(3) EDP

Faculty of Commerce and Management

Dr. Rammanohar Lohia Avadh University, Ayodhya-224001, Uttar Pradesh, India

BASED ON AICTE MODEL CURRICULUM

National Education Policy-2020

Syllabus for

COURSE- B.C.A., B.C.A. (FYUP), B.C.A. + M.C.A.

W.E.F: Session 2026-27

1	**Certificate in Computer Application**	First Year
2	**Diploma in Computer Application**	Second Year
3	**Bachelor of Computer Application**	Third Year
4	**Bachelor of Computer Application (Apprenticeship/Internship embedded Programme) OR**	Fourth Year
	Bachelor of Computer Application with Honours OR	
	Students Who Secure 75% Marks In each semester May Opt Bachelor of Computer Application (Honors with Research) **Bachelor of Computer Application (Honours with Research)**	
5	**Master of Computer Application**	Fifth Year

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Vision

To shape future-ready and socially responsible business leaders and IT Professionals through excellence in management education and research.

Mission

To empower learners with knowledge, values, and innovation-driven management and leadership skills, fostering global competence and sustainable business solutions.

Objectives

- To promote ethical values and responsible behaviour in all aspects of business education.
- To encourage creativity, innovation, and teamwork for building entrepreneurial skills.
- To provide practical and industry focused learning that builds smart skills.
- To develop confidence through communication training, leadership activities and real-world exposure.
- To develop an inquisitive mindset which would strengthen a culture of research and innovation that inspires new ideas and solutions to real business challenges.

ORDINANCE

Ordinance for the Programme 3-Years Bachelor of Computer Application or 4-Years Bachelor of Computer Application (Honors/Apprenticeship embedded Programme /Honors with Research) and 5 Years Master of Computer Application (M.C.A)

As per NEP-2020 (Effective from the Session: 2026-2027)

1. **General Information:**

1.1 The degree of BCA 3-Years/BCA Honors/Apprenticeship Embedded Programme/ Honors with Research 4 –Years/MCA of Dr. Rammanohar Lohia Avadh University, Ayodhya shall be conferred on the candidates who have pursued the prescribed course of study and have passed the examinations as prescribed in the ordinances. The course will be conducted on full time basis.

1.2 Total number of students to the BCA programmes shall be restricted to numbers decided by the University from time to time all the departments.

2. **Eligibility for Admission Entry and Exit as Per NEP-2020:**

2.1 BCA 3-Years/BCA Honours/ Apprenticeship Embedded Programme /Honours with Research 4-Years of first year in first semester (from 2026-2027) and onwards will be made through University entrance examination or merit based or as decided by Executive Council of the University.

2.2 The minimum academic qualification for appearing in the Entrance Examination will be a pass in the final examination of 10+2 system or its equivalent with Mathematics/Computer Science/Computer Application/Information Technology/Information Practice/Computer Technology and Maintenance as one of the subjects or as notified.

2.3 Application with full time one-year certificate in Computer Application/Computer Science are eligible for admission directly (within a stipulated time)* in third semester (Second Year). (Maximum up to 10% of approval intake).

2.4 Application with full time minimum two-year Diploma in Computer Application/Computer Science are eligible for admission directly (within a stipulated time)* in the fifth semester (Third Year). (Maximum up to 10% of the approval intake).

The stipulated time period depends on the maximum duration allowed for the completion of degree that is 6 academic sessions for BCA (3-Years) and 8 academic sessions for BCA Honours / Apprenticeship Embedded Programme /Honours with Research (4-Years) from the date of admission in the first semester.

2.5 Up to 5% of the seats may be filled by Son/Daughter/Spouse of RMLAU (including self-finance course) and RMLAU affiliated Government/Aided Colleges Teachers/Employees by direct admission. These shall be supernumerary seats. They shall be admitted as per University norms.

2.6 In the cases, the admission of an applicant to the BCA 3-Years/BCA Honours/Apprenticeship Embedded Programme/Honours with Research 4-Years/MCA program required that the applicant has:

- The minimum academic qualification as notified.
- Fulfilled the prescribed admission procedure and paid the prescribed fees.

2.7 Students can exit with certificate in Computer Application after the successful completion of first year of BCA.

2.8 Students can exit with Diploma in Computer Application after the successful completion of second year of BCA.

2.9 Students shall be awarded with BCA degree after the completion of third year of BCA.

2.10 Students shall be awarded with BCA Honours OR Apprenticeship Embedded Programme) OR Honours with Research (4-Years) after the completion of fourth year of BCA.

2.11 Students shall be awarded with MCA (5-Years) after the completion of fifth year of MCA.

3. **Attendance:**

3.1 Students are required to attend 100% classes. Any relaxations in attendance are subject to the satisfaction as per university norms. Normally student shall not be allowed to appear in a semester examination unless he/she has an overall average 75% attendance and 60% attendance in each of the theory/practical subjects in that semester. Attendance for dissertation work shall be verified by the supervisor/guide. However, an additional shortage by an amount not exceeding 15% of the total number of lectures delivered or practical work done in each subject may be condoned for special reasons as given below.

- A shortage up to 5% of the total number of lectures delivered or practical work done in each subject may be condoned by the head of the Department.
- A further shortage up to 10% may be condoned by the Dean of faculty on the specific recommendation of the concerned head of Department.

