Combinational Arithmetic Circuits: Adders-Subtractors-full adder-subtractor-BCD Adder.

UNIT-III COMBINATIONAL LOGIC CIRCUITS **Teaching Hours: 8 Hrs**

Multiplexers-De-Multiplexers- Decoders : -Encoders- Decoders-Sequential Logic Circuit: Flip-Flops -RS Flip flop- JK Flip flop- D Flip flop-T Flip flop and Master Slave. Counters-Synchronous and Asynchronous –Shift Registers and its types.

UNIT- IV BASIC STRUCTURE OF COMPUTERS **Teaching Hours: 8 Hrs**

Basic Operational Concepts, Bus Structures - Central Processing Unit: General Register and stack Organization-Instruction Formats Addressing Modes-Data Transfer and manipulation.

UNIT V- INPUT OUTPUT AND MEMORY ORGANIZATION **Teaching Hours: 8 Hrs**

Peripheral Devices- I/O Interface - Asynchronous Data Transfer- -Priority Interrupt – Direct Memory Access – I/O Processor.Memory Organization– Main Memory-Auxiliary Memory – Associative Cache and Virtual Memory.

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

TEXT BOOKS:

1. M. Morris Mano -Digital Logic and Computer Design- PHI.
2. M. Morris Mano, Computer System Architecture, Pearson Education.

REFERENCE BOOKS:

1 Thomas C. Bartee Digital Computer Fundamentals- McGraw HillPub.

2 Malvino& Leach- Digital Principles and Applications –McGraw HillPub.

3. S. Ramalatha - Digital Computer Fundamentals, MeenakshiAgency.
4. V. Carl Hamacher, Zvonko G. Vranesic, Safwat G. Zaky, Computer Organization, McGraw Hill HigherEducation.
5. John P. Hayes, Computer System Architecture, McGraw Hill HigherEducation

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: III Paper type: Non Major Elective - Paper 1

Paper code: Name of the Paper: Introduction to Information Technology Credit: 2

Total Hours per Week: 2 Hrs. Lecture Hours: 26 Hrs. Tutorial Hours:…. Practical Hours: …..

……

Course Objectives

1. Explain and summarize the history and development of information technologies, including computing hardware, software, and Internet-based technologies.
2. Design and implement information solutions with basic computer coding.
3. Analyze and evaluate security, privacy, policy, and other social issues inherent in information technology development and use.
4. Summarize and compare emerging information technologies and their impacts on users, society, and organizations.
5. Evaluate and create information technology solutions through systems design and programming.

Course Outcomes

1. After studied Unit I, the student is able to understand the basic concepts of computers.
2. After studied Unit II, the student understands the need for storage devices and the CPU.
3. After studied Unit III, the student will understand the insights of computer networks and the various output devices.
4. After studied Unit IV, the student knows about computer software.
5. After studied Unit V, the student understands the essential information regarding the applications of Internet and its social impact.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT-I INTRODUCTION Teaching Hours: 6 Hrs

Characteristics of Computers-Technological Evolution of Computers-The Computer Generations-Categories of Computer. **Data and Information:** Introduction-Types of Data-A Simple Model of a Computer-Data Processing Using a Computer-Desktop Computer. **Acquisition of Number and Textual Data:** Introduction- Input Units-

Internal Representation of Numeric Data-Representation of Characters in Computers–Error-Detecting Codes.

UNIT-II DATA STORAGE: Teaching Hours: 5 Hrs

Introduction-Memory Cell-Physical Devices Used as Memory Cells-Random Access Memory-Read Only Memory- Secondary Memory- Floppy Disk Drive- Compact Disk Read Only Memory (CDROM)-Archival Memory. **Central Processing Unit:** The Structure of a Central Processing Unit-Specification of a CPU-Interconnection of CPU with Memory and I/O Units.

UNIT-III COMPUTER NETWORKS: Teaching Hours: 5 Hrs

Introduction-Local Area Network (LAN)- Applications of LAN-Wide Area Network (WAN)–The Future of Internet Technology. **Output Devices:** Introduction- Video Display Devices-Flat Panel Displays–Printers.

UNIT-IV COMPUTER SOFTWARE: Teaching Hours: 5 Hrs

Introduction-Operating System-Programming Languages–A Classification of Programming Languages. **Data Organization:** Introduction-Organizing a Database-Structure of a Database- Database Management System-Example of Database Design.

UNIT-V SOME INTERNET APPLICATIONS: Teaching Hours: 5 Hrs

Introduction- E-mail- Information Browsing Service- The World Wide Web- Information Retrieval from the World WideWeb-Other Facilities Provided by Browsers - Audio on the Internet.**Societal Impactsof Information Technology:** CareersinInformation Technology.

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the

departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

TEXTBOOKS:

1. *Rajaraman,V.*2008.**IntroductiontoInformationTechnology.**[SixthPrinting]. PrenticeHall of India Pvt. Limited, New Delhi.(UNIT I toV)

2. *Nagpal,D.P.*2010.**ComputerFundamentals**.[FirstEdition,Revised].S.Chand &CompanyLtd, New Delhi. (**UNIT I(Introduction: Characteristics of Computers to Categories of Computer**))

REFERENCE BOOKS:

1. *ITL EducationsSolution Limited.* 2009. **Introduction toComputer Science**. [Fourth Impression].Pearson Education, New Delhi.
2. *Alexis Leon and Mathews Leon.* 1999. **Fundamentals of Information Technology.**[FirstEdition]. Leon TECHWorld, New Delhi.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: IV **Paper type: Core Theory - Paper 4**

Paper code: **Name of the Paper: Advanced Python for Data Science** **Credit: 3**

Total Hours per Week: 3 Hrs. Lecture Hours: 39 Hrs. Tutorial Hours: . Practical Hours: .

