XAVIER UNIVERSITY PATNA

Digha Aashiyana Road, XTTI Campus

School of Computer Science

Programme Structure 2025-2026
Bachelor of Computer Application (Data Science)
Based on Syllabus approved by AICTE

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College and Course Overview

BCA(Data Science) Course

Welcome to the undergraduate BCA (Data Science) course. This course provides an engaging and dynamic look at the cutting-edge field that is transforming how we use technology and perceive the world.

The four-year Bachelor of Science (BCA) in Data Science(DS) program prepares graduates to perform data-driven research employing statistical methods and artificial intelligence on various algorithmic approaches. Graduates of this course will gain a thorough understanding of data science, including how to analyze both quantitative and qualitative data and create innovative solutions. The concepts for seeing patterns and trends in data from a variety of industries, including *banking, manufacturing, retail, finance, healthcare, and more, will be used by the students. Both foundational and highly specialized areas are included in the extensive curriculum. The curriculum is designed in such a way that as students' progress through the program, the disciplines become increasingly specialized. The foundational courses in mathematics, statistics, computer programming, and databases comprise the first part of the course framework. After that, it progressively focused on the fields of data science, which include machine learning, big data analytics, data visualization, business intelligence, algorithms, and more. This allowed students to discover the potential of automation, AI, and analytics. After completing the course successfully, graduates will be able to comprehend and use data science principles using statistical as well as AI tools to solve problems in the real world.

Job Opportunities

Demand for analysts and data scientists is increasing daily. Various sectors have acknowledged its significance in the challenging environment. These days, the world is driven by massive data sets. The pandemic brought about a significant shift as both large and small businesses shifted to digital platforms to continue operating. In order to locate a useful set of data, these kinds of firms took advantage of this and processed all the data. Next, arrange and evaluate the information to create rational strategies for potential future developments. As a result, it is among the top paying

vocations in India and across the world. After BCA (Data science) students can pursue higher studies like MCA and MSc Data Science. The majority of graduates continue their studies by enrolling in advanced Master Computer Application courses. The career profiles that follow BCA (Data Science) are shown below; you can choose the one that interests you.

- Software Engineer
- Data Scientist
- Data Engineer
- Health Care Analyst
- Business Analyst
- Technical Team Leader
- Statistician
- Information Systems Manager
- Robotics Engineer
- Blockchain expert and many more.

Message from the Coordinator

Our BCA(Data Science) program is intended to give students the abilities and information required to succeed as professionals in the Data Science, Artificial Intelligence and IT domains. We provide a demanding curriculum that covers both the foundational subjects and more complex subjects including Big Data analytics, Statistical tools for data science, Data Visualization, Data ware Housing, Data Mining, Cloud computing, Data Security and Privacy, Artificial Intelligence, social network analysis etc.

We provide a variety of extracurricular activities and events in addition to our academic programs to give our students a holistic education. In addition to research projects, we encourage our students to take part in coding contests and hackathons. Additionally, we give students the chance to engage with entrepreneurs and industry professionals.

Additionally, our department fosters an innovative and entrepreneurial atmosphere. In addition to encouraging our students to create their own projects and ideas, we also offer them support and mentoring to help them make their ideas a reality. Additionally, we collaborate with prominent figures in the field and offer internships to our students so they can obtain practical experience.

Program Outcomes

Program Outcome(POs)

The Program Outcomes (POs) for the BCA in Data Science program from the provided document are as follows:

PO1: Apply in-depth knowledge of computer applications and data science to solve complex data-driven problems in real-world scenarios.

PO2: Develop proficiency in programming languages (java,Python,SQL, etc.), using statistical tools for data analysis and modelling.

PO3: Demonstrate the ability to collect, analyse, and visualize large datasets, drawing meaningful conclusions for business or research applications.

PO4: Communicate technical information effectively, both verbally and in writing, ensuring clarity when presenting data-driven insights**.**

PO5: Work collaboratively in multidisciplinary teams to solve complex problems in data science and related fields.

PO6: Apply comprehensive knowledge of computer applications and data science to solve complex data-driven problems in real-world scenarios.

Program Specific Outcomes(PSOs)

PSO1: Apply machine learning and data analytics techniques to extract insights from datasets.

PSO2: Develop data-driven solutions for domains like healthcare, finance, and marketing.

PSO3: Design and implement data science projects using programming tools and cloud platforms.

PSO4: Use advanced computational tools, cloud platforms, and big data technologies for data storage, processing, and analysis.

PSO5: Analyze data and make sound, evidence-based decisions to tackle industry challenges and drive innovation**.**

COURSE STRUCTURE & CREDIT DISTRIBUTION

GENERAL COURSE STRUCTURE & THEME

Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

Course code and definition:

Course code	Definitions
B	Bachelor
CA	Computer Application
DS	Data Science
L	Lecture
T	Tutorial
P	Practical
GN	General Course/ Common to both AI &ML and Data Science
C	Core/Major(CC)
E	Discipline Elective / Minor/Elective(DSE)
S	Skill Enhancement(SEC)
A	Ability Enhancement(AEC)
M	Multi-Disciplinary course(MDC)
V	Value added Courses(VAC)
I	Internship(IN)
O	Open Electives/Others(OE)
D	Dissertation with Research work

Course Name

Bachelor in Computer Application (Data Science),
Bachelor Computer Application (Data Science) Honours) and
Bachelor in Computer Application ((Data Science Honours with Research)

Course Level/Duration/System:

Undergraduate / Three or Four years/6 or 8 Semesters with multiple entry and exit. The following option will be made available to the students joining BCA Research Program:

a. **One year:** Under Graduate Certificate in Computer Application
b. **Two years**: Under Graduate Diploma in Computer Application
c. **Three years**: Bachelor in Computer Application (Data Science)

d. **Four years**: Bachelor in Computer Application with Honors: BCA (Honours) or Bachelor in Computer Application Honors with Research: BCA (Honours with Research)

Minimum Eligibility Criteria:

Minimum eligibility criteria for opting the course in the fourth year will be as follows:
BCA (Data Science Honours with Research): BCA Degree
1.**For BCA (Data Science Honours)**: BCA Degree
Note : The students who are eligible for BCA (Honours with Research) shall have choice to pursue either BCA (Honours) or BCA (Honours with Research).

BCA (DATA SCIENCE)

Credit Distribution

Credit Charts (Semester Wise)

Semesters	Discipline Specific Courses	Minor Course	Multi-disciplinary courses	Ability Enhancement Courses	Skill Enhancement Courses	Value added courses	Dissertation/ Research/ Intern-ship/online	Total Credits
I	5x2=10	4x1=4	3x1=3	2x1=2	-	2x1=2	-	21
II	5x1+4x1 +3x1=12	4x1=4	3x1=3	2x1=2	3x1=3	2x1=2	1x1=1*	27
III	5x2=10	4x1+2x1 =6	3x1=3	2x1=2	4x1=4	2x1=2	-	27
IV	5x2+3x1 =13	-	3x1=3	2x1=2	5x1=5	-	2x1=2	25
V	5x3=15	3x1=3	-	-	3x1=3	-	4x1=4	25
VI	5x1=5	5x2=10	-	-	-	-	6	21
Total	**65**	**27**	**12**	**8**	**15**	**6**	**13**	**146**
BCA (Data Science) Honours								
VII	5x1+3x1 =8	3x2=6	-	-	4x1=4	-	2x2=4	22
VIII	5x2=10	3x1=3	-	-	-	-	6	19
Total	**83**	**36**	**12**	**8**	**19**	**6**	**23**	**187**
BCA (Data Science) Honours with Research								
VII	4x1+5x1 =9	3x1=3			4x1=4		2x2=4	20
VIII	-	-	-	-	-	-	20	20
Total	**74**	**30**	**12**	**8**	**19**	**6**	**37**	**186**

Under Graduate Certificate in Computer Application	**Credit: 48**
Under Graduate Diploma in Computer Application	**Credit: 100**
Bachelor in Computer Application (Data Science)	**Credit: 146**
Bachelor in Computer Application with Honors: BCA (Data Scien0ce Honours)	**Credit: 187**
Bachelor in Computer Application with Honors: BCA (Data Science Honours withresearch)	**Credit: 186**

Core /Major Courses

Year	Semester	Course Code	Name of the course	Credit	Marks	
					CIA	EXTR
1.	I	BCAGN1C01T	Problem Solving Techniques Using C Language	3	40	60
		BCAGN1C01P	Problem Solving Lab Using C Language	2	40	60
		BCAGN1C02T	Computer Organization And Architecture	3	40	60
		BCAGN1C02P	Computer Organization And Architecture	2	40	60
	II	BCAGN2C03T	Operating System	3	40	60
		BCAGN2C03P	Operating System Lab	1	20	30
		BCAGN2C04T	Object Oriented Programming Using Java	3	40	60
		BCAGN2C04P	Java Programming Lab	2	40	60
		BCAGN2C05T	Software Engineering	3	40	60
2.	III	BCADS3C06T	Relational Database Management System	3	40	60
		BCADS3C06P	RDBMS Lab	2	40	60
		BCADS3C07T	Data Structure	3	40	60
		BCADS3C07P	Data Structure Lab	2	40	60
	IV	BCADS4C08T	Computer Network	4	40	60
		BCADS4C08P	Computer Network Lab	1	20	30
		BCADS4C09T	Design And Analysis of Algorithm	3	40	60
		BCADS4C10T	Artificial Intelligence	3	40	60
		BCADS4C10P	Artificial Intelligence Lab	2	40	60
3	V	BCADS5C11T	Introduction to Data Science	3	40	60
		BCADS5C11P	Data Science Lab	2	40	60
		BCADS5C12T	Time Series Analysis	3	40	60
		BCADS5C12P	Time Series Analysis Lab	2	40	60
		BCADS5C13T	Machine Learning	3	40	60
		BCADS5C13P	Machine Learning Lab	2	40	60
	VI	BCADS6C14T	Big Data Analysis	3	40	60
		BCADS6C15P	Big Data Analysis Lab	2	40	60
	(Data Science Honours)					
4	VII	BCADS7C16T	Advance Statistical Method for Data Science	3	40	60
		BCADS7C17T	Python for Data Science	3	40	60
		BCADS7C17P	Adv Data Science Lab	2	40	60
	VIII	BCADS8C18T	Advance Data Visualization	3	40	60
		BCADS8C18P	Data Visualization Lab	2	40	60
		BCADS8C19T	Cloud Computing for Data Analysis	3	40	60
		BCADS8C19P	Cloud Computing for Data Analysis Lab	2	40	60
	(Data Science Honours with Research)					

4	VII	BCADS8C16T	Advance Data Analysis Tools	3	40	60
		BCADS8C16P	Advance Data Analysis Lab	2	40	60
		BCADS8C17P	Research Methodology	4	40	60

Minor/Elective Course

Year	Semester	Course Code	Name of the course	Credit	Marks	
					CIA	EX TR
1	I	BCAGN1E01T	Mathematical Foundation to Computer Science	4	40	60
	II	BCAGN2E02T	Mathematical Foundation to Computer Science II	4	40	60
2	III	BCADS3E03T	Probability And Statistics	4	40	60
		BCADS3E04T	Basic of Data Analysis Using Spread Sheet	2	20	30
	IV		----------			
3	V	BCADS5E05T	R Programming	3	40	60
	VI	BCADS6E06T	Generative AI	3	40	60
		BCADS6E06P	Generative AI Lab	2	40	60
		BCADS6E07T	Exploratory Data Analysis	3	40	60
		BCADS6E07P	Exploratory Data Analysis Lab	2	40	60
(Data Science Honours)						
4	VII	BCADS7E08T	Business Intelligence And Analytics	3	40	60
		BCADS7E09T	Research Methodology for Computer Science	3	40	60
	VIII	BCADS8E10T	Data Security and Privacy	3	40	60
(Data Science Honours with Research)						
	VII	BCADS7R08T	Research Internship	3	40	60

Ability Enhancement Courses

Year	Semester	Course Code	Name of the course	Credit	Marks	
					CIA	EXTR
1	I	BCAGN1A01T	Functional English	2	20	30
	II	BCAGN2A02T	Advance Communication and Soft Skill	2	20	30
2	III	BCADS3A03T	Hindi I	2	20	30
	IV	BCADS4A04T	German/Korean Language/HindiII	2	20	30

Skill Enhancement Courses

Year	Semester	Course Code	Name of the course	Credit	Marks	
					CIA	EXTR
1	II	BCAGN2S01T	Web Technology	2	20	30
		BCAGN2S01P	Web Technology Lab	1	20	30
2	III	BCADS3S02T	Python Programming	2	20	30
		BCADS3S02P	Python Programming Lab	2	20	30
	IV	BCADS4S03T	Data Visualization	2	20	30
		BCADS4S03P	Data Visualization Lab	1	20	30
3	V	BCADS5S04P	Capstone project/Mini Project	3	40	60
4	VII	BCADS7S05T	Data Mining & Data Warehousing **(Honours)**	4	40	60
	VII	BCADS7S05T	Data Mining & Data Warehousing**(Honours with Research)**	4	40	60

Multi-Disciplinary Courses

Year	Semester	Course Code	Name of the course	Credit	Marks	
					CIA	EXTR
1	I	BCAGN1M01T	Indian Knowledge System	3	40	60
2	II	BCAGN2M02T	Digital Content Creation	3	40	60
3	III	BCAGN3M03T	Organizational Behavior	3	40	60
4	IV	BCAGN4M04T	Entrepreneurship And Innovation	3	40	60

Value Added Courses

Year	Semester	Course Code	Name of the course	Credit	Marks	
					CIA	EXTR
1	I	BCAGN1V01T	Environmental Study	3	40	60
	II	BCAGN2V02T	Indian Constitution	3	40	60
2	III	BCAGN3V03T	Yoga And Wellness	3	40	60

Internship/Project

Year	Semester	Course Code	Name of the course	Credit	Marks	
					CIA	EXTR
1	I	BCAGNO01T	Social Service	No credit		

	II	BCAGN2O02P	Online course on Scripting Language(NPTEL, Coursera , EDX)	1	25	
2	IV	BCADS4O03P	Online course on Statistical tools(NPTEL, Coursera , EDX)	2	50	
3	V	BCADS5I01P	Internship	4	40	60
	VI	BCADS6C02P	Major Project on Data Analysis	6	60	90
(Data Science Honours)						
4	VII	BCADS7D03P	Synopsis of Dissertation work (Will be evaluated in 8th Semester)	2	20	30
	VIII	BCADS8D04P	Dissertation Work (Started in Seventh Semester)	6	60	90
(Data Science Honours with Research)						
4	VII	BCADS7S01P	Synopsis of Dissertation work (will be evaluated in 8th semester)	2	20	30
	VIII	BCADS8D22P	Dissertation (for research track)	20	120	180

DETAIL SYLLABUS

SEMESTER I

First Semester							
Sl No	**Component**	**Course Code**	**Title of The course**	**Credit**		**Hour Per Week**	
				TH	**P**	**Theory**	**Practical**
1	**Major Core**	BCAGN1C01T	Problem Solving Techniques Using C Language	3		3	
2	**Major Core**	BCAGN1C01P	Problems solving Lab using C		2		4
3	**Major Core**	BCAGN1C02T	Computer Organization And Architecture	4		4	
4	**Major Core**	BCAGN1C02P	Computer Organization And Architecture		1		2
5	**Minor Core**	BCAGN1E01T	Mathematical Foundation to Computer Science	4		4	
6	**MDC**	BCAGN1M01T	Indian Knowledge System	3		3	
7	**AEC**	BCAGN1A01T	Functional English	2		2	
8	**Value Based**	BCAGN1V06T	Environmental Study	2		3	
9	**Community Engagement**	BCAGN1O07T	Social Service	-		-	
			Total Credit	21		Total Hours-25	

Semester 1	**Problem Solving Technique using C**	**C**	**L**	**T**	**P**
Course Code: BCAGN1C01T	Total Teaching Hours: 48	**5**	**3**	**0**	**2**

COURSE OUTCOMES

At the end of the course learners will be able to		
CO1	Understand basic terminology of computers, problem solving, programming Languages and their evolution.	Understand
CO2	Create specification from problem requirements by asking questions to disambiguate the requirement statement.	Create
CO3	Design the solution from specification of a problem and write pseudo code of the algorithm using basic building blocks or structured programming constructs (Sequence, Selection and Repetition statement).	Create
CO4	apply C language features such as pointers, dynamic memory allocation, and file I/O to implement advanced programming functionalities	Create
CO5	Translate an algorithm into a C computer program	Analyze
CO6	Testing and analyzing programs using debugging tools.	Analyze

Prerequisite: This is an introductory programming course and hence no prerequisites

DETAIL SYLLABUS

Unit I	Problems And Problem Instances, Generalization and Special Cases, Types of Computational Problems, Classification of Problems, Analysis of Problems, Solution Approaches, Algorithm Development, Analysis of Algorithm, Efficiency, Correctness, Role of Data Structures in Problem Solving, Problem-Solving Steps (Understand the Problem, Plan, Execute, And Review), Breaking the Problem into Subproblems, Input/Output Specification, Input Validation, Pre and Post Conditions.	**12**

Unit II	Structured Programming Concepts: Sequence (Input/Output/Assignment), Selection (If, If-Else) And Repetition (For, While, Do-While) Statements, Control Structure Stacking and Nesting. Different Kinds of Repetitions: Entry Controlled, Exit Controlled, Counter Controlled, Definite, Indefinite and Sentinel-Controlled Repetitions. Pseudocode and Flowcharts. Definition And Characteristics of Algorithms, Standard Algorithm Format. Problems Involving Iteration and Nesting: Displaying Different Patterns and Shapes Using Symbols and Numbers, Generating Arithmetic and Geometric Progression, Fibonacci and Other Sequences, Approximate Values For π, Sin(x), Cos(x), Etc. Using Taylor Series. Different Kinds of Data in The Real World and How They are Represented in The Computer Memory. Representation of Integers: Signed Magnitude Form, 1's Complement And 2's Complement. C Language: Introduction To Programming Languages, Different Generations of Programming Languages. Typed Vs Typeless Programming Languages, History of C Language, An Empty C Program. C Language Counterparts For Input (scanf()), Output (printf()) Statements, Assignment, Arithmetic, Relational and Logical Operators. If, If-Else Statements, For, While, Do-While Statements. Data Types. Translating Pseudocode/Algorithm to C Program. Incremental Compilation and Testing of The C Program. Simple Problems Involving Input, Output, Assignment Statement, Selection and Repetition. Good Coding Practices.	**12**
Unit III	Problems on Numbers: Extracting Digits of a Number (Left to Right and Right to Left), Palindrome, Prime Number, Prime Factors, Amicable Number, Perfect Number, Armstrong Number, Factorial, Converting Number from One Base to Another. Statistics (Maximum, Minimum, Sum and Average) on a Sequence of Numbers which are Read using Sentinel- Controlled Repetition using only a few Variables. C Language: else-if Ladder, switch Case, Increment/Decrement Operators, break and continue Statements.	**12**
Unit IV	Modular Programming, Top-Down and Bottom-Up Approaches to Problem Solving. Recursion. Problems on Arrays: Reading and Writing of Array Elements, Maximum, Minimum, Sum, Average, Median and Mode. Sequential And Binary Search. Any one Sorting Algorithm. Matrix Operations. C Language: Function Definition and Declaration (Prototype), Role of Return Statement, One Dimensional and Two-Dimensional Arrays. String Functions. Other Operators, Operator Precedence and Associativity. Debugging.	**12**

Text Books and Reference Books	
Text Books	1. Venkatesh, N. Y. (2024). Practical C programming for problem solving. Khanna Book Publishing Company. 2. AICTE. (2024). Programming for problem solving (with lab manual). Khanna Book Publishing Company. 3. Deitel, H., & Deitel, P. (2015). C: How to program (9th ed.). Pearson India. Dromey, R. G. (n.d.). How to solve it by computer
Reference Books	**1.** Kernighan, B. W., & Ritchie, D. (2015). The C programming language (2nd ed.). Pearson. **2.** Hanly, J., & Koffman, E. (2015). Problem solving and program design in C (8th ed.). Pearson.

Problem Solving Techniques: Lab Problems COURSE CODE: BCAGN1C01P

1. Converting degrees Celsius to Fahrenheit and vice versa?
2. Display three input numbers in sorted (non-decreasing) order?
3. Given a positive integer value n (>= 0) display number, square and cube of numbers from 1 to n in a tabular format?
4. Given an input positive integer number, display odd numbers from in the range [1,n]?
5. Display first mathematical tables, each table up to 10 rows? Generalize this to display first n (> 0) mathematical tables up to m (m > 0) rows?
6. Given the first term (a), difference/multiplier (d) and number of terms (n > 0), display the first n terms of the arithmetic/geometric progression?
7. Display the first n (n > 0) terms of the fibonacci sequence?
8. Display the first n (n > 0) terms of the Tribonacci sequence?
9. Given two positive integer numbers n1 and n2 check if the numbers are consecutive numbers of the fibonacci sequence?
10. Compute approximate value of π considering first n (n > 0) terms of the Taylor series for π?
11. Compute approximate value of e^x considering first n (n > 0) terms of the Taylor series for e^x?
12. Extract digits of an integer number (left to right and right to left)?
13. Given a sequence of digits form the number composed of the digits. Use sentinel controlled repetition to read the digits followed by -1. For example, for the input 2 7 3 2 9 -1 the output number is 27329?
14. Check if a given positive integer number is a palindrome or not?
15. Compute character grade from the marks (0 ≤ marks ≤ 100) of a subject. Grading Scheme: 80-100: A, 60 - 79: B, 50 - 59: C, 40-49: D, 0-39: F? Solve this using both else-if ladder and switch case?

16. Compute the sum of a sequence of numbers entered using sentinel controlled repetition?
17. Check if a given positive integer number is a prime number or not?
18. Compute prime factors of a positive integer number?
19. Check if two positive integer numbers are amicable numbers or not?
20. Check if a given positive integer number is a perfect number or not?
21. Check if a given positive integer number Armstrong number or not?
22. Converting a positive integer number (n > 0) from one base (inputBase) to another base (outputBase) (2 <= input Base, outputBase <= 10). Input number should be validated before converting to make sure the number uses only digits allowed in the input base?
23. Write a program to display a number in text form. For example If the number is 5432 the output should be "FIVE FOUR THREE TWO"?
24. Design a modularized algorithm/program to check if a given positive integer number is a circular prime or not?
25. Design a modularized algorithm/program to compute a maximum of 8 numbers?
26. Design a modular algorithm/program which reads an array of n integer elements and outputs mean (average), range (max-min) and mode (most frequent elements)?
27. Design a modular algorithm/program which reads an array of n integer elements and outputs median?
28. Implement your own string length and string reversal functions?
29. Design algorithm/program to perform matrix operations addition, subtraction and transpose?
30. Write a recursive program to count the number of digits of a positive integer number?
31. Recursive solutions for the following problems:
    a. Factorial of a number?
    b. Display digits of a number from left to right (and right to left)?
    c. Compute x^y using only multiplication?
    d. To print a sequence of numbers entered using sentinel controlled repetition in reverse order?