3.2 No students will be allowed to appear in the end semester examination if he/she does not satisfy the overall average attendance requirements of clause no. 3.1 and such

candidates(s) shall be treated as having failed and will be further governed by clause no. 4.2 & 4.3.

3.3 The attendance shall be counted from the date of admission in the faculty or start of academic session whichever is later.

4. **Duration of Courses:**

4.1 Total duration of the BCA 3-Years/BCA Honours/Apprenticeship Embedded Programme /Honours with Research 4-Years /MCA course shall be 3 or 4 or 5 years, each year comprising of two semesters. Each semester shall normally have teaching for the 90 working days or as prescribed by UGC/University norms from time to time.

4.2 A candidate, who has failed twice in first year due to any reason, including due to his/her non-appearance or he/she being not permitted to appear in semester examinations, shall not be allowed to continue his/her studies further.

Provided further that if a student wishes to continue third time in first year, he/she may be allowed on the recommendation of a committee constituted by the dean. However, the maximum time allowed for completing the course shall remain the same as in clause 4.3.

4.3 The maximum time allowed for a candidate admitted in first semester for completing BCA 3-Years/BCA Honours/Apprenticeship Embedded Programme /Honours with Research 4-Years, MCA course shall be 06 (Six) years , 08 (Eight) years and 10 (Ten) years respectively.

4.4 The minimum credit requirement for BCA 3-Years degree is 120.

4.5 The minimum credit requirement for BCA Honours/Apprenticeship Embedded Programme /Honours with Research 4-Years is 160.

4.6 The minimum credit requirement for MCA 5-Years degree is 200.

5. **Curriculum:**

5.1 The 3- or 4-years or 5 year curriculum has been divided into 6/8/10 semesters and shall include lectures, tutorials, practical's, seminars, projects, project dissertations, Quizzes, assignment, presentation, research dissertations, industrial training, educational tour etc. as defined in the scheme and executive instructions issued from time to time.

5.2 The curriculum shall also include such other curricular, co-curricular and extracurricular activities as may be prescribed by the faculty from time to time.

5.3 Total duration of the BCA 3-Years/BCA Honours/ Apprenticeship Embedded

Programme /Honours with Research 4-Years course shall be 3 or 4 years, each year comprising of two semesters. Each semester shall normally have teaching for the 90 working days or as prescribed by UGC/AICTE/University norms from time to time.

6. **Examination Pattern**

1. The examination pattern as per each compulsory / elective paper shall be of one hours duration for Internal examination and two hours for external examination (Subjective) and will be as per Choice Based Credit System (CBCS system) , the maximum marks allotted for each paper shall be following :

   I. Semester examination -**75 marks**
   II. Internal Assessment - **25 marks**

It shall be the duty of particular teacher- teaching in a particular course to conduct continuous internal assessment shall be consist of sessional examination of 15 marks, assignment of 5 marks and presentation/quiz/social activity/group discussion carrying 5 marks.

2. On the recommendation of Board of Studies Internal/External Examiner in Project/Research Dissertation/Summer Training Reports/practical subjects allotted by the University.

Multiple Entry and Exit Rules for BCA / MCA Programme Entry:

1. In first year, students with Intermediate/12th or equivalent with Mathematics/Computer Science/Computer Applications/Information Technology/Information Practices/Computer Technology and maintenance as one of the subjects or as notified are eligible for admission.
2. Applicant with full time one-year certificate in Computer Application/Computer Science Course are eligible for admission directly in third semester (Second Year). (Maximum up to 10% of the approval intake).
3. Applicant with full time minimum two years Diploma in Computer Application course are eligible for admission directly in the fifth semester (Third Year). (Maximum up to 10% of the approval intake).
4. Applicant with full time three year Bachelor of Computer Application course are eligible for admission directly in the seventh semester (Fourth Year). (Maximum up to 10% of the approval intake).

Exit:

1. Students can exit with Certificate in Computer Application after the completion of first year of BCA.
2. Students can exit with Diploma in Computer Application after the completion of second year of BCA.
3. Students can exit with the degree of Bachelor of Computer Application after the completion of third year of BCA.
4. Students can exit with the degree of Bachelor of Computer Application with Apprenticeship Embedded Programme after the completion of fourth year of BCA.
5. Students can exit with the degree of Bachelor of Computer Application with honours after the completion of fourth year of BCA.
6. Students can exit with the degree of Bachelor of Computer Application honours with research after the completion of fourth year of BCA.
7. Students can exit with the degree of Master of Computer Application after the completion of fifth year of MCA.

Note: - This FYUP & PG Program is governed by university letter no. LAU/ACCADEMIC/422/2025 Dated 29.03.2025/UGC/AICTE norms.

GENERAL COURSE STRUCTURE & THEME

A. 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

B. Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
CC	Core Courses
AEC	Ability Enhancement Courses
MDE	Multi-Disciplinary Elective course
SEC	Skill Enhancement courses
PE	Professional Elective

PROGRAM OUTCOMES (PO1–PO12)

&

PROGRAM SPECIFIC OUTCOMES (PSO)

PROGRAM OUTCOMES (PO1–PO12)

PO1: Apply knowledge of computing fundamentals for **competitive examinations, higher education and industry-ready employability**.