……

Course Objectives

1. 1.The main objective of the course is to provide students with the basic concepts of Python, its syntax, practice it.
2. To get insight knowledge in functions and packages to enable students to write scripts for data manipulation and analysis
3. To develop skills of writing and running a code using Python.
4. To master various variables types and their features, basic operators and statements, loops, as well as the main packages for data science: NumPy, Pandas, Matplotlib.
5. To gather knowledge and should be able to write short scripts to import, prepare and analyse data.

Course Out Comes (five outcomes for each units should be mentioned)

1. CO1. After studied unit-1, the student will be able to know about basic data types in Python.
2. CO2. After studied unit-2, the student will be able to know operators, how to clean ,merge datasets and networking concepts.
3. CO3. After studied unit-3, the student will be able to work with pandas library, the main methods for Data Frames and application programming interface.
4. CO4. After studied unit-4, the student will be able to work how to import data in Python.
5. CO5. After studied unit-5, the student will be able to know how to work with main packages.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	No	Yes	Yes
2	No	Yes	Yes	No	Yes	No
3	Yes	Yes	No	Yes	Yes	Yes
4	Yes	Yes	Yes	No	Yes	No
5	Yes	No	No	Yes	No	Yes

Unit-I: **Teaching Hours: 8 Hrs**

Generators, Iterator, Decorator: Working with yield keyword, Difference between yield and return, decorating a function with another function **Lambda Functions:** Difference between def and lambda functions, Working with filter functions, Working with map functions, Working with reduce functions, List Comprehensions, Serialization, Partial Functions, Code Introspection, Closures.

Unit-II: **Teaching Hours: 8 Hrs**

Multithreading: Multithreading Introduction-Multithreading methods N Deamon Thread- Inter Thread Communication by Using Event N Condition-Inter ThreadCommunication By Using Queue. **Networking**: Socket, Simple Server, Simple Client, Retrieving web pages using urllib, Parsing HTML using regular Expression and Beautiful Soup, Sending Email.

Unit-III: **Teaching Hours: 8 Hrs**

Web Services: Parsing XML, JSON, Application Programming Interfaces.

Unit-IV: **Teaching Hours: 7 Hrs**

NumPy Libraries for Arrays, Pandas Library for Data Processing

Unit-V: **Teaching Hours: 8 Hrs**

Matplotlib for Visualization, Seaborn Library for Visualization, Scipy Library for Statistics

Text book:

1. Wesley J Chun, Core Python Applications Programming, 3rd Edition. Pearson
2. Michael Bowles, Machine Leaning in Python, Essential techniques for predictive analysis, Wiley
3. Al Sweigart,"Automate the Boring Stuff with Python",1st Edition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)

Reference Book:

1. Mark Pilgrim, Dive into Python: Python Novice to pro (source: http://diveintopython.org/.)
2. Alex Martelli, Python Cookbook, O'REILLY
3. Luke Sneeringer, Professional Python, WROX
4. Laura Cassell, Python Projects, WROX

5. Shai Vaingast,Beginning Python Visualization , Crafting Visual Transformation Scripts, Apress.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: IV **Paper type: Core Practical - 4**

Paper code: **Name of the Paper: Advanced Python Programming Lab** **Credit: 3**

Total Hours per Week: 3 Hrs. **Lecture Hours:…. Tutorial Hours: ….. Practical Hours: 39 Hrs.**

……

Course Objectives

1. To understand the tokens of Python.
2. To learn Multithreading in Python.
3. To know about built in Email
4. To learn about the concept of JSON.
5. To understand how to Visualization.

Course Outcomes

1. After studied unit-1, the student will be able to write simple Python programs gives basic knowledge.
2. After studied unit-2, the student will be able to understand Multithreading
3. After studied unit-3, the student will be able to create email.
4. After studied unit-4, the student will be able to understand JSON.
5. After studied unit-5, the student will be able to visualization.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

LIST OF PRACTICAL EXERCISES

1. Write a program using generator function.
2. How to call same function with decorator and without decorator.
3. Create Thread using Threading Module.
4. Multi-Threading Priority Queue
5. Implement a program using Socket.
6. Implement a program using Urllib
7. Sending Email
8. Construct an XML formatted data and Write Python Program to Parse that XML data.
9. Construct a JSON formatted data and Write Python Program to Parse that XML data.
10. Accessing Array index using NumPy
11. Aggregation function using NumPy.
12. Implement
    - Matplotlib
    - Seaborn
    - SciPy

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods

may be implemented in the practices and report can be written for documentation, further discussion and research.

l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: IV **Paper type: Allied II – Paper 4**

Paper code: Name of the Paper: Statistical Methods And Their Applications II **Credit: 3**

Total Hours per Week: 4 Hrs. **Lecture Hours: 52 Hrs.Tutorial Hours: ….. Practical Hours: …..**

……

Course Objectives

1.
2.
3.
4.
5.

Course Outcomes

1.
2.
3.
4.
5.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: **Teaching Hours: 11 Hrs.**

Curve fitting by the methods of least squares -

$Y = a x + b$, $Y = a x^2 + b x + c$, $Y = a x^b$, $Y = a e^{bx}$ and $Y = ab^x$

.

Unit-2: **Teaching Hours: 11 Hrs.**

Sample Space - events - probability - Addition and Multiplication Theorem - conditional probability -Baye's Theorem. Mathematical expectation Addition and Multiplication theorem, Chebychev's Inequality.

Unit-3: **Teaching Hours: 10 Hrs.**

Standard distributions - Binomial, Poisson, Normal distribution and fitting of thesedistributions.

Unit-4: **Teaching Hours: 10 Hrs.**

Test of Significance- small sample and large sample test based on mean, S.D. correlation and proportion - confidence interval.

Unit-5: **Teaching Hours: 10 Hrs.**

Analysis of variance - One and Two way classifications - Basic principle of design of Experiments - Randomisation, Replication and Local control - C.R.D., R.B.D. and L.S.D.

