B.Sc.,
COMPUTER SCIENCE
WITH
ARTIFICIAL INTELLIGENCE

SYLLABUS

FROM THE ACADEMIC YEAR
2025 – 2026

1. Introduction

B.Sc. Computer Science with Artificial Intelligence

Artificial Intelligence is a hot core field that is rapidly growing in the fast-changing world and powering for great industrial revolution. The world workforce has changed the way the business grows without affecting humanity. A software giant predicted that around 75 million conventional jobs may disappear while 130 million jobs created during the revolution of AI. It is estimated that by 2025, 30% of the jobs will end-up unfilled due to required skills shortage.

Many organizations already face a shortage of skilled talents across different verticals. Technical jobs increasingly require technology skills, organizations have begun to search for skilled persons with specialized skills such as data scientists, robotics experts and AI engineers and block chain developers etc.

The course is designed to bridge the gap between IT industries and academic institutes by incorporating the latest Artificial Intelligence technologies into the curriculum and to give students a complete understanding within a structured framework. The curriculum supports students to gain adequate knowledge in advanced programming as well as Artificial Intelligence practices along with theoretical foundation and also includes interdisciplinary courses and electives for widening the domain expertise. State-of-the-art infrastructure provides an excellent learning environment to hone the knowledge of each student.

The course provides a strong foundations in fundamentals of computer science with the knowledge of AI for employability and/or further studies in Post-graduation. Empower students with competencies in creative thinking, working in virtual domain with AI technique problem solving in virtual domain, inter-personal communication and managerial skills. Facilitate overall understanding of technological development with legal and ethical issues. Equip the students in providing professional solutions to next generation solutions using AI techniques and adopting Virtual Reality concepts.

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**B.Sc., Computer Science with Artificial Intelligence**
Duration:	**3 years [UG]**
Programme Outcomes:	**PO1: Disciplinary knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study** **PO2: Communication Skills: Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.** **PO3: Critical thinking: Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.** **PO4: Problem solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.** **PO5: Analytical reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.** **PO6: Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation** **PO7: Cooperation/Team work: Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team** **PO8: Scientific reasoning: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically**

	evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.** **PO10 Information/digital literacy: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.** **PO 11 Self-directed learning: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.** **PO 12 Multicultural competence: Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.** **PO 13: Moral and ethical awareness/reasoning: Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demon starting the ability to identify ethical issues related to one"s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.** **PO 14: Leadership readiness/qualities: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.** **PO 15: Lifelong learning: Ability to acquire knowledge and skills, including „learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.**
Programme Specific Outcomes:	**PSO1: Think in a critical and logical based manner** **PSO2: Familiarize the students with suitable software tools of Computer Science, Information Technology and industrial applications** **PSO3: Understand, formulate, develop programming model with logical approaches to address issues arising in social science, business and other contexts.**

	PSO 4: Provide students/learners sufficient knowledge and skills enabling them to undertake further studies in Computer Science or Applications or Information Technology and its allied areas on multiple disciplines linked with Computer Science. **PSO 5: Equip with Computer Science technical ability, problem solving skills, creative talent and power of communication necessary for various forms of employment.**

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
PSO 1	Y	Y	Y	Y	Y	Y	Y	Y
PSO 2	Y	Y	Y	Y	Y	Y	Y	Y
PSO3	Y	Y	Y	Y	Y	Y	Y	Y
PSO 4	Y	Y	Y	Y	Y	Y	Y	Y
PSO 5	Y	Y	Y	Y	Y	Y	Y	Y

3 – Strong, 2- Medium, 1- Low

Highlights of the Revamped Curriculum:

- **Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.**
- **The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising mathematical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced mathematical topics in the final semester, catering to the needs of stakeholders with research aptitude.**
- **The General Studies and Mathematics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.**
- **The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.**
- **The Industrial Statistics course is newly introduced in the fourth semester, to expose the students to real life problems and train the**

students on designing a mathematical model to provide solutions to the industrial problems.

- **The Internship during the second year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.**
- **Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.**
- **State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest - Artificial Intelligence.**

B.Sc. COMPUTER SCIENCE with ARTIFICIAL INTELLIGENCE

Semester I			
Component	**List of courses**	**Credits**	**No. of Hrs**
Part I	Language – Tamil	3	6
Part II	English	3	6
Part-III	Core Course CC- I C Programming	5	5
Part-III	Core Course CC-II C Programming Laboratory	5	5
Part-III	Elective: Discrete Mathematics	3	4
Part- IV	Skill Enhancement Course SEC – 1 Computer Fundamentals Laboratory	2	2
Part- IV	Fundamentals of Computers	2	2
TOTAL		23	30

Semester II			
Component	**List of courses**	**Credits**	**No. of Hrs**
Part I	Language – Tamil	3	6
Part II	English	3	4
Part III	Core Course CC III Programming in C++	4	5
Part III	Core Course CC IV Programming in C++ Laboratory	4	5
Part III	Elective: Artificial Intelligence & Knowledge Representation	3	4
Part IV	Skill Enhancement Course SEC 2 Data Structures	2	2
Part IV	Skill Enhancement Course SEC 3 Data Structures Laboratory	2	2
	Naan Mudhalvan	2	2
TOTAL		23	30

III	Part I	Tamil	3	6	Tamil
	Part II	English	3	6	English
	Part III	Core	4	4	Python Programming
		Core lab	3	4	Python Programming Laboratory
		Elective	4	4	Optimization Techniques / Graph Theory & its Applications
	Part IV	SEC lab	2	2	Power BI Laboratory
		Skill	2	2	Skill
		VBE/ ES	2	2	VBE/ ES
			23	30	
IV	Part I	Tamil	3	6	Tamil
	Part II	English	3	6	English
	Part III	Core	4	4	Machine Learning
		Core lab	3	4	AI & ML Laboratory
		Elective	4	4	Bio-inspired Computing/ Data Visualization
	Part IV	SEC lab	2	2	Canva Laboratory
		Skill	2	2	Skill
		VBE/ EVS	2	2	VBE/ EVS
			23	30	
V	Part 3	Core 1	4	4	Database Management Systems
		Core 2	4	4	Distributed Operating Systems
		Core 3	4	4	COMPUTER NETWORKS & SECURITY
		Core lab 1	2	4	Database Management Systems Laboratory
		Core Lab 2	2	4	Android App Development Laboratory

		Mini Project	2	4	Mini Project
		Elective	4	4	Cloud Computing/ Deep Learning
	Part 4	SEC	2	2	Skill
		internship	1	---	
			25	30	
VI		Core	4	4	Data Analytics using R
		Core	4	4	Software Engineering
		Core Lab	3	6	Data Analytics using R Laboratory
		Project	3	6	Project
		Elective 1	4	4	Robotics & its Applications / Generative Artificial Intelligence for Data Science
	Part III	Elective 2	4	4	Human Computer Interaction/ Pattern Recognition & Image Analysis
	Part IV	SEC	2	2	Skill
	Part V		1	--	

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
	C PROGRAMMING	CCI	5	-	-	I	5	25	75	100

UNIT	Contents	No. of Hours
I	C Declarations:- Character Set – C tokens – Keywords and Identifiers – Identifiers – Constants – Variables – Data types – Declaration of Variables – Declaration of Storage Class – Assigning Values to Variables – Defining Symbolic Constants Operators and Expressions:- Arithmetic Operators – Relational Operators – Logical Operators – Assignment Operators – Increment and Decrement Operators – Conditional Operator – Bitwise Operators – Special Operators – Arithmetic Expressions – Evaluation of Expressions – Precedence of Arithmetic Expressions. Managing Input and Output Operations:- getchar( ) – putchar( ) – scanf( ) – printf( ).	15
II	Decision Making and Branching: Introduction – Decision Making with IF statement – Simple IF Statement – The IF.. Else Statement – Nesting of IF.Else Statements – ELSE IF Ladder – Switch statement – The? Operator –The GOTO Statement. Decision Making and Looping: Introduction – the WHILE Statement – The DO Statement- FOR Statement –Jumps in Loops	15
III	Arrays: Introduction – One Dimensional Arrays – Declaration of One Dimensional Arrays – Initialization of One Dimensional Arrays-Two Dimensional Arrays – Initializing Two Dimensional Arrays –Multi – Dimensional Arrays Character Arrays and Strings: Introduction – Declaring and Initializing string Variables – Reading strings from Terminal – Writing Strings to screen - Comparison of Two strings – String Handling Functions	15
IV	Function – Elements of User Defined Functions –Definition of Functions – Return values and their types – Function Calls – Function Declaration – Category of Functions – Recursion- Passing Arrays to Functions – Passing Strings to Functions – The Scope, Visibility and Lifetime of Variables	15

	Structure and Unions: Defining a Structure – Declaring Structure Variables - Accessing Structure Members – Unions – Bit Fields.	
V	**Pointers: Understanding Pointers – accessing the Address of a Variable – Declaring Pointer Variables – Initialization of pointer variables – Accessing a variable through its pointer – chain of pointers Expressions – pointer increments and scale Factor – pointers and Arrays – Pointer and Character Strings – Array of pointers – pointers as Function Arguments – Functions Returning pointers –pointers to functions** **File Management in C: Introduction – Defining and Operating a File – Closing a file – Input /output Operations on Files –Error handling During I/O Operations**	**15**
TOTAL HOURS		**75**

Course Outcome		**Programme Outcome**
CO	**On completion of this course, students will**	
CO1	**Describe the procedural paradigm**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO2	**Demonstrate decision making and loop statements**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO3	**Understand pass by value and pass by reference**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO4	**Identify the use of structure and union**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO5	**Explain the various file stream**	**PO1, PO2, PO3, PO4, PO5, PO6**

Textbook

1	**Programming in ANSI C – 6th Edition by E Balagurusamy – Tata McGraw Hill Publishing Company Limited.**

Reference Books

1. Computer System and Programming in C by Manish Varhney, Naha Singh – CBS Publishers and Distributors Pvt Ltd.

2. Introduction to Computer Science, ITL Education Solutions Limited, Second Edition, Pearson Education

3. Computer Basics and C Programming by V. Rajaraman – PHI Learning Private Limited

4. Programming with C, Third Edition, Byron S Gottfried, Tata McGraw Hill Education Private Limited.

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
	C PROGRAMMING LABORATORY	CCI	5	-	-	I	5	50	50	100

1. To find all possible roots of a quadratic equation using if statement
2. Program to check vowel or consonant using switch case statement
3. Evaluate Sine series using while loop

$$\sin(x) = x - x^3 / 3! + x^5 / 5! - \ldots\ldots\ x^n / n!$$

4. Sort a list of numbers in ascending order
5. Search an element in an array
6. Reverse a number
7. Check if the given string is palindrome or not
8. Find the binomial coefficient (nCr) value & gcd using recursion
9. Multiply two matrices (check for compatibility)
10. Transpose of a matrix
11. Find the sum of 'n' numbers by making function call (passing array as argument to function)
12. Alphabetical sorting
13. Exchange values using pointers and function
14. Prepare the student details using structure
15. Prepare mark sheet using file