PO2: Analyze complex problems and identify solutions for **industrial problem solving.**

PO3: Design and develop software systems that support **employability** in the IT sector.

PO4: Conduct investigations and interpret data for **higher education with research**.

PO5: Use modern IT tools effectively for **research activities** and **entrepreneurial development**.

PO6: Understand professional and ethical responsibilities for **ethical entrepreneurship**.

PO7: Apply computing solutions in societal contexts.

PO8: Work effectively as an individual and in teams for **research teamwork**.

PO9: Communicate effectively in technical environments.

PO10: Demonstrate project management abilities for **research initiatives**.

PO11: Engage in lifelong learning for **entrepreneurship and National-level examinations**.

PO12: Apply research-based knowledge and methods.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1: Software Development Proficiency

Apply programming concepts, data structures, algorithms, database systems, operating systems, and modern development tools to build functional software applications.

PSO2: Web, Cloud & Network Competency

Design and implement web technologies, computer networks, cloud-based solutions, and internet technologies for real-world digital environments.

PSO3: Data Analytics & Intelligence

Apply foundational concepts of numerical methods, statistics, data mining, artificial intelligence, and business intelligence to analyze data and derive insights.

PSO4: Professionalism, Ethics & Digital Innovation

Demonstrate ethical IT practices, teamwork, communication, cyber security awareness, and innovative thinking for entrepreneurial and industry-oriented solutions.

BCA 1st Year

BCA 3-Years or BCA Honours/ Apprenticeship Embedded Programme/ Honours with Research 4 -Years (2026-27) Syllubus semester wise with Marks and Credit Break-up

Sem	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit	(Cumulative Minimum Credits) Required for Award of Certificate/Diploma/ Degree
I	CC I	F0160701T	Problem Solving Techniques	75	25	100	3	1		4	
		F0160701P	Practical Lab for Problem Solving Techniques			50			4	2	
	CC II	F0160702T	Computer System Architecture	75	25	100	3	1		4	
		F0160703T	History of Science and Technology in Ancient India	75	25	100	2			2	
	MDE 01	F0160704T	Foundation of Mathematics for Computer Application	75	25	100	6			6	
	SEC 01		Information and Communication Technology	60	40	100	2		2	3	
	AEC 01		First aid and Basic	75	25	100	2			2	
			Total			650				23	(40 Credits Certificate i Compute Applicatio

	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits
II	CC I	F0260701T	Object Oriented Programming Using C++	75	25	100	4			4
		F0260701P	Practical Lab for Programming Using C++			50			4	2
	CC II	F0260702T	Concepts of Data Structure	75	25	100	4			4
		F0260702P	Practical Lab for Data Structure			50			4	2
	SEC 02		Web Designing	60	40	100	2		2	3
	AEC02		Human values and Environment Studies	75	25	100	3	1		2
			Total			500				17

BCA (2026-27) Syllabus semester wise with Marks Break-up

Sem	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit	(Cumulative Minimum Credits) Required for Awards of Certificate /Diploma/Degree
III	CC I	F0360701T	Java Programming and Dynamic Web Page Design	75	25	100	4			4	
		F0360701P	Practical Lab for Java Programming and Dynamic Web Page Design			50			4	2	
	CC II	F0360702T	Introduction to DBMS	75	25	100	4			4	
		F0360702P	Practical Lab for DBMS			50			4	2	
	MDE 02	F0360703T	Probability and Statistics	75	25	100	6			6	
	SEC 03		Hardware Technology & Networking	60	40	100	2		2	3	
	AECC		Physical Education and YOGA	75	25	100	2			2	
	Total					600				23	(80 Credit Diploma

	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits
IV	CC I	F0460701T	Python Programming	75	25	100	4			4
		F0460701P	Lab for Python Programming			50			4	2
	CC II	F0460702T	Operating System	75	25	100	4			4
		F0460702P	Practical Lab for Operating System			50			4	2
	Project/ Dissert	F0460703	Project / Dissertation	50	50	100	2		1	3
	AEC 04		Social Responsibility and Community Engagement as per university guide line	75	25	100	2			2
	Total					500				17

BCA 3rd Year

BCA (2026-27) Syllabus semester wise with Marks Break-up											
Sem	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit	(Cumulative Minimum Credits) Required for Awards of Certificate /Diploma/Deg
V	CC I	F0560701T	Android Programing	75	25	100	4			4	
		F0560701P	Practical Lab for Android Programing			50			4	2	
		F0560702T	Software Engineering	75	25	100	4			4	
	CC II	F0560703T	Web & Internet	75	25	100	4			4	
		F0560703P	Practical Lab for Web & Internet Technologies			50			4	2	
		F0560704T	Computer Networks	75	25	100	4			4	
	Total					500				20	

	Subject	Paper	Paper Name	Extern Marks	Intern Marks	Total Marks	L	T	P	Cred
VI	CC I	F0660701T	Artificial Intelligence	75	25	100	4			4
		F0660701P	Practical Lab for Artificial Intelligence			50			4	2
		F0660702T	Information Security	75	25	100	4			4
	CC II	F0660703T	Cloud Computing	75	25	100	3	1		4
		F0660704T	Machine Learning	75	25	100	3	1		4
		F0660704P	Practical Lab for Machine Learning			50			4	2
	Total					500				20