Internal Assessment Methods: (The following items may be brought under test, seminar andassignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the coursestudy for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can begiven by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adoptedby the

departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Text books:

Reference Books:

1. Fundamental of Mathematical Statistics - S.C. Gupta & V.K. Kapoor - Sultan Chand
2. Fundamental of Applied Statistics - S.C. Gupta & V.K. Kapoor – Sultan Chand
3. Statistical Methods - Snedecor G.W. & Cochran W.G. oxford & +DII
4. Elements of Statistics - Mode . E.B. – Prentice Hall

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: IV Paper type: Non Major Elective – Paper 2

Paper code: Name of the Paper: Internet Technology Credit: 2 Total

Hours per Week: 2 Hrs. Lecture Hours: 26 Hrs. Tutorial Hours:.. Practical Hours: …..

……

Course Objectives

1. Aims to build the concepts regarding Fundamentals of Internet, Connectivity and its Resource Requirements.
2. To understand the Internet Technology and its applications
3. To Understand WWW and Web Browsers.
4. To Understand Mailing system and applications of Internet.
5. To Understand relay chat

Course Outcomes

1. After studied unit-1, the student will be able to understand the Fundamentals of Internet, Connectivity and its Resource Requirements.

2. After studied unit-2, the student will be able to understand the Internet Technology and its applications

3. After studied unit-3, the student will be able to understand the basis of WWW and Web Browsers.

4. After studied unit-4, the student will be able to learn how to Mailing system and applications of Internet.

5. After studied unit-5, the student will be able to Understand relay chat that is how to read e-contents.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: **Teaching Hours: 5 Hrs.**

Introduction to internet: What is Internet? Evolution and History of Internet- Growth of Internet-Owners of Internet- Internet Services- How does the Internet Works?-Anatomy of Internet-Internet Addressing-Internet vs Intranet-Impact of Internet- Governance of Internet.

Unit-2: **Teaching Hours: 5 Hrs.**

Internet Technology and Protocol: ISO-OSI Reference Model**-Internet Connectivity:** Getting Connected- Different Types of Connections- Levels of Internet Connectivity- Internet Service Provider. **Internet Tools and Multimedia:** Current Trends on Internet-Multimedia and Animation.

Unit-3: **Teaching Hours: 5 Hrs.**

WWW and Web Browser: WWW-Evolution of Web-Basic Elements of WWW-Web Browsers- Search Engines- Search Criteria. **Web Publishing:** Web Publishing- Web Page Design.

Unit-4: **Teaching Hours: 5 Hrs.**

Email: E-Mail Basics- E-Mail System-E-Mail Protocol-E-Mail Addresses-Structure of an E-Mail Message-E-Mail Clients&Servers-MailingList-E-MailSecurity.

Unit-5: **Teaching Hours: 6 Hrs.**

Usenet and Internet Relay Chat: What is Usenet?-Newsgroup Hierarchies-What is a Newsreader?- How do you Read Newsgroups?- Who Administers Usenet?- Common News reading Tasks- How to Read Articles from Network News?- Relationship between Netnews and E-Mail-What is IRC?-Channels-Nicknames- Microsoft NetMeeting. **Internet and Web Security**: Overview of Internet Security-Aspects and Need of Security-E-Mail Threats and Secure E-mail-Web Security and Privacy Concepts-Firewall.

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.

f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Text book:

1. ISRD Group. 2012. **Internet Technology and Web Design.** [Fourth reprint]. Tata McGraw-Hill Education Private Limited., New Delhi.

Reference Books:

1. Deitel,H.M Dietel,P.J.andGoldbergA.B.2008.**Internet&Worldwide Web- How toProgram.**[Third Edition].PHL,New Delhi.
2. Comdex.2000.**Teachyourselfcomputersandtheinternetvisually**.[First Edition]. IDGBookIndia (p)Ltd.
2. Ramachandran,T.M.Nambissan.2003.**AnOverviewofinternetandweb development**. [FirstEdition].T M-Dhruv Publications.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: V **Paper type: Core Theory – Paper 5**

Paper code: **Name of the Paper: Relational Database System** **Credit: 4**

Total Hours per Week:6 Hrs. Lecture Hours: 78 Hrs. Tutorial Hours: ….. Practical Hours: …..

……

Course Objectives

1. Gain a good understanding of the architecture and functioning of Database Management Systems as well as associated tools and techniques.
2. Understand and apply the principles of data modelling using Entity Relationship and develop a good database design.
3. Understand the use of Structured Query Language (SQL) and its syntax.
4. Apply Normalization techniques to normalize a database.
5. Understand the need of transaction processing and learn techniques for controlling the consequences of concurrent data access.

Course Outcomes

1. After studied Unit I, the student is able to understand the database archiotecture and ER modeling.
2. After studied Unit II, the student understands the need for the relational model.
3. After studied Unit III, the student will understand the insights of normalization.
4. After studied Unit IV, the student knows about storage and file organization.
5. After studied Unit V, the student understands the essential information regarding query processing and transaction management.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT- I : DATABASE ARCHITECTURE AND ER DIAGRAM Teaching Hours: 16 Hrs

Database system applications - Purpose of database systems - View of data- Database languages - Database architecture - Database users and administrators - History of database systems-Entity relationship modeling: entity types, entity set, attribute and key, relationships, relation types, roles and structural constraints, weak entities, enhanced E-R and object modeling, sub classes; super classes, inheritance, specialization and generalization

UNIT- II: RELATIONAL DATA MODEL **Teaching Hours: 16 Hrs**

Relational model concepts, Relational constraints, Relational Languages : Relational Algebra, The Tuple Relational Calculus - The Domain Relational Calculus - SQL: Basic Structure-Set Operations- Aggregate Functions-Null Value-Nested Sub Queries-Views Complex QueriesModification Of Database-Joined Relations-DDL-Embedded SQL-Dynamic SQL-Other SQL Functions- -Integrity and Security.