Semester 1	Computer Organization & Architecture	C	L	T	P
Course Code: BCAGN1C02T	Total Teaching Hours: 60	5	4	0	1

COURSE OUTCOMES

At the end of the course learners will be able to		
CO1	To Understand the basics of Digital Electronics and Binary Number System.	Understand
CO2	To Learn the implementation of Combinational Circuit.	Create
CO3	To Learn the implementation of Sequential Circuit.	Create
CO4	To Understand the Organization of basic computers.	Understand
CO5	To Understand the concept of Parallel Processing and Memory organization	Analyze

Prerequisite: This is an introductory programming course and hence no prerequisites

SYLLABUS

Unit I	**Digital Principles:** Definition for Digital signals, Digital logic, Digital computers, Von Neumann Architecture, Boolean Laws and Theorems, K-Map: Truth Tables to K-Map, 2, 3 and 4 variable K Map, K-Map Simplifications, Don't Care Conditions, SOP and POS. **Number Systems:** Decimal, Binary, Octal, Hexadecimal, Number System Conversions, Binary Arithmetic, Addition and subtraction of BCD, Octal Arithmetic, Hexadecimal Arithmetic, Binary Codes, Decimal Codes, Error detecting and correcting codes, ASCII, EBCDIC, Excess- 3 Code, The Gray Code.	**15**
Unit II	**Combinational Circuits:** Half Adder and Full Adder, Subtractor, Decoders, Encoder, Multiplexer, Demultiplexer **Sequential Circuits:** Flip-Flops- SR Flip- Flop, D Flip-Flop, J-K Flip-Flop, T Flip-Flop. Counter Design using various Flip Flop **Register:** 4 bit register with parallel load, Shift Registers- Bidirectional shift register with parallel load Binary Counters-4 bit synchronous and Asynchronous binary counter	**15**
Unit III	Basic Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instructions, Input- Output Interrupt, Complete Computer Description, Design of Basic Computer, Design of Accumulator logic. Central Processing Unit: Introduction, General	**12**

	Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer(RISC), RISC Vs CISC.	
Unit IV	Pipeline and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, RISC Pipeline. Input-Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous data transfer, Modes of Transfer, Priority Interrupt, Direct memory Access, Input-Output Processor(IOP). Memory Organization: Memory Hierarchy, Main Memory, Auxiliary memory, Associate Memory, Cache Memory, Virtual Memory, Memory Management Hardware. Architecture of 8086 microprocessor and its various addressing mode. Instruction set architecture	**18**

Text Books and Reference Books

Text Books	1. Leach, D. P., Malvino, A. P., & Saha, G. (2011). Digital principles & applications. Tata McGraw Hill Education Private Limited. 2. Mano, M. M. (n.d.). Computer system architecture (3rd ed.). Pearson/PHI.
Reference Books	1. Stallings, W. (n.d.). Computer organization and architecture (6th ed.). Pearson/PHI. 2. Tanenbaum, A. S. (n.d.). Structured computer organization (4th ed.). PHI Pearson. 3. Subramanyam, M. V. (n.d.). Switching theory and logic design. Laxmi Publications (P) Ltd. 4. Singh, I. (n.d.). Computer organization architecture. Khanna Book Publishing.

Computer Organization & Architecture: Lab Problems
COURSE CODE : BCAGN1C02P

1. Verify logic behavior of AND, OR, NAND, NOR, EX-OR, EX-NOR, Invert and Buffer gates.
2. To study and verify NAND as a Universal Gate
3. To verify De- Morgan's theorem for 2 variables
4. Design and test of an S-R flip-flop using NAND/NOR gate.
5. Convert BCD to Excess-3 code using NAND gate
6. To Convert Binary to Grey Code
7. Verification of Truth Tables of J-K Flip-Flop using NAND/NOR gate
8. Realize Decoder and Encoder circuit using Basic Gates.
9. Design and implement the 4:1 MUX using gates.
10. Implementation of 4-Bit Parallel Adder Using 7483 IC.
11. Design and verify operation of half adder and full adder.
12. Design and verify operation of half subtractor.
13. Design and Implement a 4 bit shift register using Flip flops.
    Implement Boolean function using logic gates in both SOP and POS
14. Design and Implement a 4 bit synchronous counter.
15. Design and verify 4 bit asynchronous counter.

Semester 1	Mathematical Foundation of Computer Science	C	L	T	P
Course Code: BCAGN1E01T	Total Teaching Hours: 60	4	4	0	0

COURSE OUTCOMES

At the end of the course learners will be able to		
CO1	Provide a basic understanding of fundamental mathematical concepts such as sets, functions, matrix algebra, and discrete mathematics	Understand
CO2	This course enables the students to use mathematical models and techniques to analyze and understand problems in computer science.	Analyze
CO3	This course demonstrates how the mathematical principles give succinct abstraction of computer science problems and help them to efficiently analyze.	Analyze
CO4	To use algebraic mathematics in computer science	Understand
CO5	Use of discrete mathematics in computer science	Analyze

Prerequisite: Knowledge of basics of mathematics

DETAIL SYLLABUS

Unit I	**Set, Relation and Function:** Set, Set Operations, Properties of Set operations, Subset, Venn Diagrams, Cartesian Products. Relations on a Set, Properties of Relations, Representing Relations using matrices and digraphs, Types of Relations, Equivalence Relation, Equivalence relation and partition on set, Closures of Relations, Warshall's algorithm. Functions, properties of functions (domain, range), composition of functions, surjective (onto), injective (one-to-one) and bijective functions, inverse of functions. Some useful functions for Computer Science: Exponential and Logarithmic functions, Polynomial functions, Ceiling and Floor functions.	**18**

Unit II	**Counting and Recurrence Relation:** Basics of counting, Pigeonhole principle, permutation, combination, Binomial coefficients, Binomial theorem. Recurrence relations, modelling recurrence relations with examples, like Fibonacci numbers, the tower of Hanoi problem. Solving linear recurrence relation with constant coefficients using characteristic equation roots method.	**15**
Unit III	**Elementary Graph Theory:** Basic terminologies of graphs, connected and disconnected graphs, subgraph, paths and cycles, complete graphs, digraphs, weighted graphs, Euler and Hamiltonian graphs. Trees, properties of trees, concept of spanning tree. Planar graphs. Definitions and basic results on the topics mentioned.	**15**
Unit IV	**Matrix Algebra:** Types of matrices, algebra of matrices–addition, subtraction, and multiplication of matrices, determinant of a matrix, symmetric and skew-symmetric matrices, orthogonal matrix, rank of a matrix, inverse of a matrix, applications of matrices to solve system of linear equations, Eigen values and Eigen vectors, Caley-Hamilton theorem.	**12**

Text Books and Reference Books

Text Books	1. Garg, R. (2024). Engineering mathematics. Khanna Book Publishing Company. (AICTE Recommended Textbook) Garg, R. (2023). Advanced engineering mathematics. Khanna Book Publishing Company.
Reference Books	1. Grimaldi, R. P., & Ramana, B. V. (2007). Discrete and combinatorial mathematics: An applied introduction (5th ed.). Pearson Education. 2. Rosen, K. H., & Krithivasan, K. (2019). Discrete mathematics and its applications. McGraw Hill India. 3. West, D. B. (2015). Introduction to graph theory (2nd ed.). Pearson Education.

Semester 1	Indian Knowledge System	C	L	T	P
Course Code: BCAGN1M01T	**Total Teaching Hours: 45**	**3**	**3**	**0**	**0**

0COURSE OUTCOMES

At the end of the course learners will be able to		
CO1	Identify and explain the origin, meaning, and scope of the Indian Knowledge System, including its ethical foundations and perspectives from major Indian and global religions.	0
CO2	Analyze the diverse cultural expressions of Indian Knowledge Systems such as classical and folk arts, music, architecture, cuisine, and clothing, and their relevance to Indian identity.	Analyze
CO3	Demonstrate an understanding of traditional Indian approaches to health and wellness through Yoga and Ayurveda, and their global impact and modern relevance.	Demonstrate
CO4	Evaluate the contributions of ancient India in science, mathematics, astronomy, medicine, and education, with reference to ancient universities and scholarly traditions.	Evaluate
CO5	Critically assess contemporary initiatives for the preservation and promotion of traditional Indian knowledge and propose methods to integrate them into modern systems.	Assess

Prerequisite:

SYLLABUS

UNIT-I: Indian Knowledge System: Tradition and its Promotion	**Topics:** • Indian Knowledge System: Origin Meaning and Scope • "Knowledge' in Hinduism, Buddhism, Jainism, Islam and Christianity • Yoga: Meaning and types of yoga • Initiatives to, preserve and promote traditional knowledge • Ethical foundations: Truth, Non-Violence, Karma	**10**
UNIT-II: Cultural Dimension of Indian Knowledge System	**Topics:** • Classical and folk-dance forms • Classical and vocal music and sangeet gharana • Painting, sculpture and architecture in ancient and mediaeval times • Sports and martial arts of India • Indian cuisine and clothes	**10**

UNIT-III: Education and Technology in Indian Knowledge System	**Topic:** • Science and Technology in Ancient India • Mathematics and Astronomy in Ancient India • Traditional knowledge of Indian medicine • Ancient universities: and their functioning India's Global Contributions: Yoga, Ayurveda, Numerals, Astronomy	**10**
Text Books and Reference Books		
Text Books	1. Mahadevan, B., Ramasubramanian, V., & Saraswati, S. A. S. (2022). Introduction to Indian knowledge system: Concepts and applications. PHI Learning. **2.** Nitonde, R. (2023). Introduction to Indian knowledge system: A textbook for UG students as per NEP 2020. Notion Press.	

Semester 1	Functional English	C	L	T	P
Course Code: BCAGN1A01T	Total Teaching Hours: 30	3	3	0	0

COURSE OUTCOMES

At the end of the course learners will be able to		
CO1	Understand and apply basic vocabulary, sentence structures, and paragraph organization.	Understand
CO2	Identify and correct grammatical errors in common usage.	Analyze
CO3	Demonstrate the ability to engage in everyday spoken conversations effectively.	Create
CO4	Develop listening comprehension skills through guided listening tasks.	Understand

Prerequisite: Basic Knowledge of English

SYLLABUS

Unit I	**Functional Grammar and Vocabulary Building** Topics: Grammar: Subject-verb agreement, article and preposition usage, Tense, Active and Passive, Narration; Common Errors: Misplaced modifiers, pronoun errors, redundancies and Vocabulary Building: Word Formation: Root Words | Prefixes | Suffixes; Synonyms, Antonyms, and Standard Abbreviations; Business Vocabulary: Corporate Terms | Finance & Accounting | Marketing & Sales | Human Resources |Operations & Strategy Startup/Innovation; Academic Vocabulary: Research & Writing | Critical Thinking | Essay/Report Writing | Presentation | Study Skills | Quantitative Terms | General Academic Use |Pronunciation Practice: Word and sentence stress | Connected speech (linking, elision, assimilation) | Common pronunciation errors | Listening to Different English Accents: Exposure to various accents (British, American, Indian, Australian) | **Class Activity:** 1. Participants may work in pairs or small groups to identify and correct grammar errors in sentences related to subject-verb agreement, tense usage, and active/passive voice. 2. The instructor may provide root words and ask participants to form new words using prefixes and suffixes. Then, introduce	**10**

	business terms from areas like marketing, finance, and human resources and have participants use them in sentences. 3. The course instructor may distribute paragraphs with common grammar errors (e.g., misplaced modifiers, redundancy, pronoun mistakes). Let the participants identify the errors and rewrite the sentences correctly.	
Unit II	**Basic Writing Skills** Sentence Construction: Basic sentence structure: Subject + Verb + Object (SVO) | Compound and complex sentences | Sentence fragments vs. run-on sentences; Paragraph Coherence: Topic sentence and supporting details | Coherence through logical flow | Unity in a paragraph: relevance of supporting idea; Punctuation: End punctuation: period, question mark, exclamation mark | Comma rules | Semicolons and colons | Quotation marks, parentheses, ellipses; Linking Devices: Coordinating conjunctions (for, and, nor, but, or, yet, so) | Subordinating conjunctions (although, because, unless, while) | Transitional phrases: in addition, however, consequently, etc	**10**
Unit III	**Reading Tips, Analysis and Practices** Comprehension strategies: skimming, scanning, inference; Reading short articles, essays, and fiction excerpts; Composition and its Types: Descriptive writing | Narrative writing | Argumentative writing | Expository writing	**10**

Text Books and Reference Books

Text Books	1. Church, P. (2010). *Added value: The life story of Indian business leaders: N. R. Narayan Murthy*. Lotus Roli.
Reference Books	1. Kumar, K. B. (2021). Effective communication skills. Khanna Book Publishing. 2. Swan, M. (2016). Practical English usage (4th ed.). Oxford University Press. 3. Zinsser, W. (2006). On writing well: The classic guide to writing nonfiction. Harper Perennial. 4. Hamp-Lyons, L., & Heasly, B. (2006). Study writing: A course in written English for academic purposes. Cambridge University Press. 5. Tiwari, A. (2021). Communication skills in English with lab manual (AICTE prescribed). Khanna Book Publishing. 6. Central Institute of English and Foreign Languages. (2006). Exercises in spoken English (Parts I–III). Oxford University Press.

Semester 1	Environmental Study	C	L	T	P
Course Code: BCAGN1V01T	Total Teaching hours: 45	3	3	0	0

COURSE OUTCOMES

At the end of the course learners will be able to		
CO1	Understand Historical Human-Environment Interactions, recognize the historical evolution of human relationships with the environment across time and regions.	Understand
CO2	Identify types, distribution, and uses of natural resources, with a focus on their status and management in India.	Analyze
CO3	Analyze resource availability and conservation, examine the factors affecting resource availability and evaluate methods for their conservation and sustainable management.	Analyze
CO4	Explain the principles, challenges, and global strategies associated with sustainable development.	Understand
CO5	Gain foundational knowledge of ecosystems, biodiversity, and the importance of conservation practices.	Analyze

Prerequisite:

SYLLABUS

Unit I	**Humans and the Environment** Introduction to Environmental Studies: Definition, Concept & Importance; Historical significance: Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change; Environmental Ethics and emergence of environmentalism: UN Conference on Human Environment 1972; Concept of sustainable development; Rio Summit and subsequent international efforts.	**5**
Unit II	**Natural Resources and Sustainable Development** Overview and definition of natural resources; Classification of natural resources- biotic and abiotic, renewable and non-renewable; Water resources: Types of water resources- fresh water and marine resources; Availability and use of water resources; Environmental impact of over-exploitation, issues and challenges; Water scarcity and stress; Soil and	**15**

	mineral resources: Important minerals; Mineral exploitation; Environmental problems due to extraction of minerals and use; Soil as a resource and its degradation. Energy resources: Sources of energy and their classification, renewable and non-renewable sources of energy; Conventional energy sources- coal, oil, natural gas, nuclear energy; Non-conventional energy sources- solar, wind, tidal, hydro, wave, ocean thermal, geothermal, biomass, hydrogen Implications of energy use on the environment	
Unit III	**- Conservation of Biodiversity and Ecosystems** Biodiversity and its distribution: Biodiversity as a natural resource; Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Species and ecosystem threat categories; Threats to biodiversity and ecosystems:; Commercial exploitation of species; Invasive species; Fire, disasters and climate change; Major conservation policies: in-situ and ex-situ conservation approaches.	**10**
Unit IV	**Environmental Pollution, Health, and Climate Change** Understanding pollution: Definition; Point sources and non-point sources of pollution; Air pollution: Sources of air pollution; Primary and secondary pollutants; National Ambient Air Quality Standards; Water pollution: Sources of water pollution; Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life; Soil pollution and solid waste; Noise pollution; Thermal and Radioactive pollution; Understanding climate change: Importance of 1.5 °C and 2.0 °C limits to global warming; Climate change projections for the Indian sub-continent; Mitigation of climate change; Green House Gas (GHG) reduction vs. sink enhancement.	**15**
Text Books and Reference Books		
Text Books	1. Adenle, A., Azadi, H., & Arbiol, J. (2015). Global assessment of technological innovation for climate change adaptation and mitigation in developing world. Journal of Environmental Management, 161(15), 261–275. 2. Ahluwalia, V. K. (2015). Environmental pollution and health. The Energy and Resources Institute (TERI). 3. Barnett, J., & O'Neill, S. (2010). Maladaptation. Global Environmental Change—Human and Policy Dimensions, 20, 211–213. 4. Bawa, K. S., Oomen, M. A., & Primack, R. (2011). Conservation biology: A primer for South Asia. Universities Press.	

SEMESTER -II

Second Semester							
Sl No	**Component**	**Course Code**	**Title of The course**	**Credit**		**Hr Per Week**	
				TH	**P**	**Theory**	**Practical**
1	**Major CC**	BCAGN2C03T	Operating System	3		3	
2	**Major CC**	BCAGN2C03P	Operating System Lab		2		2
3	**Major CC**	BCAGN2C04T	Object Oriented Programming Using Java	3		3	
4	**Major CC**	BCAGN2C04P	Java Programming Lab		2		4
5	**Major CC**	BCAGN2C05T	Software Engineering	3		3	
6	**Minor CC**	BCAGN2E02T	Mathematical Foundation to Computer Science -II	4		4	
7	**MDC**	BCAGN2M02T	Digital Content Creation	3		3	
8	**AEC**	BCAGN2A02T	Advanced Communication and Soft Skills	2		2	
9	**SEC**	BCAGN2S01T	Web Technology	2		2	
10	**SEC**	BCAGN2S01P	Web Technology Lab		1		2
11	**Value Based**	BCAGN2V02T	Indian Constitution	2		2	
12	**Mandatory**	BCAGN2O02P	Online course on Scripting Language(NPTEL, Coursera , EDX)	1			0
			Total Credit	27*		Total Hours-31	

Semester 2	Operating Systems	C	L	T	P
Course Code: BCAGN2C03T	Total Teaching Hours: 50	**5**	**3**	**0**	**2**

COURSE OUTCOMES

At the end of the course learners will be able to		
CO1	Explain the fundamentals of operating systems.	Understand
CO2	Comprehend multithreaded programming, CPU scheduling, process management, process synchronization, memory, deadlocks, and storage management.	Understand
CO3	Compare the performance of CPU scheduling algorithms.	Analyze
CO4	Identify the features of I/O and file handling methods.	Analyze

Prerequisite: This is an introductory programming course and hence no prerequisites

SYLLABUS

UNIT I	Definition, Evaluation of O.S, Components & Services of OS, Structure, Architecture, Types of Operating Systems, Batch Systems, Concepts of Multiprogramming and Time Sharing, Parallel, Distributed and real-time Systems. Operating system services and system calls, system programs, operating system structure, operating system generations.	15
UNIT II	Process Definition, Process States, Process State Transitions, Process Scheduling, Process Control Block, Threads, Concept of Multithreads, Benefits of Threads, Types of Threads. Scheduling Objectives, Scheduling Algorithms, CPU Scheduling (Preemptive and Non-preemptive), Performance Evaluation of Scheduling Algorithms.	15
UNIT III	Introduction, Inter-process Communication, Race Conditions, Critical Section Problem, Mutual Exclusion, Semaphores, Monitors. System Model, Deadlock Characterization, Deadlock Prevention, Avoidance, Banker's Algorithm, Deadlock Detection, and Recovery from Deadlocks	10
UNIT IV	Logical and Physical Address Map, Swapping, Memory Allocation, MFT, MVT, Internal and External Fragmentation and Compaction, Paging, Segmentation. Demand Paging, Page Replacement	

	Algorithms, Allocation of Frames, Thrashing. Principles of I/O Hardware: Disk Structure, Disk Scheduling Algorithms.	10

Text Books & Reference Book

Text Books	1. Walia, E. (2022). Operating systems concepts. Khanna Publishing House. (AICTE Recommended Textbook) 2. Silberschatz, A., Galvin, P. B., & Gagne, G. (2006). Operating system principles (7th ed. or later). Wiley India Private Limited.
Reference Books	1. Stallings, W. (2006). Operating systems: Internals and design principles (5th ed.). Pearson Education India. 2. Tanenbaum, A. S. (n.d.). Modern operating systems (3rd ed.). Prentice Hall India. 3. Das, S. (n.d.). UNIX concepts and applications (4th ed.). Tata McGraw-Hill.

Operating Systems: LAB Problems: Course Code BCAGN2C03P

1. Write C program to simulate the FCFS CPU Scheduling algorithm.
2. Write C program to simulate the SJF CPU Scheduling algorithm.
3. Write C program to simulate the Round Robin CPU Scheduling algorithm.
4. Write a C program to simulate Bankers Algorithm for Deadlock Avoidance.
5. Write a C program to implement the Producer – Consumer problem using semaphores.
6. Write a C program to illustrate the IPC mechanism using Pipes.
7. Write a C program to illustrate the IPC mechanism using FIFOs.
8. Write a C program to simulate Paging memory management technique.
9. Write a C program to simulate Segmentation memory management technique.
10. Write a C program to simulate the Best Fit contiguous memory allocation technique.
11. Write a C program to simulate the First Fit contiguous memory allocation technique.
12. Write a C program to simulate the concept of Dining-Philosophers problem.
13. Write a C program to simulate the MVT algorithm.
14. Write a C program to implement FIFO page replacement technique.
15. Write a C program to write a C program for implementing sequential file allocation method.

Semester 2	Object Oriented Programming Using Java	C	L	T	P
Course Code: BCAGN2C04T	Total Teaching Hours: 48	**5**	**3**	**0**	**4**

Course Outcome

At the end of the course learners will be able to		
CO1	Explain the fundamentals of operating systems.	Understand
CO2	Comprehend multithreaded programming, CPU scheduling, process management, process synchronization, memory, deadlocks, and storage management.	Understand
CO3	Compare the performance of CPU scheduling algorithms.	Analyze
CO4	Identify the features of I/O and file handling methods.	Analyze

SYLLABUS

UNIT I	Fundamentals of Object-Oriented Programming: Basic Concepts of OOP, Benefits and Applications of OOP. Java Evolution: Java Features, Difference between Java, C, and C++, Java and Internet, Java Environment. Overview of Java Language: Introduction to Simple Java Program, Use of Comments, Math Functions, Java Program Structure, Java Tokens and Statements, Implementing Java Program and JVM, Command Line Arguments.	12
UNIT II	Constants, Variables, and Data Types: Declaration, Giving values to variables, Symbolic Constants, Type Casting. Operators & Expressions: Arithmetic, Relational, Logical, Assignment, Increment & Decrement, Bitwise, Conditional Operators. Decision Making, Branching & Looping: Control Statements, Looping Statements, Jump in Loops, Labeled Loops.	12
UNIT III	Classes, Objects, and Methods: Defining Class, Method Declaration, Constructors, Method Overloading, Overriding Methods, Inheritance. Arrays, Strings, and Vectors: 1D & 2D Arrays, Strings, Vectors, Wrapper Classes, Enumerated Types. Inheritance: Defining, Extending Classes, Implementing Interfaces, Multiple Inheritance, and Polymorphism.	15

UNIT IV	Packages: Basics, System Packages, User-Defined Packages, Adding Class to a Package. Exception Handling: try, catch, throw, throws, finally; Nested try, Multiple catch Statements, User-Defined Exceptions.	12

Text Books & Reference Book

Text Books	1. Balaguruswamy, E. (2023). Programming with JAVA: A primer (7th ed.). McGraw Hill Education. 2. Schildt, H. (2022). Java: The complete reference (12th ed.). McGraw-Hill Education.
Reference Books	1. Goyal, A. (2012). The essentials of JAVA. Khanna Book Publishing Company Private Limited. 2. Alam, T. (2015). Core JAVA. Khanna Book Publishing Company Private Limited. 3. Liang, Y. D. (2008). Introduction to Java programming (7th ed.). Pearson. 4. Malhotra, S., & Choudhary, S. (2014). Programming in Java (2nd ed.). Oxford University Press.

Object Oriented Programming Using Java Course Code BCAGN2C04P

1. Write a program to read two numbers from user and print their product.
2. Write a program to print the square of a number passed through command line arguments.
3. Write a program to send the name and surname of a student through command line arguments and print a welcome message for the student.
4. Write a java program to find the largest number out of n natural numbers.
5. Write a java program to find the Fibonacci series & Factorial of a number using recursive and non recursive functions.
6. Write a java program to multiply two given matrices.
7. Write a Java program for sorting a given list of names in ascending order.
8. Write a Java program that checks whether a given string is a palindrome or not . Ex:MADAM is a palindrome.
9. Write a java program to read n number of values in an array and display it in reverse order.
10. Write a Java program to perform mathematical operations. Create a class called AddSub with methods to add and subtract. Create another class called MulDiv that extends from AddSub class to use the member data of the super class. MulDiv should have methods to multiply and divide A main function should access the methods and perform the mathematical operations.
11. Create a JAVA class called Student with the following details as variables within it.
    a. USN, NAME, BRANCH, PHONE, PERCENTAGE
    b. Write a JAVA program to create n Student objects and print the USN, Name, Branch, Phone, and percentage of these objects with suitable headings.
12. Write a Java program that displays the number of characters, lines and words in a text.
13. Write a Java program to create a class called Shape with methods called getPerimeter() and getArea(). Create a subclass called Circle that overrides the getPerimeter() and getArea() methods to calculate the area and perimeter of a circle.