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BCA 4thYear

Apprenticeship/internship embedded U.G Degree Program
4th year

Apprenticeship/internship embedded U.G Degree Program	**4th year**	**12 months Apprenticeship/internship through NATS or from equivalent Organization/Industry/Institute**	**1(40)1200 * hours Internship**		

Or

BCA (2026-27) Syllabus semester wise with Marks Break-up

Sem	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit	(Cumulativ Minimum Required f Awards of Certificate /Diploma/I
VII	CC	XXXX	Professional Elective-I	75	25	100	4			4	
		XXXX	Professional Elective-II	75	25	100	4			4	
		XXXX	Professional Elective-III	75	25	100	4			4	
		F076070 7T	Python for Data Science	75	25	100	4			4	
		F076070 7P	Practical Lab for Data Science Using Python	50	50	100			4	4	
			Total			500				20	

	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits	
VIII	CC	XXXX	Professional Elective-I	75	25	100	4			4	(160 Cr Bache Comp Applic (Hon
		XXXX	Professional Elective-II	75	25	100	4			4	
		XXXX	Professional Elective-III	75	25	100	4			4	
		F086070 5T	Advanced Data Base Management System	75	25	100	4			4	
		F086070 5P	Lab for Advanced Data Base Management System	50	50	100			4	4	
			Total			500				20	

Or

Students Who Secure 75% Marks In each semester May Opt Bachelor of Computer Application (Honors with Research)

BCA (2026-27) Syllabus semester wise with Marks Break-up											
Sem	**Subject**	**Paper Code**	**Paper Name**	**External Marks**	**Internal Marks**	**Total Marks**	**L**	**T**	**P**	**Credit**	**(Cumulative Minimum Credits) Required for Awards of Certificate /Diploma/Degree**
VII	CC	F0760708T	Research Methodology	75	25	100	3	1		4	(160 Credits) Bachelor of Computer Application (Honors with Research)
		F0760709T	Advanced Data Analysis Tools	75	25	100	3	1		4	
		F0760710T	Python for Data Science	75	25	100	3	1		4	
		F0760710P	Practical Lab for Data Science Using Python	50	50	100				4	
		F0760711R	Research Project/ Dissertation	50	50	100			4	4	
			Total			500				20	
VIII	**Subject**	**Paper Code**	**Paper Name**	**External Marks**	**Internal Marks**	**Total Marks**	**L**	**T**	**P**	**Credits**	
	CC	xxxxx	Professional Elective-I	75	25	100	4			4	
		xxxxx	Professional Elective-II	75	25	100	4			4	
		F0860706T	Advanced Data Base Management System	75	25	100	3	1		4	
		F0860707P	Lab for Advanced Data Base Management System	50	50	100			4	4	
		F0860708 R	Research Project/ Dissertation	50	50	100				4	
			Total			500				20	

BCA (2026-27) Syllabus semester wise with Marks Break-up											
Sem.	**Subject**	**Paper Code**	**Paper Name**	**External Marks**	**Internal Marks**	**Total Marks**	**L**	**T**	**P**	**Credits**	**(Cumulative Minimum Credits) Required for Awards of Certificate /Diploma/Degree/ Master Degree Program**
IX	CC I	xxxx	Professional Elective-I	75	25	100	4			4	(160 Credits) Bachelor of Computer Application (Honors with Research) + (40 Credits)Master in Faculty
		xxxx	Professional Elective-II	75	25	100	4			4	
		F09607 05T	Advance Java Programing	75	25	100	3	1		4	
		F09607 05P	Practical Lab for Advance Java Programing	50	50	100				4	
		F09607 06 R	Research Project	50	50	100			4	4	
			Total			500				20	
X	**Subject**	**Paper Code**	**Paper Name**	**External Marks**	**Internal Marks**	**Total Marks**	**L**	**T**	**P**	**Credits**	
	CC II	xxxx	Professional Elective-I	75	25	100	4			4	
		xxxx	Professional Elective-I	75	25	100	4			4	
		F10607 05T	Advance Data Science	75	25	100	3	1		4	
		F10607 05P	Practical Lab for Data Science	50	50	100			4	4	
		F10607 06 R	Research Project	50	50	100				4	
			Total			500				20	

Proposed Professional Electives for
BCA Honour & BCA Honour with
Research

S. No.	Semester	Course Code	Professional Electives
1	VII	F0760701T	Business Intelligence and Analytics
2	VII	F0760702T	Cloud Computing for Data Analytics
3	VII	F0760703T	Advanced Software Engineering
4	VII	F0760704T	Explainable AI
5	VII	F0760705T	Research Methodology
6	VII	F0760706T	Advanced Data Analysis Tools
7	VIII	F0860701T	Security Aspects of MI
8	VIII	F0860702T	Digital Image Processing
9	VIII	F0860703T	Data Mining and Warehousing
10	VIII	F0860704T	Advanced Data Visualization

Proposed Professional Electives for MCA

S. No.	Semester	Course Code	Professional Electives
1	IX	F0960701T	Internet of Things
2	IX	F0960702T	Data Mining
3	IX	F0960703T	Cloud Computing
4	IX	F0960704T	Data Analysis & Algorithm
1	X	F1060701T	Advance Computer Network
2	X	F1060702T	Theory of Computation
3	X	F1060703T	Deep Learning
4	X	F1060704T	Machine Learning

BCA I Semester

Course Code	Course Name	L	T	P	Credit
F0160701T	Problem Solving Techniques	3	1		4

COURSE OUTCOMES (COs):

CO1: Understand problem-solving principles and algorithmic thinking.
CO2: Apply structured programming constructs and representations.
CO3: Develop C programs using control structures and functions.
CO4: Analyze numerical/array/matrix problems using algorithms.
CO5: Demonstrate professional and ethical programming practices.