UNIT - III: DATA NORMALIZATION **Teaching Hours: 15 Hrs**

Pitfalls in relational database design – Decomposition – Functional dependencies – Normalization – First normal form – Second normal form – Third normal form – Boyce-codd normal form – Fourth normal form – Fifth normal form.

UNIT- IV: STORAGE AND FILE ORGANIZATION **Teaching Hours: 15 Hrs**

Disks - RAID -Tertiary storage - Storage Access -File Organization – organization of files – Data Dictionary storage

UNIT- V: QUERY PROCESSING AND TRANSACTION MANAGEMENT **Teaching Hours: 16 Hrs**

Query Processing - Transaction Concept - Concurrency Control - Locks based protocol

Deadlock Handling -Recovery Systems.

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

TEXT BOOK:

1. Abraham Silberschatz, Henry Korth, S.Sudarshan, Database Systems Concepts, Sixth Edition, McGraw Hill, 2010. 2. Raghu Ramakrishnan and Johannes Gehrke, Database management systems, Third Edition,2002

REFERENCES:

1. Bipin Desai, An Introduction to database systems, Galgotia Publications, 2010. 2. Ramez Elamassri, Shankant B-Navathe, Fundamentals of Database Systems, Pearson, 7th Edition, 2015

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: V **Paper type: Core Theory – Paper 6**

Paper code: **Name of the Paper: Data Visualization Techniques** **Credit: 4**

Total Hours per Week: 6 Hrs. Lecture Hours: 78 Hrs. Tutorial Hours: ….. Practical Hours: …..

……

Course Objectives

1. Aims for the use of powerful mediums of visualization.
2. To identify trends, patterns and other hidden elements of the data.
3. Enhances the knowledge in creating visual presentation of their data.
4. Can highlight good and bad designs of data.
5. To have an insight on the steps in adequate visualization of data.

Course Outcomes

1. After studied Unit I, the student is able to understand the philosophy behind data visualization.
2. After studied Unit II, the student understands the need for Tableau I and the various chart types.
3. After studied Unit III, the student will understand the insights of Tableau II.
4. After studied Unit IV, the student gets a glimpse on various case studies.
5. After studied Unit V, the student understands the essential information regarding some of the statistical applications .

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT I: Data Visualization Philosophy **Teaching Hours: 16 Hrs**

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

Teaching Hours: 16 Hrs

UNIT II

Tableau I: Build Charts and Analyze Data, Calculated Fields, custom aggregations, chart types and visualizations, Use parameters and input controls to give users control over certain values using filters, highlighters. **Chart Types**: Line chart, Bar chart, Histogram, Scatterplot, Boxplot, Pareto chart, Pie chart, Area chart, Control chart , Run chart, Stem-and-leaf display, Cartogram, Sparkline, Box Whisker Plot, Spider Plot

UNIT III **Teaching Hours: 16 Hrs**

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

UNIT IV **Teaching Hours: 15 Hrs**

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

UNIT V **Teaching Hours: 15 Hrs**

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

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

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.

- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

TEXT BOOKS:

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

REFERENCE BOOKS:

1. "Information Dashboard Design: Displaying Data for At-a-glance Monitoring" by Stephen Few
2. "Beautiful Visualization, Looking at Data Through the Eyes of Experts by Julie Steele, Noah Iliinsky"
3. "The Visual Display of Quantitative Information" by Edward R.Tufte
4. "The Accidental Analyst: Show Your Data Who's Boss" by Eileen and Stephen McDaniel

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: V **Paper type: Core Theory – Paper 7**

Paper code: Name of the Paper: Natural Language Processing **Credit: 3**

Total Hours per Week: 4 Hrs. **Lecture Hours: 52 Hrs. Tutorial Hours:.... Practical Hours: …..**

……

Course Objectives

1. Teach students the fundamentals of deep learning methods for natural language processing (NLP).

2. Will instill practical skills for implementing basis deep learning-based NLP systems.

3. Able to convert text into vectorized representations.

4. Able to apply deep learning-based algorithms to the representations.

5. Will be able to understand from a functional perspective current literature on deep learning-based NLP.

Course Outcomes

1. After studied Unit I, the student is able to understand the basic concepts of corpus.
2. After studied Unit II, the student understands the need for corpus annotation and speech processing.
3. After studied Unit III, the student will understand the insights of Morphology.
4. After studied Unit IV, the student knows about Syntax Sphere.
5. After studied Unit V, the student understands the essential informatiotion on Automata and Grammars.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT I: **Teaching Hours: 11 Hrs**

The concept of a corpus-Corpus taxonomy –Written versus spoken – The historical point of view– The language of corpora – Who collects and distributes corpora? – The Gutenberg project – The Linguistic Data Consortium – The Lifecycle of a Corpus –Needs analysis – Design of Scenarios to collect data for the Corpus – Collection of the Corpus – Transcription.

UNIT II: **Teaching Hours: 11 Hr**

Corpus Annotation –Corpus Documentation –Statistical analysis of data – The Use of Corpora in NLP – Examples of Existing Corpora –The Sphere of Speech – Linguistic Studies of Speech – Phonetics – Phonology – Speech Processing – Automatic Speech Recognition – Speech Synthesis.

UNIT III: **Teaching Hours: 10 Hrs**

Morphology Sphere – Elements of Morphology – Morphological typology – Morphology of English – Parts of Speech – Terms, Collocations and Colligations – Automatic Morphological Analysis – Stemming – Regular Expressions for Morphological Analysis – Informal Introduction to finite state machines – Two level Mrphology and FST – Part-of-Speech Tagging.