14. Write a Java program to create a class Employee with a method called calculateSalary(). Create
    a. two subclasses Manager and Programmer. In each subclass, override the calculateSalary() method to calculate and return the salary based on their specific roles.
15. Write a Java program using an interface called 'Bank' having function 'rate_of_interest()'. Implement this interface to create two separate bank classes 'SBI' and 'PNB' to print different rates of interest. Include additional member variables, constructors also in classes 'SBI' and 'PNB'.
16. Write a Java package program for the class book and then import the data from the package and display the result.
17. Write a Java program for finding the cube of a number using a package for various data types and then import it in another class and display the results.
18. Write a Java program for demonstrating the divide by zero exception handling.
19. Write a Java program that reads a list of integers from the user and throws an exception if any numbers are duplicates.
20. Create an exception subclass UnderAge, which prints "Under Age" along with the age value when an object of UnderAge class is printed in the catch statement. Write a class exceptionDemo in which the method test() throws UnderAge exception if the variable age passed to it as argument is less than 18. Write main() method also to show working of the program.

Semester 2	Software Engineering	C	L	T	P
Course Code: BCAGN2C05T	Total Teaching Hours: 46	**3**	**3**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Explain the fundamental concepts of software engineering and software development processes.	Understand
CO2	Analyze software requirements and risk management strategies.	Analyze
CO3	Apply software design and testing strategies for quality assurance.	Apply
CO4	Evaluate quality management, release management, and product sustenance.	Evaluate

SYLLABUS

UNIT I	The evolving role of software, changing nature of software, layered technology, a process framework, Process models: The waterfall model, incremental process models, evolutionary process models, the unified process. Agile software development: Agility Principles, Agile methods, Plan-driven and agile development, Extreme programming, Scrum, A Tool Set for the Agile Process.	10
UNIT II	Software Requirements Engineering: Functional and non-functional requirements, software requirements document, Requirements specification, Requirements engineering processes, Requirements elicitation and analysis, Requirements validation, Requirements management. Risk management: Reactive Vs proactive risk strategies, software risks, risk identification, risk projection, risk refinement, RMMM, RMMM plan. Project planning- Software pricing, Plan-driven development, Project scheduling, Agile planning, Estimation techniques.	12
UNIT III	Design: Design process and design quality, design concepts, the design model, software architecture, data design, architectural design, Basic structural modeling, class diagrams, sequence diagrams, collaboration diagrams, use case diagrams, component diagrams. Testing Strategies: A strategic approach to software testing, test strategies for conventional software, black-box and white-box testing, validation testing, system testing, the art of debugging. Product metrics: Software quality, metrics for analysis model, metrics for design model, metrics for source code, metrics for testing, metrics for maintenance.	12

UNIT IV	Quality Management: Quality concepts, software quality assurance, software reviews, formal technical reviews, statistical software quality assurance, software reliability. Release Management: Release planning, development and build plans, release strategies, risk management, and post-deployment monitoring. Product sustenance: Maintenance, updates, End of life, migration strategies.	12
Text Books & Reference Book		
Text Books	1. *Pressman, R. S. (2014). Software engineering: A practitioner's approach (7th ed.). McGraw Hill.* 2. *Sommerville, I. (2015). Software engineering (10th ed.). Pearson.*	
Reference Books	1. *Jalote, P. (2005). An integrated approach to software engineering (3rd ed.). Springer.* 2. *Mall, R. (2018). Fundamentals of software engineering (5th ed.). PHI Learning.*	

Semester 2	**Mathematics Foundation to Computer Science – II**	**C**	**L**	**T**	**P**
Course Code: BCAGN2E02T	Total Teaching Hours: 60	**4**	**4**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand correct lines of argument and proof techniques.	Understand
CO2	Apply mathematical techniques that form the foundation for computational methods, including numerical methods and optimization.	Apply
CO3	Analyze and utilize problem-solving strategies to tackle theoretical and practical challenges in computer science.	Analyze

SYLLABUS

UNIT I	**Logic and Methods of Proofs**: Propositions, logical operations (basic connectives), compound statements, construction of truth tables, quantifiers, conditional statements, tautology, contradiction, contingency, logical equivalence. **Normal Forms**: Conjunctive Normal Forms (CNF) and Disjunctive Normal Forms (DNF). **Methods of Proofs**: Rules of inference for propositional logic, modus ponens, modus tollens, syllogism, proof by contradiction, Mathematical Induction.	15
UNIT II	**Algebraic Structures**: Semi-group, Monoid, Group, Subgroup, Cyclic group.	12
UNIT III	**Numerical Methods**: Concept and importance of errors in numerical methods. **Solution of Algebraic and Transcendental Equations**: Bisection method, Newton-Raphson method. **Numerical Interpolation**: Newton's Forward and Backward interpolation formulas, Lagrange's formula. **Numerical Integration**: Trapezoidal rule, Simpson's 1/3 rule. *(Only formula and problem-solving for all topics)*	15

UNIT IV	**Optimization Techniques**: **Linear Programming**: Introduction, LP formulation, graphical method for solving LPs with two variables, special cases in graphical methods, Simplex method, Duality. **Transportation Problem**: Definition, Linear form, North-west corner method, Least cost method, Vogel's approximation method for finding feasible solution, MODI method for finding optimum solution.	18
Text Books & Reference Book		
Text Books	1. Kolman, B., Busby, R., & Ross, S. (2015). Discrete mathematical structures (6th ed.). Pearson Education. 2. Sastry, S. S. (2022). Introductory methods of numerical analysis (5th ed.). PHL. 3. Taha, H. A. (2003). Operations research: An introduction (8th ed.). Pearson Prentice Hall. 4. Singh, S. B. (2023). Discrete structures. Khanna Book Publishing. (AICTE Recommended Textbook)	
Reference Books	1. Rosen, K. H., & Krithivasan, K. (2019). *Discrete mathematics and its applications*. McGraw Hill India. 2. Chakravorty, J. G., & Ghosh, P. R. (2017). *Linear programming and game theory*. Moulik Library. 3. Sharma, J. K. (2007). *Operations research: Theory and applications* (4th ed.). Macmillan Publishers.	
Web Resources	1. https://nptel.ac.in/courses/111107127 2.https://www.math.iitb.ac.in/~siva/si50716/SI507lecturenotes.pdf	

Semester 2	Digital Content Creation	C	L	T	P
Course Code: BCAGN2M02T	Total Teaching Hours: 45	**3**	**3**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Explain core concepts and strategies in digital content planning and creation.	Understand
CO2	Design visually engaging graphics and infographics using professional tools	Create
CO3	Produce, edit, and publish short-form video content tailored for digital platforms.	Analyze
CO4	Record and edit audio content for podcasts with basic production quality.	Create

SYLLABUS

UNIT I	**Introduction to Digital Content Creation** Definition and types of digital content: textual, visual, audio, video, interactive; The digital content ecosystem: web, social media, streaming platforms; Content goals: informational, promotional, entertainment, educational; Overview of content creation workflow; Identifying target audiences using personas; Creating content goals and KPIs, Content lifecycle and editorial calendars, Storytelling techniques: narrative arc, visual grammar, tone and voice.	9
UNIT III	**Introduction to Video Content** Video formats: reels, shorts, vlogs, explainers; Pre-production: ideation, scriptwriting, storyboarding; Shooting basics: mobile and DSLR videography, framing, lighting, audio capture; Case studies of viral short-form videos; Importing and managing media; Timeline editing, basic transitions, text overlays; Tools: Adobe Premiere Pro (standard), CapCut (mobile-friendly) and Canva **Assignment: Edit a 60-second video for Instagram Reels**	9
UNIT III	**Writing for Digital Platforms** Writing headlines, captions, hashtags; SEO basics: keyword research, meta descriptions; Writing blogs and short-form posts; Tools: Grammarly, Hemingway, Google Trends	9

UNIT IV	**Social Media Content Creation** Platform-specific strategies: Instagram, YouTube, LinkedIn, Twitter, Facebook; Content buckets: promotional, behind-the-scenes, educational, entertaining; Scheduling and publishing with tools like Hootsuite and Buffer; Metrics: reach, engagement, CTR, conversions	9
UNIT V	**Digital Ethics, Copyright & Monetization** Fair use, Creative Commons, copyright laws; Consent and representation in digital content; Introduction to monetization (ads, affiliate marketing, brand collaborations); Influencer economy and digital credibility **Project Presentation** • Each student presents a portfolio of three content types (video, textual, graphic/post)	9

Text Books & Reference Book

Text Books	1. Bullas, J. (2018). Digital content marketing: How to grow your brand. CreateSpace Independent Publishing. 2. Enfield, N. J. (2022). How we talk: The inner workings of conversation. Basic Books. **3.** McDonald, J. (2022). Adobe Premiere Pro classroom in a book (2022 release). Adobe Press.
Reference Books	1. Bayles, D., & Orland, T. (2001). *Art & fear: Observations on the perils (and rewards) of artmaking*. Image Continuum Press. 2. Hein, L., & Hein, M. (2021). *Master content strategy: How to maximize your reach and boost your bottom line every time you hit publish*. Independently Published. 3. Kern, J. (2008). *Sound reporting: The NPR guide to audio journalism and production*. University of Chicago Press. 4. Krug, S. (2014). *Don't make me think, revisited: A common sense approach to web usability* (3rd ed.). New Riders. 5. Lupton, E. (2014). *Thinking with type: A critical guide for designers, writers, editors, and students* (2nd ed.). Princeton Architectural Press. **6.** Rose, G. (2022). *Visual methodologies: An introduction to researching with visual materials* (5th ed.). SAGE Publications.

Semester 2	Advanced Communication and Soft Skills	C	L	T	P
Course Code: BCAGN2A02T	Total Teaching Hours: 30	**2**	**2**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Analyse and interpret academic and professional texts.	Analyze
CO2	Compose structured written communication	Create
CO3	Engage effectively in oral and coherent written communication.	Apply

SYLLABUS

UNIT I	**Advanced Writing** Topics: Communication for Employment (Written) | Articles | Essay | Paragraph Writing | Composition and Composition Types | Summary | Report Writing | E-Mails | Circular and Memos | Reports of Survey | Professional Brochure Writing | Writing a Proposal | Letter Writing – Formal & Informal | Report Writing – Official and Business Reports | Cover Letter | Resume | CV | Job Application and Follow-up Letter | Business Letters and Its Types effective| Business emails | Proposals **Class Activity**: (Any One) 1. The Course Teacher may give participants a case (e.g., "Decline in customer satisfaction at a Shopping Malls "). Participants' Groups can generate and circulate google forms to gather data and survey results. With the help of the datasets, the participants would draft an official business report including: Executive summary Findings (with charts or bullet points) and Recommendations. 2. The participants can be asked to prepare a tailored resume and cover letter for a specific job. In class, they exchange drafts with a peer and use a guided rubric to critique: Relevance and clarity of content Format and structure Tone and professionalism. The Course teacher can give participants different business scenarios (e.g., replying to a customer complaint, requesting leave, responding to a promotion announcement, negotiating a deadline). Each student or pair must write a short, professionally formatted email.	9

UNIT II	**Effective Reading and Critical Analysis** **Topics:** Effective Reading: Techniques of Critical Reading | Extensive and Intensive Reading | Comprehension | Case Study: Analysing complex business cases or media cases, identifying problems, and proposing solutions. **Selected Reading:** (Any One) 1. "Machine Learning" (Pages-61 page -69) in John Joseph Adams Machine Learning: New and Collected Stories 2. "June 2001: Reality TV" (An excerpt from Rushdie, Salman: *Step Across This Line*) 3. Industry-specific texts and resources suggested and recommended by the Course Teacher **Class Activity:** (Any One) 1. Pick a character (e.g., from "Who Moved My Cheese?" or the ML story) and ask students to perform a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of their choices in the story. 2. Provide a brief media/business case (or let students select from recent events). Assign roles (reporter, CEO, stakeholder, analyst). Each group must analyse the problem, identify biases (if media), and propose actionable solutions. 3. Use a layered passage from "Machine Learning" or Rushdie's essay. Ask students to: a) Infer what's implied but not said. b) Highlight ambiguity or irony. c) Predict author intent or outcome.	9
UNIT III	**Industry-Specific Communication and Soft Skills** **Industry-Specific Communication** **Topics:** Communication as a Medium of Transference | Process of Communication | General business language and industry-specific language | Functions of Effective Communication | Effective Communication and its Function | Theories of Communication and Communication Models | Types of Communication | Miscommunication and Barriers in Communication | Principles of Communication | Organizational Communication and Its Types/ Hierarchical vs. flat organizational communication | Verbal Communication: Intrapersonal Communication | Interpersonal Communication | Small Group Communication | Public Speaking or Mass Communication | Nonverbal Communication: Paralanguage | Kinesics | Haptic | Proxemics | Sign and Symbols | Body Language and Behavior | Appearance | Posture | Gesture	12

	| Eye Contact | Artifacts | Voice Modulation | Types of Corporate Communication | Internal vs. External **Soft Skills** **Topics:** Soft Skills | Emotional Intelligence at Workplace | Professional Etiquette | Interpersonal Skills | Time Management and Prioritization | Adaptability **Note:** The course Instructor need to talk on the following aspects of Professional skills while discussing this unit: 1. Emotional Intelligence (self-control, empathy, social awareness) 2. Professional Etiquette (tone, behaviour, dressing, punctuality) 3. Interpersonal Skills (teamwork, conflict resolution) 4. Time Management & Prioritization 5. Adaptability (handling change and ambiguity) **Class Activity:** The course Instructor may assign students to small groups representing different departments in a company (e.g., Marketing, HR, IT). S/he may present a scenario (e.g., launching a product or resolving a customer complaint). Each group prepares and performs a role-play simulating, using industry-specific language, voice modulation, eye contact, gestures, and other nonverbal cues.	
Text Books & Reference Book		
Text Books	**1.** Carnegie, D. (2010). How to win friends and influence people. Simon & Schuster. **2.** Chaturvedi, P. D., & Chaturvedi, M. (n.d.). Business communication. Pearson Education. **3.** Cialdini, R. B. (2006). Influence: The psychology of persuasion (Rev. ed.). Harper Business. **4.** Covey, S. R. (2004). The 7 habits of highly effective people: Powerful lessons in personal change. Free Press. **5.** Goleman, D. (2006). Emotional intelligence: Why it can matter more than IQ (10th anniversary ed.). Bantam Books. **6.** Levinson, J. C., & Perry, J. (2005). Guerrilla etiquette: Advance praise for the new rules of business etiquette. Houghton Mifflin. **7.** Robbins, S. P., & Judge, T. A. (2019). Organizational behaviour (18th ed.). Pearson. **8.** Stein, S. J., & Book, H. E. (2011). The EQ edge: Emotional intelligence and your success (3rd ed.). Wiley.	

	9. Strunk, W., Jr., & White, E. B. (2000). The elements of style (4th ed.). Longman. **10.** Suri, G. K., & Suri, R. K. (2017). Soft skills. S. Chand Publishing. **11.** Tracy, B. (2007). Eat that frog! 21 great ways to stop procrastinating and get more done in less time. Berrett-Koehler Publishers.

Semester 2	**Web Technology**	**C**	**L**	**T**	**P**
Course Code: BCAGN2S01T	Total Teaching Hours: 30	**3**	**2**	**0**	**2**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the concepts and architecture of the World Wide Web, markup languages, and Cascading Style Sheets.	Understand
CO2	Apply event handling and data validation techniques in web applications.	Apply
CO3	Implement embedded dynamic scripting on the client and server sides using JavaScript, AJAX, and XML.	Implement
CO4	Develop interactive and responsive web applications using modern web technologies.	Create

Prerequisites:

- Proficiency in at least one programming language (Python, Java, or C++).
- Understanding of programming concepts such as loops, conditionals, functions, and data structures.
- Familiarity with object-oriented programming (OOP) principles including classes, objects, inheritance, and polymorphism.

SYLLABUS

UNIT I	**Introduction to Web Technologies:** Introduction to HTML, history of HTML, objective, basic structures of HTML, header tags, body tags, paragraph tags. **HTML Elements:** Tags for FORM creation, table, form, textarea, select, img, iframe, fieldset, anchor, lists, div tag, navbar design. **CSS & Bootstrap:** Introduction to CSS, types, selectors, responsiveness, introduction to Bootstrap, downloads/linking, using Bootstrap classes, understanding the Grid System. **Web Hosting & Protocols:** Introduction to WWW, protocols, applications, development tools, web browsers, DNS, web hosting providers, setting up Windows/Linux/Unix web servers, cloud hosting, types of web hosting.	15
UNIT II	**JavaScript Fundamentals:** Introduction to JavaScript, functions, events, Document Object Model (DOM) traversing. **JavaScript Data Handling:** Output system (Alert, Input box, Console), variables, arrays, date and string handling. **JavaScript & CSS Manipulation:** Form validation (required validator, length validator, pattern validator), advanced JavaScript, combining HTML, CSS, and JavaScript events.	15

	AJAX & XML: Introduction to AJAX, purpose, advantages, disadvantages, AJAX-based web applications, alternatives. **XML & JSON:** XML key concepts, DTD, schemas, XSL, XSLT, transforming XML using XSLT, introduction to XHTML. JSON: Keys and values, types of values, arrays, objects, transforming JSON data.	

Text Books & Reference Book

Text Books	1. *Lemay, L. (2016). Mastering HTML, CSS & JavaScript web publishing. BPB Publications.* 2. *Powell, T. A. (2017). The complete reference HTML & CSS (5th ed.).*
Reference Books	1. *Moreto, S. (2016). Bootstrap 4 by example.* 2. *Alam, T. (2011). Web technologies. Khanna Book Publishing.*
Web Resources	1. JavaTpoint. (n.d.). Web technology. https://www.javatpoint.com 2. W3Schools. (n.d.). HTML, CSS, JavaScript tutorials. https://www.w3schools.com 3. GeeksforGeeks. (n.d.). Web technology. https://www.geeksforgeeks.org

Web Technology: LAB Problem **Course Code: BCAGN2S01P**

PART – A (HTML & CSS Basics)

1. Create a class timetable using the table tag.
2. Design a Webpage for your college containing descriptions of courses, departments, faculties, library, etc., using list tags, href tags, and anchor tags.
3. Create a webpage using Frame with rows and columns including header frame, left frame, right frame, and status bar frame. Clicking on the left frame should display content in the right frame.
4. Create your Resume using HTML (text, links, size, color, lists).
5. Create a Web Page for a supermarket using internal CSS.
6. Use Inline CSS to format the resume created earlier.
7. Use External CSS to format the timetable created.
8. Apply all CSS types (inline, internal, external) to format the college webpage created earlier.
9. Write an HTML program to create a college website optimized for mobile devices.

PART – B (JavaScript, AJAX, XML, JSON)

1. Write an HTML/JavaScript page to create a login page with validations.
2. Develop a simple calculator for addition, subtraction, multiplication, and division using JavaScript.
3. Use Regular Expressions for validations in the login page using JavaScript.
4. Write a program to retrieve data from a text file and display it using AJAX.
5. Create an XML file to store student information (Register Number, Name, Mobile Number, DOB, Email-ID).
6. Create a DTD for the XML file.
7. Create an XML Schema for the XML file.
8. Create an XSL file to convert the XML file to XHTML format.
9. Write a JavaScript program using Switch Case.

10. Write a JavaScript program using 5 different events.
11. Write a JavaScript program using built-in JavaScript objects.
12. Write a program for populating values from JSON text.
13. Write a program to convert JSON text into a JavaScript object.

Semester 2	Indian Constitution	C	L	T	P
Course Code: BCAGN2V02T	Total Teaching Hours : 45	**3**	**3**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the meaning, historical background, and the salient features of the Indian Constitution, including the philosophy behind its making.	Understand
CO2	Explain the structure, functions, and powers of the Union Government including the President, Prime Minister, and the Parliament.	Understand
CO3	Describe the role and functions of State Governments and Union Territories, including the relationship between the Centre and States.	Understand
CO4	Analyze the structure, powers, and jurisdiction of the Indian Judiciary, along with the concepts of judicial review, activism, and PIL.	Understand
CO5	Understand the emergency provisions and types of emergencies under the Constitution.	Understand
CO6	Evaluate the role, powers, and functioning of the Election Commission and other constitutional and statutory bodies related to social justice	Understand

SYLLABUS

UNIT I	**Introduction to Indian Constitution** Constitution meaning of the term - The making of the Indian Constitution - Sources and constitutional history –Salient features of the Constitution, Preamble as part of the Constitution, Philosophy of Constituent Assembly - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy – comparing parliamentary and presidential system, separation of powers, Citizenship	9
UNIT II	**Central Government** Union Government and its Administration Structure: President and Vice President: Role, power and position, PM and Council of ministers, Cabinet , Lok Sabha, Rajya Sabha, Parliament, Parliament, Union Budget	9
UNIT III	**The States and The Union Territories**	9

	State Government and its Administration: Governor - Role and Position - CM and Council of ministers, State Secretariat: Organization, Structure and Functions – Relation between the Union and the States.	
UNIT IV	**Indian Judiciary & Constitution Bodies** Supreme court and High court and subordinate courts: Jurisdictions and powers, Judicial review, Judicial activism, PIL: Features and scopes,	9
UNIT V	**Emergency Provisions and Election Commission** Emergency: Proclamation of Emergency, types of emergency - Elections in India, Election Process, Election Commission: Independence, Powers & Functions, Role of Chief Election Commissioner - State Election Commission - SC/ST Commissions for the welfare of SCs & STs	9

Text Books & Reference Book

Text Books	1. Bhargava, R. (2008). Ethics and politics of the Indian constitution. Oxford University Press. 2. Fadia, B. L. (2017). The constitution of India (New ed.). Sahitya Bhawan. **3.** Basu, D. D. (2018). Introduction to the constitution of India (23rd ed.). Lexis Nexis.
Web Resources	1. Constitution.org. (n.d.). *The Constitution of India*. https://www.constitution.org/cons/india/const.html 2. Legislative.gov.in. (n.d.). *Constitution of India*. http://www.legislative.gov.in/constitution-of-india 3. Supreme Court of India. (n.d.). *Constitution*. https://www.sci.gov.in/constitution 4. Toppr. (n.d.). *The Constitution of India*. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/

SEMESTER –III

Third Semester							
Sl No	**Component**	**Course Code**	**Title of The course**	**Credit**		**Hour Per Week**	
				TH	**P**	**Theory**	**Practical**
1	**Major Core**	BCADS3C06T	Relational Database Management System	3		3	
2	**Major Core**	BCADS3C06P	RDBMS LAB		2		4
3	**Major Core**	BCADS3C07T	Data Structure	3		3	
004	**Major Core**	BCADS3C07P	Data Structure Lab		2		4
5	**Minor**	BCADS3E03T	Probability And Statistics	4		4	
6	**Minor**	BCADS3E04T	Basics of Data Analysis using Spread Sheet	2		1	
7	**Minor**	BCADS3E04P	Basics of Data Analysis using Spread Sheet		1		2
8	**MDC**	BCAGN3M03T	Organizational Behavior	2		2	
9	**AEC**	BCADS3A03T	German/Korean Language/Hindi I	2		2	
10	**SEC**	BCADS3S02T	Python Programming	2		2	
11	**SECP**	BCADS3S02P	Python lab		2		4
12	**Value Based**	BCAGN3V03T	Yoga And Wellness	2			2
			Total Credit	27		Total Hours-33	

Semester 3	Relational Database Management System	C	L	T	P
Course Code: BCADS3C06T	Total Teaching Hours: 50	5	3	0	4

Course Outcomes

At the end of the course learners will be able to		
CO1	Understand what DBMS is and what is its positioning in application design	Understand
CO2	Identify the components of DBMS and their Functioning	Analyze
CO3	Design database tables, functions and subroutines	Apply
CO4	Make use of PL SQL statements	Apply
CO5	Define and implement business logic through PL SQL statement	Create
CO6	Incorporate data integrity and security through customized PL SQL statements	Apply

Prerequisite: Basic knowledge of Set Theory.