Unit I	**Problem Solving and Algorithmic Thinking- Define and explain** problems and problem instances, **differentiate** between generalization and special cases, and **classify** different types of computational problems. They will **analyze** problems to identify inputs, outputs, constraints, and solution approaches. Learners will **develop algorithms** and **analyze** their efficiency and correctness. **Explain** the role of data structures in problem solving and **apply** systematic problem-solving steps such as understanding the problem, planning, execution, and review. Students will also **analyze** problems by breaking them into sub problems and **formulate** input/output specifications, input validation rules, and preconditions and post conditions.
Unit II	**Structured Programming Concepts:** Explain structured programming concepts including sequence, selection, and repetition. They will apply control structures such as if, if-else, for, while, and do-while statements and analyze nesting and stacking of control structures. Learners will distinguish between different types of repetition mechanisms such as entry-controlled, exit-controlled, counter-controlled, definite, indefinite, and sentinel-controlled loops. **Algorithm Representation and Communication:** Construct pseudo code and flowcharts, explain algorithm characteristics and formats, and interpret data representation of integers and floating-point numbers in memory. Students will also understand and apply character encoding schemes such as ASCII and Unicode and implement structured programming concepts using the C language.

BCA I Semester

Course Code	Course Name	L	T	P	Credit
F0160701T	Problem Solving Techniques	3	1		4

COURSE OUTCOMES (COs)

CO1: Understand problem-solving principles and algorithmic thinking.
CO2: Apply structured programming constructs and representations.
CO3: Develop C programs using control structures and functions.
CO4: Analyze numerical/array/matrix problems using algorithms.
CO5: Demonstrate professional and ethical programming practices.

Unit I	**Problem Solving and Algorithmic Thinking- Define and explain** problems and problem instances, **differentiate** between generalization and special cases, and **classify** different types of computational problems. They will **analyze** problems to identify inputs, outputs, constraints, and solution approaches. Learners will **develop algorithms** and **analyze** their efficiency and correctness. **Explain** the role of data structures in problem solving and **apply** systematic problem-solving steps such as understanding the problem, planning, execution, and review. Students will also **analyze** problems by breaking them into sub problems and **formulate** input/output specifications, input validation rules, and preconditions and post conditions.
Unit II	**Structured Programming Concepts:** Explain structured programming concepts including sequence, selection, and repetition. They will apply control structures such as if, if-else, for, while, and do-while statements and analyze nesting and stacking of control structures. Learners will distinguish between different types of repetition mechanisms such as entry-controlled, exit-controlled, counter-controlled, definite, indefinite, and sentinel-controlled loops. **Algorithm Representation and Communication:** Construct pseudo code and flowcharts, explain algorithm characteristics and formats, and interpret data representation of integers and floating-point numbers in memory. Students will also understand and apply character encoding schemes such as ASCII and Unicode and implement structured programming concepts using the C language.

Unit III	**C Language:** Explain the evolution of programming languages, generations of programming languages, and typed versus type less languages. History and structure of the C language and identify components of a basic C program. C language constructs for input, output, assignment, arithmetic, relational, and logical operations. Apply decision-making and looping statements and select appropriate data types. Translation of algorithms and pseudo code into correct and executable C programs.
Unit IV	**Problems on Numbers:** Extracting Digits of a Number (Left to Right and Right to Left), Palindrome, Write the Program prime Number, Prime Factors, Amicable Number, Perfect Number, Armstrong Number, Factorial, Analyze and implement logic For Converting Number from One Base to Another. C Language: else-if Ladder, switch Case, Increment/Decrement Operators, break and continue Statements.
Unit V	**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, analyze Operator Precedence and Associativity. **Professional and Ethical Issues in Programming-** Responsible use of algorithms, and societal impact of software solutions.

Books:

1. Venkatesh, Nagaraju Y, Practical C Programming for Problem Solving, Khanna Book Publishing Company, 2024.
2. AICTE's Programming for Problem Solving (with Lab Manual), Khanna Book Publishing Company, 2024.
3. Harvey Deitel and Paul Deitel, C How to Program, 9th edition, Pearson India, 2015.
4. R G Dromey, How to Solve It by Computer.

CO–PO MATRIX:-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	1	1	1	1	1	0	1	1	1.17
CO2	3	3	2	1	2	1	1	1	1	0	1	1	1.42
CO3	3	3	3	2	2	1	1	1	1	1	1	1	1.67
CO4	3	3	3	2	2	1	1	2	2	1	2	2	2.00
CO5	2	2	1	1	1	3	1	2	2	1	2	2	1.67
Avg	2.8	2.6	2.0	1.4	1.6	1.4	1.0	1.4	1.4	0.6	1.4	1.4	**1.58**

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	**3**	1	**2**	1	1.75
CO2	**3**	1	1	**0**	1.25
CO3	**3**	1	**0**	**0**	1.00
CO4	**2**	**0**	**3**	**0**	1.25
CO5	1	**0**	**0**	**3**	1.00
Avg	2.4	0.6	1.2	0.8	**1.25**

BCA I Semester

Course Code	Course Name	L	T	P	Credit
F0160702T	Computer System Architecture	4			4

COURSE OUTCOMES (COs)

CO1: Understand the fundamentals of computer architecture, organization, and components.
CO2: Apply addressing modes, instruction formats, and micro-operations in problem solving.