DISCRETE MATHEMATICS

Subject Code	L	T	P	Semester	Credits	Inst. Hours	Marks		
							CIA	External	Total
	4	0	0	I	3	4	25	75	100

Learning Objectives	
LO1	To get the knowledge about the relations
LO2	To understand the functions and their classifications
LO3	To understand the propositions and normal forms
LO4	To understand the usage of matrix
LO5	To acquire knowledge about the graphs

Prerequisites: Mathematics Fundamentals

Unit	Contents	No. of Hours
I	Introduction to Relations – Binary relation – Classification of Relations – Composition of Relations–Inverse of Relation–Closure operation on Relations–Matrix representation of Relation – digraphs	12
II	Introduction to Functions–Addition and Multiplication of Functions –Classifications of Functions – Composition of Function – Inverse Function	12
III	Introduction – Statement (Propositions) – Laws of Formal Logic –Basic Set of Logical operators/operations-Propositions and Truth Tables–Algebra Propositions-Tautologies and Contradictions – Logical Equivalence – Logical Implication – Normal Forms.	12
IV	Definition of a Matrix –Types of Matrices– Operations on Matrices – Related Matrices–Transpose of a Matrix–Symmetric and Skew-symmetric Matrices – Complex Matrix–Conjugate of a Matrix– Determinant of a Matrix– Typical Square Matrices–Adjoint and Inverse of a Matrix – Singular and Non-singular Matrices – Adjoint of a Square Matrix – Properties – Properties of Inverse of a Matrix.	12
V	Introduction–Graph and Basic Terminologies–Types of Graphs–Sub Graph and Isomorphic Graph – Operations on Graphs – Representation of Graph	12
	TOTAL	60

CO	Course Outcomes

CO1	To recall basic concepts for clear understanding of mathematical principles
CO2	To explain practical problems
CO3	To construct matrices using discrete mathematics
CO4	To analyze techniques to draw graph using mathematics
CO5	To design graphs using the representations
Textbooks	
DISCRETE MATHEMATICS, Swapan Kumar Chakraborty and Bikash Kanti Sarkar, OXFORD University Press	
Reference books	
DISCRETE MATHEMATICS, Third Edition, Seymour Lipschutz and Marc Lars Lipson, Tata McGraw Hill Education Private Limited	
Discrete Mathematical Structures with Applications to Computer Science by J.P.Tremblay, R.Manohar TMH edition	
Web Reference	
https://www.tutorialspoint.com›discrete_mathematics	

Mapping with Programme Outcomes:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO 1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3
CO 4	3	3	3	3	2	3
CO 5	3	3	2	3	3	2
Weightage of course contributed to each PSO	15	15	14	15	14	14

S-Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	L	T	P	S	Credits	Marks		
							CIA	External	Total
	COMPUTER FUNDAMENTALS LABORATORY	2	-	-	I	2	50	50	100

Use Editing Options in WORD
Insert Chart in Excel
Create a Presentation with Animation
Create your own Google classroom and invite all your friends through email id. Post study material in Google classroom using Google drive.
Create a meeting using Google calendar and share meeting id to the attendees.Transfer the ownership to the Manager once the meeting id is generated.
Create one-page story in your mother tongue by using voice recognition facility of Google Docs
Create a registration form for your Department Seminar or Conference using Google Forms.
Create a question paper with multiple choice types of questions for a subject of your choice,using Google Forms.

Course Outcomes		Programme Outcomes
CO	On completion of this course, students will	
CO1	Understand the basics of Computer and its Generations. Be able to understand the components of computer.	PO1, PO2, PO3, PO4, PO5, PO6
CO2	To Understand the introduction about MS Word. Be able to perform the Elements of window, Text Formatting, Text Manipulating options in MS Word.	PO1, PO2, PO3, PO4, PO5, PO6
CO3	To Understand the introduction about MS Excel. Be able to inserting and sizing the cells Implementing formulas and inserting worksheet.	PO1, PO2, PO3, PO4, PO5, PO6
CO4	To Understand the introduction about MS PowerPoint Be able to perform the slides manipulation. Implementing Multimedia and templates.	PO1, PO2, PO3, PO4, PO5, PO6
CO5	To Understand the introduction about Internet and Intranet. Be able to access the browsers. To get knowledge about basic components of E-Mail and E-Commerce	PO1, PO2, PO3, PO4, PO5, PO6

Textbooks

1. G. Manjunath, “Computer Basics”, Vasan Publications, 2010.

2	Pradeep K. Sinha&PritiSinha, "Computer Fundamentals", 6th Edition, BPB Publications, 2004.

Web Resources

1.	https://www.tutorialspoint.com/computer_fundamentals/index.htm
2.	https://www.tutorialspoint.com/basics_of_computers/index.htm
3.	https://www.tutorialspoint.com/word/index.htm
4.	https://www.tutorialspoint.com/excel/index.htm
5.	https://www.tutorialspoint.com/powerpoint/index.htm

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	2	2	3	3	2
CO 3	2	3	3	3	3	3
CO 4	3	3	2	3	3	3
CO 5	3	3	3	3	2	3
Weightage of course contributed to each PSO	14	14	13	15	14	14

S-Strong-3 M-Medium-2 L-Low-1

Fundamentals of Computers

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
	2	0	0	I	2	2	25	75	100

Learning Objectives	
LO1	To analyze a problem with appropriate problem solving techniques
LO2	To understand the main principles of imperative, functional and logic oriented programming languages and
LO3	to increase the ability to learn new programming languages.
Prerequisites: Basic knowledge about programming concepts	

Unit	Contents	No. of Hours
I	Introduction: Characteristics of Computers - Evolution of Computers Basic Computer Organization: I/O Unit - Storage Unit - Arithmetic Logic Unit - Control Unit - Central Processing Unit	6
II	Computer Software: Types of Software - System Architecture Computer Languages: Machine Language - Assembly Language - High Level Language - Object Oriented Languages	6
III	Problem Solving Concepts: Problem Solving in Everyday life - Types of Problems - Problem solving with computers - Difficulties with Problem Solving	6
IV	Problem Solving concepts for the computer: Constant Variables - Data Types - Functions -Operators - Expressions and Equations - Organizing the Solution: Analyzing the problem - Algorithm - Flowchart - Pseudo code	6
V	Programming Structure: Structuring a solution - Modules and their function - Local and Global variables - Parameters - Return values - Sequential Logic Structure - Problem solving with Decision - Problem Solving with Loops	6
TOTAL		30

CO	Course Outcomes
CO1	Outline the Computer fundamentals and various problem solving concepts in Computers
CO2	Describe the basic computer organization, software, computer languages, software development life cycle and the need of structured programming in solving a computer problem
CO3	Identify the types of computer languages, software, computer problems and examine how to set up expressions and equations to solve the problem.
CO4	Choose most appropriate programming languages, constructs and features to solve the problems in diversified domains.

CO5	Analyze the design of modules and functions in structuring the solution and various Organizing tools in problem solving.
Textbooks	
➢	Pradeep K.Sinha and Priti Sinha, (2004) —Computer Fundamentals‖, Sixth Edition, BPB Publications. (Unit I : Chapter 1 & 2, Unit II : Chapter 10 & 12)
➢	Maureen Sprankle and Jim Hubbard, (2009) —Problem Solving and Programming Concept, Ninth Edition, Prentice Hall. (Unit III: Chapter 1,2 &3) Unit IV : Chapter 3, Unit V : Chapter 4,5 ,6,7 & 8)
Reference Books	
1.	R.G. Dromey, (2007), —How to Solve it by Computer‖, Prentice Hall International Series in Computer Science.
2.	C. S. V. Murthy, (2009), —Fundamentals of Computers‖, Third Edition, Himalaya Publishing House.
NOTE: Latest Edition of Textbooks May be Used	
Web Resources	
1.	http://www.tutorialspoint.com/computer_fundamentals/
2.	http://www.comptechdoc.org/basic/basictut/
3.	http://www.homeandlearn.co.uk/
4.	http://www.top-windows-tutorials.com/computer-basics/
5.	https://www.programiz.com/article/flowchart-programming (Algorithm and flow chart)

CO/ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	2	2	2	3
CO2	3	2	2	2	3	2
CO3	3	3	3	3	2	2
CO4	3	2	2	2	2	3
CO5	3	3	2	2	3	2
Weightage of course contributed to each PSO	15	12	11	11	12	12

FIRST YEAR –SEMESTER- II

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
	OBJECT ORIENTED PROGRAMMING IN C++	CCI	5	-	-	II	4	25	75	100

Learning Objectives	
LO1	To make students understand the concepts of Object Oriented Programming concepts using the C++ language.
LO2	To describe and use constructors and destructors.
LO3	To impart knowledge on the principles of Operator overloading and inheritance.
LO4	To understand tokens, expressions, and control structures
LO5	To understand and employ file management.

UNIT	Contents	No. of Hours
I	Introduction to C++ - key concepts of Object-Oriented Programming –Advantages – Object Oriented Languages – I/O in C++ - C++ Declarations. Control Structures: - Decision Making and Statements: If ... else, jump, goto, break, continue, Switch case statements - Loops in C++: for, while, do - functions in C++ - inline functions – Function Overloading	15
II	Classes and Objects: Declaring Objects – Defining Member Functions – Static Member variables and functions – array of objects –friend functions – Overloading member functions – Bit fields and classes – Constructor and destructor with static members.	15
III	Operator Overloading: Overloading unary, binary operators – Overloading Friend functions – type conversion – Inheritance: Types of Inheritance – Single, Multilevel, Multiple, Hierarchal, Hybrid, Multi path inheritance – Virtual base Classes – Abstract Classes.	15
IV	Pointers – Declaration – Pointer to Class, Object – this pointer – Pointers to derived classes and Base classes – Arrays – Characteristics – array of classes – Memory models – new and delete operators – dynamic object – Binding, Polymorphism and Virtual Functions.	15
V	Files – File stream classes – file modes – Sequential Read / Write operations – Binary and ASCII Files – Random Access Operation – Templates – Exception Handling - String – Declaring and Initializing string objects – String Attributes – Miscellaneous functions.	15

TOTAL HOURS	**75**

Course Outcomes		Programme Outcomes
CO	**On completion of this course, students will**	
CO1	**Describe the procedural and object oriented paradigm with concepts of streams, classes, functions, data and objects**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO2	**Demonstrate the various basic programming constructs like decision making statements. Looping statements and functions**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO3	**Explain the object oriented concepts like overloading, inheritance, polymorphism, virtual functions , constructors and destructors**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO4	**Explain the various file stream classes; file types, usage of templates and exception handling mechanisms.**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO5	**Compare the pros and cons of procedure oriented language with the concepts of object oriented language**	**PO1, PO2, PO3, PO4, PO5, PO6**