UNIT IV: **Teaching Hours: 10 Hrs**

Syntax Sphere – Basic Syntactic Concepts – Delimitation of the field of Syntax – the Concept of Grammaticality – Syntactic Constituents – Syntactic typology of typology and agreement–Syntactic ambiguity – Syntactic specificities of spontaneous oral Language – Elements of Formal Syntax – Syntax Trees and Rewrite Rules – Languages and Formal Grammars – Hierarchy of Languages – Feature structures and Unification – Definite Clause Grammar.

UNIT V: **Teaching Hours: 10 Hrs**

Syntactic Formalisms – X-bar – Head-driven Phrase Structure Grammar –Lexicalized Tree-adjoining Grammar – Automatic Parsing –Finite-State Automata – Recursive Transition Networks – Top-Down Approach – Bottom-Up Approach – Mixed Approach – Tabular Parsing – Probablistic Parsing – Neural Networks – Parsing algorithms for Unification-based grammars – Robust Parsing Approaches – Generation Algorithms.

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

TEXT BOOKS:

1. Natural Language Processing and Computational Linguistics 1, Speech, Morphology and Syntax, Mohamed Zakaria Kurdi, Wiley Publications, 2016.

REFERENCE BOOKS:

1. Natural Language Processing with python, Steven Bird, Ewan Lein, Edward Loper, 2009, O Reilly Media.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: V **Paper type: Core Practical –5**

Paper code: **Name of the Paper: Relational Database Management System Lab** **Credit: 3**

Total Hours per Week:4 Hrs. Lecture Hours: ….. Tutorial Hours:….. Practical Hours: 52 Hrs.

……

Course Objectives

1. Gain a good understanding of the architecture and functioning of Database Management Systems as well as associated tools and techniques.
2. Understand and apply the principles of data modelling using Entity Relationship and develop a good database design.
3. Understand the use of Structured Query Language (SQL) and its syntax.
4. Apply Normalization techniques to normalize a database.
5. Understand the need of transaction processing and learn techniques for controlling the consequences of concurrent data access.

Course Outcomes

1. To understand the database architecture and ER modeling.
2. Understands the need for the relational model.
3. To understand the insights of normalization.
4. Knows about storage and file organization.
5. Understands the essential information regarding query processing and transaction management.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

LAB EXERCISES:

1. Execute a single line query and group functions.
2. Execute DDL Commands.
3. Execute DML Commands
4. Execute DCL and TCL Commands.
5. Implement the Nested Queries.

6. Implement Join operations in SQL

7. Create views for a particular table

8. Implement Locks for a particular table.

9. Write PL/SQL procedure for an application using exception handling.

10. Write PL/SQL procedure for an application using cursors.

11. Write a PL/SQL procedure for an application using functions

12. Write a PL/SQL procedure for an application using package

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: V **Paper type: Core Practical –6**

Paper code: **Name of the Paper: Data Visualization Technique Lab** **Credit: 3**

Total Hours per Week:4 Hrs. Lecture Hours: ….. Tutorial Hours: ….. Practical Hours: 52 Hrs.

……

Course Objectives

1. Aims for the use of powerful mediums of visualization.
2. To identify trends, patterns and other hidden elements of the data.
3. Enhances the knowledge in creating visual presentation of their data.
4. Can highlight good and bad designs of data.
5. To have an insight on the steps in adequate visualization of data.

Course Outcomes

1. The student is able to understand the philosophy behind data visualization.
2. The student understands the need for Tableau I and the various chart types.
3. The student will understand the insights of Tableau II.
4. The student gets a glimpse on various case studies.
5. The student understands the essential information regarding some of the statistical applications .

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

LIST OF PRACTICAL EXERCISE

1. Implement Chart Types.
2. Implement Filters and Highlighters.
3. Demonstrate grasp of Tableau Tool.
4. Design a map for a Township or Institution
5. Create a Dashboard for a self-created dataset which includes calculated fields and aggregate bins
6. Statistical Analysis of existing dataset
7. Create a KPI for an existing dataset, Visualize key aspects

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: V **Paper type: Elective – Paper 1**

Paper code: **Name of the Paper: Tensor Flow** **Credit: 3**

Total Hours per Week: 3 Hrs. Lecture Hours: 39 Hrs. Tutorial Hours: ….. Practical Hours: …..

……

Course Objectives

1. Create machine learning models in TensorFlow.
2. Use the TensorFlow libraries to solve numerical problems.
3. Troubleshoot and debug common TensorFlow code pitfalls.
4. To create, train, and evaluate an ML mode
5. Find a good, generalizable solution using gradient descent and a thoughtful way of creating datasets.

Course Outcomes

1. After studied Unit I, the student is able to understand the basic concepts of tensorflow.
2. After studied Unit II, the student understands the need for Linear and Logistic regression.
3. After studied Unit III, the student will understand the insights of variablr sharing and managing experiments.
4. After studied Unit IV, the student knows about convnet.
5. After studied Unit V, the student understands the essential information regarding the seq2seq with attention.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT I: **Teaching Hours: 8 Hrs**

Introduction: Overview of Tensorflow: Why Tensorflow? Graphs and Sessions. Operations: Basic operations, constants, variables, Control dependencies, Data pipeline, TensorBoard.

UNIT II: **Teaching Hours: 8 Hrs**

Linear and Logistic Regression: TensorFlow's Optimizers, tf.data - Example: Birth rate - life expectancy, MNIST dataset. Eager execution: Example: word2vec, linear regression

UNIT III: **Teaching Hours: 8 Hrs**

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

UNIT IV: **Teaching Hours: 7 Hrs**

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

UNIT V: **Teaching Hours: 8 Hrs**

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

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: V **Paper type: Skill Based Subject – Paper 3**

Paper code: **Name of the Paper: Machine Learning** **Credit: 2**

Total Hours per Week: 3 Hrs. **Lecture Hours: 39 Hrs. Tutorial Hours: ….. Practical Hours: …..**

……

Course Objectives

1. To discover patterns in the user data
2. Make predictions based on the discovered patterns.
3. Intricate patterns for answering business questions and solving business problems.
4. Helps in analysing the data as well as identifying trends.
5. Identify the common types of machine learning tasks.