CO3: Analyze memory hierarchy, I/O organization, and CPU design concepts.
CO4: Evaluate performance based on control unit design, pipelining, and RISC/CISC features.
CO5: Demonstrate professional skills in interpreting computer hardware standards and tools.

Unit I	**Basic Computer Organization** Define and explain computer systems, evolution of computer architecture, functional units of a computer, block diagram and working of a digital computer, explain structure of Central Processing Unit (CPU), arithmetic logic unit (ALU), control unit, registers and register organization, instruction cycle, fetch–decode–execute cycle, system bus organization (data bus, address bus, control bus).
Unit II	**Data Representation and Basic Computer Arithmetic:** Explain Number systems, complements, fixed and floating-point representation, addition, subtraction, magnitude comparison, multiplication and division algorithms for integers, Logic gates, Boolean algebra, combinational circuits, circuit simplification, flip-flops and sequential circuits, decoders, multiplexers, registers, counters.
Unit III	**Basic Computer Organization and Design:** Computer registers, bus system, instruction set, timing and control, instruction cycle, memory reference, input-output and interrupt, Interconnection Structures, Bus Interconnection design of basic computer.
Unit IV	**Central Processing Unit:** Register organization, arithmetic and logical micro-operations, stack organization, micro programmed control. Instruction formats, addressing modes, instruction codes, machine language, assembly language, input output programming, RISC, CISC architectures, analyze pipelining and parallel architecture.
Unit V	**Memory Organization:** Cache memory, Associative memory, mapping. **Input-Output Organization:** Input / Output- External Devices, I/O Modules, Programmed I/O, Interrupt-Driven I/O, Direct Memory Access, I/O Channels. **Green Computing and Ethical Hardware Practices:** Energy-efficient computer systems, environmental impact of computer hardware, e-waste management.

Books

1. M. Mano, Computer System Architecture, Pearson Education 1992.
2. Digital Design, M.M. Mano, Pearson Education Asia, 2015.
3. W. Stallings, Computer Organization and Architecture Designing for Performance, 8th Edition, Prentice Hall of India, 2009.

CO–PO MATRIX (Semester–I):-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	0	1	1	0	1	1	1.17
CO2	3	3	2	2	2	1	0	1	1	1	1	1	1.50
CO3	3	3	3	2	2	1	1	1	1	1	1	2	1.75
CO4	3	3	3	3	2	2	1	1	2	1	2	2	2.08
CO5	2	2	1	1	2	3	1	2	3	1	2	2	1.83
Avg	2.8	2.6	2.0	1.8	2.0	1.6	0.6	1.2	1.6	0.8	1.4	1.6	1.67

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	1	1	1.5
CO2	3	1	1	0	1.25
CO3	2	2	1	0	1.25
CO4	2	2	1	0	1.25
CO5	1	1	0	3	1.25
Avg	2.2	1.4	0.8	0.8	1.30

Course Code	Course Name	L	T	P	Credit
F01607037	History of Science and Technology in Ancient India	2			2

COURSE OUTCOMES (COs):

CO1: Understand ancient India's contribution to mathematics, astronomy, medicine, and technology.
CO2: Demonstrate knowledge of traditional scientific methods and cultural development.
CO3: Analyze historical evidence of scientific growth in ancient civilizations.
CO4: Interpret the evolution of Indian innovations and their modern relevance.
CO5: Develop appreciation of ethical, cultural, and intellectual heritage of India.

Unit-I	**Indus Civilization:** Metallurgy, Mathematics and Astronomy, Town Planning, Flora and Fauna.
Unit-II	**A brief History of Astronomy in Ancient India:** Vedic Period, Vedinga, Classical Age.
Unit-III	**A brief history of Chemistry in Ancient India upto NBPW Period:** Metallurgy: Copper in Chalcolithicto pre-NBPW Period, Iron Technology from earliest time to NBPW Period, Glass: Technology from earliest time to NBPW Period
Unit-IV	An Outline of the development of Mathematics in Ancient India up to Gupta Period: Baksali Mathematics, Geometry, Algebra, Arithmetic.