	Textbooks
1	**Ashok N Kamthane, Object-Oriented Programming with Ansi and Turbo C++, Pearson Education, 2006..**
	Reference Books
1.	**E. Balagurusamy, Object-Oriented Programming with C++, TMH, 2000**
2.	**Maria Litvin& Gray Litvin, C++ for you, Vikas publication, 2002**
3.	**John R Hubbard, Programming with C, 2nd Edition, TMH publication, 2002.**
	Web Resources
1.	**https://onlinecourses.swayam2.ac.in/aic20_sp06/preview**
2.	**https://onlinecourses.swayam2.ac.in/arp19_ap79/preview**

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	3	3	2	3
CO 3	3	3	3	3	2	2
CO 4	3	3	3	3	2	3

CO 5	**3**	**2**	**3**	**3**	**3**	**3**
Weightage of course contributed to each PSO	**15**	**14**	**15**	**15**	**13**	**14**

S-Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
	PROGRAMMING IN C++ LABORATORY		-	-	5	II	4	50	50	100

Course Objectives:

1. **Be able to design and program C++ applications.**
2. **Be able to create loops and decision statements in C++.**
3. **Be able to work with functions and pass arguments in C++.**
4. **Be able to work on the concept of Inheritance.**
5. **Be able to read and write files in C++.**

	Required Hours
LAB EXERCISES: 1. **Program using Class and Object.** 2. **Program using C++ operators.** 3. **Program using Decision-making Statements** 4. **Program using Loop Statements.** 5. **Program using Inline Function.** 6. **Program for Passing object to function and Returning object from function** 7. **Program using Constructor and Destructor.** 8. **Program using Function Overloading** 9. **Program using Virtual Function** 10. **Program using operator overloading** 11. **Program using Inheritance.** 12. **Program using Command line arguments.**	**75**

Course Outcomes	
On completion of this course, students will	
CO1	**To understand the concepts of Object-Oriented Programming Paradigm**
CO2	**Illustrate the concept of Virtual Classes, inline functions and friend function**
CO3	**Analyze ile stream classes; file types, usage of templates and exception handling**

CO4	**Know the pros and cons of procedure oriented language & object oriented language**
CO5	**Apply the various basic programming constructs like decision making statements. Looping statements, functions, concepts like overloading, inheritance, polymorphism, virtual functions , constructors and destructors**

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	1	3	2	3
CO 3	3	3	3	3	2	2
CO 4	3	3	3	3	2	3
CO 5	3	2	3	3	3	3
Weightage of course contributed to each PSO	15	15	13	15	13	14

S-Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Artificial Intelligence & Knowledge Representation	Core	4	-	-	II	3	5	25	75	100

Course Objective	
C1	To learn various concepts of AI Techniques.
C2	To learn various Search Algorithm in AI.
C3	To learn probabilistic reasoning and models in AI.
C4	To learn about Markov Decision Process.
C5	To learn various type of Reinforcement learning.

UNIT	Contents	No. of Hours
I	Introduction: Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree	15
II	Search Algorithms : Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search	15
III	Probabilistic Reasoning : Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model.	15
IV	Reinforcement Learning : Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning	15
V	Parallel and Distributed AI: Psychological Modelling – Parallelism in Reasoning Systems – Distributed Reasoning Systems - Hopfield networks, neural networks	15
	Total	75

Course Outcomes		Programme Outcome
CO	On completion of this course, students will	
1	Understand the various concepts of AI Techniques.	PO1
2	Understand various Search Algorithm in AI.	PO1, PO2
3	Understand probabilistic reasoning and models in AI.	PO4, PO6
4	Understand Markov Decision Process.	PO4, PO5, PO6
5	Understand various Reinforcement learning Techniques.	PO3, PO4

Textbook	
1	Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach” , 4th Edition, Prentice Hall.

2	Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill
3	Carl Townsend, "Introduction to Prolog Programming"
4	Ivan Bratko, "PROLOG Programming for Artificial Intelligence", Addison-Wesley, 2nd Edition.
5	Klocksin and Mellish, "Programming with PROLOG"
Reference Books	
1.	Trivedi, M.C., "A Classical Approach to Artifical Intelligence", Khanna Publishing House, Delhi.
2.	SarojKaushik, "Artificial Intelligence", Cengage Learning India, 2011
3.	David Poole and Alan Mackworth, "Artificial Intelligence: Foundations for Computational Agents", Cambridge University Press 2010
Web Resources	
1.	https://github.com/dair-ai/ML-Course-Notes
2.	https://web.cs.hacettepe.edu.tr/~erkut/ain311.f21/index.html
3.	https://www.toolify.ai/?gclid=CjwKCAjwvdajBhBEEiwAeMh1U6tlqU1LXlRFbcghLMZVwICm_4PkIRcDRE-VYq_wTDcuaQeq_bCHnhoCcm4QAvD_BwE

Mapping with Programme Outcomes:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	1	2	1	2
CO2	3	3	2	2	3	3
CO3	3	3	2	3	3	2
CO4	3	2	3	2	2	3
CO5	3	2	2	2	3	3
Weightage of course contributed to Each PSO	15	12	10	11	12	13

S-Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
	DATA STRUCTURES	SEC	2	-	-	II	2	25	75	100

Learning Objectives	
LO1	Understand the meaning asymptotic time complexity analysis and various data structures
LO2	To enhancing the problem solving skills and thinking skills
LO3	To write efficient algorithms and Programs
LO4	To make the students learn best practices in programming
LO5	To understand how to handle the files in Data Structure

UNIT	Contents	No. Of. Hours
I	Arrays and ordered Lists Abstract data types – asymptotic notations – complexity analysis- Linked lists: Singly linked list – doubly linked lists-	6
II	Stacks – Queues – Circular Queues Trees – Binary Trees – Binary Tree Traversal – Binary Tree Representations – Binary Search Trees	6
III	Searching and Sorting: Sorting – Insertion Sort, Quick Sort, Merge Sort Searching – Linear search, Binary search	6
IV	Graphs - Representation of Graphs – Graph implementation – graph Traversals - Minimum Cost Spanning Trees	6
V	Backtracking – 8-Queen‟s problem - Graph Colouring– Branch And Bound:– Travelling Sales Person Problem	6
	TOTAL HOURS	30

Course Outcomes		Programme Outcomes
CO	On completion of this course, students will	
CO1	To understand the concepts of Linked List, Stack and Queue.	PO1, PO2, PO3, PO4, PO5, PO6
CO2	To understand the Concepts of Trees and Graphs	PO1, PO2, PO3, PO4, PO5, PO6
CO3	To apply searching and sorting techniques	PO1, PO2, PO3, PO4, PO5, PO6

Textbooks	
1	**Seymour Lipshutz(2011),Schaum"s Outlines - Data Structures with C, Tata McGraw Hill publications.**
2	**Ellis Horowitz and SartajSahni (2010), Fundamentals of Computer Algorithms, Galgotia Publications Pvt., Ltd.**
3	**Dr. K. Nagesware Rao, Dr. Shaik Akbar, ImmadiMurali Krishna, Problem Solving and Python Programming(2018)**
Reference Books	
1.	**Gregory L.Heileman(1996), Data Structures, Algorithms and Object-Oriented Programming, McGraw Hill International Edition, Singapore.**

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
	DATA STRUCTURES LABORATORY	CC 4 -1	-	-	2	II	2	50	50	100

Objectives

To predict the performance of different algorithms in order to guide design decisions, provide theoretical estimation for the required resources of an algorithm to solve a specific computational problem

LIST OF PROGRAMS	Required Hour
1. Perform stack operations 2. Perform queue operations 3. Perform tree traversal operations 4. Search an element in an array using linear search. 5. Search an element in an array using binary search 6. Sort the given set of elements using Merge Sort. 7. Sort the given set of elements using Quick sort. 8. Sort the given set of elements using Insertion sort. 9. Create a Linked list and perform insertion and deletion 10. Create a Doubly Linked list and perform insertion and deletion	

Course Outcomes

CO	On completion of this course, students will
CO1	To understand the concepts of Linked List, Stack and Queue.
CO2	Concepts of Trees and Graphs. Perform traversal operations on Trees and Graphs. To enable the applications of Trees and Graphs.

CO3	**To apply searching and sorting techniques**
CO4	**To determine the concepts of Greedy Method To apply searching techniques.**
CO5	**Usage of File handlings in python, Concept of reading and writing files, Do programs using files.**

Learning Resources:

- **RecommendedTexts**

1. Ellis Horowitz , Sartaj Sahni, Susan Anderson Freed, Second Edition , "Fundamentals of Data in C", Universities Press

2. E. Horowitz, S. Sahni and S. Rajasekaran, Second Edition ,"Fundamentals of Computer Algorithms " Universities Press

Reference Books

1. Seymour Lipschutz ,"Data Structures with C", First Edition, Schaum's outline series in computers, Tata McGraw Hill.

2. R.Krishnamoorthy and G.Indirani Kumaravel, Data Structures using C, Tata McGrawHill – 2008.

3. A.K.Sharma, Data Structures using C , Pearson Education India,2011.

4. G. Brassard and P. Bratley, "Fundamentals of Algorithms", PHI, New Delhi, 1997.

5. A.V. Aho, J.E. Hopcroft, J.D. Ullmann,, "The design and analysis of Computer Algorithms", Addison Wesley, Boston, 1974

6. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press, 2009

7. Sanjoy Dasgupta, C.Papadimitriou and U.Vazirani , Algorithms , Tata McGraw-Hill, 2008.

Course Outcomes

CO	**On completion of this course, students will**
CO1	**Implement data structures**
CO2	**Implement various types of linked lists and their applications**
CO3	**Implement Tree Traversals**
CO4	**Implement various algorithms**
CO5	**Implement different sorting and searching algorithms**

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3
CO 3	3	3	2	2	3	3
CO 4	3	3	3	3	3	3
CO 5	3	3	3	3	1	2
Weightage of course contributed to each PSO	15	15	14	14	13	14

S-Strong-3 M-Medium-2 L-Low-1

SECOND YEAR –SEMESTER- III

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
	Python Programming	CCI	5	-	-	I	5	25	75	100