SYLLABUS

Unit I	**Introduction to Databases:** Definition of Data, Database, and DBMS, Overview of Database Applications, Advantages and Disadvantages of DBMS, Roles of Database Users and Administrators **Data Models:** Introduction to Data Models, Types of Data Models (Hierarchical, Network, Relational, Object-oriented), Importance of Data Models in DBMS **Database Design Keys:** Primary Key, Candidate Key, Super Key, Foreign Key, Composite Key, Alternate Key, Unique Key, Surrogate Key,Constraints in a table: Primary Key, Foreign Key, Unique Key, NOT NULL, CHECK, Entity-Relationship (ER) Model, Entities and Entity Sets, Attributes and Relationships, ER Diagrams, Key Constraints and Weak Entity Sets, Extended ER Features, Introduction to the Relational Model and Relational Schema	**10**
Unit II	**Relational Algebra and Calculus:** Introduction to Relational Algebra, Operations: Selection, Projection, Set Operations, Join Operations, Division, Tuple and Domain Relational Calculus **Structured Query Language (SQL):** SQL Basics: DDL and DML, Aggregate Functions (Min(), Max(), Sum(), Avg(), Count()), Logical operators (AND, OR, NOT), Predicates (Like, Between, Alias, Distinct), Clauses(Group By, Having,	**15**

	Order by, top/limit), Inner Join, Natural Join, Full Outer Join, Left Outer Join, Right outer Join, Equi Join **Advanced SQL:** Analytical queries, Hierarchical queries, Recursive queries, Views, Cursors, Stored Procedures and Functions, Packages, Triggers, Dynamic SQL Normalization and Database Design: Functional Dependencies: Armstrong's Axioms, Definition, Properties (Reflexivity, Augmentation, Transitivity), Types (Trivial, Non-Trivial, Partial and Full Functional Dependency), Closure of Functional Dependencies, Normal Forms (1NF, 2NF, 3NF, BCNF), Denormalization.	
Unit III	**Transaction Management:** ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock-Based Concurrency Control, Performance of Locking, Transaction Support in SQL, Introduction to Crash Recovery, 2PL, Serializability, and Recoverability, Introduction to Lock Management, Dealing with Deadlocks **Database Storage and Indexing:** Data on External Storage, File Organizations and Indexing, Index Data Structures, Comparison of File Organizations, Indexes and Performance Tuning, Guidelines for Index Selection, Basic Examples of Index Selection	**10**
Unit IV	**NoSQL Databases and Big Data:** Introduction to NoSQL, Data Models: Document, Key value, Column family, Graph. Uses and Features of NO/SQL document databases. CAP theorem, BASE vs ACID, CRUD operations, MongoDB operators, Overview of Big Data Technologies: Hadoop, MongoDB, Cassandra. **Database Security and Advanced Topics**: Introduction to Database Security, Access Control, Discretionary Access Control, Introduction to Data Warehousing, OLAP, Data Mining	**15**

Text Books & Reference Book

Text Books	1. Ramakrishnan, R., & Gehrke, J. (2018). Database management systems (3rd ed.). McGraw-Hill. 2. Rosenzweig, B., & Rakhimov, E. (2015). Oracle PL/SQL by example (5th ed.). Prentice Hall. 3. Dayley, B. (2024). NoSQL with MongoDB in 24 hours (1st ed.). Sams Publishing.
Reference Books	1. Korth, H. F., Silberschatz, A., & Sudarshan, S. (2019). Database system concepts (7th ed.). McGraw-Hill. 2. Mahapatra, R. P., & Verma, G. (2025). Database management systems. Khanna Publishing House.
Web Resources	1. Oracle Base. (n.d.). Articles. https://oracle-base.com/articles 2. Oracle. (n.d.). SQL and PL/SQL community forum. https://forums.oracle.com/ords/apexds/domain/dev-community/category/sql_and_pl_sql 3. Oracle. (n.d.). Ask Tom. https://asktom.oracle.com/ords/f?p=100:1:0

Relational Database Management System: LAB Problem Course Code: BCADS3C06P

1. Draw an ER Diagram of Registrar Office
2. Draw an ER Diagram of Hospital Management System
3. Reduce The ER diagram in question no 1 into tables
4. Reduce the ER diagram of question no 2 into tables

Consider the following Schema
Supplier(SID, Sname, branch, city, phone)
Part(PID, Pname, color, price)
Supplies(SID, PID, qty, date_supplied)

DDL Commands

5. Create the above tables
6. Add a new attribute state in supplier table
7. Remove attribute city from supplier table
8. Modify the data type of phone attribute
9. Change the name of attribute city to address
10. Change a table's name, supplier to sup
11. Use truncate to delete the contents of supplies table
12. Remove the part table from database

DML Commands

1. Insert at least 10 records in tables supplier, part and supplies
2. Show the contents in tables supplier, part and supplies
3. Find the name and city of all suppliers
4. Find the name and phoneno of all suppliers who stay in 'Delhi'
5. Find all distinct branches of suppliers
6. Delete the record of the supplier whose SID is 204001
7. Delete all records of supplier table
8. Delete all records of suppliers whose city starts with capital A.
9. Find the supplier names which have 'lk' in any position
10. Find the supplier name where 'R' is in the second position
11. Find the name of supplier whose name starts with 'V' and ends with 'A'
12. Change the city of all suppliers to 'BOMBAY'
13. Change the city of supplier 'Vandana' to 'Goa'

Queries with Constraints

1. Create the supplier table with Primary Key Constraint
2. Create supplies table with Foreign key Constraint
3. Create a part table with UNIQUE Constraint
4. Create supplier Table with Check Constraints
5. Create Supplier table with Default Constraint

Queries on TCL

1. Create Savepoints
2. Rollback to SavePoints
3. Use Commit to save on

Aggregate Functions:

Queries on Aggregate Functions

1. Find the minimum, maximum, average, and sum of costs of parts.

2. Count the total number of parts present.
3. Retrieve the average cost of all parts supplied by 'Mike'.

Queries on GROUP BY, HAVING, and ORDER BY Clauses

1. Display total price of parts of each color.
2. Find the branch and the number of suppliers in that branch for branches that have more than 2 suppliers.
3. Find all parts, sorted by pname in ascending order and cost in descending order.
4. Find the branch and the number of suppliers in that branch.

Queries on Analytical, Hierarchical, and Recursive Nature

1. Find out the 5th highest earning employee details.
2. Identify which department has the highest number of employees with a salary above $80,000, and what percentage of employees in that department have a salary above $80,000.
3. Retrieve employee table details using the hierarchy query and display that hierarchy path starting from the top level, indicating if it is a leaf and whether there exists a cycle.
4. Compute the average salary for employees in the top 2 departments with the highest average salary, and display the hierarchy of departments and sub-departments for these top 2 departments.
5. Use recursion to retrieve the employee table and display the result in breadth-first and depth-first order.
6. Write a recursive query to show the equivalent of level, connect_by_root and connect_by_path
7. Use recursion to retrieve the employee table and display the result in depth first order showing id, parent_id, level, root_id, path and leaf.

Queries on Operators

1. Find the pname, phoneno and cost of parts which have cost equal to or greater than 200 and less than or equal to 600.
2. Find the sname , SID and branch of suppliers who are in ‘local’ branch or ‘global’ branch
3. Find the pname, phoneno and cost of parts for which cost is between 200 and 600.
4. Find the pname and color of parts , which has the word ‘NET’ anywhere in its pname.
5. Find the PID and pname of parts with pname either ‘NUT’ or ‘BOLT’
6. List the suppliers who supplied parts on ‘1st may2000’, ‘12 JAN 2021’ ,’17 dec 2000’ ,’10 Jan 2021’
7. Find all the distinct costs of parts.

Join Operators

1. Perform Inner join on two tables
2. Perform Natural Join on two tables
3. Perform Left Outer Join on tables
4. Perform Right Outer join on tables
5. Perform Full Outer Join on tables

Set Theory Operators

1. Show the use of UNION operator with union compatibility
2. Show the use of intersect operator with union compatibility
3. Show the use of minus operator with union compatibility
4. Find the cartesian product of two tables

Queries on Set Theory Operators

1. List all parts except 'NUT' and 'BOLT' in ascending order of costs
2. display all parts that have not been supplied so far
3. To display the supplier names who have supplied 'green' part with cost 500 Rupees AND 'red' part with cost 400 Rupees.
4. To display the supplier names who have supplied 'green' part with cost 500 Rupees OR 'red' part with cost 400 Rupees.
5. To Display the name of suppliers who have supplied all parts that are 'red' in color.

PL/SQL Programs

1. Write a PL/SQL Code to add two numbers
2. Write a PL/SQL code for Fibonacci series
3. Write a PL/SQL Code for greatest of 3 numbers
4. Write a PL/SQL code for area and circumference of a circle

PL/SQL Programs on Cursors

1. Write a Program using CURSOR to display SID and city of 1st record of supplier
2. Write a program using cursors to display the SID and City of all suppliers and then print the count of suppliers.

PL/SQL Programs on Triggers, Procedures and Functions

1. Write a Program using TRIGGER on UPDATE
2. Write a command to See the effect of trigger
3. Write a Program using PROCEDURE to increase the cost by Rs.1000 for part whose PID is passed as an argument.
4. Write a procedure to update the city of an supplier whose SID and city are passed as arguments and the procedure returns the name of supplier whose city is updated.
5. Write a function to return the total number of suppliers
6. Write a function to return the PID of part, for which the part name is passed
7. Write a function to find the sum total of costs of all parts.

PL/SQL Programs on Implicit Cursors

1. Insert a record using %ROWTYPE
2. Write a code using %NOTFOUND, %FOUND, %ROWCOUNT
3. Write a code using %TYPE

MongoDB Queries

1. Create a collection and insert documents into it using insertOne() and insertMany()
2. Select all documents in collection
3. Find the count of all suppliers
4. Find all records that have city = 'Delhi'
5. Retrieve all documents that have color equal to 'red' or 'green'
6. Retrieve all documents where part_name is 'P1' or price is less than 200.
7. Update the record of 'Geeta' ,set city = 'Bombay' and phoneno = '11223344'
8. Delete all records where price is greater than 5000
9. Display only the name and city of the supplier
10. Sort all suppliers on city and display only the first two records.

Semester III	**Data Structures**	**C**	**L**	**T**	**P**
Course Code: BCADS3C07T	Total Teaching Hours: 48	**5**	**3**	**0**	**4**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the fundamental concepts of data structures and their applications	Understand
CO2	Implement various linear and non-linear data structure	Apply
CO3	Analyze the efficiency of different searching and sorting algorithms	Analyze
CO4	Implement stacks, queues, linked lists, trees, and graphs	Apply
CO5	Solve real-world problems using appropriate data structures	Create

SYLLABUS

Unit I	**Introduction to Data Structures**: Basic concepts, Need for Data Structures, Types of Data Structures (Linear and Non-Linear), Operations on Data Structures (Traversal, Insertion, Deletion, Searching, Sorting, Merging). **Arrays**: Definition, Representation, Operations on Arrays (Insertion, Deletion, Searching, Traversing, Merging), Applications of Arrays. **Strings**: Representation, Operations on Strings, String Matching Algorithms (Brute Force, KMP, Rabin-Karp).	12
Unit II	**Linked Lists**: Introduction, Representation of Linked Lists, Types (Singly Linked List, Doubly Linked List, Circular Linked List), Operations (Insertion, Deletion, Searching, Traversing, Merging), Applications of Linked Lists. **Stacks**: Definition, Representation using Arrays and Linked Lists, Operations (Push, Pop, Peek), Applications (Expression Evaluation, Backtracking, Function Call Stack). **Queues**: Definition, Types (Simple Queue, Circular Queue, Priority Queue, Deque), Operations (Enqueue, Dequeue, Peek), Applications.	12
Unit III	**Trees**: Definition, Terminologies (Node, Degree, Depth, Height), Types (Binary Tree, Binary Search Tree, AVL Tree, B-Trees, Heap), Operations (Insertion, Deletion, Traversal: Inorder, Preorder, Postorder), Applications (Huffman Coding, Expression Trees). **Graphs**: Definition, Terminologies (Vertices, Edges, Degree, Paths), Representation (Adjacency Matrix, Adjacency List), Graph Traversal (BFS, DFS), Applications of Graphs.	12

Unit IV	**Sorting Algorithms**: Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort, Heap Sort, Radix Sort, Time Complexity Analysis. **Searching Algorithms**: Linear Search, Binary Search, Interpolation Search, Hashing (Hash Functions, Collision Handling: Chaining, Open Addressing). **Advanced Data Structures**: Tree, Segment Tree, Disjoint Set Union (DSU), Applications.	12

Text Books & Reference Book

Text Books	1. Kamthane, A. N. (n.d.). Introduction to data structure in C. Pearson. 2. Lipschutz, S. (2011). Data structures with C. Schaum's Outlines. Tata McGraw-Hill. 3. Kanetkar, Y. (2022). Data structures through C (4th ed.). BPB Publications.
Reference Books	1. Thareja, R. (2014). *Data structures using C* (2nd ed.). Oxford University Press. 2. Horowitz, E., Sahni, S., & Anderson-Freed, S. (2007). *Fundamentals of data structures in C* (2nd ed.). Universities Press.
Web Resources	1. GeeksforGeeks. (n.d.). Data structures tutorial. https://www.geeksforgeeks.org/data-structures/ 2. Khan Academy. (n.d.). Algorithms course. https://www.khanacademy.org/computing/computer-science/algorithms

Data Structures :LAB Problems Course Code: BCADS3C07P

1. Write a program for insertion and deletion operations in an array.
2. Write a program to search for an element in an array using Linear Search and Binary Search.
3. Write a program to sort an array using Bubble Sort, Selection Sort, and Insertion Sort.
4. Write a program to merge two arrays.
5. Write a program to add and subtract two matrices.
6. Write a program to multiply two matrices.
7. Write a program to insert an element into a Singly Linked List:
(a)At the beginning b) At the end c)At a specified position
8. Write a program to delete an element from a Singly Linked List:
(a)At the beginning B)At the end c)A specified element
9. Write a program to perform the following operations in a Doubly Linked List:
(a)Create B)Search for an element
10. Write a program to perform the following operations in a Circular Linked List:
(a)Create (b) Delete an element from the end
11. Write a program to implement stack operations using an array.
12. Write a program to implement stack operations using a linked list.
13. Write a program to add two polynomials using linked lists.
14. Write a program to evaluate a postfix expression using a stack.
15. Write a program to perform the following using recursion:
(a)Find the factorial of a number
(b)Find the GCD of two numbers

(c) Solve Towers of Hanoi problem

16. Write a program to implement simple queue operations using an array.
17. Write a program to implement circular queue operations using an array.
18. Write a program to implement circular queue operations using a linked list.
19. Write a program to perform the following operations on a binary search tree:

(a) Preorder Traversal (b) Inorder Traversal (c) Postorder Traversal

20. Write a program to perform insertion operation in a binary search tree.

Semester III	**Probability and Statistics**	**C**	**L**	**T**	**P**
Course Code: BCADS3E03T	Total Teaching Hours: 60	**4**	**4**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand and handle randomness scientifically using probability theory	Understand
CO2	Represent statistical data systematically and analyze it to extract meaningful information.	Analyze
CO3	Apply probabilistic and statistical techniques to solve real-life problems.	Apply

SYLLABUS

Unit I	**Introduction to Statistics:** Basic concepts, qualitative and quantitative data, classification of data, construction of frequency distribution, diagrammatic representation of data. **Measures of Central Tendency:** Arithmetic mean, median, and mode—their properties. **Measures of Dispersion:** Range, mean deviation, quartile deviation, variance, and standard deviation.	15
Unit II	**Correlation:** Definition, scatter diagram, types of correlation, measures—Karl Pearson's correlation coefficient and Spearman's rank correlation coefficient. **Regression:** Linear regression-fitting by least square method and interpretation.	14
Unit III	**Concepts of Probability:** Experiment and sample space, events and operations with events, probability of an event, basic probability rules, applications of probability rules, conditional probability. **Random Variables:** Discrete and continuous random variables, probability distributions, probability mass function, probability density function, expectation and variance of a random variable. **Standard Probability Distributions:** Binomial, Poisson, and Normal distributions.	16
Unit IV	**Sampling Distribution:** Concept of Population and Sample, parameter and statistic, sampling distribution of sample mean and sample proportion. **Statistical Inference:** Estimation and Hypothesis Testing (only concept). **Hypothesis Testing for a Single Population:** Concept of hypothesis testing, tests involving a population mean and population proportion (z-test and t-test). **Chi-Square Test:** Test for independence of attributes and goodness of fit.	15
Text Books & Reference Book		

Text Books	1. Sharma, M., & Gupta, A. (2010). *The practice of business statistics*. Khanna Book Publishing Company. (AICTE Recommended Textbook) 2. Das, N. G. (2010). *Statistical methods* (Combined ed.). Tata McGraw Hill. 3. Ross, S. M. (2021). *Introduction to probability and statistics for engineers and scientists* (6th ed.). Elsevier. 4. Miller, I., & Miller, M. (2005). *Mathematical statistics with applications* (7th ed.). Pearson Education.
Reference Books	1. Pal, N., & Sarkar, S. (2013). Statistics: Concepts and applications (2nd ed.). PHI. 2. Montgomery, D., & Runger, G. C. (2016). Applied statistics and probability for engineers. Wiley. 3. Garg, R. (2024). Engineering mathematics. Khanna Publishing House.
Web Resources	1. NPTEL. (n.d.). Probability and statistics. https://nptel.ac.in/courses/111106112 2. NPTEL. (n.d.). Introduction to statistics. https://nptel.ac.in/courses/111105041

Semester III	**Basics of Data Analytics Using Spreadsheet**	**C**	**L**	**T**	**P**
Course Code: BCADS3E04T	Total Teaching Hours: 16	**2**	**1**	**1**	**2**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the basics of data analytics and its applications.	Understand
CO2	Develop proficiency in using spreadsheet software for data manipulation and analysis.	Apply
CO3	Build and use spreadsheet models for decision making & Communicate data insights effectively	Apply

Prerequisite:. Knowledge on basics of mathematical & Statistical concepts such as arithmetic, percentages, averages, and basic algebra

SYLLABUS

Unit I	**Introduction to Data Analytics** Understanding data and its types (structured, unstructured, semi-structured)-What is Data Analytics- Types of data Analytics- Importance of Data Analytics- Applications of Data Analytics**.**	8
Unit II	**Data, Ethics, and Industry: Case Studies** Data Collection Methods - Different Data Sources & format - Data Cleaning and Transformation - Handling Missing Data and Outliers. - Ethical considerations in data analytics. - Real-world Applications	8

Text Books & Reference Book

Text Books	1. Jose, J. (2024). Beginner's guide for data analysis using R programming. Khanna Publishing House. 2. Jain, V. K. (2024). Data analytics. Khanna Book Publishing Company. 3. Nelson, S. L., & Nelson, E. C. (2016). Excel data analysis for dummies (3rd ed.). John Wiley & Sons. 4. Data analysis using Microsoft Excel. (n.d.). [Publisher not provided].
Reference Books	1. Alexander, M., Kusleika, R., & Walkenbach, J. (2018, September 25). Excel 2019 Bible. John Wiley & Sons. 2. Ragsdale, C. T. (2015). Spreadsheet modeling and decision analysis: A practical introduction to business analytics. Cengage Learning Asia. 3. WebTech Solutions. (2024). Mastering Excel. Khanna Publishing House.

Basics of Data Analytics using Spreadsheet: Lab Program List Course Code : BCADS3E04P

Introduction to Excel and Basic Functions

1. Getting started with Excel: Workbook, Worksheet, Cells, and Ranges
2. Data entry and basic formatting techniques
3. Using basic arithmetic functions: SUM, AVERAGE, MIN, MAX, ROUND
4. Introduction to cell referencing: relative, absolute, and mixed

Data Importing and Pre-processing

1. Importing data from various sources (CSV, text files, web data)
2. Data cleaning: removing duplicates, handling missing data, and standardizing formats
3. Data transformation: text-to-columns, data validation techniques
4. Using the "Find & Replace" and "Text Functions" (LEFT, RIGHT,MID, CONCATENATE)

Descriptive Statistics Using Excel

1. Calculating measures of central tendency: mean, median, mode
2. Computing measures of dispersion: range, variance, standard deviation
3. Creating and interpreting frequency distributions and histograms
4. Using Excel's "Data Analysis Toolpak" for basic statistical analysis

PART- B: Beyond the Basics: Visualizing and Communicating Data

Advanced Spreadsheet Functions

1. Using logical functions: IF, AND, OR, IFERROR
2. Lookup and reference functions: VLOOKUP, HLOOKUP, INDEX, MATCH
3. Data aggregation techniques: SUMIFS, COUNTIFS, AVERAGEIFS
4. Text functions for data manipulation: TRIM, CLEAN, TEXT, RIGHT, LRFT, MID

Data Visualization Techniques

1. Introduction to Excel and Basic Functions
1. Getting started with Excel: Workbook, Worksheet, Cells, and Ranges
2. Data entry and basic formatting techniques
3. Using basic arithmetic functions: SUM, AVERAGE, MIN, MAX, ROUND
4. Introduction to cell referencing: relative, absolute, and mixed

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1. Importing data from various sources (CSV, text files, web data)
2. Data cleaning: removing duplicates, handling missing data, and standardizing formats
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2. Computing measures of dispersion: range, variance, standard deviation
3. Creating and interpreting frequency distributions and histograms
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PART- B: Beyond the Basics: Visualizing and Communicating Data

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4. Text functions for data manipulation: TRIM, CLEAN, TEXT, RIGHT, LRFT, MID

Data Visualization Techniques

1. Creating various chart types: bar, line, pie, scatter
2. Advanced charting techniques: combo charts, dual-axis charts
3. Data visualization best practices: choosing the right chart, formatting, and styling
4. Creating and customizing PivotTables and Pivot Charts

Dashboard Creation

1. Introduction to dashboards: concepts and components
2. Using PivotTables and Pivot Charts for dashboard elements
3. Applying conditional formatting for dynamic visual cues
4. Creating interactive dashboards with slicers and timeline Dashboard Creation

1. Introduction to dashboards: concepts and components
2. Using PivotTables and Pivot Charts for dashboard elements
3. Applying conditional formatting for dynamic visual cues
4. Creating interactive dashboards with slicers and timeline

Semester III	Organizational Behavior	C	L	T	P
Course Code: BCAGN3M03T	Total Teaching Hours: 45	3	3	0	0

Course Outcome

At the end of the course learners will be able to		
CO1	Describe the multi-disciplinary nature of OB and understand its role and significance in achieving organizational goals.	Apply
CO2	Understand the key determinants of individual behaviour in terms of concepts, processes, and models/theories (where applicable) and apply such knowledge to identify and analyse its implications for human behaviour in organizations.	Analyze
CO3	Understand and manage the way individuals are organized into groups and teams, the internal structures, processes and dynamics thereof.	Evaluate
CO4	Identify the sources of power and understand the role it plays in organizational politics as well as suggest conflict resolution mechanisms.	Evaluate
CO5	Initiate, manage, and implement organizational change.	Evaluate

SYLLABUS

Unit I	Conceptual Framework in understanding Organizational Behaviour (OB), Disciplines contributing to the development of OB; Significance of OB, Goals of OB. Personality: Determinants of Personality, Personality Theories: The Big Five Model; Type A and Type B personalities, Key personality traits influencing Organisational Behaviour	15
Unit II	(a) Perception: Perceptual process; Factors influencing the perceptual process, Perceptual Errors. (b) Learning: Determinants of Learning; Elements of Learning; Learning Process (c) Group Dynamics: Group development stages; Group Norms; Group Cohesiveness; Factors influencing group cohesiveness (d) Teams: Difference between groups and teams,Types.	15

Unit III	(a) Organisational Change: Process of Organisational Change; Resistance to Change; Managing organizational change – Kurt Lewin's Model of Organizational Change (b) Organizational Culture: Concept, Determinants, How employees learn organization, Creating an Ethical Organizational Culture	15
Text Books & Reference Book		
Text Books	1. Robbins, S. P., Judge, T. A., & Vohra, N. (n.d.). Organizational behavior. Pearson. 2. Luthans, F. (n.d.). Organizational behavior – An evidence-based approach. McGraw Hill Education-Asia. 3. Griffin, R. W., & Moorhead, G. (n.d.). Organizational behavior: Managing people and organizations. Cengage.	
Reference Books	1. McShane, S. L. (n.d.). Organizational behavior (Special Indian ed.). McGraw Hill. 2. Hersey, P., Blanchard, K. H., & Johnson, D. E. (n.d.). Management of organizational behavior. Pearson Education-Prentice Hall. 3. Pareek, U., & Khanna, S. (n.d.). Understanding organizational behaviour. Oxford University Press.	