Books:-

1. Hegde, K.T.M., An Introduction to Ancient Indian Metallurgy, Banglore, 1991.
2. Hodges, H., Technology in the Ancient world, London, Pelican, 1970.
3. Kutumbia, P., Ancient Indian Medicine, New Delhi, 1962.
4. Prasad, G., Bharatiya Jyotis a Ka Itihasa, Lucknow, 1974.
5. Randhawa, M.S., A History of Agriculture in India, New Delhi, 1980.
6. Rose, D.M. et al., Concise History of Science of India, New Delhi, 1971.
7. Satya Prakash, Pracina Bharata mem Rasayan Ka Vikasa (Hindi), Varanasi, 1960.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	2	1	0	1	1	1	3	1	1	0	1	1	1.09
CO2	2	1	1	1	1	1	3	1	1	0	1	1	1.18
CO3	2	2	1	2	1	1	3	1	1	1	1	2	1.45
CO4	2	2	1	2	1	1	3	2	2	1	2	2	1.72
CO5	1	1	0	1	1	2	3	2	2	1	2	2	1.45
Avg	1.8	1.4	0.6	1.4	1.0	1.2	3.0	1.4	1.4	0.6	1.4	1.6	1.38

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1:	1	0	2	3	1.5
CO2:	0	0	1	3	1.0
CO3:	0	0	2	2	1.0
CO4:	2	1	2	3	2.0
CO5:	0	0	0	3	0.75
Avg	0.6	0.2	1.4	2.8	1.25

Course Code	Course Name	L	T	P	Credit
F0160704T	Foundation of Mathematics for Computer Applications	3	1		4

COURSE OUTCOMES (COs)

CO1: Understand foundational mathematics concepts such as sets, relations, functions, and logic.
CO2: Apply matrix algebra, differentiation, and integration for computational problems.
CO3: Analyze discrete structures and mathematical modeling used in computer science.
CO4: Solve real-world problems using mathematical reasoning and quantitative techniques.
CO5: Demonstrate accuracy, logical reasoning, and ethical mathematical practices.

Unit I	Basic concepts of set theory, Operations on sets: power set, Venn diagram Cartesian product, relations, functions, types of functions, composition of functions.
Unit II	Mathematical logic-introduction, statements, connectives, negation, conjunction, disjunction, statement formulas and truth tables, conditional and bi-conditional statements, tautology, contradiction, equivalence of formulas, duality law-Predicates and Quantifiers, Arguments.
Unit III	Matrix algebra: Types of matrices, matrix operations, transpose of a matrix, determinant of matrix, inverse of a matrix, Cramer's rule, Matrix: Rank of a matrix, normal form, echelon form, Cayley-Hamilton theorem, Eigen values, Eigen Vectors
Unit IV	Differential calculus: Functions and limits, Simple Differentiation of Algebraic Functions, Evaluation of First and Second Order Derivatives, Maxima and Minima,
Unit V	Integral Calculus: Integral as Limit of Sum, Fundamental Theorem of Calculus (without proof), Indefinite Integrals, Methods of Integration Substitution, By Parts, Partial Fractions, Reduction Formulae for Trigonometric Functions, Gamma and Beta Functions (definition).

Books:

1. B.S. Grewal, —Elementary Engineering Mathematicsl, 34th Ed., 1998.
2. Shanti Narayan, —Integral Calculusl, S. Chand & Company, 1999
3. H.K. Dass, —Advanced Engineering Mathematicsl, S. Chand & Company, 9th Revised Edition, 2001.
4. Shanti Narayan, —Differential Calculusl, S. Chand & Company, 1998.

CO–PO MATRIX:-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	1	1	1	1	1	0	1	1	1.17
CO2	3	3	2	1	2	1	1	1	1	0	1	1	1.42
CO3	3	3	2	2	2	1	1	1	1	1	1	2	1.67
CO4	3	3	3	2	2	1	1	2	2	1	2	2	2.00
CO5	2	2	1	1	1	2	1	2	2	1	2	2	1.58
Avg	2.8	2.6	1.8	1.4	1.6	1.2	1.0	1.4	1.4	0.6	1.4	1.6	1.57

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	2	1	1.75
CO2	2	1	3	0	1.5
CO3	3	1	3	0	1.75
CO4	2	1	3	1	1.75
CO5	1	0	1	3	1.25
Avg	2.2	0.8	2.4	1.0	1.60

BCA I Semester

Course Code/Course Name	Course Name	L	T	P	Credit
F0160701P	Problem Solving Techniques			4	2

On the recommendation of Board of Studies Internal/External Examiner allotment by the University. Practical will be based on the Theory Paper of Problem Solving Techniques on whole Syllabus.

BCA IInd Semester									
Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits
CC I	F0260701T	Object Oriented Programming Using C++	75	25	100	4			4
	F0260701P	Practical Lab for Programming Using C++			50			4	2
CC II	F0260702T	Concepts of Data Structure	75	25	100	4			4
	F0260702P	Practical Lab for Data Structure			50			4	2
SEC 02		Web Designing	60	40	100	2		2	3
AEC02		Human values and Environment Studies	75	25	100	2			2
Total					500				17

Course Code	Course Name	L	T	P	Credit
F0260701T	Object Oriented Programming Using C++	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Object Oriented Programming Using C++.

CO2: Apply principles of Object Oriented Programming Using C++ to solve computational problems.

CO3: Analyze and evaluate techniques related to Object Oriented Programming Using C++.

CO4: Develop solutions using tools and methodologies from Object Oriented Programming Using C++.

CO5: Demonstrate professional skills and ethical considerations in Object Oriented Programming Using C++ applications.