UNIT	Contents	No. of Hours
I	Basics of Python Programming: History of Python-Features of Python-Literal-Constants-Variables - Identifiers–Keywords-Built-in Data Types-Output Statements – Input Statements-Comments – Indentation- Operators-Expressions-Type conversions. Python Arrays: Defining and Processing Arrays – Array methods.	15
II	Control Statements: Selection/Conditional Branching statements: if, if-else, nested if and if-elif-else statements. Iterative Statements: while loop, for loop, else suite in loop and nested loops. Jump Statements: break, continue and pass statements.	15
III	Functions: Function Definition – Function Call – Variable Scope and its Lifetime-Return Statement. Function Arguments: Required Arguments, Keyword Arguments, Default Arguments and Variable Length Arguments- Recursion. Python Strings: String operations- Immutable Strings - Built-in String Methods and Functions - String Comparison. Modules: import statement-The Python module – dir() function – Modules and Namespace – Defining our own modules.	15
IV	Lists: Creating a list -Access values in List-Updating values in Lists-Nested lists -Basic list operations-List Methods. Tuples: Creating, Accessing, Updating and Deleting Elements in a tuple – Nested tuples– Difference between lists and tuples. Dictionaries: Creating, Accessing, Updating and Deleting Elements in a Dictionary – Dictionary Functions and Methods - Difference between Lists and Dictionaries.	15

V	**Python File Handling: Types of files in Python - Opening and Closing files-Reading and Writing files: write() and writelines() methods- append() method – read() and readlines() methods – with keyword – Splitting words – File methods - File Positions- Renaming and deleting files.**	**15**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
CO1	• **Learn the basics of python, Do simple programs on python,** **Learn how to use an array.**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO2	• **Develop program using selection statement, Work with Looping and jump statements, Do programs on Loops and jump statements.**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO3	**Concept of function, function arguments, Implementing the concept strings in various application, Significance of Modules, Work with functions, Strings and modules.**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO4	• **Work with List, tuples and dictionary, Write program using list, tuples and dictionary.**	**PO1, PO2, PO3, PO4, PO5, PO6**
CO5	**Usage of File handlings in python, Concept of reading and writing files, Do programs using files.**	**PO1, PO2, PO3, PO4, PO5, PO6**

Textbooks	
1	**Reema Thareja, "Python Programming using problem solving approach", First Edition, 2017, Oxford University Press.**
2	**Dr. R. Nageswara Rao, "Core Python Programming", First Edition, 2017, Dream tech Publishers.**
Reference Books	
1.	**VamsiKurama, "Python Programming: A Modern Approach", Pearson Education.**
2.	**Mark Lutz, "Learning Python", Orielly.**
3.	**Adam Stewarts, "Python Programming", Online.**

4.	**Fabio Nelli, "Python Data Analytics", APress.**
5.	**Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication.**
Web Resources	
1.	**https://www.programiz.com/python-programming**
2.	**https://www.guru99.com/python-tutorials.html**
3.	**https://www.w3schools.com/python/python_intro.asp**
4.	**https://www.geeksforgeeks.org/python-programming-language/**
5.	**https://en.wikipedia.org/wiki/Python_(programming_language)**

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	2
CO 3	3	3	3	3	2
CO 4	3	3	3	3	2
CO 5	3	2	3	3	3
Weightage of course contributed to each PSO	15	14	15	15	13

S-Strong-3 M-Medium-2 L-Low-1

Subject Code	Subject Name	Category	L	T	P	S	Credits	Marks		
								CIA	External	Total
	Python LABORATORY	Practical	-	-	4	4	3	50	50	100

Course Objectives:

1. **Be able to design and program Python applications.**
2. **Be able to create loops and decision statements in Python.**
3. **Be able to work with functions and pass arguments in Python.**
4. **Be able to build and package Python modules for reusability.**
5. **Be able to read and write files in Python.**

LAB EXERCISES	Required Hours
1. Program using variables, constants, I/O statements in Python. 2. Program using Operators in Python. 3. Program using Conditional Statements. 4. Program using Loops. 5. Program using Jump Statements. 6. Program using Functions. 7. Program using Recursion. 8. Program using Arrays. 9. Program using Strings. 10. Program using Modules. 11. Program using Lists. 12. Program using Tuples. 13. Program using Dictionaries.	60

14. Program for File Handling	

Course Outcomes	
On completion of this course, students will	
CO1	**Demonstrate the understanding of syntax and semantics of**
CO2	**Identify the problem and solve using PYTHON programming techniques.**
CO3	**Identify suitable programming constructs for problem solving.**
CO4	**Analyze various concepts of PYTHON language to solve the problem in an efficient way.**
CO5	**Develop a PYTHON program for a given problem and test for its correctness.**

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	1	3	2

CO 3	**3**	**3**	**3**	**3**	**2**
CO 4	**3**	**3**	**3**	**3**	**2**
CO 5	**3**	**2**	**3**	**3**	**3**
Weightage of course contributed to each PSO	**15**	**15**	**13**	**15**	**13**

S-Strong-3 M-Medium-2 L-Low-1

Elective	OPTIMIZATION TECHNIQUES		
Semester III	Lecture Hours:(L) per week: 4	Lab Practice Hours: (P)per week	Total:(L+T+P) per week: 4

Course Outcome:

CO1. Formulate and solve Linear Programming Problems.

CO2. Analyze the usage of Sequencing Problems.

CO3. Evaluate Queueing Models.

CO4. Apply PERT and CPM techniques to find the optimal solution.

CO5: Analyze the usage of assignment and transportation problems

Units	Contents	Hours
I	**INTRODUCTION-LINEAR PROGRAMMING PROBLEM** The Nature and Meaning of OR – Management – Applications of OR – Modeling in OR – General methods for solving OR models – Scope of OR. Linear Programming Problem: Formulation of LP problems – Graphical solution of LP problems – General formulation of LPP – Slack and Surplus variables – Standard form of LPP – Some important forms of LPP – Simplex Method I.	12
II	Assignment Problem: Mathematical formulation–Hungarian method–Unbalanced assignment problem – Various types	12
III	**TRANSPORTATION PROBLEMS** Transportation Model: Mathematical formulation – Matrix form–Methods for finding Initial Basic Feasible solution and Optimal solution – Degeneracy in Transportation Problems – Unbalanced Transportation Problem.	12
IV	**SEQUENCING PROBLEMS AND QUEUING MODELS** Sequencing Problems: Assumptions – Solutions to Sequencing Problems: Processing n jobs through 2 machines – Processing n jobs through 3 machines – Processing n jobs on m machines.	12

	Queuing Models: Queuing System – Transient and Steady States– Kendal's Notation for representing Queuing Models – Various Models in Queuing System – Birth and Death Model.	
V	**PERT AND CPM TECHNIQUES** **PERT and CPM Techniques: Basic Steps – Network Diagram representation– Rules for drawing Network Diagram – Labeling Fulkerson's I–J Rule – Time Estimates and Critical Path in Network Analysis – Examples on optimum duration and minimum duration cost – PERT.**	**12**

Learning Resources:

TEXT BOOK

S.D.Sharma, "Operations Research", Tenth Edition,Pearson,2017.

REFERENCE BOOKS

1. **Hamdy A Taha,"Operations Research", Ninth Edition,2016.**
2. **V.Sundaresan, K.S.Ganapathy Subramanian, K.Ganesan, "Resource Management Techniques", Ninth Edition, A. R.Publications, 2015.**

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	2	2	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	1
Weightage of course contributed to each PSO	15	15	14	14	13

S-Strong-3 M-Medium-2 L-Low-1

Elective	Graph Theory and its applications		Credits: 3
Semester III	Lecture Hours:(L) per week: 4	Lab Practice Hours: (P)per week	Total:(L+T+P) per week: 4

Learning Objectives:

1. **Definition of Graph, sub graph their representations, degree and algebraic operations.**
2. **Connected graphs, weighted graphs and shortest paths**
3. **Trees: Characterizations, spanning tree, minimum spanning trees**
4. **Eulerian and Hamiltonian graphs: Characterization, Necessary and sufficient conditions**
5. **Special classes of graphs: Bipartite graphs, line graphs, chordal graphs.**

Course Outcome:

CO1: To Introduce the fundamental concepts in graph theory Graphs, subgraphs, walks, Euler graphs, Hamiltonian Paths Tree Properties, Hamiltonian paths and circuits

CO2: Understanding the concepts of Circuits, Cut set and its Properties, Network Flows, Isomorphism and Combinatorial and Planar Graphs.

CO3: Applying the concept of Colouring with Chromatic Number, Directed Graphs, Matching, Covering Pattern and Euler Graphs

CO4:Analysing the Various Concepts of Representation of Graphs, Euler Paths Circuit, Kruskals and Prims Algorithms, Connected Components.

CO5: evaluate the Applications with travelling sales person Problem, K colour Problem with n vertices in a Graph and Shortest Path finding Problem using Directed and Undirected Graphs.

Units	Contents	Hours
I	**INTRODUCTION: Graph-mathematical definition-Introduction – sub graphs –Walks, paths, Circuits connectedness- Components- Euler Graphs- Hamiltonian paths and circuits-Trees- properties of Trees- Distance and centers in Tree- Rooted and Binary Trees** **Directed Graph – undirected graphs**	12
II	**CONNECTIVITY AND PLANARITY: Introduction to circuits - cut set- properties of cut set- All cut sets –**	12

	connectivity & separability – Network Flows - 1-Isomorphism - 2-isomorphism- Combinatorial and Geometric graphs- Planar Graphs – Different representation of planar graph.	
III	**COLORING AND DIRECTED GRAPH: Basics of Colouring & Chromatic number – Chromatic partitioning – Graph Colouring – four colour Problem Chromatic polynomial - Matching – Covering - Directed graphs - Types of Directed Graphs – Diagraphs and binary relations – Directed paths- Euler Graph.**	**12**
IV	**GRAPH: REPRESENTATION & TRAVERSAL: Matrix representation of graphs, Sub graphs& Quotient Graphs, Transitive Closure digraph, Euler's Path & Circuit (only definitions and examples), spanning Trees of Connected Relations, Prim's Algorithm to construct Spanning Trees, Weighted Graphs, Minimal Spanning Trees by Kruskal's Algorithm.**	**12**
V	**APPLICATIONS OF GRAPH: Traveling Sales Person Problem with Directed and Undirected Graph, Graph with n vertices and k colours- Shortest path from one to many Cities with directed graph- Shortest Paths with Undirected Graphs - Connected Components.**	**12**

Learning Resources:

1 Narsingh Deo, " Graph Theory with Application to Engineering and Computer Science" Prentice Hall of India 2010(Reprint)

2 Rosen H "Discrete Mathematics and Its Application" Mc Graw Hill, 2007

Reference Books:

1 Discrete Mathematics for Computer Scientists & Mathematicians - Mott, Kandel, Baker

2 Clark J and Holton DA "First look at Graph Theory" Allied Publishers 1995

Web resources: NDL Library, E-content from open source libraries https://d3gt.com/

https://www.coursera.org/courses?query=graph%20theory

Skill	Power BI Laboratory		
Semester III	Lecture Hours:(L) per week:	Lab Practice Hours: (P)per week	Total:(L+T+P) per week: 4