Course Outcomes

1. After studied Unit I, the student is able to understand the basic concepts of machine learning.
2. After studied Unit II, the student understands the need for supervised learning.
3. After studied Unit III, the student will understand the insights of unsupervised learning and preprocessing.
4. After studied Unit IV, the student knows about dimensionality reduction and feature extraction.
5. After studied Unit V, the student understands the essential information regarding data representation and engineering features.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	No	Yes	No	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	No	No	Yes	No

UNIT I: INTRODUCTION TO MACHINE LEARNING **Teaching Hours: 8 Hrs**

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

UNIT II: SUPERVISED LEARNING **Teaching Hours: 8 Hrs**

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

UNIT III: UNSUPERVISED LEARNING AND PREPROCESSING: **Teaching Hours: 7 Hrs**

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

UNIT IV: DIMENSIONALITY REDUCTION, FEATURE EXTRACTION, AND MANIFOLD LEARNING **Teaching Hours: 8 Hrs**

Principal Component Analysis (PCA), Non-Negative Matrix Factorization (NMF), Manifold Learning with t-SNE , Clustering: k-Means Clustering, Agglomerative Clustering, DBSCAN, Comparing and Evaluating Clustering Algorithms, Summary of Clustering Methods.

UNIT V: REPRESENTING DATA AND ENGINEERING FEATURES: **Teaching Hours: 8 Hrs**

Categorical Variables: One- Hot-Encoding (Dummy Variables), Numbers Can Encode Categorical, Binning, Discretization, Linear Models, and Trees , Automatic Feature Selection : Univariate Statistics, Model-Based Feature Selection, Iterative Feature Selection, Utilizing Expert Knowledge .

Internal Assessment Methods:

- Book review and research paper review, syllabus and curriculum review.
- Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
- Workshops, preparing technical term dictionaries from text books and reference books.
- Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
- Forming digital library: collecting text and reference books, course material.
- Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

- Extracurricular and cultural activities may be framed through the syllabus content.
- Grouping students for self discussion, self learning process.
- Following institution and intellectual and writing reports in the course field.
- Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.

For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

Text Books

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

Reference Books

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

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: VI **Paper type: Core Theory – Paper 8**

Paper code: **Name of the Paper: Big Data Analytics** **Credit: 4**

Total Hours per Week: 4 Hrs. Lecture Hours: 52 Hrs. Tutorial Hours:. Practical Hours: …..

……

Course Objectives

1. To understand basic concept of big data.
2. To understand data storage concept in big data.
3. To understand basic concept of HADOOP
4. To understand the basic concepts of Map reduce
5. To understand how to store a data in big data and Techniques.

Course Outcomes

1. After studied unit-1, the student will be able to understand the concepts of big data
2. After studied unit-2, the student will be able to understand the concepts of data storage in big data.
3. After studied unit-3, the student will be able to understand the concepts of Hadoop
4. After studied unit-4, the student will be able to understand the concepts of Map reduce.
5. After studied unit-5, the student will be able to understand the concepts of Storage of data with techniques

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I: INTRODUCTION TO BIG DATA: Teaching Hours: 11 Hrs

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

UNIT II: BIG DATA STORAGE CONCEPTS Teaching Hours: 11 Hrs

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

UNIT III: INTRODUCTION TO HADOOP Teaching Hours: 10 Hrs

Features – Advantages – Versions. Overview of Hadoop Ecosystem - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL – RDBMS vs Hadoop – Hadoop Distributed File System –HDFS Architecture – Features of HDFS – Hadoop Yarn – Hbase – Hive –Sqoop – ZooKeeper – Flume –Oozie.

UNIT IV: UNDERSTANDING MAP REDUCE FUNDAMENTALS Teaching Hours: 10 Hrs

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

UNIT V BIG DATA STORAGE TECHNOLOGY Teaching Hours: 10 Hrs

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

Internal Assessment Methods: (The following items may be brought under test, seminar andassignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be

adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.

l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Chandrakant Naikodi, "Managing Big Data", Vikas Publishing, 2015
2. Michael Frampton, "Big Data Made Easy: A Working Guide to the Complete HadoopToolset", Apress, 2014
3. Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.
4. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", CUP, 2012.
5. Arshdeep Bahga, Vijay Madisetti, "Big Data Science & Analytics: A HandsOn Approach ",VPT, 2016
6. Thomas Erl ,"Big Data Fundamentals Concepts, Drivers and Techniques", Pearson
7. Education First Edition,2016
8. Vijay Srinivas Agneeswaran, "Big Data Analytics beyond HADOOP", Pearson Education(2015)

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: VI **Paper type: Core Theory– Paper 9**

Paper code: **Name of the Paper: R for Analyticals** **Credit: 4**

Total Hours per Week: 4 Hrs. **Lecture Hours: 52 Hrs. Tutorial Hours: ….. Practical Hours: …..**

……

Course Objectives

1. To understand basic R programming and its preliminary.
2. To understand concept of list and data frames.
3. To understand the concept of Univariate and Bivariate Data
4. To understand the basic concepts of Multivalued data.
5. To understand the concept of correlations.