Semester III	**HINDI I**	**C**	**L**	**T**	**P**
CourseCode: BCADS3A03T	Total Teaching Hours: 27	**2**	**2**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	हिंदी भाषा की मूल संरचना, व्याकरण और प्रयोगात्मक स्वरूप को समझना।	Understand
CO2	व्यावहारिक स्थितियों में प्रभावी हिंदी संप्रेषण की क्षमता विकसित कर सकेंगे।	Understand
CO3	हिंदी के मूल व्याकरणिक नियमों का प्रयोग करके स्पष्ट रूप से संवाद कर सकेंगे।	Understand
CO4	सरल औपचारिक पत्र, आवेदन, और सूचना लिख सकेंगे।	Evaluate
CO5	व्यावसायिक दस्तावेज, ईमेल, रिपोर्ट आदि तैयार करने में सक्षम होंगे।	Apply
CO6	संप्रेषण के विभिन्न माध्यमों में हिंदी का व्यवहारिक उपयोग कर सकेंगे।	Apply

SYLLABUS

Unit I	**भाषा की मूलभूत समझ:** हिंदी भाषा का स्वरूप और महत्त्व, वर्णमाला, उच्चारण, संधि, शब्द भंडार: पर्यायवाची, विलोम.	**6**
Unit II	**: व्याकरण का परिचय:** संज्ञा, सर्वनाम, विशेषण, क्रिया, वचन, लिंग, कारक, काल, वाक्य रचना: सरल और संयुक्त वाक्य, वाक्य रचना की विविधताएँ, काल और क्रिया के प्रयोग.	**6**
Unit III	**मौखिक संप्रेषण कौशल:** आत्मपरिचय देना, दैनिक संवाद (बाज़ार, कार्यालय, यातायात आदि), टेलीफोन/मोबाइल संवाद की भाषा, संवाद लेखन एवं भूमिका-निर्वाह (Role Play).	**9**
Unit IV	**लेखन अभ्यास:** सरल पत्र लेखन (आवेदन, सूचना, निमंत्रण), अनुच्छेद लेखन, ईमेल और संदेश लेखन	**6**
Text Books & Reference Book		

Text Books	1. Verma, R. D. (2016). Vyavaharik Hindi vyakaran evam rachna. Delhi: Lokbharti Prakashan. 2. Sharma, R. (2018). Karyalayin Hindi evam patra vyakaran. Lucknow: Naveen Prakashan. 3. Sinha, S. (2016). Hindi bhasha: Sampreshan aur sanvad. Delhi: Orient Publishing.

Semester III	**Python Programming**	**C**	**L**	**T**	**P**
Course Code: BCADS3S02T	Total Teaching Hours: 45	**4**	**2**	**0**	**4**

Course Outcome

At the end of the course learners will be able to		
CO1	Develop modular Python programs.	Apply
CO2	Apply suitable Python programming constructs, built-in data structures using Python libraries to solve a problem.	Apply
CO3	Understand basic Data visualization and File handling in Python.	Understand

SYLLABUS

Uni1	**Introduction to Python:** History and application areas of Python; Structure of Python Program; Identifiers and Keywords; Operators and Precedence; Basic Data Types and Type Conversion; Statements and Expressions; Input/Output statements. **Strings:** Creating and Storing Strings, Built-in functions for strings; String Operators, String Slicing and Joining; Formatting Strings. **Control Flow Statements:** Conditional Flow Statements; Loop Control Statements; Nested Control Flow; Continue and Break Statements; Pass and Exit.	15
Unit II	**Functions:** Built-In Functions, Function Definition and Call; Scope and Lifetime of Variables; Default Parameters, Command Line Arguments; Lambda Functions; Assert Statement; Importing User-defined Modules. **Mutable and Immutable Objects:** Lists, Tuples, and Dictionaries; Commonly used Functions on Lists, Tuples, and Dictionaries; Passing Lists, Tuples, and Dictionaries as Arguments to Functions. **Using Math and NumPy module:** Operations on List of Integers and Arrays.	15
Unit III	**Files:** Types of Files; Creating, Reading, and Writing Text and Binary Files; The Pickle Module; Reading and Writing CSV and JSON Files. **Exception Handling:** Try-Except-Else-Finally block; Raise Statement; Hierarchy of Exceptions; Adding Custom Exceptions. **Data Visualization:** Plotting various 2D and 3D Graphics; Histogram; Pie Charts; Sine and Cosine Curves.	15
Text Books & Reference Book		

Text Books	1. Venkatesh, N. Y. (2021). Introduction to Python programming. Khanna Publishing House. 2. Jose, J. (2023). Introduction to computing & problem solving with Python. Khanna Publishing House. 3. Taneja, S., & Kumar, N. (2017). Python programming: A modular approach with graphics, database, mobile and web applications. Pearson.
Reference Books	1. Downey, A. (2015). Think Python (2nd ed.). O'Reilly. 2. Dowling, B. (n.d.). An introduction to Python for absolute beginners. Cambridge University Press. 3. Guttag, J. (2016). Introduction to computation and programming using Python (2nd ed.). PHI India.
Web Resources	1. LearnPython. (n.d.). Learn Python. https://www.learnpython.org/ 2. W3Schools. (n.d.). Python tutorial. https://www.w3schools.com/python/default.asp

Python Programming :LAB Problems Course Code: BCADS3S02P

1. Write a program to check whether a given number is a prime number.
2. Write a program to compute m^n, where m and n are read from the user.
3. Write a program with a parameterized function that returns True if the given number is even, otherwise False.
4. Write a program to print the summation of the following series up to n terms:
   1 - 2 + 3 - 4 + 5 - 6 + ... ± n.
5. Write a menu-driven program to perform the following string operations:
   a. Find the frequency of a character in a string.
   b. Replace a character with another character in a string.
   c. Remove the first occurrence of a character from a string.
   d. Remove all occurrences of a character from a string.
6. Write a program that accepts two strings and returns the indices of all occurrences of the second string in the first string as a list. If the second string is not present, return -1.
7. Using NumPy, write a menu-driven program to:
   a. Create an array filled with 1s.
   b. Find the maximum and minimum values in an array.
   c. Compute the dot product of two arrays.
   d. Reshape a 1-D array into a 2-D array.
8. Write a function that takes a sentence as input from the user and calculates the frequency of each letter. Use a dictionary to maintain the count.
9. Consider a tuple t1 = (1,2,5,7,9,2,4,6,8,10). Write a program to perform the following operations:
   a. Print the contents of t1 in two separate lines such that half of the values appear on one line and the other half on the next line.
   b. Print all even values of t1 as another tuple t2.
   c. Concatenate a tuple t2 = (11,13,15) with t1.
   d. Return the maximum and minimum values from t1.

10. Write a function that reads a file file1 and copies only alternative lines to another file file2. The copied lines should be the odd-numbered lines.
11. Write a Python program to handle a ZeroDivisionError exception when dividing a number by zero.
12. Write a program that reads a list of integers from the user and throws an exception if any numbers are duplicates.
13. Write a program that makes use of a function to display sine, cosine, polynomial, and exponential curves.
14. Take input for the months and profits made by a company ABC over a year. Represent this data using a line plot. The generated line plot must include:X-axis label: Month Number Y-axis label: Total Profit.

Semester III	**Yoga & Wellness**	**C**	**L**	**T**	**P**
Course Code: BCAGN3V03T	Total Teaching Hours:	**3**	**0**	**0**	**3**

Course Outcome

At the end of the course learners will be able to		
CO1	To understand the importance of a healthy lifestyle	Understand
CO2	To familiarize students about physical and mental health	Apply
CO3	To create an awareness of various lifestyle related diseases	Analyze
CO4	To provide understanding of stress management	Apply
CO5	Apply yogic principles to manage psycho-somatic ailments and promote resilience.	Apply

SYLLABUS

Unit I	**Introduction to Health & Wellness** ● Definition of Health ● Importance of health in everyday life ● Components of health – physical, social, mental, spiritual and its relevance ● Concept of wellness ● Mental health and wellness ● Determinants of health behavior	8
Unit II	**Mind Body and Well-Being** ● Mind body connection in health – concept and relation ● Implications of mind-body connection ● Wellbeing – why it matters? ● Digital wellbeing	8
Unit III	**Deficiency & Diseases** ● Malnutrition, under nutrition and over nutrition ● Body system and common diseases ● Sedentary lifestyle and risk of disease ● Modern lifestyle and associated health risks	6
Unit IV	**Indian system of well being** ● Health beliefs of India ● Health systems in India – AYUSH. ● Perspective of indigenous people towards health ● Happiness and well-being in India	8

Text Books & Reference Book	
Text Books	1. Carr, A. (n.d.). Positive psychology: The science of happiness and human strength. Routledge. 2. Nyambichu, C., & Lumiri, J. (n.d.). Lifestyle disease: Lifestyle disease management.

SEMESTER –IV

Fourth Semester							
Sl No	**Component**	**Course Code**	**Title of the course**	**Credit**		**Hour Per Week**	
				TH	**P**	**Theory**	**Practical**
1	**Major CC**	BCADS4C08T	Computer Network	4		4	
2	**Major C**	BCADS4C08P	Computer Network Lab		1		2
3	**Major CC**	BCADS4C09T	Design And Analysis of Algorithm	3		3	
4	**Major DSC**	BCADS4C10T	Artificial Intelligence	3		3	
5	**Major DSCP**	BCADS4C10P	Artificial Intelligence Lab		2		4
6	**MDC**	BCAGN4M04T	Entrepreneurship And Innovation	3		3	
7	**AEC**	BCADS4A04T	Design Thinking and Innovation/Hindi II	2		2	
8	**SEC**	BCADS4S03T	Data Visualization	3		3	
9	**SEC P**	BCADS4S03P	Data Visualization Lab		2		4
10	**Online Course**	BCADS4O03P	Online course on Statistical tools(NPTEL, Coursera , EDX)	2			
			Total Credit	25		Total Hours-28	

Semester IV	Computer Network	C	L	T	P
Course Code: BCADS4C08T	Total Teaching Hours: 60	5	4	0	2

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the fundamental concepts of Computer Networks and their applications.	Understand
CO2	Develop problem-solving skills related to network design, implementation, and troubleshooting.	Apply
CO3	Implement network protocols and configure network devices.	Apply

Prerequisites:

1. Basic Networking Knowledge: Familiarity with basic networking concepts such as IP addressing and network topologies.

2. Programming Skills: Ability to write basic network programs and scripts in languages such as Python or C.

3. Operating Systems: Understanding of OS concepts related to networking, such as process management and memory allocation

SYLLABUS

Unit I	Introduction to Computer Networks: Definition and Objectives, Applications and Examples, Network Components and Architecture, Network Models (OSI Model: Layers and Functions, TCP/IP Model: Layers and Functions), Comparison between OSI and TCP/IP Models, Network Topologies (Physical vs. Logical, Star, Ring, Bus, Mesh, Hybrid, Advantages & Disadvantages), Data Transmission (Analog vs. Digital Signals, Transmission Modes, Bandwidth & Latency), Networking Devices (Routers, Switches, Hubs, Bridges, Gateways: Functions & Configurations).	15
Unit II	Data Link Layer and Networking Protocols: Functions of the Data Link Layer, Framing, Error Detection & Correction, Flow Control Mechanisms, Ethernet (Standards, Frame Structure, MAC Addressing, ARP), Ethernet Switching (Concepts & Methods), Network Protocols (TCP/IP Protocol Suite, IP Addressing: IPv4 & IPv6, Subnetting, CIDR Notation), Address Resolution Protocol (ARP Operation, Security Considerations), Virtual LANs (Concept, VLAN Tagging & Configuration, Benefits & Use Cases).	15

Unit III	Network Layer and Transport Layer: IP Routing (Static vs. Dynamic), Routing Protocols (RIP, OSPF, BGP), Network Address Translation (NAT), Transport Layer (TCP vs. UDP, TCP Handshake & Connection Management, Flow Control & Congestion Control in TCP), Congestion Control Algorithms (Slow Start, Congestion Avoidance, Fast Retransmit, Fast Recovery, TCP Variants: Reno, Vegas), Quality of Service (QoS Principles, Differentiated Services, Integrated Services), Network Security Fundamentals (Threats, Vulnerabilities, Firewalls, VPNs, Encryption).	15
Unit IV	Application Layer and Emerging Technologies: Application Layer Protocols (HTTP/HTTPS, FTP, SMTP, POP3, IMAP, DNS), Network Applications (Web Browsing, Email, File Transfer, VoIP, Streaming), Emerging Technologies (Software-Defined Networking (SDN), Network Function Virtualization (NFV), Internet of Things (IoT)), Network Management (SNMP, Monitoring Tools & Techniques), Future Trends in Networking (5G, Network Automation, AI in Networking).	15

Text Books & Reference Book

Text Books	1. Tanenbaum, A. S. (2011). Computer networks (5th ed.). Pearson Education. 2. Kurose, J. F., & Ross, K. W. (2021). Computer networking: A top-down approach (8th ed.). Pearson.
Reference Books	1. Forouzan, B. A. (2012). Data communications and networking (5th ed.). McGraw-Hill Education. 2. Peterson, L. L., & Davie, B. S. (2019). Computer networks: A systems approach (6th ed.). Morgan Kaufmann. 3. Sidhu, B. (2023). An integrated approach to computer networks. Khanna Publishing House. 4. Mastering PC hardware & networking. (2024). Khanna Publishing House.
Web Resources	1. Cisco Networking Academy. (n.d.). Online courses and resources. https://www.netacad.com 2. NetworkLessons.com. (n.d.). Tutorials on various networking topics. https://networklessons.com

Computer Networks: LAB Problems Course Code: BCADS4C08P

1. **Configure Basic Network Settings:**
   a) IP Address Configuration
   b) Subnet Mask and Gateway Settings
2. **Implement Network Protocols:**
   a) Write a simple Python script to perform DNS resolution.
   b) Implement a basic HTTP client-server application.
3. **Network Simulation:**
   a) Use network simulation tools (e.g., Cisco Packet Tracer) to design and simulate network topologies.
   b) Configure routers and switches in a simulated environment.

4. **Performance Measurement:**
   a) Measure network performance using tools like ping, traceroute, and iperf.
   b) Analyze network traffic using Wireshark.
5. **Implement VLANs:**
   a) Configure VLANs on a switch and verify using simulation tools.
6. **Set Up a Simple Web Server:**
   a) Deploy a basic web server and configure HTTP/HTTPS access.
7. **Network Security Lab:**
   a) Implement basic firewall rules and VPN configurations.
   b) Perform vulnerability scanning and analyze results.
8. **Network Troubleshooting:**
   a) Diagnose and resolve common network issues.
   b) Use troubleshooting commands and techniques to fix connectivity problems.

Semester IV	**Design and Analysis of Algorithms**	**C**	**L**	**T**	**P**
Course Code: BCADS4C09T	Total Teaching Hours : 48	**3**	**3**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand fundamental concepts of algorithm design and analysis.	Understand
CO2	Apply problem-solving skills to design and optimize algorithms.	Apply
CO3	Implement algorithms using appropriate data structures and techniques.	Apply

Prerequisites:

1. **Basic Programming Knowledge**: Familiarity with programming concepts in C, C++, or Python.
2. **Data Structures**: Understanding of arrays, linked lists, stacks, queues, trees, and graphs.
3. **Mathematical Foundations**: Basics of discrete mathematics, probability, and set theory.

SYLLABUS

Unit I	Introduction to Algorithms and Complexity Analysis: Definition and importance of algorithms, Algorithm performance analysis: Time and Space Complexity, Asymptotic Notations (O, Ω, Θ), Analysis of sorting and searching algorithms (Sequential search, Bubble Sort, Selection Sort, Insertion Sort, Matrix multiplication), Recursion and Recursive Algorithm Analysis, Master's Theorem and Divide & Conquer Method.	12
Unit II	Divide & Conquer and Greedy Algorithms: **Divide & Conquer Approach** - Binary search, Merge Sort, Quick Sort, Best and worst-case analysis, Strassen's Matrix Multiplication, Lower Bound for Comparison-based Sorting. **Greedy Algorithm Approach** - Knapsack Problem, Minimum Spanning Trees (Prim's & Kruskal's Algorithm), Single-source shortest path (Dijkstra's Algorithm).	12
Unit III	Dynamic Programming and Graph Algorithms: **Dynamic Programming Approach** - Fibonacci series computation, Binomial Coefficients, All-Pairs Shortest Path (Floyd-Warshall Algorithm), 0/1 Knapsack Problem. **Graph Algorithms** - Breadth-First Search (BFS) and Depth-First Search (DFS), Finding Connected Components, Topological Sorting.	12

Unit IV	Limitations of Algorithmic Power and Complexity Classes: **Backtracking and NP-Complete Problems** - N-Queen Problem, Hamiltonian Circuit Problem, Vertex Cover Problem. **Computational Complexity** - Overview of Non-Deterministic Algorithms, P, NP, NP-Complete, and NP-Hard Problems.	12

Text Books & Reference Book

Text Books	1. Sharma, G. (n.d.). Design and analysis of algorithms. Khanna Publishing House. (AICTE Recommended) 2. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to algorithms (3rd ed.). PHI. 3. Horowitz, E., Sahni, S., & Rajasekaran, S. (2012). Fundamentals of computer algorithms. University Press. 4. Levitin, A. (2012). Introduction to design and analysis of algorithms (3rd ed.). Pearson.
Reference Books	1. Aho, A. V., Hopcroft, J. E., & Ullman, J. D. (1983). The design & analysis of computer algorithms. Addison Wesley. 2. Kleinberg, J., & Tardos, E. (2006). Algorithm design. Pearson Education.
Web Resources	1. NPTEL. (n.d.). Design and analysis of algorithms. https://nptel.ac.in/courses/106101060 2. Mount, D. (n.d.). CMSC 451: Design and analysis of computer algorithms lecture notes. University of Maryland. https://www.cs.umd.edu/~mount/451/Lects/451lects.pdf

Semester IV	**Artificial Intelligence**	**C**	**L**	**T**	**P**
Course Code: BCADS4C10T	Total Teaching Hours: 48	**5**	**3**	**0**	**4**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the characteristics of rational agents, the environment in which they operate, and gain insights into problem-solving agents.	Understand
CO2	Gain insights into Uninformed and Heuristic search techniques and apply them to solve search applications.	Apply
CO3	Appreciate the concepts of knowledge representation using Propositional logic and Predicate calculus and apply them for inference/reasoning.	Apply
CO4	Obtain insights about Planning and handling uncertainty through probabilistic reasoning and fuzzy sets.	Understand
CO5	Obtain a basic understanding of AI domains and their applications and examine the legal and ethical issues of AI.	Analyze

Prerequisites:
Basic understanding of computer science concepts, including data structures and algorithms.
Proficiency in minimum one programming language, such as Python.

SYLLABUS

Unit I	**Introduction to AI**: Definition and Importance of AI, Intelligent Agents (Agents and Environment, Concept of Rationality, Nature of Environment, Structure of Agents), Knowledge-Based Agents (Introduction, The Wumpus World Example), Problem-Solving Agents	12
Unit II	**Advanced Search Techniques**: Uninformed Search (DFS, BFS, Iterative Deepening Search), Informed Search (Best First Search, A* Search, AO* Search), Adversarial Search & Games (Two-Player Zero-Sum Games, Minimax Search, Alpha-Beta Pruning), Constraints & CSPs (Backtracking Search for CSP), Evolutionary Search (Genetic Algorithms, Applications in AI)	12
Unit III	**Logical Reasoning and Uncertainty**: Logic (Propositional Logic, First-Order Predicate Logic, Propositional vs. First-Order Inference, Unification and Lifting), Inference (Forward Chaining, Backward Chaining, Resolution, Truth Maintenance Systems), Planning (Blocks World Problem, STRIPS), Handling Uncertainty (Non-Monotonic Reasoning, Probabilistic Reasoning, Fuzzy Set Theory)	12

Unit IV	**Domains and Applications of AI**: AI Domains (Machine Learning, Computer Vision, Robotics, Natural Language Processing, Deep Neural Networks), Expert Systems (Architecture, Role, Two Case Studies), Legal and Ethical Issues in AI	12

Text Books & Reference Book

Text Books	1. Trivedi, M. C. (2024). A classical approach to artificial intelligence. Khanna Book Publishing Company. (AICTE Recommended) 2. Nilsson, N. J. (n.d.). Artificial intelligence: A new synthesis. Morgan Kaufmann Publishers Inc. 3. Patterson, D. W. (2010). Introduction to artificial intelligence & expert systems. PHI Learning. 4. Chopra, R. (2024). Data science with artificial intelligence, machine learning, and deep learning. Khanna Book Publishing Company.
Reference Books	1. Trivedi, M. C. (2024). Introduction to AI and machine learning. Khanna Book Publishing Company. 2. Russell, S., & Norvig, P. (n.d.). Artificial intelligence: A modern approach (3rd ed.). Prentice Hall. 3. Van Hirtum, A., & Kolski, C. (2020). Constraint satisfaction problems: Algorithms and applications. Springer. 4. Chopra, R. (2024). Machine learning and machine intelligence. Khanna Book Publishing Company.
Web Resources	1. NPTEL. (n.d.). Artificial intelligence. https://nptel.ac.in/courses/106101060 2. Mount, D. (n.d.). CMSC 451: Design and analysis of computer algorithms lecture notes. University of Maryland. https://www.cs.umd.edu/~mount/451/Lects/451lects.pdf

Artificial Intelligence: Lab Problems Course Code: BCADS4C10P

Prerequisites: Basic understanding of algorithms and data structures (e.g., trees, graphs, lists). Proficiency in Python programming, including libraries like NLTK for NLP tasks.

LAB Experiments

The lab experiments may be implemented in Python. Libraries like NLTK, Tensorflow and Keras may be used for Machine learning experiments.

1. Demonstrate basic problem-solving using **Breadth-First Search (BFS)** on a simple grid.
2. Implement **Depth-First Search (DFS)** on a small graph.
3. Solve the **Water Jug Problem** using **Breadth-First Search (BFS)**.
4. Implement a **Hill Climbing Search** to find the peak in a numeric dataset.
5. Apply the *A Search Algorithm** to find the shortest path in a **4x4 grid**.
6. Implement the **Minimax Search Algorithm** for **2-player games** using a game tree with **3 plies**.
7. Solve the **4-Queens Problem** as a **Constraint Satisfaction Problem (CSP)** using **backtracking**.

8. Use **constraint propagation** to solve a **Magic Square Puzzle**.
9. Apply **optimization techniques** to find the **maximum value** in a list.
10. Represent and evaluate **Propositional Logic Expressions**.
11. Implement a **Basic Rule-Based Expert System** for **weather classification**.
12. Implement a **Basic AI Agent** with **simple decision-making rules**.
13. Implement a **Basic Rule-Based Chatbot**.
14. Using **Python NLTK**, perform the following **Natural Language Processing (NLP)** tasks for text content:

a) **Tokenizing** b) **Filtering Stop Words** c) **Stemming** d) **Part of Speech (POS) Tagging** e) **Chunking** f) **Named Entity Recognition (NER)**

15. Perform **Image Classification** for a given dataset using **Convolutional Neural Networks (CNN)**. You may use **TensorFlow/Keras**.