1. **Import Data from Excel**
2. **Perform ETL operations using Power Query Editor.**
    i. **Remove null values.**
    ii. **Replace missing data.**
    iii. **Split columns.**
    iv. **Merge two tables.**
    v. **Remove duplicate records.**
3. **Create Basic Visualizations using simple charts and graphs**
4. **Build Interactive Dashboard**
5. **Data Modeling and Relationships**
6. **DAX Calculations and Measures**
7. **Time Series Analysis**
8. **Geographic Map Visualization**

Semester IV

Semester	Subject Name	Category	L	T	P	S	Credits		Marks		
									CIA	External	Total
IV	MACHINE LEARNING	Core	4	-	-	-	4		25	75	100
Learning Objectives											
LO1	To Learn about Machine Intelligence and Machine Learning applications										
LO2	To implement and apply machine learning algorithms to real-world applications										
LO3	To identify and apply the appropriate machine learning technique to classification, pattern recognition, optimization and decision problems										
LO4	To create instant based learning										
LO5	To apply case based learning										
UNIT	Contents										No. Of. Hours
I	Introduction Machine Learning - Difference between AI, Machine Learning and Big data. Supervised and unsupervised learning, parametric vs non-parametric models, parametric models for classification and regression- Linear Regression, Logistic Regression										12
II	Neural networks Neural Network Representation – Problems – Perceptron – Activation Functions- Single Layer Perceptron - Multilayer Networks and Back Propagation Algorithms										12
III	Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evaluation and Learning.										12
IV	Bayesian and computational learning Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier – Bayesian Belief Network – EM Algorithm – Probability Learning										12
V	Instant based learning K- Nearest Neighbour Learning – Locally weighted Regression – Radial Basis Functions – Case Based Learning.										12
										TOTAL HOURS	60

Course Outcomes		Programme Outcomes
CO	On completion of this course, students will	
CO1	Appreciate the importance of visualization in the data analytics solution	PO1, PO2, PO3, PO4, PO5, PO6
CO2	Apply structured thinking to unstructured problems	PO1, PO2, PO3, PO4, PO5, PO6
CO3	Understand a very broad collection of machine learning algorithms and problems	PO1, PO2, PO3, PO4, PO5, PO6
CO4	Learn algorithmic topics of machine learning and mathematically deep enough to introduce the required theor	PO1, PO2, PO3, PO4, PO5, PO6
CO5	Develop an appreciation for what is involved in learning from data.	PO1, PO2, PO3, PO4, PO5, PO6
1	Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.	
2	Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning" 2015, MIT Press	
Reference Books		
1.	Ethem Alpaydin, —Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.	
2	Stephen Marsland, —Machine Learning: An Algorithmic Perspective, CRC Press, 2009.	

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	3	3	2	3
CO 3	3	3	3	3	3	3
CO 4	3	3	2	3	3	3
CO 5	3	3	3	3	3	2

Weightage of course contributed to each PSO	**15**	**15**	**14**	**15**	**14**	**14**

S-Strong-3 M-Medium-2 L-Low-1

	AI & ML Laboratory		
Semester IV	**Lecture Hours:(L) per week:**	**Lab Practice Hours: (P)per week**	**Total:(L+T+P) per week: 4**

Objectives

1. **To understand the basic concepts of Artificial Intelligence and Machine Learning.**
2. **To implement AI search algorithms and problem-solving techniques using Python.**
3. **To perform data preprocessing and visualization for Machine Learning applications.**
4. **To develop Machine Learning models for classification, regression, and clustering tasks.**
5. **To build and evaluate predictive models using standard Machine Learning algorithms.**

List of Programs:

1. **Write a program to implement Breadth First Search (BFS) algorithm.**
2. **Write a program to implement Depth First Search (DFS) algorithm.**
3. **Write a program to implement Hill Climbing Algorithm.**
4. **Write a program to implement A* Search Algorithm.**
5. **Develop a program to implement the Tic-Tac-Toe game using Artificial Intelligence concepts.**
6. **Write a program for data preprocessing using Pandas.**
7. **Write a program for data visualization using Matplotlib.**
8. **Implement Naïve Bayes classification model.**
9. **Build a Machine Learning model using Linear Regression.**
10. **Build a Machine Learning model using Logistic Regression.**
11. **Build Decision Tree and Random Forest models.**
12. **Build Support Vector Machine (SVM) models.**
13. **Implement Ensemble Learning techniques.**
14. **Implement Clustering algorithms.**

Semester IV Elective	BIO-INSPIRED COMPUTING	

OBJECTIVES:

- **To Learn bio-inspired theorem and algorithms**
- **To Understand random walk and simulated annealing**
- **To Learn genetic algorithm and differential evolution**
- **To Learn swarm optimization and ant colony for feature selection**
- **To understand bio-inspired application in image processing**

UNIT I INTRODUCTION

Optimisation, Modelling, and Simulation Problems Evolutionary Computing Evolutionary Algorithm Representation, Mutation, and Recombination Fitness, Selection, and Population Management

UNIT II RANDOM WALK AND ANEALING

Random variables - Isotropic random walks - Levy distribution and flights - Markov chains - step sizes and search efficiency

importance of randomization- Eagle strategy-Annealing and Boltzmann Distribution - parameters -SA algorithm - Stochastic Tunneling.

UNIT III GENETIC ALOGORITHMS AND DIFFERENTIAL EVOLUTION

Genetic Algorithms - Evolution Strategies - Evolutionary Programming - Genetic Programming - Learning Classifier Systems - Differential Evolution

Evolutionary Algorithm Parameters= EAs and EA Instances - Designing Evolutionary Algorithms

UNIT IV SWARM OPTIMIZATION Swarm intelligence - PSO algorithm - accelerated PSO - implementation - convergence analysis - binary PSO

Ant colony optimization -toward feature selection. – Bee colony optimization

UNIT V

FIREFLY ALGORITHM

The Firefly algorithm - - implementation - Cuckoo Search Algorithm – Bat Algorithm – Feature Selection

OUTCOME:

Upon completion of the course, the students should be able to

- **Explain random walk and simulated annealing**
- **Implement and apply genetic algorithms**
- **Explain swarm intelligence and ant colony for feature selection**
- **Apply bio-inspired techniques in image processing**

Text Book

1. **Xin-She Yang, "Nature Ispired Optimization Algorithm,Elsevier First Edition 2014**
2. **Eiben,A.E.,Smith,James E, "Introduction to Evolutionary Computing", Springer 2015.**
3. **Yang ,Cui,XIao,Gandomi,Karamanoglu ,"Swarm Intelligence and Bio-Inspired Computing", Elsevier First Edition 2013**

REFERENCES:

1. **Helio J.C. Barbosa, "Ant Colony Optimization - Techniques and Applications", Intech 2013**
2. **Xin-She Yang , Jaao Paulo papa, "Bio-Inspired Computing and Applications in Image Processing",Elsevier 2016**

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	2
CO 2	3	3	3	2	3	3
CO 3	3	3	3	2	3	3
CO 4	3	3	3	3	3	3
CO 5	3	3	3	3	3	3
Weightage of course contributed to each PSO	15	15	15	13	15	14

S-Strong-3 M-Medium-2 L-Low-1

Elective	Data Visualization		Credits:
Lecture Hours: (L) per week: 4	Tutorial Hours : (T) per week	Lab Practice Hours: (P)per week	Total: (L+T+P) per week: 4

Unit:1 Introduction to Data Visualization **12 hours**

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

Unit:2 Interactive Data Visualization **12 hours**

Introduction to D3 - Fundamental Technology: The Web – HTML – DOM – CSS – JavaScript –SVG. D3 Setup – Generating Page Elements – Binding Data - Drawing with data – Scales: Domains and Ranges – Normalization – Creating a Scale – Scaling the Scatter Plot – Other Methods and Other Scales. Axes – Modernizing the Chart – Update the Data – Transition – Updates – Interactivity.

Unit:3 D3 Based Reusable Chart Library **12 hours**

Setup and Deployment – Generate Chart – Customize Chart: Additional Axis – Show Axis Label – Change Chart Type – Format Values – Size – Color – Padding –Tooltip. Use APIs: Load and Unload – Show and Hide – Focus – Transform – Groups – Grid – Regions – Flow – Revert – Toggle –Legend – Sub chart – Zoom – Resize. Customize Style. Building Real time and Live Updating animated graphs with C3.

Unit:4 Tableau Introduction **12 hours**

Environment Setup – Navigation – File & Data Types. TA SOURCE: Custom Data View – Extracting Data – Fields Operations – Editing Meta Data – Data Joining – Data Blending. Worksheets.

Unit:5 Basic and Advanced Charts in Tableau **12 hours**

Bar Chart – Line Chart – Pie Chart – Scatter Plot – Bubble Chart –Gantt Chart – Histograms -Waterfall Charts. Dashboard – Formatting – Forecasting – Trend Lines

Text Book(s)

1 Ben Fry, “Visualizing Data: Exploring and Explaining Data with the Processing Environment”, O'Reilly, 1st Edition, 2008.

2 Scott Murray, “Interactive data visualization for the web: An Introduction to Designing with D3”, O'Reilly, 2nd Edition, 2017.

3 Joshua N. Milligan, “Learning Tableau 2019: Tools for Business Intelligence, data prep, and visual analytics”, Packt Publishing Limited, 2019.

4 Claus O. Wilke, “Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures”, O.Reilly, 2019.

Reference Books :

1 Ritchie S. King, “Visual Storytelling with D3: An Introduction to Data Visualization in JavaScript”, Addison-wesley Data and Analytics, 2014.

2 Elijah Meeks, “D3.js in Action: Data visualization with JavaScript”, Second Edition, Manning Publications, 2017.

3 Lindy Ryan, “Visual Data Storytelling with Tableau”, 1st Edition, Pearson, 2018..

Skill	CANVA Laboratory		
Semester IV	Lecture Hours:(L) per week:	Lab Practice Hours: (P)per week	Total:(L+T+P) per week: 4

CANVA PRACTICAL PROGRAM LIST

1. Create a resume template
2. Create a college poster using canva
3. Design a certificate template
4. Create a presentation for college seminar
5. Create a brochure for a department
6. Create a magazine cover page
7. Create a photo collage
8. Design a logo using canva
9. Create an educational Infographic
10. Design a website mockup

Semester V

	DATABASE MANAGEMENT SYSTEMS		
Semester IV	**Lecture Hours:(L) per week:**	**Lab Practice Hours: (P)per week**	**Total:(L+T+P) per week: 4**

UNIT I: Introduction to Databases and Database System Concepts 12 hours

Introduction – Characteristics of the Database Approach – Actors on the Scene and Workers behind the Scene – Advantages of Using the Database Management System Approach – Database Applications – Data Models, Schemas, and Instances – Three-Schema Architecture of a Database Management System – Data Independence – Database Languages and Interfaces – Database System Environment – Architectures for Database Management Systems Database Management Systems – Classification of Database Management Systems.