Course Outcomes

1. After studied unit-1, the student will be able to understand the concepts R programming
2. After studied unit-2, the student will be able to understand the concepts of data frames
3. After studied unit-3, the student will be able to understand the concepts of univariate and bivariate data.
4. After studied unit-4, the student will be able to understand the concepts of multivalued data.
5. After studied unit-5, the student will be able to understand the concepts of correlations.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I **Teaching Hours: 11 Hrs**

Introduction and Preliminaries – The R Environment, R and statistics, R Commands, Data permanency and removing objects, Simple manipulations, Numbers and Vectors, Objects- modes and attributes, Ordered and unordered Factors, Arrays and Matrices

UNIT II **Teaching Hours: 11 Hrs**

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

UNIT III **Teaching Hours: 10 Hrs**

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

UNIT IV **Teaching Hours: 10 Hrs**

Data Exploration for Multivariate Data-Multivariate Data -Storing multivariate data in R data frames, Accessing and manipulating data in R data frames, view multivariate data, apply( ) family functions - apply( ), sapply(), lapply( ), tapply( ), dplyr package- select( ), filter( ), arrange( ), rename( ), mutate( ), group_by( ), %>%, summarize( ).

UNIT V **Teaching Hours: 10 Hrs**

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

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.

j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

TEXT BOOKS:

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

2. John Verzani, simpleR – Using R for Introductory Statistics, CRC Press, Taylor & Francis Group, 2005.

REFERENCE BOOKS:

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

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: VI **Paper type: Core – Practical -7**

Paper code: **Name of the Paper: Big Data Analytical Lab** **Credit: 3**

Total Hours per Week: 4 Hrs. Lecture Hours:.. Tutorial Hours: ….. Practical Hours: 52 Hrs.

……

Course Objectives

1. To understand basic concept of big data,
2. To understand concept of Hadoop file system
3. To understand to write word count using map reduce.
4. To understand the basic concept finding min and max values.
5. To understand the basic concept of MongoDB

Course Outcomes

1. The student will be able to understand the concepts of big data
2. The student will be able to understand the concepts of Hadoop file system.
3. The student will be able to understand the concepts of simple programs.
4. The student will be able to understand the concepts of min and max values.
5. The student will be able to understand the concepts of MongoDB.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

LIST OF PRACTICAL EXCERCISES

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

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

i. Book review and research paper review, syllabus and curriculum review.
ii. Data collection and paper writing practices: books level, field study level. Using the coursestudy for society and nature development – exercise
iii. Workshops, preparing technical term dictionaries from text books and reference books.
iv. Preparing question paper by the candidates: objective type, descriptive type, training can begiven by the teacher
v. Forming digital library: collecting text and reference books, course material.
vi. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
vii. Extracurricular and cultural activities may be framed through the syllabus content.
viii. Grouping students for self discussion, self learning process.
ix. Following institution and intellectual and writing reports in the course field.
x. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
xi. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
xii. Extracurricular activities may be framed through their syllabus content.
xiii. Bring the industries to the campus. Bring the students to the industry.
xiv. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: VI **Paper type: Core - Practical - 8**

Paper code: **Name of the Paper: R for Analytical Lab** **Credit: 2**

Total Hours per Week: 4 Hrs. Lecture Hours: ….. Tutorial Hours: .. Practical Hours: 52 Hrs.

……

Course Objectives

1. To understand basic techniques of Numbers and vectors
2. To understand concept of Array and matrices.
3. To understand basic concept of categorical and numerical data.
4. To understand the usage of dplyr pacakages.
5. To understand the concept of correlations.

Course Outcomes

1. The student will be able to understand the concepts Numbers and vectors
2. The student will be able to understand the concepts of arrays and matrices
3. The student will be able to understand the concepts of categorical and numerical data.
4. The student will be able to understand the concepts of dplyr pacakages.
5. The student will be able to understand the concepts of correlations.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

LIST OF PRACTICAL EXCERCISES

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

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation,

further discussion and research.

l. Extracurricular activities may be framed through their syllabus content.

m. Bring the industries to the campus. Bring the students to the industry.

n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: VI **Paper type: Elective – Paper 2**

Paper code: **Name of the Paper: Artificial Intelligence** **Credit: 3**

Total Hours per Week: 3 Hrs. Lecture Hours: 39 Hrs. Tutorial Hours: ….. Practical Hours: …..

……

Course Objectives

1. To understand basics of artificial neural network.
2. To understand basics of problem solving methods.
3. To understand and develop objects and reasoning in AI
4. To understand the basic concepts of fuzzy logic.
5. To understand the concepts of speech recognition.

Course Outcomes

1. After studied unit-1, the student will be able to understand the concepts of artificial neural network
2. After studied unit-2, the student will be able to understand the concepts of problem solving methods
3. After studied unit-3, the student will be able to understand the objects and reasoning in AI.
4. After studied unit-4, the student will be able to understand the concepts of fuzzy logic.
5. After studied unit-5, the student will be able to understand the concepts of speech recognition.

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I: INTRODUCTION TO ARTIFICIAL INTELLIGENCE: Teaching Hours: 8 Hrs

History of AI – Artificial Narrow Intelligence (ANI) – Artificial General Intelligence (AGI) – Artificial Super Intelligence (ASI) – Characteristics – Types of AI – Domains – Programming Languages of AI – Applications of AI – Future of AI.

UNIT II: AI – PROBLEM SOLVING METHODS: Teaching Hours: 8 Hrs

Problem solving Methods – Search Strategies: Uninformed – Informed – Heuristics – Generate and test – hill climbing – Best first search – problem reduction – Local Search Algorithms and Optimization – Game Playing mini–max procedure – Optimal Decisions in Games – Alpha – Beta Pruning – Stochastic Games

UNIT III: AI – KNOWLEDGE REPRESENTATION: Teaching Hours: 8 Hrs

Procedural Versus declarative knowledge – logic programming – Forward Versus backward reasoning – Matching – Control knowledge – Ontological Engineering– Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories –Reasoning with Default Information.

UNIT IV: STATISTICAL REASONING AND AGENTS: Teaching Hours: 8 Hrs

Probability and Bayes Theorem – Certainty factors – Probabilistic Graphical Models – Bayesian Networks – Markov Networks – Fuzzy Logic. Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi–agent systems.