Semester IV	Entrepreneurship And Innovation	C	L	T	P
Course Code: BCAGN4M04T	Total Teaching Hours: 42	3	3	0	0

Course Outcome

At the end of the course learners will be able to		
CO1	To understand Entrepreneurship and its types	Understand
CO2	To understand that not all ideas can be turned into viable business models and guestimate business potential of an idea	Understand
CO3	To be able to draft business plans on an identified idea	Create
CO4	To know what is a Family Business and how is it different from Entrepreneurship	Analyze

Unit I	**Introduction to Entrepreneurship & Family Business** Definition and Concept of entrepreneurship Entrepreneur Characteristics Classification of Entrepreneurs Role of Entrepreneurship in Economic Development –Start-ups Knowing the characteristics of Family business with discussion on few Indian cases of Family Business like Murugappa, Dabur, Wadia, Godrej, Kirloskar etc.	10
Unit II	**Evaluating Business opportunity** ● Sources of business ideas and opportunity recognition ● Guesstimating the market potential of a business idea ● Feasibility analysis of the idea ● Industry, competition and environment analysis	12
Unit III	**Building Blocks of starting ventures** ● Low cost Marketing using digital technologies ● Team building from scratch ● Venture Funding ● Establishing the value-chain and managing operations ● Legal aspects like IPR and compliances	10
Unit IV	**Start-up Ecosystem** ● Know the components of the start-up ecosystem including Incubators, Accelerators, Venture Capital Funds, Angel Investors etc. ● Know various govt. schemes like Start-up India, Digital India, MSME etc.	10

Text Books & Reference Book	
Text Books	1. Roy, R. (n.d.). Entrepreneurship. Oxford University Press. 2. Ireland, R. D., & Barringer, B. R. (n.d.). Entrepreneurship: Successfully launching new ventures. Pearson Publishing. 3. Agarwal, R. (n.d.). Family business management. Sage Publishing. 4. Start Up India. (n.d.). Startup India learning program. https://www.startupindia.gov.in 5. Tiwari, A. (n.d.). Mapping the startup ecosystem in India. Economic & Political Weekly.

Semester IV	Design Thinking and Innovation	C	L	T	P
Course Code: BCADS4A04T	Teaching Hours: 32	2	2	0	0

Course Outcome

At the end of the course learners will be able to		
CO1	Propose real-time innovative product designs and choose appropriate frameworks, strategies, and techniques during prototype development.	Apply
CO2	Identify and frame wicked problems in a consensus-driven manner that is agreeable to all stakeholders using appropriate frameworks, strategies, and techniques.	Analyze
CO3	Analyze emotional experiences and inspect emotional expressions to better understand users while designing innovative products.	Evaluate

Prerequisites:
Basic understanding of computer science concepts, including data structures and algorithms.
Proficiency in minimum one programming language, such as Python.

SYLLABUS

Unit I	**Basics of Design Thinking** 1. Understand the concept of innovation and its significance in business 2. Understanding creative thinking process and problem solving approaches 3. Know Design Thinking approach and its objective 4. Design Thinking and customer centricity – real world examples of customer challenges, use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product. 5. Discussion of a few global success stories like AirBnB, Apple, IDEO, Netflix etc. 6. Explain the four stages of Design Thinking Process – Empathize, Define, Ideate, Prototype, Implement	8
Unit II	**Learning to Empathize and Define the Problem** 1. Know the importance of empathy in innovation process – how can students develop empathy using design tools. 2. Observing and assimilating information 3. Individual differences & Uniqueness Group Discussion and Activities to encourage the understanding, acceptance and appreciation of individual differences. 4. What are wicked problems	8

	5. Identifying wicked problems around us and the potential impact of their solutions	
Unit III	**Ideate, Prototype and Implement** **1**. Know the various templates of ideation like brainstorming, systems thinking 2**.** Concept of brainstorming – how to reach consensus on wicked problems 3**.** Mapping customer experience for ideation 4**.** Know the methods of prototyping, purpose of rapid prototyping. 5. Implementation	8
Unit IV	**Feedback, Re-Design & Re-Create** **1.** Feedback loop, focus on User Experience, address ergonomic challenges, user focused design 2. Final concept testing, 3. Final Presentation – Solving Problems through innovative design concepts & creative solution	8

Text Books & Reference Book

Text Books	1. Balaguruswamy, E. (2023). Developing thinking skills: The way to success. Khanna Book Publishing Company. 2. Brown, T. (2008). Change by design: How design thinking transforms organizations and inspires innovation. Harvard Business Review Press. 3. Krishnan, R. T., & Dabholkar, V. (n.d.). 8 steps to innovation. Collins Publishing.
Reference Books	1. Cross, N. (n.d.). *Design thinking*. Bloomsbury.
Web Resources	1. NPTEL. (n.d.). Design thinking. https://nptel.ac.in/courses/106101060 2. Mount, D. (n.d.). CMSC 451: Design and analysis of computer algorithms lecture notes. University of Maryland. https://www.cs.umd.edu/~mount/451/Lects/451lects.pdf

Semester IV	**Hindi II**	**C**	**L**	**T**	**P**
Course Code: BCADS4A04T	Total Teaching Hours: 30	**2**	**2**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	उन्नत स्तर की हिंदी में स्पष्ट, सटीक एवं प्रभावी संवाद कर सकेंगे।	Understand
CO2	व्यावसायिक तथा डिजिटल माध्यमों में हिंदी के प्रयोग में आत्मविश्वास प्राप्त करेंगे।	Understand
CO3	हिंदी भाषा की जटिल व्याकरणिक रचनाओं को समझ और प्रयोग कर सकेंगे।	Understand
CO4	तकनीकी तथा अकादमिक लेखन में उपयुक्त हिंदी का प्रयोग कर सकेंगे।	Apply
CO5	व्यावसायिक दस्तावेज, ईमेल, रिपोर्ट आदि तैयार करने में सक्षम होंगे।	Apply
CO6	साक्षात्कार, समूह चर्चा, प्रस्तुतिकरण आदि में आत्मविश्वास से भाग ले सकेंगे।	Apply

Prerequisites: Knowledge of Basic Hindi Grammar

SYLLABUS

Unit I	**उन्नत हिंदी भाषा और व्याकरण:** वाक्य रचना: सरल, संयुक्त, मिश्र वाक्य, वाच्य: कर्तृवाच्य, कर्मवाच्य, भाववाच्य, , मुहावरे एवं लोकोक्तियाँ एवं उनका प्रयोग, पारिभाषिक शब्दावली (तकनीकी एवं प्रशासनिक), तत्सम, तद्भव, देशज और विदेशी शब्दों का उपयोग, व्यावसायिक शब्दावली का प्रयोग.	**6**
Unit II	**औपचारिक एवं कार्यस्थलीय संचार:** औपचारिक पत्र लेखन (प्रार्थना पत्र, आवेदन पत्र, सूचना आदि), कार्यालयीन संप्रेषण - नोट, आलेख, और संक्षेप लेखन, ज्ञापन, रिपोर्ट, रेज़्यूमे और बायोडाटा लेखन.	**6**
Unit III	**मौखिक संप्रेषण कौशल:** समूह चर्चा, वाद-विवाद, साक्षात्कार की तैयारी और अभ्यास, भाषण, प्रस्तुति एवं मंच संचालन.	**6**
Unit IV	**डिजिटल और सामाजिक माध्यमों में हिंदी:** सोशल मीडिया एवं ब्लॉग लेखन, समाचारों का विश्लेषण एवं संक्षेपण, तकनीकी भाषा और संप्रेषण.	**6**

Unit V	**व्यावसायिक क्षेत्र आधारित संवाद (Stream-specific):** छात्र के व्यावसायिक क्षेत्र से संबंधित संवाद का अभ्यास, संबंधित शब्दावली और अभिव्यक्ति का प्रयोग, संप्रेषण शैली एवं शब्द चयन	**6**

Text Books & Reference Book

Textbooks	1. Verma, R. D. (2016). Vyavaharik Hindi vyakaran evam rachna. Delhi: Lokbharti Prakashan. 2. Sharma, R. (2018). Karyalayin Hindi evam patra vyakaran. Lucknow: Naveen Prakashan. 3. Agrawal, N. (2015). Anuvad: Siddhant aur prayog. Delhi: Lokbharti Prakashan. 4. Tripathi, C. (2014). Vyavsayik sanchar aur patrachar. Delhi: Rajkamal Prakashan. 5. Pandey, R. N. (2017). Vyavsayik anuvad aur sanchar kaushal. Delhi: Rajpal & Sons. 6. Mishra, S. (2019). Samkaleen Hindi sanchar madhyam. Delhi: Diamond Books. 7. Chaturvedi, M. G., & Tiwari, B. N. (2013). Hindi vyakaran aur rachna. Varanasi: Vani Prakashan. 8. Singh, B. P. (2012). Hindi vyakaran darshan. Allahabad: Bharati Bhavan. 9. Sinha, S. (2016). Hindi bhasha: Sampreshan aur sanvad. Delhi: Orient Publishing. 10. Jain, P., & Awasthi, S. (2020). Digital madhyam aur Hindi sanchar. Delhi: Kitab Mahal.
Reference Books	1. Chaturvedi, M. G., & Tiwari, B. N. (2013). Hindi vyakaran aur rachna. Delhi: Vani Prakashan. 2. Rai, U. S. (2012). Prayojanmulak Hindi. New Delhi: Vikas Publishing House. 3. Mishra, S. (2018). Vyavsayik sanchar kaushal aur karyalayin patrachar. Delhi: Diamond Books. 4. Tripathi, C. (2015). Karyalayin Hindi aur sanchar. Lucknow: Naveen Prakashan. 5. Sharma, R. (2017). Vyavaharik Hindi: Samvad aur patrachar. Allahabad: Kitab Mahal. 6. Agrawal, N. (2014). Anuvad: Siddhant, prakriya aur prayog. Delhi: Lokbharti Prakashan. 7. Sinha, S. (2016). Media aur Hindi bhasha. Delhi: Rajkamal Prakashan. 8. Pandey, R. N. (2016). Takneekik aur vyavsayik anuvad. Delhi: Rajpal & Sons. 9. Sharma, S. K. (2019). Bhasha, sanchar aur manch kaushal. Jaipur: Surya Prakashan Mandir. 10. Jain, P., & Awasthi, S. (2020). Digital madhyam mein Hindi: Prayog evam chunautiyan. Delhi: Kitab Ghar.

Semester IV	Data Visualization	C	L	T	P
Course Code: BCADS4S03T	Total Teaching Hours: 45	**3**	**3**	**0**	**4**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the fundamentals of data visualization and its importance.	Understand
CO2	Learn about visual perception and its impact on data interpretation.	Apply
CO3	Explore the ethical considerations and challenges in data visualization.	Understand
CO4	Study different types of visualizations and their appropriate uses.	Apply
CO5	Utilize Power BI to create and customize various types of visualizations.	Create

Prerequisite:

Familiarity with using a computer, including file management and basic software navigation. Basic knowledge of data structures, such as tables and databases. Basic understanding of data analysis concepts and familiarity with data types.

SYLLABUS

Unit I	**Introduction to Data Visualization** Definition and importance of data visualization-Role of data visualization in decision making- Types of data (numerical, categorical, temporal, geographical)-Data visualization process (data collection, exploration, analysis, visualization, interpretation)-Challenges and limitations of data visualization	**15**
Unit II	**Visualization tools & Data Storytelling** Overview of Visualization Tools (e.g., Excel, Tableau, Power BI, Python)- Comparing and contrasting features and Use Cases among these tools. Principles of Data Storytelling: Narrative and Context-Best Practices for Dashboard Layout and Interactivity	**15**
Unit III	**Designing Effective Visualizations** Principles of Good Visualization Design - Understanding and Using Color in Visualizations – Importance of Data Modelling in Visualization**.**	**15**

Text Books & Reference Book	
Text Books	1. Knaflic, C. N. (2015). Storytelling with data: A data visualization guide for business professionals (1st ed.). Wiley. 2. Tufte, E. (2001). The visual display of quantitative information (2nd ed.). Graphics Press USA.
Reference Books	1. Healy, K. (2018). Data visualization: A practical introduction. Princeton University Press. 2. Ferrari, A., & Russo, M. (2017). Analyzing data with Power BI and Power Pivot for Excel (1st ed.). Microsoft Press. 3. Knight, D., Knight, B., Pearson, M., & Quintana, M. (2018). Microsoft Power BI complete reference (1st ed.). Packt Publishin
Introduction to ML: LAB Problems Course Code : BCADS4S03P	

Introduction to Power BI Interface and Basics

1. Installation and interface overview
2. Exploring the Power BI workspace: Ribbon, panes, and canvas.
3. Importing data from Excel and CSV files.
4. Introduction to multiple data sources
5. Basic report creation: Adding visuals and saving a report.

Data Transformation and Preparation

1. Using Power Query Editor
2. Cleaning data: Removing duplicates, handling missing values.
3. Transforming data: Splitting columns, changing data types, renaming columns.
4. Merging and appending queries.
5. Creating custom columns and calculated columns

Data Modeling

1. Creating relationships between tables
2. Identifying and resolving data inconsistencies
3. Creating calculated columns and measures

Creating Basic Visualizations

1. Creating various chart types (bar, column, line, pie, area, etc.,)
2. Formatting and customizing visualizations

Publishing and Sharing Reports

1. Publishing a report to Power BI Service.
2. Sharing reports and dashboards with team members.
3. Setting up data refresh schedules and managing permissions.

SEMESTER -V

Fifth Semester							
Sl No	Component	Course Code	Title of The course	Credit		Hour Per Week	
				TH	P	Theory	Practical
1	**Major Core**	BCADS5C11T	Introduction to Data Science	3		3	
	Major Core	BCADS5C11P	Data Science Lab		2		4
2	**Major Core**	BCADS5C12T	Time Series Analysis	3		3	
	Major Core	BCADS5C12P	Time Series Analysis Lab		2		4
3	**Major Core**	BCADS5C13T	Machine Learning	3		3	
	Major Core	BCADS5C13P	Machine Learning Lab		2		4
4	**Minor**	BCADS5E05T	R Programming	3			3
5	**SEC**	BCADS5S04P	Capstone project/Mini Project		3		4
6	**Internship**	BCADS5I01P	Internship		4		2*
			Total Credit	25		Total Hours-30*/28	

Semester 5	Introduction to Data Science	C	L	T	P
Course Code: BCADS5C11T	Total Teaching Hours: 48	5	3	0	4

Course Outcome

At the end of the course learners will be able to		
CO1	Define the data science process	Understand
CO2	Understand different types of data description for data science process	Understand
CO3	Gain knowledge on relationships between data	Analyze
CO4	Use the Python Libraries for Data Wrangling	Create
CO5	Apply visualization Libraries in Python to interpret and explore data	Create

SYLLABUS

UNIT I	**Introduction** Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model– presenting findings and building applications - Data Mining - Data Warehousing – Basic Statistical descriptions of Data	8
UNIT II	**DESCRIBING DATA** Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores	10
UNIT III	**DESCRIBING RELATIONSHIPS** Correlation –Scatter plots –correlation coefficient for quantitative data – computational formula for correlation coefficient – Regression – regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean	10
UNIT IV	**PYTHON LIBRARIES FOR DATA WRANGLING** Basics of Numpy arrays –aggregations –computations on arrays – comparisons, masks, boolean logic – fancy indexing – structured arrays	10

	– Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables	
UNIT V	**DATA VISUALIZATION** Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting – Geographic Data with Basemap - Visualization with Seaborn.	**10**

Practical/ Lab Experiments Course Code : BCADS5C11P

1. Download, install and explore the features of NumPy, SciPy, Jupyter, Statsmodels and Pandas packages.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Reading data from text files, Excel and the web and exploring various commands for doing descriptive analytics on the Iris data set.
5. Use the diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:
    a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
    b. Bivariate analysis: Linear and logistic regression modelling
    c. Multiple Regression analysis
    d. Also compare the results of the above analysis for the two data sets.
6. Apply and explore various plotting functions on UCI data sets.
    a. Normal curves
    b. Density and contour plots
    c. Correlation and scatter plots
    d. Histograms
    e. Three dimensional plotting
7. Visualizing Geographic Data with Basemap

Text Books & Reference Book

Text Books	1. Tufte, E. (2001). *The visual display of quantitative information* (2nd ed.). Graphics Press USA. 2. Jose, J. (2023). *Introduction to computing & problem solving with Python*. Khanna Publishing House.
Reference Books	1. Ferrari, A., & Russo, M. (2017). *Analyzing data with Power BI and Power Pivot for Excel* (1st ed.). Microsoft Press

Semester 5	Time Series Analysis	C	L	T	P
Course Code: BCADS5C12T	Total Teaching hours :46	5	3	0	4

Course Outcome

At the end of the course learners will be able to		
CO1	Showcase your ability to analyze time series data using relevant statistical approaches such as decomposition, trend analysis, and seasonal adjustment.	Understand
CO2	Use several time series models, including as ARIMA, SARIMA, and exponential smoothing, to reliably estimate future values and assess the uncertainty of such projection.	Create
CO3	Evaluate the stationarity of time series data and apply the appropriate modification to accomplish it.	Analyze
CO4	Implement time series models with statistical software such as HR or Python And effectively analyse the findings	Create
CO5	Utilised time series analysis techniques to analyse real world data sets from different fields, including environmental sciences, finance and economics and make intelligible finding to aid in decision making.	Create

SYLLABUS

UNIT I	**Introduction To Time Series Analysis** Time series data definition, Qualities of time series information, Time series analysis applications, Time Series Elements, and (partially) Decomposition	**8**
UNIT II	**Stationarity And Time Series Component** Seasonality, cyclical elements, and trends, Methods of decomposition: multiplicative and additive models, The meaning of stationarity	**8.**
UNIT III	**Time Series Modelling Autocorrelation function (ACF) and partial autocorrelation function (PACF)** Models of moving averages (MAs), Models of Autoregressive (AR) ARIMA models, or autoregressive integrated moving averages, Model Determination and Approximation (In part)	**10**
UNIT IV	**Forecasting and Model Evaluation.** Jenkins-Box technique, Model selection standards: BIC and AIC, Estimating parameters and fitting models, Methods for Diagnostic Checking and Forecasting	**10**
UNIT V	**Advances Topis & Applications**	**10**

	SARIMA models (seasonal ARIMA models), Transfer function models, extended memory functions, Uses and Examples, Examine and Combine	

Text Books & Reference Book	
Text Books	1. Shumway, R. H., & Stoffer, D. S. (n.d.). Time series analysis and its applications: With R examples. Springer. ISBN: 978-3319524511 2. Box, G. E. P., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (n.d.). Time series analysis: Forecasting and control. Wiley. ISBN: 978-1118675021
Reference Books	1. Chatfield, C. (n.d.). *The analysis of time series: An introduction*. Chapman and Hall/CRC. ISBN: 978-1584883173 2. Brockwell, P. J., & Davis, R. A. (n.d.). *Time series: Theory and methods*. Springer. ISBN: 978-1441903198 3. Cryer, J. D., & Chan, K. S. (n.d.). *Time series analysis: With applications in R*. Springer. ISBN: 978-0387759586

Time Series Anlysis Lab : Course Code: BCADS5C12P

Students are expected to use R-Programming to model data from git hub for Time series analysis and forecasting.

Semester V	Machine Learning	TH	PR	T	P
Course Code: BCADS5C13T	Total Teaching Hours:48	**3**	**2**	**3**	**4**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the concept of computational intelligence like machine learning	Understand
CO2	Ability to get the skill to apply machine learning techniques to address the real time problems in different areas new line understand the neural network and its uses in machine learning application.	Create
CO3	Understand the neural network and its uses in machine learning application	Analyze

SYLLABUS

UNIT I	I**ntroduction** - Well-posed learning problems, designing a learning system, Perspectives and issues in machine learning Concept learning and the general to specific ordering – introduction, a concept learning task, concept learning as search, find-S: finding a maximally specific hypothesis, version spaces and the candidate elimination algorithm, remarks on version spaces and candidate elimination, inductive bias. **Decision Tree Learning –** Introduction, decision tree representation, appropriate problems for decision tree learning, the basic decision tree learning algorithm, hypothesis space search in decision tree learning, inductive bias in decision tree learning, issues in decision tree learning. .	**8**
UNIT II	**Artificial Neural Networks-1**– Introduction, neural network representation, appropriate problems for neural network learning, perceptions, multilayer networks and the back-propagation algorithm. **Artificial Neural Networks-2**- Remarks on the Back-Propagation algorithm, An illustrative example: face recognition, advanced topics in artificial neural networks. **Evaluation Hypotheses –** Motivation, estimation hypothesis accuracy, basics of sampling theory, a general approach for deriving confidence intervals, difference in error of two hypotheses, comparing learning algorithms.	**10**
UNIT III	**Bayesian learning –** Introduction, Bayes theorem, Bayes theorem and concept learning, Maximum Likelihood and least squared error hypotheses, maximum likelihood hypotheses for predicting	**10**

	probabilities, minimum description length principle, Bayes optimal classifier, Gibs algorithm, Naïve Bayes classifier, an example: learning to classify text, Bayesian belief networks, the EM algorithm. **Computational learning theory –** Introduction, probably learning an approximately correct hypothesis, sample complexity for finite hypothesis space, sample complexity for infinite hypothesis spaces, the mistake bound model of learning. **Instance-Based Learning-** Introduction, k-nearest neighbour algorithm, locally weighted regression, radial basis functions, case-based reasoning, remarks on lazy and eager learning.	
UNIT IV	**Genetic Algorithms** – Motivation, Genetic algorithms, an illustrative example, hypothesis space search, genetic programming, models of evolution and learning, parallelizing genetic algorithms. **Learning Sets of Rules –** Introduction, sequential covering algorithms, learning rule sets: summary, learning First-Order rules, learning sets of First-Order rules: FOIL, Induction as inverted deduction, inverting resolution. **Reinforcement Learning –** Introduction, the learning task, Q–learning, non- deterministic, rewards and actions, temporal difference learning, generalizing from examples, relationship to dynamic programming.	**10**
UNIT V	**Analytical Learning-1-** Introduction, learning with perfect domain theories: PROLOG-EBG, remarks on explanation-based learning, explanation-based learning of search control knowledge. **Analytical Learning-2-**Using prior knowledge to alter the search objective, using prior knowledge to augment search operators. **Combining Inductive and Analytical Learning –** Motivation, inductive-analytical approaches to learning, using prior knowledge to initialize the hypothesis	**10**
	Practical/Experiments **Course Code: BCADS5C13P**	
	List of Experiments: 1. Devise a program to import, load and view dataset **2.** Create a program to display the summary and statistics of the dataset **3.** Implement linear regression to perform prediction **4.** Implement Bayesian logistic regression and SVM for classification **5.** Implement K-means clustering, mixtures of Gaussians and Hierarchical clustering algorithm to categorize data. 6. Create a program to perform PCA 7. Implement HMM to predict the sequential data 8. Implement CART learning algorithms to perform categorization 9. Implement Ensemble learning models to perform classification	

Text Books & Reference Book	
TEXT BOOKS	1. Mitchell, T. M. (n.d.). *Machine learning*. McGraw-Hill.
Reference Books	1. Marsland, S. (n.d.). Machine learning: An algorithmic perspective. Taylor & Francis.