UNIT II: Entity Relationship Model and Relational Model 12 hours

Entity Types, Entity Sets, Attributes, and Keys – Relationship Types – Steps to Model an Entity Relationship Diagram – Relational Model Concepts – Relational Model Constraints and Relational Database Schemas – Update Operations, Transactions, and Dealing with Constraint

Violations – Mapping Entity Relationship Model to Relational Data Model.

UNIT III: Relational Algebra and Structured Query Language 12 hours

Unary Relational Operations: SELECT and PROJECT – Relational Algebra Operations from Set Theory – Binary Relational Operations: Cartesian Product – Equi Join – Left Outer Join – Right Outer Join – Full Outer Join – Data Definition Language – Data Manipulation Language – Transaction Control Language – Aggregate Functions – Joins – Nested Queries –Views – Stored Procedures – Cursors – Functions – Triggers.

UNIT IV: Database Normalization 12 hours

Functional Dependencies – First Normal Form – Second Normal Form – Third Normal Form – Boyce-Codd Normal Form – Multivalued Dependency and Fourth Normal Form – Join Dependencies and Fifth Normal Form.

UNIT V: Transaction Processing and Concurrency Control 12 hours

Introduction to Transaction Processing – Transaction and System Concepts – Properties of Transactions – Characterizing Schedules Based on Recoverability – Characterizing Schedules Based on Serializability – Transaction Support in SQL – Concurrency Control Techniques – Two-Phase Locking Techniques for Concurrency Control – Concurrency Control Based on Timestamp Ordering.

Text Books:

1. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Seventh Edition, Pearson Education, 2016.

2. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, Seventh Edition, McGraw Hill Education, 2020.

Reference:

http://www.uoitc.edu.iq/images/documents/informaticsinstitute/Competitive_exam/Database_Systems.pdf

An Introduction Relational Database Theory, Hugh Darwen, EBook

http://www.zums.ac.ir/files/research/site/ebooks/it-programming/an-introductionto-relational-database-theory.pdf

Distributed Operating Systems	

CO1. Get an insight about networking concepts

CO2.Gainknowledgeaboutoperatingsystemconcepts

CO3. Understand file system concepts

CO4.AnalyzeDeadlock

CO5.ExploreProcessmanagement

UNIT– I 12hours

Evolution of Distributed Computing System–Distributed Computing System Models–Why are Distributed Computing Systems gaining popularity – What is a Distributed Computing System – Issues in Designing Distributed Computing System – Introduction to Distributed Computing Environment

UNIT– II 12hours

Message Passing: Introduction Desirable features – Issues in PC Message Passing– Synchronization – Buffering – Multi datagram Messages – Encoding and Decoding – Process Addressing – Failure Handling – Group Communication

UNIT– III 12hours

Remote Procedure Calls : RPC models – Transparency of RPC–Stub generation– RPC messages– Marshaling arguments and results–Exception Handling–Lightweight RPC; Distributed Shared Memory: Introduction – General Architecture of DSM system – Design and Implementation Issues of DSM – Granularity – Structure of Shared Memory – Consistency Models – Replacement Strategy – Thrashing.

UNIT– IV 12hours

Synchronization: Introduction–Clock Synchronization–Event Ordering– Mutual Exclusion – Deadlock – Election Algorithm– Process Management: Introduction-Process Migration– Threads.

UNIT– V 12hours

Distributed File System: Introduction – Desirable features – File Models – File Accessing Models – File Sharing Semantics – File Caching Schemes – File Replication – Fault Tolerance – Atomic Transactions – Design Principles.

Textbooks:

1. **Pradeep K Sinha, —Distributed Operating Systems – Concepts and Design‖, PHI,2016**
2. **Andrew S Tanenbaum,—Distributed OperatingS ystems, First Edition,PHI. 2017**

Reference Books

1. **Abraham Silberschatz, Peter B. Galvin G. Gagne, Operating Systems Concepts, Ninth edition, Addison Wesley Publishing Co., 2018.**
2. **Coulouris George, Dollimore Jean, Blair Gordon–Distributed systems-concepts and design Pearson 2017.**

COMPUTER NETWORKS & SECURITY		
Unit : 1	**BASICS OF NETWORKS AND OSI MODEL**	
Network Hardware : LAN–WAN–MAN–Wireless–Home Networks. Network Software : Protocol Hierarchies–Design Issues for the Layers–Connection-oriented and connectionless services – Service Primitives – The Relationship of services to Protocols. Reference Models : OSI Reference Model–TCP/IP reference Model–Comparison of OSI and TCP/IP-Critique of OSI And protocols– Critique of the TCP/IP Reference model.		
Unit : 2	**PHYSICAL LAYER**	**15 hours**
PHYSICAL LAYER-Guided Transmission Media : Magnetic Media–Twisted Pair–Coaxial Cable– Fiber Optics. Wireless Transmission : Electromagnetic Spectrum–Radio Transmission–Microwave Transmission–Infrared and Millimeter Waves – Light Waves. Communication Satellites : Geostationary, Medium-Earth Orbit, Low Earth- Orbit Satellites–Satellites versus Fiber.		
Unit : 3	**DATA-LINK LAYER**	
DATA-LINK LAYER : Error Detection and correction–Elementary Data-link Protocols–Sliding		
Window Protocols. MEDIUM-ACCESS CONTROL SUB LAYER : Multiple Access Protocols–		
Ethernet–Wireless LANs-Broadband Wireless–Bluetooth.		
Unit : 4	**NETWORK LAYER**	
NETWORK LAYER : Routing algorithms–Congestion Control Algorithms. TRANSPORT LAYER : Elements of Transport Protocols–Internet Transport Protocols : TCP.		
Unit : 5	**APPLICATION LAYER**	
APPLICATION LAYER : DNS–E-mail. NETWORK SECURITY : Cryptography–		
Symmetric Key Algorithms–Public Key Algorithms–Digital Signatures.		
Text Book(s)		
Computer Networks, Andrew S. Tanenbaum, 4th edition, PHI. (UNIT-I : 1.2-1.4 UNIT-II : 2.2-2.4UNIT-III : 4.2-4.6UNIT-IV : 5.2,5.3,6.2,6.5UNIT-V : 7.1,7.2,8.1-8.4)		
Reference Books		

DataCommunicationandNetworks,AchyutGodbole,2007,TMH.
Computer Networks : Protocols,Standards,andInterfaces,UylessBlack,2nded,PHI

DATABASE MANAGEMENT SYSTEMS LABORATORY			
Semester V	Lecture Hours:(L) per week:	Lab Practice Hours: (P)per week	Total:(L+T+P) per week: 4

Write programs for the following:

1. Data Definition Language – Create – Alter – Drop – Enforcing Primary Key and Foreign Key Constraints

2. Data Manipulation Language – Insert – Delete – Update –Transaction Control Language – Commit – Rollback – Save Points.

3. Cartesian Product – Equi Join – Left Outer Join – Right Outer Join – Full Outer Join.

4. Set Operations – Creating Views – Creating Sequence – Indexing – Aggregate Functions – Analytic Functions – Nested Queries. (separate programs)

4. Creating Stored Procedures, Functions and Triggers (separate programs)

Android App Development Laboratory

Objectives

1. **To understand the fundamentals of Android application development using Android Studio.**
2. **To design user interfaces using various Android layouts and UI components.**
3. **To implement event handling and user interaction in Android applications.**
4. **To develop Android applications using Activities, Intents, Menus, and Spinner components.**
5. **To perform data storage and retrieval operations using SQLite Database.**
6. **To develop problem-solving and mobile application development skills through practical implementation of Android applications.**

List of Programs:

1. **Develop an Android application to display a message using a Button.**
2. **Develop an application that accepts a name through a TextBox and displays a welcome message along with the entered name when the user clicks the OK Button.**
3. **Develop an Android application using Linear Layout.**
4. **Develop an Android application using Relative Layout to display Date and Time.**
5. **Develop an Android application using Table Layout.**
6. **Develop an Android application to display images using ImageView component.**
7. **Develop an Android application to perform simple arithmetic operations using Button click events.**
8. **Develop an Android application to display dropdown menu items using the Spinner component and allow the user to select an item.**
9. **Develop an Android application to change the screen color based on the user's selection from a Menu.**
10. **Develop a sample Android application with a Login Module to validate Username and Password, and display appropriate Toast messages.**
11. **Design an Android application using Intent with a Button to pass values from one Activity to another Activity.**
12. **Develop an Android application to demonstrate SQLite Database storage with basic CRUD (Create, Read, Update, Delete) operations.**

	Mini Project		**Credits:**
	Year Semester:		
Units	**Contents**		**Required Hours**
	Students (Individual or maximum three in a group) will take a specific problem for the Project and solve it using any one of latest tool and submit a report. **Further each student will participate in regular project review with group project guide / Faculty.**		

	Cloud Computing		Credits: 3
Lecture Hours:(L) per week 4	Tutorial Hours: (T)per week	Lab Practice Hours: (P)per week	Total:(L+T+P) per week: 4

Learning Objectives:

- To impart fundamental concepts of Cloud Computing.
- To impart a working knowledge of the various cloud service types and their uses and pitfalls.
- To enable the students to know the common features and differences in the service offerings of the three major Cloud Computing service providers, namely Amazon, Microsoft and Google.
- To provide know-how of the various aspects of application design, benchmarking and security on the Cloud.

Course Outcome:

CO1:To understand the concepts and technologies involved in Cloud Computing.

CO2: To understand the concepts of various cloud services and their implementation in the Amazon, Microsoft and Google cloud computing platforms.

CO3:To understand the aspects of application design for the Cloud.

CO4:To understand the concepts involved in benchmarking and security on the Cloud.

CO5: To understand the way in which the cloud is used in various domains.