UNIT V: MACHINE LEARNING AND APPLICATIONS Teaching Hours: 7 Hrs

Types of Machine Learning – Neural Networks – Deep Learning – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving.

Internal Assessment Methods: (The following items may be brought under test, seminar andassignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher
e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within

the framework of question setting pattern and internal assessment pattern.

k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

TEXT BOOKS:

1. "Artificial Intelligence", Elaine Rich, Kevin Knight, Tata McGraw Hill, II Edition.
2. "Artificial Intelligence: A Modern Approach," Stuart Russell, Peter Norvig, Third Edition, Prentice Hall of India, New Delhi, 2010.
3. "Prolog: Programming for Artificial Intelligence", I.Bratko, Addison – Wesley Educational Publishers Inc., Fourth edition 2011.

REFERENCES:

1. "Machine Learning for Beginners 2019", Matt Henderson, This is Charlotte,2019
2. "Introduction to Artificial Intelligence and Expert Systems", Dan W. Patterson, Pearson, 2015

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
(Bachelor of Data Science) – 2022-2023 onwards

Semester: VI **Paper type: Elective – Paper 3**

Paper code: **Name of the Paper: Operating System** **Credit: 3**

Total Hours per Week: 3 Hrs. Lecture Hours:39 Hrs. Tutorial Hours: ….. Practical Hours: …..

……

Course Objectives

1. To understand the structure and functions of operating systems.

2. To understand the principles of scheduler, scheduler algorithms and Deadlock.

3. To learn various memory management schemes.

4. To study I/O management, File system and Mass Storage Structure .

5. To learn the basics of UNIX, LINUX systems and perform administrative tasks on LINUX servers.

Course Outcomes

1. After studied unit-1, the student will be able to learn operating system structure and services.

2. After studied unit-2, the student will be able to Enrich the process scheduling skills.

3. After studied unit-3, the student will be able to know about memory allocation.

4. After studied unit-4, the student will be able to understand disk structure and allocation methods.

5. After studied unit-5, the student will be able to understand LINUX system.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	No	No	No	No	No	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: OPERATING SYSTEM BASICS **Teaching Hours: 7 Hrs.**

Basic Concepts of Operating System – Services of Operating System – Operating System Types – Computer System Operation – I/O Structure – Storage Structure – Memory Hierarchy – System Components – System Calls – System Programs – System Design and Implementation – Introduction to Process – Process State – Process Control Block – Process Scheduling – Operations on Process – Interprocess Communication – Communication in Client/Server Systems – Threads.

Unit-2: CPU SCHEDULING ALGORITHM AND PREVENTION **Teaching Hours: 8 Hrs.**

Introduction –Types of CPU Scheduler – Scheduling Criteria – Scheduling Algorithms – Semaphores – Classic Problems of Synchronization – Basic Concept of Deadlocks – Deadlock Characterization – Deadlock Prevention – Deadlock Avoidance – Deadlock Detection – Recovery of Deadlock.

Unit-3: STORAGE MANAGEMENT **Teaching Hours: 8 Hrs.**

Memory Management – Basics Concept of Memory – Address Binding – Logical and Physical Address Space – Memory Partitioning – Memory Allocation – Paging – Segmentation – Segmentation and Paging – Protection – Fragmentation – Compaction – Demand Paging – Page Replacement Algorithm – Classification of Page Replacement Algorithm .

Unit-4: I/O SYSTEMS **Teaching Hours: 8 Hrs.**

File System Storage – File Concept– File Access Methods – Directory Structure – File Sharing – File Protection – File System Implementation – File System Structure – Allocation Methods – Free Space Management – Mass Storage Structure – Disk structure – Disk Scheduling and Management – RAID Levels.

Unit-5: CASE STUDIES **Teaching Hours: 8 Hrs.**

UNIX System – A Case Study – LINUX System – Case Study – Design Principles – Process Management – Scheduling – Memory Management – File Systems – Security

Internal Assessment Methods: (The following items may be brought under test, seminar and assignment framework)

a. Book review and research paper review, syllabus and curriculum review.
b. Data collection and paper writing practices: books level, field study level. Using the course study for society and nature development – exercise
c. Workshops, preparing technical term dictionaries from text books and reference books.
d. Preparing question paper by the candidates: objective type, descriptive type, training can be given by the teacher

e. Forming digital library: collecting text and reference books, course material.
f. Villages, institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
g. Extracurricular and cultural activities may be framed through the syllabus content.
h. Grouping students for self discussion, self learning process.
i. Following institution and intellectual and writing reports in the course field.
j. Bloom Taxonomy may be introduced for teaching, learning and evaluation process within the framework of question setting pattern and internal assessment pattern.
k. For application oriented study: Villages, Institutions, various people groups may be adopted by the departments of the colleges for practicing their theoretical study. Innovative methods may be implemented in the practices and report can be written for documentation, further discussion and research.
l. Extracurricular activities may be framed through their syllabus content.
m. Bring the industries to the campus. Bring the students to the industry.
n. Ph.D. Research Methodology is applicable to write project report and any kind of research reports like assignment, seminar papers, case study reports, etc.

Text book:

1. "Operating System Concepts" –Abraham Silberschatz Peter B. Galvin, G. Gagne, Sixth Edition, Addison Wesley Publishing Co., 2003.

2. "Operating System" – William Stalling, Fourth Edition, Pearson Education,2003

Reference Book:

1. "Operating systems – Internals and Design Principles", W. Stallings, 6th Edition, Pearson.
2. "Modern Operating Systems", Andrew S.Tanenbaum, Second Edition, Addison Wesley Publishing Co., 2001.
3. "Fundamentals of Operating System", Prof. R. Sriddhar, Dynaram Publication, Bangalore Company.

Mapping with Programme Outcomes

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

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low (may be avoided)

****