Semester V	R Programming	C	L	T	P
Course Code: BCADS5E05T	Total Teaching Hours :40	**3**	**3**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	To install, Code and Use R Programming Language in R Studio IDE to perform basic tasks on Vectors, Matrices and Data frames.	Understand
CO2	To describe key terminologies, concepts and techniques employed in Statistical Analysis.	Apply
CO3	To define, Calculate, Implement Probability and Probability Distributions to solve a wide variety of problems.	Apply
CO4	To conduct and Interpret a variety of Hypothesis Tests to aid Decision Making.	Understand
CO5	To understand, Analyze, Interpret Correlation and Regression to analyze the underlying relationships between different variables.	Analyze

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SYLLABUS

Unit I	Introduction to R : What exactly is R? R and R-Studio, Installation, R-Studio, Overview Functioning in the Console Arithmetic, Operators, Logical Procedures Making Use of Functions, Obtaining Assistance in R and Leaving R-Studio	7
Unit II	**Operators, Variables in R** Variables, Numeric, Characteristic, and Logical Data, Vectors, Data Frames, Factors, Numeric, Character, and Factor Vector Sorting, Special Values	7
Unit III	**Control Statements** If, if…else statement, if else () function, switch function, repeat loop, while loop, for loop, break statement, next statement, while loops, for loops, R Plot, R Line, R Pie Chart, R Bars	8
Unit IV	**Data Structure in R** Creating Vectors, accessing elements of a Vector, Operations on Vectors, Vector Arithmetic, creating matrices, accessing matrices' elements Matrices operations, transpose a matrix Creating strings, copying, and pasting Using format to format integers and strings manipulation of strings Creating and modifying lists, as well as manipulating list elements	10

	combining lists, converting lists to vectors, Arrays are created, and array elements are accessed. Calculations between array components, data frame creation Data frame operations, data frame access, and data frame manipulation Putting together data frames from a variety of sources	
Unit V	**Data Visualization in R** Data visualization need. Bar Graph, Categorical data plotting Graph with stacked bars Line plot and histogram plot functions as pie chart / a three-dimensional pie chart Scatter graph, Graph in a box, creating a working directory, Downloading, and importing data, working with missing data Extracting a subset of a data frame, Writing R scripts, Adding comments and documentation	8
Unit VI	**Data & File Handling** Reading and writing data: R CSV file, R Excel file, R XML file, R Database, Writing SQL statements in R Using the Select, From, Where Is, Like, Order By, Limit, Max, Min SQL functions, scripting, Introducing R-Studio and R-Studio-Cloud	10
Text Books & Reference Book		
Text Books	1. Peng, R.D. (2020). R Programming for Data Science. 2. R in Action, By - Robert L. Kabacoff, Latest Edition – Second	

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Semester 5	Capstone Project/ Mini Project	Credit		Hours/ Week	
Course Code: BCADS5S04P		T	PR	T	P
		0	0	0	3

Semester 5	**Internship** (Student will go for internship after the exam of 5th semester)	**Credit**	**Hours/ Week**
Course Code: BCADS5I01P		**4**	

SEMESTER –VI

Sixth Semester							
Sl No	Component	Course Code	Title of The course	Credit		Hour Per Week	
				TH	P	Theory	Practical
1	**Major Core**	BCADS6C14T	Big Data Analysis	3		3	
2	**Major Core**	BCADS6C15P	Big Data Analysis Lab		2		4
3	**Major Core**	BCADS6C02P	Major Project on Data Analysis	6			6*(NO CLASS)
z	**Minor**	BCADS6E06T	Generative AI	3		3	
5	**Minor**	BCADS6E06P	Generative AI Lab		2		4
6	**Minor**	BCADS6E07T	Exploratory Data Analysis	3		3	
7	**Minor**	BCADS6E07P	Exploratory Data Analysis Lab		2		4
			Total Credit	21		Total Hours-21	

Semester 6	Big Data Analytics	Credit		Hours/ Week	
Course Code:	Total Teaching Hours: 48	TH	PR	T	P
BCADS6C14T		3	2	3	4

Course Outcome

At the end of the course learners will be able to		
CO1	Describe big data and use cases from selected business domains.	Understanding
CO2	Explain NoSQL big data management.	Apply
CO3	Install, configure, and run Hadoop and HDFS.	Create
CO4	Perform map-reduce analytics using Hadoop.	Apply
CO5	Use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.	Apply

SYLLABUS

UNIT I	**UNDERSTANDING BIG DATA** Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications– big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics.	**10 Hrs.**
UNIT II	**NOSQL DATA MANAGEMENT** Introduction to NoSQL – aggregate data models – key-value and document data models – relationships – graph databases – schemaless databases – materialized views – distribution models – master-slave replication – consistency - Cassandra – Cassandra data model – Cassandra examples – Cassandra clients	**8 Hrs.**
UNIT III	**MAP REDUCE APPLICATIONS** MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN	**10 Hrs.**

	– failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.	
UNIT IV	**BASICS OF HADOOP** Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures -Cassandra – Hadoop integration**..**	**10 Hrs.**
UNIT V	**HADOOP RELATED TOOLS** Hbase – data model and implementations – Hbase clients – Hbase examples – praxis. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation HiveQL queries.	**10 Hrs.**
	Examples of LIST OF EXPERIMENTS: Course Code: BCADS6C14P	
	1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files. 2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files 3. Implement of Matrix Multiplication with Hadoop Map Reduce 4. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. 5. Installation of Hive along with practice examples. 6. Installation of HBase, Installing thrift along with Practice examples 7. Practice importing and exporting data from various databases. **Software Requirements:** Cassandra, Hadoop, Java, Pig, Hive and HBase.	
	Text Books & Reference Book	
Text Books	1. Minelli, M., Chambers, M., & Dhiraj, A. (2013). Big data, big analytics: Emerging business intelligence and analytic trends for today's businesses. Wiley. 2. Sammer, E. (2012). Hadoop operations. O'Reilly Media. 3. Sadalage, P. J. (2013). NoSQL distilled. Addison-Wesley.	
Reference Books	1. Capriolo, E., Wampler, D., & Rutherglen, J. (2012). Programming Hive. O'Reilly Media. 2. George, L. (2011). HBase: The definitive guide. O'Reilly Media. 3. Hewitt, E. (2010). Cassandra: The definitive guide. O'Reilly Media. 4. Gates, A. (2011). Programming Pig. O'Reilly Media.	

Semester 6	Major Project on Data Analysis	Credit	Hours/ Week
Course Code: BCADS6C02P		4	

Semester VI	**Generative AI**	**C**	**L**	**T**	**P**
Course code: BCADS6E06T	Total Teaching Hours: 47	**4**	**3**	**0**	**2**

Course Outcome

At the end of the course learners will be able to		
CO1	Understand the evolution of AI and the significance of Deep Learning.	Understand
CO2	Apply various Neural Network architectures for tasks like image recognition and sequence modelling.	Apply
CO3	Analyse data pre-processing and training techniques for neural networks.	Create
CO4	Understand large language models' architecture and pre-training techniques	Apply

SYLLABUS

Unit I	Foundations of Ai and Neural Networks: History and evolution of AI/ML, Deep learning revolution , Transfer learning ,History of Neural Natural Language Processing , Structure of Artificial Neural Networks , Steps in Training an Artificial Neural Network , Parameters and Hyper parameters , Backpropagation.	**10**
Unit II	Data Preprocessing: Probability and Statistic s, Data Preprocessing Techniques , Model Training Techniques	**10**
Unit III	Generative AI Applications: Applications in Various Fields: Art and Creativity, Image and Video Generation, Text Generation, Music Composition, Healthcare Finance. Real-world use cases and challenges in deploying generative AI models	**12**
Unit IV	Advanced Neural Network Architectures: Introduction to advanced architectures, Introduction to Generative AI Models: Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), Transformers , Attention Mechanism Long Short-Term Memory Networks(LSTMs).	**15**
Text Books & Reference Book		
Text Books	1. Rehmani, A. (n.d.). Generative AI for everyone: Understanding the essentials and applications of this breakthrough technology. [Publisher not specified]. **2.** Dhamani, N. (2024). Introduction to generative AI [Kindle ed.].	

Semester VI	**Generative AI Lab**	**C**	**L**	**T**	**P**
Course code : BCADS6E06P		**2**		**0**	**3**
Students are supposed to use prompt engineering technologies to use generative ai technologies. **They must explore the fields like** Art and Creativity, Image and Video Generation, Text Generation, Music Composition, Healthcare Finance					

Semester 6	Exploratory Data Analysis	TH	PR	T	P
Course Code: BCADS6E07T	Total Teaching Hours: 56	**3**	**2**	**3**	**4**

At the end of the course learners will be able to		
CO1	Explain the basic principles and working of evolutionary algorithms.	Understanding
CO2	Differentiate between different types of evolutionary algorithms.	Analyze
CO3	Design and implement evolutionary algorithms for solving optimization problems.	Apply
CO4	Evaluate and compare the performance of evolutionary algorithms.	Analyze
CO5	Apply evolutionary computing techniques in various domains.	Apply

SYLLABUS

UNIT I	Introduction to Evolutionary Algorithms Overview of Evolutionary Computation (EC) - Biological Inspiration: Natural Selection, Genetic Inheritance - Differences between Evolutionary Algorithms and Traditional Optimization Methods - Genetic Algorithm (GA): Basics and Flow - Applications of Evolutionary Algorithms	10
UNIT II	Genetic Algorithms (GA) Representation (Binary and Real Encoding) - Selection Techniques: Roulette Wheel, Tournament, Rank Selection - Crossover Operators: One-Point, Two-Point, Uniform Crossover - Mutation Operators: Bit Flip, Swap, Scramble Mutation - Termination Criteria and Convergence Analysis	12
UNIT III	Other Evolutionary Techniques Evolution Strategies (ES) and Differential Evolution (DE) - Particle Swarm Optimization (PSO) - Ant Colony Optimization (ACO) - Artificial Immune System (AIS) - Comparison of Different Evolutionary Algorithms	12
UNIT IV	Hybrid and Advanced Evolutionary Techniques Hybrid Evolutionary Algorithms - Multi-Objective Optimization using Evolutionary Algorithms - Constraint Handling in Evolutionary Algorithms - Applications in Machine Learning and Data Science - Parallel and Distributed Evolutionary Algorithms	6
UNIT V	Implementation and Applications Implementation of Genetic Algorithms using Python/MATLAB - Case Studies on Optimization Problems (TSP, Function Optimization,	10

	etc.) - Evolutionary Computation in Robotics and Image Processing - Hands-on Projects: Solving Real-World Problems with Evolutionary Algorithms	
UNIT 6	Performance Analysis and Future Trends Performance Metrics: Fitness Function, Convergence Speed - Benchmarking and Testing of Evolutionary Algorithms - Limitations and Challenges - Recent Trends and Research Directions in Evolutionary Computation.	6
Text Books & Reference Book		
Reference Books	1. Goldberg, D. E. (1989). Genetic algorithms in search, optimization, and machine learning. Addison-Wesley. 2. Eiben, A. E., & Smith, J. E. (2015). Introduction to evolutionary computing. Springer. 3. Simon, D. (2013). Evolutionary optimization algorithms. Wiley. 4. Haupt, R. L., & Haupt, S. E. (2004). Practical genetic algorithms. Wiley. 5. Mitchell, M. (1998). An introduction to genetic algorithms. MIT Press. 6. Bäck, T., Foussette, C., & Krause, P. (2013). Contemporary evolution strategies (Vol. 86). Springer. 7. Emmerich, M., Shir, O. M., & Wang, H. (2018). Evolution strategies. In Y. Ong & A. Gupta (Eds.), Evolutionary computation techniques (pp. 89–119). Springer.	
Exploratory Data Analysis Lab Course Code: BCADS6E07P		
	Examples of Lab Exercises: Implementation of Genetic Algorithm for function optimization. Solving the Traveling Salesman Problem (TSP) using Evolutionary Algorithms. Experimenting with different crossover and mutation operators. Implementation of Particle Swarm Optimization. Case study on applying Evolutionary Algorithms in Machine Learning. Developing a hybrid optimization model.	

SEMESTER –VII Honours

Seventh Semester(Data Science Honors)							
Sl No	Component	Course Code	Title of The course	Credit		Hour Per Week	
				TH	P	Theory	Practical
1	**Major(DSC)**	BCADS7C16T	Advanced Statistical Method for Data Science	3		3	
2	**Major(DSC)**	BCADS7C17T	Python For Data Science	3		3	
		BCADS7C17P	Adv Data Science Lab		2		4
3	**Minor(DSC)**	BCADS7E08T	Business Intelligence and Analytics	3		3	
4	**Minor DSC**	BCADS7E09T	Research Methodology for Computer Science	3		3	
5	**SEC**	BCADS7S05T	Data Mining and Ware housing	4		4	
6	**Mandatory**	BCADS7O16P	Mooc Course on Data Science		2		2*
7	**Research Project/ Dissertation**	BCADS7D03P	Synopsis of Dissertation work	-	2		-
			Total Credit	22		Total Hours-20	

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Semester VII	**Advanced Statistical Methods for Data Science**	**Credit**		**Hours/ Week**	
Course Code:	Total Teaching Hours: 46	**TH**	**PR**	**T**	**P**
BCADS7C16T		**3**	**0**	**3**	**0**

At the end of the course learners will be able to		
CO1	simple linear regression in large volume of data	Apply
CO2	python programming in linear regression	Apply
CO3	multiple regression on large data set.	Create
CO4	python programming on multiple regression.	Apply

Syllabus

UNIT I	**Linear Regression** Linear Regression – the theory: What is simple linear regression and its uses – Types of variables – Assumptions of simple linear regression – Perform a simple linear regression involving test & training data sets – Interpreting the results – Presenting the results.	12 Hrs.
UNIT II	**Linear Regression using Python** Carry out Simple Linear regression analysis in Python and interpreting the results using pandas, numpy, maplotlib, seaborn, sklearn. Multi Linear Regression Multi Linear Regression – the theory: What is Multi linear regression and its uses – Types of variables – Assumptions of Multi linear regression – Perform a Multi linear regression – Interpreting the results – Presenting the results	12 Hrs.
UNIT III	**Multi Linear Regression using Python** Carry out Multi-Linear regression analysis in Python and interpreting the results using pandas, numpy, maplotlib, seaborn, sklearn **Logistic Regression** Logistic Regression – the theory: What is Logistic regression and its uses – Linear regression vs logistic regression – Types of variables – Assumptions of Logistic regression – Types of Logistic regression models – Perform a Logistic regression – Interpreting the results – Presenting the results	12 Hrs.
Unit IV	**Logistic Regression using Python** Carry out Binary Logistic regression analysis in Python and interpreting the results using pandas, numpy, maplotlib, seaborn, sklearn.	10 hours

Semester VII	Python for Data Science	Credit		Hours/ Week	
Course Code: BCADS7C17T	Total Teaching Hours : 50	TH	PR	T	P
		3	2	3	4

At the end of the course learners will be able to		
CO1	Basic concept of data science with respect to AI and ML	Understanding
CO2	Relation of data with probability and testing techniques	Analyze
CO3	Using python programming in data science	Apply
CO4	Visualizing data using python	Analyze
CO5	Applying Python API for Data science	Apply

Syllabus

UNIT I	**Introduction:** Data Science Overview, Data Science Disciplines Data Science and Business Buzzwords, difference between Analysis and Analytics. An Introduction--Business Analytics, Data Analytics, and Data Science Data Science Diagram Introduction -- BI, ML and AI. Careers in Data Science Fields. **Data Overview**: What is Data, Measuring Data, Measurement of Central Tendency, Measurements Dispersion, Measurement Quartile, Bi-variate Data and Co-variance, Pearson Correlation Coefficient **Probability** -What is Probability, Permutations, Combinations, Intersections, Unions and Complements. Independent and Dependent Events, Conditional Probability, Addition and Multiplication Rules. Bayes Theorem	12 Hrs.
UNIT II	**Distributions:** Introduction to Distributions, Uniform Distribution, Binomial Distribution, Poisson Distribution Normal Distribution. **Statistics**: What is Statistics, Sampling, Central Limit Theorem, Standard Error, Hypothesis Testing, Type 1 and Type 2 Errors, Students T Distribution, What are Confidence Intervals Correlation Matrix **Anova**: Introduction to ANOVA, Two Way ANOVA Overview, F-Distribution **Chi Square Analysis**	12 Hrs.

UNIT III	**Python: Environment Setup and Essentials**: Introduction to Anaconda, Installation of Anaconda, Python Distribution - Jupyter Notebook Installation, Jupyter Notebook Introduction **Data Analysis**- Numpy, Introduction to Numpy, Numpy Array, Numpy Indexing. Numpy Operations, Broadcasting Numpy Array **Data Analysis – Pandas:** Introduction to Pandas, Series , Data Frames, Missing Data, Groupby, Operations, Merging, Joining and concatenating, Missing Data, Data Input and Output.	10 Hrs.
UNIT IV	**Python for Data Visualization:** Matplotlib Introduction, Matplotlib Drawing Graph -- Histogram, Plotting, Box Plot etc **Seaborn**: Introduction, Distribution, Categorical Plots, Matrix Plots, Regression Plots, Grids, : Style and Colors **Data Visualization with Pandas**: Pandas Built-in Data Visualization. **Data Visualization** - Geographical Plotting, Introduction to Geographical Plotting, Choropleth Maps - Part 1 - USA Choropleth Maps - Part 2 – World **Time Series Analysis**: Pandas for Time Series, Introduction to Time Series with Pandas, Date time Index, Time Re-sampling, Time Shifts, Pandas Rolling and Expanding, Time Series Analysis Introduction to Time Series Time Series Basics, Introduction to Statsmodel, ETS Theory, EWMA Theory, ARIMA Theory, ACF and PACF, ARIMA with Statsmodel **Scientific computing with Python (Scipy)**: SciPy and its Characteristics SciPy sub-packages SciPy sub-packages Integration SciPy sub-packages Optimize Linear Algebra	16

DATA SCIENCE Lab Exercises Course Code BCADS7C17P

List of Experiments:

1. Python program to display details about the operating system, working directory, files and directories in the current directory, lists the files and all directories, scan and classify them as directories and files**.**

2. Python program to convert an array to an array of machine values and vice versa.

3. Python program to get information about the file pertaining to the file mode and to get time values with components using local time and gm time.

4. Python program to connect to Google using socket programming.

5. Python program to perform Array operations using Numpy package**.**

6. Python program to perform Data Manipulation operations using Pandas package.

7. Python program to display multiple types of charts using Matplotlib package.

8. Python program to perform File Operation on Excel Data Set.

9. Python program to implement with Python Sci Kit-Learn & NLTK.

10. Python program to implement with Python NLTK/Spicy/Py NLPI.

Semester 7	Business Intelligence & Analytics	Credit		Hours/ Week	
Course Code:	Total Teaching Hours: 48	TH	PR	T	P
BCADS7E08T		3	0	3	0

At the end of the course learners will be able to		
CO1	Explain the fundamentals of business intelligence	Understand
CO2	Link data mining with business intelligence	Create
CO3	Apply various modeling techniques	Create
CO4	Explain the data analysis and knowledge delivery stages	Analyze
CO5	Apply business intelligence methods to various situations And apply BI for Data Analytics	Create

SYLLABUS

UNIT I	**BUSINESS INTELLIGENCE** Effective and timely decisions – Data, information and knowledge – Role of mathematical models – Business intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence	**8 Hrs.**
UNIT II	**KNOWLEDGE DELIVERY** The business intelligence user types, Standard reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, dimensional analysis, Alerts/Notifications, Visualization: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Visualization, Integrated Analytics, Considerations: Optimizing the Presentation for the Right Message	**12 Hrs.**
UNIT III	**EFFICIENCY** Efficiency measures – The CCR model: Definition of target objectives- Peer groups – Identification of good operating practices; cross efficiency analysis – virtual inputs and outputs – Other models. Pattern matching – cluster analysis, outlier analysis	**12 Hrs.**
UNIT IV	**FUTURE OF BUSINESS INTELLIGENCE** Future of business intelligence – Emerging Technologies, Machine Learning, Predicting the Future, BI Search & Text Analytics – Advanced Visualization – Rich Report, Future beyond Technology	**12 Hrs.**

UNIT V	**Data Analytics: -** Introduction ,Evolution , Concept and Scopes , Data , Big Data, Metrics and Data classification, Data Reliability & Validity, Problem Solving with Analytics, Different phases of Analytics in the business and Data science domain, Descriptive Analytics, Predictive Analytics and Prescriptive Analytics , Different Applications of Analytics in Business, Text Analytics and Web Analytics, Skills for Business Analytics, Concepts of Data Science, Basic skills required for understanding Data Science	**12Hrs.**
Text Books & Reference Book		
Text Books	1. Turban, E., Sharda, R., & Delen, D. (2013). Decision support and business intelligence systems (9th ed.). Pearson. 2. Loshin, D. (2012). Business intelligence: The savvy manager's guide (2nd ed.). Morgan Kaufmann. 3. Vercellis, C. (2009). Business intelligence: Data mining and optimization for decision making. Wiley.	
Reference Books	1. Howson, C. (2007). *Successful business intelligence: Secrets to making BI a killer app*. McGraw-Hill.	

Semester VII	**Research Methodology For Computer Science**	**C**	**L**	**T**	**P**
Course code: BCADS7E09T	Total Teaching Hours: 48	**3**	**3**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Skills in qualitative and quantitative data analysis and presentation.	Understand
CO2	Able to understand and comprehend the basics in research methodology and applying them in research/ project work	Create
CO3	An appropriate research design.	Apply
CO4	Demonstrate the ability to choose methods appropriate to research objectives.	Analyze

SYLLABUS

Unit I	**Foundations of Research** Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process	**8**
Unit II	**Problem Identification and Formulation** Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.	**8**
Unit III	**Research Design** Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables	**8**

Unit IV	**Qualitative and Quantitative Research** Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio	**8**
Unit V	**Sampling** Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size	**8**
Unit 6	**Data Analysis Tools and Techniques** Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	**8**
Text Books & Reference Book		
Text Books	1. Cooper, D., & Schindler, P. (n.d.). Business research methods (9th ed.). Tata McGraw-Hill. 2. Bryman, A., & Bell, E. (n.d.). Business research methods. Oxford University Press. **3.** Kothari, C. R. (n.d.). Research methodology: Methods and techniques.	

Semester VII	**Data Mining & Warehousing**	Credit		Hours/ Week	
Course Code: BCADS7S05T	**Total Teaching Hours : 60**	TH	PR	T	P
		4	0	4	0

Course Outcome:

At the end of the course learners will be able to		
CO1	Explain the significance of data warehousing in decision support systems.	Understand
CO2	Perform data pre-processing techniques such as data cleaning, integration, and transformation.	Apply
CO3	Apply frequent pattern mining techniques to identify associations and correlations in data.	Apply
CO4	Develop classification and prediction models for decision-making applications.	Create
CO5	Implement clustering algorithms to group similar data objects effectively.	Understand
CO6	Utilize data mining tools to analyze large datasets for business and scientific applications	Create

SYLLABUS

UNIT I	**Data Warehousing:** OLAP & OLTP, Data warehouse & Data mart, OLAM architecture, Extraction, Transform & Loading (ETL) concept for generic, two-tier, three - tier architecture, Data warehousing schema - Star, Snowflake, Fact Constellation (Galaxy) - Data Cube , Operations on Data cube (slicing, roll up, roll down, drill up etc)	**10**
UNIT II	**Introduction to data mining (DM):** Motivation for Data Mining - Data Mining-Definition and Functionalities – Classification of DM Systems - DM task primitives - Integration of a Data Mining system with a Database or a Data Warehouse - Issues in DM – KDD Process	**10**
UNIT III	**Data Pre-processing:** Data summarization, data cleaning, data integration and transformation, data reduction, data discretization and concept hierarchy generation, feature extraction , feature transformation, feature selection, introduction to Dimensionality Reduction, CUR decomposition.	**10**

UNIT IV	**Mining Frequent Patterns, Associations and Correlations:** Efficient and scalable frequent item-set mining methods, mining various kind of association rules, from association mining to correlation analysis, Advanced Association Rule Techniques, Measuring the Quality of Rules.	**10**
UNIT V	**Classification and Prediction:** Classification vs. prediction, Issues regarding classification and prediction, Statistical-Based Algorithms, Distance-Based Algorithms, Decision Tree- Based Algorithms, Neural Network-Based Algorithms, Rule-Based Algorithms, Combining Techniques, accuracy and error measures, evaluation of the accuracy of a classifier or predictor. Neural Network Prediction methods: Linear and nonlinear regression, Logistic Regression Introduction of tools such as DB Miner / WEKA / DTREG DM Tools	**10**
UNIT 6	**Cluster Analysis** Clustering: Problem Definition, Clustering Overview, Evaluation of Clustering Algorithms, Partitioning Clustering -K-Means Algorithm, K-Means Additional issues, PAM Algorithm; Hierarchical Clustering – Agglomerative Methods and divisive methods, Basic Agglomerative Hierarchical Clustering, Strengths and Weakness; Outlier Detection, Clustering high dimensional data, clustering Graph and Network data	**10**
Text Books & Reference Books		
Reference Books	1. Han, J., & Kamber, M. (n.d.). Data mining: Concepts and techniques. Morgan Kaufmann. 2. Kantardzic, M. (n.d.). Data mining: Concepts, models, methods and algorithms. John Wiley & Sons. 3. Ponnian, P. (n.d.). Data warehousing fundamentals. John Wiley & Sons. 4. Dunham, M. (n.d.). Data mining: Introductory and advanced topics. Pearson Education. 5. Tan, N., Kumar, V., Steinbach, M., & Pang, N. (n.d.). Introduction to data mining. Pearson Education.	