Units	Contents	Required Hours
I	Introduction to Cloud Computing:Définition of Cloud Computing – Characteristics of Cloud Computing – Cloud Models – Cloud Service Examples – Cloud-based Services and Applications. Cloud Concepts and Technologies:Virtualization – Load balancing – Scalability and Elasticity – Deployment – Replication – Monitoring – Software Defined Networking – Network FunctionVirtualization – MapReduce – Identity and Access Management	12
II	Cloud Services	12

	Compute Services: Amazon Elastic Computer Cloud - Google Compute Engine - Windows Azure Virtual Machines. Storage Services: Amazon Simple Storage Service - Google Cloud Storage - Windows Azure Storage **Database Services: Amazon Relational Data Store - Amazon Dynamo DB - Google Cloud SQL - Google Cloud Data Store - Windows Azure SQL Database - Windows Azure Table Service** **Application Services: Application Runtimes and Framework - Queuing Services - Email Services - Notification Services - Media Services** **Content Delivery Services: Amazon CloudFront - Windows Azure Content Delivery Network** **Analytics Services: Amazon Elastic MapReduce - Google MapReduce Service - Google BigQuery - Windows Azure HDInsight** **Deployment and Management Services: Amazon Elastic Beanstack - Amazon Cloud Formation** **Identity and Access Management Services: Amazon Identiy and Access Management - Windows Azure Active Directory** **Open Source Private Cloud Software: CloudStack – Eucalyptus - OpenStack**	
III	**Cloud Application Design: Introduction – Design Consideration for Cloud Applications – Scalability – Reliability and Availability – Security – Maintenance and Upgradation – Performance – Reference Architectures for Cloud Applications – Cloud Application Design Methodologies: Service Oriented Architecture (SOA), Cloud Component Model, IaaS, PaaS and SaaS Services for Cloud Applications, Model View Controller (MVC), RESTful Web Services – Data Storage Approaches: RelationalApproach (SQL), Non-RelationalApproach (NoSQL).**	**17**
IV	**Cloud Application Benchmarking and Tuning:Introduction to Benchmarking – Steps in Benchmarking – WorkloadCharacteristics – Application Performance Metrics – Design Consideration for**	**12**

	Benchmarking Methodology – Benchmarking Tools and Types of Tests – DeploymentPrototyping.	
V	**Cloud Security:Introduction – CSA Cloud Security Architecture – Authentication (SSO) – Authorization – Identity and Access Management – Data Security : Securing data at rest, securing data in motion – Key Management – Auditing.** **Case Studies : Cloud Computing for Healthcare – Cloud Computing for Energy Systems - Cloud Computing for Transportation Systems**	**12**

Learning Resources:

- **Recommended Texts**

  1. **Arshdeep Bahga, Vijay Madisetti, *Cloud Computing – A Hands On Approach*, Universities Press (India) Pvt. Ltd., 2018.**

- **Reference Books**

  1. **Anthony T Velte, Toby J Velte, Robert Elsenpeter, *Cloud Computing: A Practical Approach*, Tata McGraw-Hill, 2013.**
  2. **Barrie Sosinsky, *Cloud Computing Bible*, Wiley India Pvt. Ltd., 2013.**
  3. **David Crookes, *Cloud Computing in Easy Steps*, Tata McGraw Hill, 2012.**
  4. **Dr. Kumar Saurabh, *Cloud Computing*, Wiley India, Second Edition 2012.**

Web resources: Web resources from NDL Library, E-content from open-source libraries

DEEP LEARNING	

Unit I: Basics of artificial neural networks (ANN): Artificial neurons, Computational models of neurons, Structure of neural networks, Functional units of ANN for pattern recognition tasks -Feed forward neural networks: Pattern classification using perceptron, Multilayer Feed forward neural networks (MLFFNNs), Backpropagation learning, Empirical risk minimization, Regularization, Autoencoders

Unit II: Deep neural networks (DNNs): Difficulty of training DNNs, Greedy layer wise training, Optimization for training DNNs, Newer optimization methods for neural networks (AdaGrad, RMSProp, Adam), Second order methods for training, Regularization methods (dropout, drop connect, batch normalization)

Unit III: Convolution neural networks (CNNs): Introduction to CNNs – convolution, pooling, Deep CNNs, Different deep CNN architectures – LeNet, AlexNet, VGG, PlacesNet, training a CNNs: weights initialization, batch normalization, hyperparameter optimization, Understanding and visualizing CNNs.

Unit IV: Recurrent neural networks (RNNs): Sequence modeling using RNNs, Backpropagation through time, Long Short Term Memory (LSTM), Bidirectional LSTMs, Bidirectional RNNs, Gated RNN Architecture - Generative models: Restricted Boltzmann Machines (RBMs), Stacking RBMs, Belief nets.

Unit V: Learning sigmoid belief nets, Deep belief nets Under complete - Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders.

Applications: Applications in vision, speech and natural language processing

Recommended Texts:

1. S. Haykin, Neural Networks and Learning Machines , Prentice Hall of India, 2016

2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, " Deep Learning", MIT Press, 2017

Reference Books:

1. Satish Kumar, Neural Networks - A Class Room

2. B. Yegnanarayana, Artificial Neural Networks, Prentice- Hall of India, 1999

3. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.

4. Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017.

5. Francois Chollet "Deep Learning with Python", Manning Publications, 2017.

Semester VI

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst.	Marks		
									CIA	External	Total
	Data Analytics using R	Core	4	1	-	-	4	5	25	75	100

Course Objective	
C1	To understand the problem solving approaches
C2	To learn the basic programming constructs in R Programming
C3	To learn the basic programming constructs in R Programming
C4	To use R Programming data structures - lists, tuples, and dictionaries.
C5	To do input/output with files in R Programming.

UNIT	Contents
I	INTRODUCTION – R Studio, R data types and objects, reading and writing data, sub setting R Objects, Essentials of the R Language, Installing R, Running R, Packages in R, Calculations, Complex numbers in R, Rounding, Arithmetic, Modulo and integer quotients, Variable names and assignment, Operators, Integers, Factors, Logical operations
II	CONTROL STRUCTURES AND VECTORS -Control structures, functions, scoping rules, dates and times, Introduction to Functions, preview of Some Important R Data Structures, Vectors, Character Strings, Matrices, Lists, Data Frames, Classes Vectors: Generating sequences, Vectors and subscripts, Extracting elements of a vector using subscripts, Working with logical subscripts, Scalars, Vectors, Arrays, and Matrices, Adding and Deleting Vector Elements, Obtaining the Length of a Vector, Matrices and Arrays as Vectors Vector Arithmetic and Logical Operations, Vector Indexing, Common Vector Operations
III	LISTS- Lists: Creating Lists, General List Operations, List Indexing Adding and Deleting List Elements, Getting the Size of a List, Extended Example: Text Concordance Accessing List Components and Values

	Applying Functions to Lists, Data Frames, Creating Data Frames, Accessing Data Frames, Other Matrix-Like Operations
IV	**FACTORS AND TABLES - Factors and Levels, Common Functions Used with Factors, Working with Tables, Matrix/Array-Like Operations on Tables , Extracting a Sub table, Finding the Largest Cells in a Table, Math Functions, Calculating a Probability, Cumulative Sums and Products, Minima and Maxima, Calculus, Functions for Statistical Distributions R PROGRAMMING**
V	**OBJECT-ORIENTED PROGRAMMING S Classes, S Generic Functions, Writing S Classes, Using Inheritance, S Classes, Writing S Classes, Implementing a Generic Function on an S Class, visualization, Simulation, code profiling, Statistical Analysis with R, data manipulation**
	Total

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	**Work with big data tools and its analysis techniques.**	**PO1**
2	**Analyze data by utilizing clustering and classification algorithms.**	**PO1, PO3**
3	**Learn and apply different mining algorithms and recommendation systems for large volumes of data.**	**PO2, PO6**
4	**Perform analytics on data streams.**	**PO4, PO5, PO6**
5	**Learn NoSQL databases and management.**	**PO5, PO6**

Text Book

1	**Roger D. Peng," R Programming for Data Science ", 2012**
2	**Norman Matloff, "The Art of R Programming- A Tour of Statistical Software Design", 2011**

Reference Books

1.	**Garrett Grolemund, Hadley Wickham,"Hands-On Programming with R: Write Your Own Functions and Simulations" , 1st Edition, 2014**
2.	**Venables ,W.N.,andRipley,"S programming", Springer, 2000.**

Web Resources

1.	**https://www.simplilearn.com**

Mapping with Programme Outcomes:

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	3	3
CO2	3	3	2	3	2	2
CO3	3	2	3	3	3	2
CO4	3	2	3	2	3	3
CO5	2	3	3	3	3	3
Weightage of course contributed to each PSO	14	13	14	14	14	13

S-Strong-3 M-Medium-2 L-Low-1

	Software Engineering		Credits:
Lecture Hours:(L) per week: 5	**Tutorial Hours: (T)per week**	**Lab Practice Hours: (P)per week**	**Total:(L+T+P) per week: 5**

Learning Objectives:

To understand the software engineering concepts and to create a system model in real life applications

Course Outcome:

CO1: Gain basic knowledge of analysis and design of systems

CO2: Ability to apply software engineering principles and techniques

CO3: Model a reliable and cost-effective software system

CO4: Ability to design an effective model of the system

CO5: Perform Testing at various levels and produce an efficient system.

Units	Contents	Required Hours
I	Introduction: The software engineering discipline, programs vs. software products, why study software engineering, emergence of software engineering, Notable changes in software development practices, computer systems engineering. Software Life Cycle Models: Why use a life cycle model, Classical waterfall model, iterative waterfall model, prototyping model, evolutionary model, spiral model, comparison of different life cycle models.	**15**
II	**Requirements Analysis and Specification:** Requirements gathering and analysis, Software requirements specification (SRS) **Software Design**: Good software design, cohesion and coupling, neat arrangement, software design approaches, object- oriented vs function-oriented design	**15**
III	Function-Oriented Software Design: Overview of SA/SD methodology, structured analysis, data flow diagrams (DFD's), structured design, detailed design.	**15**

	User-Interface design: Characteristics of a good interface; basic concepts; types of user interfaces; component based GUI development, a user interface methodology.	
IV	Coding and Testing: Coding; code review; testing; testing in the large vs testing in the small; unit testing; black-box testing; white-box testing; debugging; program analysis tools; integration testing; system testing; some general issues associated with testing. Software Reliability and Quality Management: Software reliability; statistical testing; software quality; software quality management system; SEI capability maturity model; personal software process.	**15**
V	Computer Aided Software Engineering: CASE and its scope; CASE environment; CASE support in software life cycle; other characteristics of CASE tools; towards second generation CASE tool; architecture of a CASE environment. Software Maintenance: Characteristic of software maintenance; software reverse engineering; software maintenance process models; estimation of maintenance cost;	**15**

Learning Resources:

- **Recommended Texts**

1. Rajib Mall, Fundamentals of Software Engineering, Fifth Edition, Prentice-Hall of India, 2018

- **Reference Books**

1. Richard Fairley, Software Engineering Concepts, Tata McGraw-Hill publishing company Ltd, Edition 1997.
2. Roger S. Pressman, Software Engineering, Seventh Edition, McGraw-Hill.
3. James A. Senn, Analysis & Design of Information Systems, Second Edition, McGraw-Hill International Editions.

Data Analytics using R Laboratory		
Course Objective		
C1	To understand problem solving approaches	
C2	To learn the basic programming constructs in R Programming	
C3	To practice various computing strategies for R Programming -based solutions to real world problems	
C4	To use R Programming data structures - lists, tuples, and dictionaries.	
C5	To do input/output with files in R Programming.	
Sl. No	Contents	
1.	convert the given temperature from Fahrenheit to Celsius and vice versa depending upon user's choice.	
2.	find the area of rectangle, square, circle and triangle by accepting suitable input parameters from user.	
3.	Write a program to find list of even numbers from 1 to n using R-Loops.	
4.	Create a function to print squares of numbers in sequence.	
5.	join columns and rows in a data frame using cbind() and rbind()	
6.	Implement different String Manipulation functions	
7.	Implement different data structures (Vectors, Lists, Data Frames)	
8	Write a program to read a csv file and analyze the data in the file	
9	Create pie chart and bar chart for a data set	
10	Create a data set and do statistical analysis on the data	
11	Program to find factorial of the given number using recursive function	
12	count the number of even and odd numbers from array of N numbers.	
Course Outcomes		Program Outcome
CO	On completion of this course, students will	

1	Acquire programming skills in core R Programming	PO1,PO4,PO5
2	Acquire Object-oriented programming skills in R Programming.	PO1, PO4,PO6
3	Develop the skill of designing graphical-user interfaces (GUI) in R Programming	PO1,PO3,PO6
4	Acquire R Programming skills to move into specific branches	PO3,PO4
5		PO1,PO5,PO6
Text Book		
1	Roger D. Peng," R Programming for Data Science ", 2012	
2	Norman Matloff, "The Art of R Programming- A Tour of Statistical Software Design", 2011	
Reference Books		
1	Garrett Grolemund, Hadley Wickham,"Hands-On Programming with R: Write Your Own Functions and Simulations" , 1st Edition, 2014	
2.	Venables ,W.N., and Ripley,"S programming", Springer, 2000.	
Web Resources		
1.	https://www.simplilearn.com	

	Project	**Credits:**
	Year Semester:	

Units	**Contents**	**Required Hours**
	Students (Individual or maximum three in a group) will take a specific problem for the Project and solve it using any one of latest tool and submit a report. **Further each student will participate in regular project review with group project guide / Faculty.**	

CourseCode	Robotics and Its Applications	

Learning Objectives:

- **To make the students familiar with the various drive systems of robots, sensors and their applications in robots**
- **To introduce the parts of robots, basic working concepts and types of robots**

Course Outcomes:

CO1:Describe the different physical forms of robot architecture

CO2: Kinematically model simple manipulator and mobile robots

CO3:Mathematically describe a kinematic robot system.

CO4: Analyze manipulation and navigation problems using knowledge of coordinate frames, kinematics, optimization, control, and uncertainty.

CO5: Program robotics algorithms related to kinematics, control, optimization, and uncertainty.

Units	Contents	RequiredHours
I	**Introduction :Introduction, brief history, components of robotics, classification, workspace, work-envelop, motion of robotic arm, end-effectors and its types, service robot and its application, Artificial Intelligence in Robotics.**	1 2
II	**Actuators and sensors :Types of actuators, stepper-DC-servo-and brushless motors- model of a DC servo motor-types of transmissions-purpose of sensor-internal and external sensor-common sensors-encoders tachometers-strain gauge based force torque sensor-proximity and distance measuring sensors** **Kinematics of robots :Representation of joints and frames, frames transformation, homogeneous matrix, D-H matrix, Forward and inverse kinematics: two link planar (RR) and spherical robot**	1 2

	(RRP). Mobile robot Kinematics: Differential wheel mobile robot	
III	**Localization: Self-localizations and mapping - Challenges in localizations – IR based localizations – vision based localizations – Ultrasonic based localizations - GPS localization systems.**	**1 2**
IV	**Path Planning :Introduction, path planning-overview-road map path planning-cell decomposition path planningpotential field path planning-obstacle avoidance-case studies** **Vision system: Robotic vision systems-image representation-object recognition-and categorization-depth measurement- image data compression-visual inspection-software considerations**	**1 2**
V	**Application : Ariel robots-collision avoidance robots for agriculture-mining-exploration-underwater-civilian- and military applications-nuclear applications-space applications-Industrial robots-artificial intelligence in robots-application of robots in material handling-continuous arc welding-spot welding-spray painting-assembly operation-cleaning-etc.**	**1 2**

LearningResources:

- **Recommended Texts**

1. **Richared D.Klafter. Thomas Achmielewski and MickaelNegin, Robotic Engineering and Integrated Approach, Prentice Hall India-Newdelhi-2001**
2. **Saeed B.Nikku, Introduction to robotics, analysis, control and applications, Wiley-India, 2 nd edition 2011**

- **Reference Books**

1. Industrial robotic technology-programming and application by M.P.Groover et.al, McGrawhill2008

2. Robotics technology and flexible automation by S.R.Deb, THH-2009

- **Webresources**

GENERATIVE ARTIFICIAL INTELLIGENCE FOR DATA SCIENCE		
	Year Semester:	
Units	**Contents**	**Required Hours**
Unit I : Scope of Generative AI- Overview of generative models and their applications -Importance of Generative AI in various domains- Ethical considerations and challenges. Language Models and LLM Architectures: Language models and their role in AI **Unit II Understanding GPT (Generative Pre-trained Transformer): GPT and its significance - Pre-training and fine-tuning processes in GPT - Architecture and working of GPT models - ChatGPT: ChatGPT and its purpose - Training data and techniques for ChatGPT - Handling user queries and generating responses** **Unit III LangChain: Simplifying Development with Language Models - LangChain and its objectives - LangChain framework and its components - Streamlining application development using LangChain** **Unit IV Prompt Engineering: Enhancing Model Outputs - Significance of prompt engineering - Strategies for designing effective prompts- Techniques for controlling model behavior and output quality** **Unit V: The Future of Generative Modeling: The Transformer Positional Encoding Multihead Attention The Decoder Analysis of the Transformer BERT GPT-2 MuseNet Advances in Image Generation ProGAN Self-Attention GAN (SAGAN)**		
Textbooks: **1. Generative Deep Learning: A Practical Guide by David Foster, O'Reilly, 2019** **2. Applied Generative AI for Beginners: Practical Knowledge on Diffusion Models, ChatGPT, and Other LLMs by Akshay Kulkarni, Adarsha Shivananda, Anoosh Kulkarni and Dilip Gudivada, Springer, 2023** **3. Modern Generative AI with ChatGPT and OpenAI Models by Valentina Alto, 2023, O'Reilly** **Reference Books:** **1. Generative AI by Tom Taulli** **2. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville** **3. Generative Adversarial Networks: An Introductory Guide by Luke Metz** **4. Autoencoders: Neural Networks for Unsupervised Learning by Ian Goodfellow**		

Title of the Course	**HUMAN COMPUTER INTERACTION**
UNIT-I : Foundations: The Human: Introduction-Input-Output Channels- Memory. The Computer: Introduction- Text Entry Devices- Display Devices- Memory. The Interaction: Introduction – Models of Interaction-Frameworks and HCI Ergonomics-Interaction Styles-Elements of the WIMP Interface-Interactivity - The Context of the Interactions	
UNIT-II : Design Process: Design Basics- Introduction - Process- User Focus-Scenarios-Navigation Design- Screen Design and Layout-Interaction and Prototyping. Design Rules-Introduction- Principles to Support Usability-Guidelines-Golden Rules and Heuristics-HCI Patterns	
UNIT-III : Implementation Support: Introduction - Elements of Windowing Systems - Programming the Application- Using Toolkits-User Interface Management Systems. Evaluation Techniques: What is an Evaluation- Goal of Evaluation-Evaluation Through Expert Analysis-Choosing an Evaluation Method	
UNIT-IV : Universal Design: Introduction - Universal Design Principles-Designing for Diversity. User Support: Introduction-Requirements of User Support-Approaches to User Support-Adaptive Help Systems-Designing User Support Systems	
UNIT-V: Models: Cognitive Models: Introduction-Goals and Task-Linguistic Models-Challenge of Display Based System-Physical and Device Models - Cognitive Architectures	
Recommended Text	**Alan dix, Janet finlay, Gregory D. Abowd and Russell Beale,(2004),Human Computer Interaction, 3rd edition, Pearson Education**
Reference Books	**1. John C. Caroll, (2002), Human Computer Interaction in the new millennium, Pearson Education Jenny Preece, Yvonne Rogers, Helen Sharp (2019), Interaction Design: Beyond Human–Computer Interaction,fifth edition, John Wiley & Sons Inc.**

Website and e-Learning Source	1. http://courses.iicm.tugraz.at/hci/ 2. http://www.hcibook.com/hcibook/downloads/pdf/exercises.pdf 3. http://www.idemployee.id.tue.nl/g.w.m.rauterberg/lectures.html 4. http://user.medunigraz.at/andreas.holzinger/holzinger/papersen/HCI/Workshop/forISSEP%2 02005.pdf 5. http://universaldesign.ie/What-is-Universal-Design/The-7-Principles/

Title of the Course	**PATTERN RECOGNITION AND IMAGE ANALYSIS**

Course Outcome:

CO1. Get acquainted with natural language processing

CO2.ApplybasicalgorithmsinNLP

CO3.Understandthealgorithmicdescriptionofthemainlanguagelevels

CO4. Grasp basics of knowledge representation

CO5.Recognize patterns

UnitI **12hours**

IntroductiontoImageProcessing:Imageformation,imagegeometryperspective andothertransformation,stereoimagingelementsofvisualperception.Digital Image-sampling and quantization serial & parallel Image processing.

UnitII **12hours**

Image Restoration: Constrained and unconstrained restoration Wiener filter, motion blur remover, geometric and radiometric correction Image data compression-Huffman and other codes transform compression, predictive compression two tone Image compression, block coding, run length coding, and contour coding.

UnitIII **12hours**

Segmentation Techniques-thresh holding approaches, region growing, relaxation, line and edge detection approaches, edge linking, supervised and unsupervised classification techniques, remotely sensed image analysis and applications, Shape Analysis – Gestalt principles, shape number, moment Fourier and other shape descriptors, Skelton detection, Hough trans-form, topological and texture analysis, shape matching.

UnitIV **12hours**

Basics of pattern recognition, Design principles of pattern recognition system, Learning and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi squared test.

UnitV **12hours**

Statistical Pattern Recognition -Bayesian Decision Theory, Classifiers, Normal densityanddiscriminantfunctions,Parameterestimationmethods:Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods – Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization(EM),Hidden Markov Models(HMM),Gaussian mixture models.

TEXTBOOKS

- Digital Image Processing–Gonzalez and Wood, AddisonWesley,1993.
- Fundamental of Image Processing–Anil K. Jain, Prentice Hall of India.
- Pattern Classification–R.O.Duda ,P.E.Hartand D.G.Stork, Second Edition John Wiley, 2006

REFERENCE BOOKS

- Digital Picture Processing–Rosen feld and Kak, vol.I & vol .II, Academic,1982
- Computer Vision–BallardandBrown,PrenticeHall,1982
- An Introduction to Digital Image Processing–Wayne Niblack, Prentice Hall, 1986
- Pattern Recognition and Machine Learning–C.M.Bishop,Springer,2009.
- Pattern Recognition–S Theodoridis and K.Koutroumbas,4thEdition, Academic Press, 2009