Semester 7	**Online Course on Data Science** **List will be provided by Mentors**	Credit		Hours/ Week	
Course Code: BCADS7O16P		TH	PR	T	P
		2	0	2	0

SEMESTER –VIII Honours

Eight Semester(Data Science Honors)							
Sl No	Component	Course Code	Title of The course	Credit		Hour Per Week	
				TH	P	Theory	Practical
1	**Major Core**	BCADS8C18T	Advance Data Visualization	3		3	
2	**Major Core**	BCADS8C18P	Data Visualization Lab		2		4
3	**Major Core**	BCADS8C19T	Cloud Computing for Data Analysis	3		3	
4	**Major Core**	BCADS8C19P	Cloud Computing for Data Analysis Lab		2		4
5	**Minor**	BCADS8E10T	Data Security and Privacy	3		3	
6	**Research Project/ Dissertation**	BCADS8D04P	Dissertation Work(Started in Seventh Semester	6			4*
			Total Credit	19		Total Hours-17*	

Semester VIII	Advance Data Visualization	TH	PR	T	P
Course Code: BCADS8C18T	Total Teaching Hours: 50	3	2	3	4

Course Outcome:

At the end of the course learners will be able to		
CO1	Apply descriptive statistics to obtain a deterministic view of data.	Apply
CO2	Perform data handling using Numpy arrays.	Understand
CO3	Load, clean, transform, merge and reshape data using Pandas.	Apply
CO4	Visualize data using Panda and Matplot libraries.	Create

SYLLABUS

Units		Hours
UNIT I	**Introduction to basic statistics and Analysis** Fundamentals of Data Analysis, Statistical foundations for Data Analysis, Types of data, Descriptive Statistics, Correlation and covariance, Linear Regression, Statistical Hypothesis Generation and Testing, Python Libraries: NumPy, Pandas, Matplotlib.	10
UNIT-2	**Array manipulation using Numpy** Numpy array, Creating NumPy arrays, various data types of NumPy arrays, indexing and slicing, swapping axes, transposing arrays, data processing using Numpy arrays.	15
UNIT-3	**Data Manipulation using Pandas** Data Structures in Pandas: Series, DataFrame, Index objects, loading data into Pandas data frame, Working with DataFrames: Arithmetics, DRAFT Statistics, Binning, Indexing, Reindexing, Filtering, Handling missing data, Hierarchical indexing, Data wrangling: Data cleaning, transforming, merging and reshaping	15
UNIT-4	**Plotting and Visualization** Using matplotlib to plot data: figures, subplots, markings, color and line styles, labels and legends, Plotting functions in Pandas: Line,bar, Scatter plots, histograms, stacked bars, Heatmap	10
Text Books & Reference Books		
Text Books	1. McKinney, W. (2018). Python for data analysis: Data wrangling with pandas, NumPy, and IPython (2nd ed.). O'Reilly Media. 2. Molin, S. (2019). Hands-on data analysis with pandas. Packt Publishing.	

	3. Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons
Reference Books	1. Chen, D. Y. (2018). Pandas for everyone: Python data analysis. Pearson. 2. Miller, J. D. (2017). Statistics for data science. Packt Publishing.
Data Visualization Lab Exercises : Course Code: BCADS8C18P	
	1. Identification of different types of data on the dataset 2. Visualization of datasets in terms of Line Chat, Area Chart, Bar Chart, Pie Chart, histogram, scatterplot, violin plot etc. 3. Representation of datasets and performing various statistical operation 4. Interactive Development of dashboard 5. Creating Visualization with Tableau 6. Presenting the working of dataset with Pivot Tables and Pivot Chart 7. Making World Map interaction with D3.js and SVG 8. Analysis of Variance (ANOVA) 9. Analysis of Covariance(ANCOVA) 10. Statistics associated with cluster Analysis 11. Design and development of Analytical products

Semester VIII	Cloud Computing for Data Analytics	C	L	T	P
Course Code: BCADS8C19T	Total Teaching Hours: 50	3	3	0	

Course Outcome:

At the end of the course learners will be able to		
CO1	To understand the necessary theoretical background for computing and storage clouds environments.	Understand
CO2	To know the methodologies and technologies for the development of applications that will be deployed and offered through cloud computing environments.	Analyze
CO3	To be able to realize cloud infrastructures by using IaaS software, while also developing cloud applications by utilizing PaaS software.	Create

SYLLABUS

Units		Hours
UNIT I	Cloud computing architecture, cloud computing stack, comparison with traditional computing architecture (client-server), cloud storage, server storage, storage as a service, data storage in cloud computing, resource virtualization, Cloud Computing Technology, Introduction, Network- Basic Public Internet, The Accelerated Internet- Optimized Internet Overlay- Site-to-Site VPN, Software defined Network, Network function virtualization.	10 Hrs.
UNIT-2	Introduction to cloud application design, cloud design consideration for cloud applications, Design considerations: Scalability, Reliability, Availability, security, maintenance, up gradation and performance, Reference architecture for cloud application, cloud application design methodology, Service Oriented Architecture (SOA), Cloud Component Model (CCM), Data Storage approaches: Relational and Non-relational approaches, example.	10 Hrs.
UNIT-3	Service Management in Cloud Computing, Service Level Agreements(SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting enormously, Managing Data: Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing.	15 Hrs.
UNIT-4	Introduction to Amazon Web Services (AWS), Amazon Elastic Compute Cloud (EC2), Amazon Simple Storage Service (S3), Google Compute Engine, Google app engine, Saleforce, Accessing the Cloud, Web Application Framework- Web Hosting Services- Proprietary	15 Hrs.

	Methods, Web Applications- API's in Cloud Computing, Browsers for Cloud Computing- Internet Explorer- Mozilla Firefox- Safari- Chrome.	
Text Books & Reference Books		
Text Books	1. Shroff, G. (n.d.). Enterprise cloud computing. Cambridge University Press. 2. Bahga, A., & Madisetti, V. (n.d.). Cloud computing: A hands-on approach. University Press (India) Private Ltd.	
Reference Books	1. (n.d.). Google Apps. University Press (India) Private Ltd.; Pearson Publication. 2. Hurwitz, J., Bloor, R., Kaufman, M., & Halper, F. (n.d.). Cloud computing for dummies. Wiley India Edition.	
Cloud Computing for Data analysis lab Course Code: BCADS8C19T		
	Examples For Experiments: 1. Install Apache Hadoop 2. Develop a MapReduce program to calculate the frequency of a given word in a given file. 3. Develop a MapReduce program to find the maximum temperature in each year. 4. Develop a MapReduce program to find the grades of student's. 5. Develop a MapReduce program to implement Matrix Multiplication. 6. Develop a MapReduce to find the maximum electrical consumption in each year given electrical consumption for each month in each year. 7. Develop a MapReduce to analyze weather data set and print whether the day is shinny or cool day. 8. Develop a MapReduce program to find the number of products sold in each country by considering sales data containing fields like Transaction Date Product Price Payment _Type Na me Ci ty St ate Country Account_ Created Last login Latitude Longitude 9. Develop a MapReduce program to find the tags associated with each movie by analyzing movie lens data.	

Semester VIII	Data Security & Privacy	Credit		Hours/ Week	
Course Code: BCADS8E10T	Total teaching hours: 52	TH	PR	T	P
		3	0	3	0

Course Outcome:

At the end of the course learners will be able to		
CO1	fundamentals of cryptography and its application to network security.	Learn & Understand
CO2	Understand network security threats, security services, and countermeasures.	Understand
CO3	Vulnerability analysis of network security.	Analysis
CO4	Acquire background on hash functions; authentication; firewalls; intrusion detection techniques.	Analyze
CO5	Identify and mitigate software security vulnerabilities in existing systems	Create

Syllabus

Units		Hours
UNIT I	**Introduction to Information Security**: Attacks, Vulnerability, Security Goals, Security Services and mechanisms **Conventional Cryptographic Techniques:** Conventional substitution and transposition ciphers, One-time Pad, Block cipher and Stream Cipher, Steganography	12 Hrs.
UNIT-2	**Symmetric and Asymmetric Cryptographic Techniques**: DES, AES, RSA algorithms. **Authentication and Digital Signatures:** Use of Cryptography for authentication, Secure Hash function, Key management – Kerberos	10 Hrs.
UNIT-3	**Program Security :** Non malicious Program errors – Buffer overflow, Incomplete mediation, Time-of-check to Time-of- use Errors, Viruses, Trapdoors, Salami attack, Man-in-the- middle attacks, Covert channels	15 Hrs.
UNIT-4	**Security in Networks**: Threats in networks, Network Security Controls – Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP,S/MIME	15 Hrs.
Text Books & Reference Books		
Text Books	1. Pfleeger, C. P. (n.d.). Security in computing (4th ed.). Pearson Education. 2. Stallings, W. (n.d.). Cryptography and network security: Principles and practice (4th or 5th ed.). Pearson. 3. Mao, W. (n.d.). Modern cryptography: Theory and practice. Prentice Hall. 4. Stallings, W. (n.d.). Network security essentials: Applications and standards. Prentice Hall.	

SEMESTER-VII Honours with Research

Seventh Semester (Data Science Honors with research)							
Sl No	Component	Course Code	Title of The course	Credit		Hour Per Week	
				T	P	Theory	Practical
1	**Major Core**	BCADS8C16T	Advance Data Analysis tools	3		3	
2	**Major Core**	BCADS8C16P	Advance Data Analysis Lab		2		4
3	**Major Core**	BCADS8C17P	Research Methodology	4		4	
4	**Minor**	BCADS7R08T	Research Internship Report with Viva-voce	3		3	
6	**SEC**	BCADS7S05T	Data Mining and Ware housing	4		4	
7	**Mandatory**	BCADS7O25T	MooC Course on Data Science		2		2*
8	**Research Project/ Dissertation**	BCADS7S01P	Synopsis of Dissertation work	-	2		2*
			Total Credit	20		Total Hours-18	

Semester VII	Advance Data Analytic Tools	C	L	T	P
Course code BCADS8C16T	Total Teaching hours: 60	5	3	0	4

Course Outcome

At the end of the course learners will be able to		
CO1	To Understand the basic concept of Big Data and its characteristics	Understand
CO2	Discuss about the key features of spark with analysis and debugging	Understand
CO3	Describe the concepts of Machine learning approaches for Model selection and evaluation for Big Data	Understand
CO4	Explains the concepts of Statistical Analysis and Data Quality	Analyze
CO5	Describe the concepts of data manipulation and Key stores in NoSQL	Understand

SYLLABUS

Unit I	**INTRODUCTION TO BIG DATA** Evolution of Big data – Best Practices for Big data Analytics – Big data characteristics – Validating – The Promotion of the Value of Big Data – Big Data Use Cases- Characteristics of Big Data Applications – Perception and Quantification of Value -Understanding Big Data Storage – A General Overview of High-Performance Architecture – HDFS – MapReduce and YARN – Map Reduce Programming Model	**12**
Unit II	**BIG DATA ANALYTICS USING SPARK** Key Features of Spark - High-level Architecture - Application Programming Interface (API)- Application Execution - Caching - Spark Jobs - Shared Variables - Interactive Data Analysis with Spark Shell - REPL Commands - Number Analysis - Logical Analysis - Monitoring and Debugging.	**12**
Unit III	**MACHINE LEARNING FOR BIG DATA** Introducing Machine Learning - Features - Labels - Hyperparameter - Model Evaluation - Machine Learning High-level Steps - Spark Machine Learning Libraries - Integration with Other Spark Libraries - Statistical Utilities - . Spark ML - FRequent Item sets - Regression - Apriori Algorithm - Principal Component Analysis (PCA) -	**12**

	Ranking – Multidimensional Scaling - Cluster Manager - YARN Cluster.	
Unit IV	**STATISTICS AND DATA QUALITY** Introduction to Streams Concepts – Standard Deviation: The Standard Measure of Dispersion- Gaussian Curve - Hypothesis Testing - Regression and Correlation - Structured, Unstructured, and Semistructured Data - Ambiguous Data - Biases - Data-Centric Methods - Troubleshooting Queries from Source Data.	**12**
Unit V	**NOSQL DATA MANAGEMENT FOR BIG DATA AND VISUALIZATION** NoSQL Databases : Schema-less Models: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores – Tabular Stores – Object Data Stores – Graph Databases Hive – Sharding – Hbase– Big data for E-Commerce Big data for blogs – Review of Basic Data Analytic Methods using R.	**12**
Text Books & Reference Book		
Text Books	1. Rajaraman, A., & Ullman, J. D. (2021). Mining of massive datasets. Cambridge University Press. 2. Loshin, D. (2018). Big data analytics: From strategic planning to enterprise integration with tools, techniques, NoSQL, and graph. Morgan Kaufmann/Elsevier. 3. Pries, K. H., & Dunnigan, R. (2015). Big data analytics: A practical guide for managers. CRC Press.	

Semester VII	Research Methodology	C	L	T	P
Course code: BCADS8C17P	Teaching hours: 48	**3**	**3**	**0**	**0**

Course Outcome

At the end of the course learners will be able to		
CO1	Skills in qualitative and quantitative data analysis and presentation.	Understand
CO2	Able to understand and comprehend the basics in research methodology and applying them in research/ project work	Create
CO3	An appropriate research design.	Apply
CO4	Demonstrate the ability to choose methods appropriate to research objectives.	Analyze

SYLLABUS

Unit I	**Foundations of Research** Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process	**8**
Unit II	**Problem Identification and Formulation** Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.	**8**
Unit III	**Research Design** Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables	**8**
Unit IV	**Qualitative and Quantitative Research** Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio	**8**

Unit V	**Sampling** Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size	**8**
Unit 6	**Data Analysis Tools and Techniques** Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	**8**
Text Books & Reference Book		
Text Books	1. Cooper, D., & Schindler, P. (n.d.). Business research methods (9th ed.). Tata McGraw-Hill. 2. Bryman, A., & Bell, E. (n.d.). Business research methods. Oxford University Press. 3. Kothari, C. R. (n.d.). Research methodology: Methods and techniques.	

Semester VII	Research Internship With Viva Voce	C	L	T	P
Course code BCADS7R08T		3	3	0	0

Semester VII	Data Mining and Data ware housing	C	L	T	P
Course code BCADS7S05T	Total Teaching Hours: 60	4	4	0	0

Course Outcome

At the end of the course learners will be able to		
CO1	To understand data warehouse concepts, architecture, business analysis and tools	Understand
CO2	To understand data pre-processing and data visualization techniques	Create
CO3	Knowledge of algorithms for finding hidden and interesting patterns in data	Apply
CO4	apply various classification and clustering techniques using tools.	Analyze

SYLLABUS

Unit I	**Data Warehouse Fundamentals** Introduction to Data Warehouse, OLTP Systems; Differences between OLTP Systems and Data Warehouse: Characteristics of Data Warehouse; Functionality of Data Warehouse: Advantages and Applications of Data Warehouse; Advantages, Applications: Top-Down and Bottom-Up Development Methodology: Tools for Data warehouse development: Data Warehouse Types	**5**
Unit II	**Planning and Requirements:** Introduction: Planning Data Warehouse and Key Issues: Planning and Project Management in constructing Datawarehouse: Data Warehouse Project; Data Warehouse Development Life Cycle, Kimball Lifecycle Diagram, Requirements Gathering Approaches: Team organization, Roles, and Responsibilities: **Data Warehouse Architecture:** Introductions, Components of Data Warehouse Architecture: Technical Architectures; Data warehouse architectures 1: Data warehouse architecture 2: Data warehouse architecture 3: Tool selection: Federated Data Warehouse Architecture:	**8**

Unit III	**Dimensional Modeling** **E-R Modeling:** Dimensional Modeling: E-R Modeling VS Dimensional Modeling: Data Warehouse Schemas; Star Schema, Inside Dimensional Table, Inside Fact Table, Fact Less Fact Table, Granularity, Star Schema Keys: Snowflake Schema: Fact Constellation Schema: Extract, Transform and Load: Introduction: ETL Overview or Introduction to ETL: ETL requirements and steps: Data Extraction; Extraction Methods, Logical Extraction Methods, Physical Extraction Methods: Data Transformation; Basic Tasks in Transformation, Major Data Transformation Types: Data loading; Data Loading Techniques: ETL Tools: Data Warehouse & OLAP: Introduction: What is OLAP?; Characteristics of OLAP, Steps in the OLAP Creation Process, Advantageous of OLAP: What is Multidimensional Data: OLAP Architectures; MOLAP, ROLAP, HOLAP: Data Warehouse and OLAP: Hypercube & Multicubes	**15**
Unit IV	**Meta data Management in Data Warehouse** Introductions to Metadata: Categorizing Meta data: Meta data management in practice; Meta data requirements gathering, Meta data classification, Meta data collection strategies: Meta Data Management in Oracle and SAS: Tools for Meta data management: Introduction to Data Mining: Introduction: Scope of Data Mining: What is Data Mining; How does Data Mining Works, Predictive Modeling: Data Mining and Data Warehousing: Architecture for Data Mining: Profitable Applications: Data Mining Tools	**10**
Unit V	**Data Pre-processing** Introduction, Data Preprocessing Overview, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Data Mining Techniques- An Overview: Introduction, Data Mining, Data Mining Versus Database Management System, Data Mining Techniques- Association rules, Classification, Regression, Clustering, Neural networks.	**10**
Unit VI	**Clustering and Web Mining** Clustering: Introduction, Clustering, Cluster Analysis, Clustering Methods- K means, Hierarchical clustering, Agglomerative clustering, Divisive clustering, clustering and segmentation software, evaluating clusters. Web Mining: Introduction, Terminologies, Categories of Web Mining – Web Content Mining, Web Structure Mining, Web Usage	**12**

	Mining, Applications of Web Mining, and Agent based and Data base approaches, Web mining Software. Applications of Data mining	

Text Books & Reference Book	
Text Books	1. Berson, A., & Smith, S. J. (2016). Data warehousing, data mining & OLAP (35th reprint ed.). Tata McGraw-Hill. 2. Soman, K. P., Diwakar, S., & Ajay, V. (2006). Insight into data mining: Theory and practice. Eastern Economy Edition, Prentice Hall of India. 3. Witten, I. H., & Frank, E. (n.d.). Data mining: Practical machine learning tools and techniques (2nd ed.). Elsevier.

Semester VII	**MOOC course on data science**	**C**	**L**	**T**	**P**
Course code BCADS7O25T		**2**	**-**	**0**	**0**

SEMESTER VIII Honours with Research

Semester VIII	Dissertation work	Credit		Hours/ Week	
Course Code:		TH	PR	T	P
BCADS8D22P		20	0		0

Annexure I

Mini Project / Capstone Project Guidelines

Objective

To provide hands-on learning experience related to the design, development, and analysis of a suitable product or process, enhancing students' technical skill sets using knowledge acquired in previous semesters. The project may be based on **AI & ML** or **Data Analysis using AI tools**.

Expected Course Outcomes

By the end of this course, the student will be able to:

1. Formulate specific problem statements with well-defined assumptions and constraints.
2. Conduct a literature survey to gain in-depth knowledge in the chosen domain.
3. Develop a suitable solution methodology for the problem.
4. Conduct experiments, perform design and analysis, and document the results.
5. Perform error analysis, benchmarking, and costing.
6. Synthesize the results and arrive at scientific conclusions, products, or solutions.
7. Document findings in the form of a technical report and presentation.

Contents

1. Capstone Project may include theoretical analysis, modeling and simulation, experimentation and analysis, prototype design, fabrication of equipment, correlation and analysis of data, software development, applied research, or any related activity.
2. The project duration is **5 months**, depending on credit requirements as per academic regulations.
3. It should be a **team project** with a maximum of **4 members per team**.
4. The project may be carried out **within the University** or at any **relevant industry outside** the University.
5. **Publication in reputed journals or international conferences** will be an added advantage.

Mode of Evaluation

- **Periodic Reviews:** At least two reviews (a preliminary review and one prior to final submission).
- **Final Presentation & Viva:** Conducted by a departmental evaluation committee after submission of the project.

Annexure II

Project and Industrial Internship Guidelines

Purpose

During their academic tenure, students must gain exposure to the work environment of the industry, which differs significantly from the academic setting.

Internship Details

- All students must undergo a **four-week industrial internship** after the **fourth semester examination**.
- This internship must be completed in **one continuous stretch**.
- The **School of Computer Science**, in collaboration with the **Placement Cell**, will identify appropriate industries (educational institutions or corporate sectors).
- Students are required to **maintain a logbook** documenting their daily activities and learning.
- Upon completion, students must submit:
    - A **training report**
    - A **completion certificate** from the respective industry/institution to the **HoD** of their department.

Evaluation

- An **Industrial Internship Evaluation Committee** will be formed by the School of Computer Science to award marks.
- **Industrial visits** are **compulsory** as part of the next semester's curriculum.

Annexure III

Final Year Project / Research Work

Objective

To enable students to undertake innovative project work during the final semester, applying knowledge acquired from coursework and labs.

General Guidelines

- Projects must reflect analytical, design, fabrication, and presentation skills.
- The project may be carried out **individually** or in a **team (max 4 students)**, inside the University or in collaboration with an **industry/organization/research institution**.
- Each student will be assigned a **faculty guide**. With the HoD's permission, external guides may also be assigned in coordination with internal ones.
- In group projects, **each student must submit an individual report with a unique title**, reflecting their contribution.
- Submitting a **purchased/borrowed/previously submitted** project will be considered **malpractice** and awarded an **'N' grade**, requiring **re-registration** in a future semester.
- Failure or absence in the **final viva-voce** also requires re-registration.
- Though group projects are permitted, **final viva-voce must be conducted in person**.

Project Planning & Review

- Project area and title should be finalized during the **pre-final semester**, along with a **literature review**.
- A presentation must be made to the **Project Monitoring Committee** after the pre-final semester.
- Project types may include:
    - Theoretical analysis
    - Modeling & simulation
    - Experimentation & analysis
    - Prototype design and fabrication
    - Data analysis
- All timelines for project monitoring and evaluation must be **strictly followed**.

Final Evaluation

- Conducted by a committee consisting of:
    - **HoD** (Chairperson)
    - **External Examiner** (optional)
    - **One Internal Expert**
    - **Guide and Co-guide** (if applicable)
- Committee to have a **minimum of 3 and a maximum of 5 members**, nominated by the **Dean of the School of Computer Science**.

Project Proposal format

PROJECT PROPOSAL (SYNOPSIS)

The proposal must be prepared in consultation with the project guide and should clearly state the objectives and technical environment.

Structure of the Proposal

1. **Title of the Project**
2. **Introduction and Objectives**
3. **Project Category** (e.g., AI, Expert Systems, Data Analysis, RDBMS, Web Applications)
4. **System Design**
    - DFDs (up to Level 2) or UML diagrams (if applicable)
    - ER Diagrams / Class Diagrams / Database Design (as required)
5. **Modules Description**
    - Number of modules and their details
    - Data Structures used in each module
    - Logic and process flow
    - Testing methods
    - Tentative content of reports
6. **Tools and Platforms**
    - Hardware and software requirements
7. **Industry/Client Collaboration**
    - Are you doing the project for a company/client? (Yes/No)
    - If Yes, provide name and address
8. **Future Scope**
    - Potential for future enhancement
9. **References and Bibliography**