UNIT-I	**Introduction:** Introducing Object – Oriented Approach, Relating to other paradigms{Functional, Data decomposition}. **Basic terms and ideas:** Abstraction, Encapsulation, Inheritance, Polymorphism, Review of C, Difference between C and C++ - cin, cout, new, delete, operators.
UNIT-II	**Classes and Objects:** Encapsulation, information hiding, abstract data types, Object & classes, attributes, methods, C++ class declaration, State identity and behaviour of an object, Constructors and destructors, instantiation of objects, Default parameter value, object types, C++ garbage collection, dynamic memory allocation, Metaclass / abstract classes.
UNIT-III	**Inheritance and Polymorphism:** Inheritance, Class hierarchy, derivation – public, private & protected, Aggregation, composition vs classification hierarchies, Polymorphism, Categorization of polymorphism techniques, Method polymorphism, Polymorphism by parameter, Operator overloading, Parametric Polymorphism.
UNIT-IV	**Generic function:** Template function, function name overloading, overriding inheritance methods, Run time polymorphism, Multiple Inheritance.
UNIT-V	**Files and Exception Handling:** Streams and files, Namespaces, Exception handling, Generic Classes.

Books:

1. A. R. Venugopal, Rajkumar, T. Ravishanker —Mastering C++, TMH, 1997.
2. S. B. Lippman & J. Lajoie, — C++ Primer‖, 3rd Edition, Addison Wesley, 2000.
3. R. Lafore, —Object Oriented Programming using C++‖, Galgotia Publications, 2004
4. D. Parasons, —Object Oriented Programming using C++‖, BPB Publication.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	2	1	2	1	0	1	1	0	1	1	1.33
CO2	3	3	3	2	3	1	0	1	1	1	1	1	1.67
CO3	2	3	3	3	2	1	0	1	1	1	1	1	1.58
CO4	3	3	3	3	3	1	0	2	1	1	1	2	1.92
CO5	1	2	2	1	2	3	1	2	2	1	2	2	1.75
Avg	2.4	2.8	2.6	2.0	2.4	1.4	0.2	1.4	1.2	0.8	1.2	1.4	**1.65**

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	1	1	1.50
CO2	3	1	1	1	1.50
CO3	3	1	1	0	1.25
CO4	3	2	1	0	1.50
CO5	1	0	0	3	1.00
Avg	2.6	1.0	0.8	1	1.35

Course Code	Course Name	L	T	P	Credit
F02607021	Concepts of Data Structure	4			3

Course Outcomes (COs):

CO1: Understand the fundamental concepts of Concepts of Data Structure.

CO2: Apply principles of Concepts of Data Structure to solve computational problems.

CO3: Analyze and evaluate techniques related to Concepts of Data Structure.

CO4: Develop solutions using tools and methodologies from Concepts of Data Structure.

CO5: Demonstrate professional skills and ethical considerations in Concepts of Data Structure applications.

UNIT-I	**Introduction to Data Structure and Its Characteristics Array:** Representation of single and multidimensional arrays; Sparse arrays – lower and upper triangular matrices and Tridiagonal matrices with Vector Representation also.
UNIT-II	**Stacks and Queues:** Introduction and primitive operations on stack; Stack application; Infix, postfix, prefix expressions; Evaluation of postfix expression; Conversion between prefix, infix and postfix, introduction and primitive operation on queues, D- queues and priority queues.
UNIT-III	**Lists** Introduction to linked lists; Sequential and linked lists, operations such as traversal, insertion, deletion searching, two way lists and Use of headers.
UNIT-IV	**Trees:** Introduction and terminology; Traversal of binary trees; Recursive algorithms for tree operations such as traversal, insertion, deletion; Binary Search Tree.
UNIT-V	**B-Trees:** Introduction, the invention of B-Tree; Statement of the problem; Indexing with binary search trees; a better approach to tree indexes; B-Trees; working up from the bottom; Example for creating a B-Tree, Sorting Techniques- Insertion sort, selection sort, merge sort, heap sort, searching Techniques: linear search, binary search and hashing.

Books:

1. E. Horowiz and S. Sahani, — Fundamentals of Data structures, Galgotia Book source Pvt. Ltd., 2003.
2. R.S. Salaria, — Data Structures & Algorithmsl , Khanna Book Pblishing Co. (P) Ltd.,,2002.
3. Y. Langsam et. Al., — Data Structures using C and C++, PHI, 1999.

CO–PO MATRIX (Semester–I):-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	2	2	2	1	0	1	1	0	1	1	1.33
CO2	3	3	3	2	3	1	0	1	1	1	1	1	1.67
CO3	3	3	3	3	3	1	0	1	2	1	1	2	1.92
CO4	3	3	3	3	3	1	0	2	2	1	2	2	2.08
CO5	2	2	1	1	2	3	1	2	3	1	2	2	1.83
Avg	2.8	2.6	2.4	2.2	2.6	1.4	0.2	1.4	1.8	0.8	1.4	1.6	1.76

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	1	1	1.50
CO2	3	2	2	1	2.00
CO3	3	1	2	0	1.50
CO4	3	2	2	0	1.75
CO5	1	0	0	3	1.00
Avg	2.6	1.2	1.4	1.0	1.55

Course Code	Course Name	L	T	P	Credit
F0260701 P	Practical Lab for Object Oriented Programming Using C++			4	2

On the recommendation of Board of Studies Internal/External Examiner allotment by the University. Practical will be based on the Theory Paper of Object-Oriented Programming Using C++ on whole Syllabus.

Course Code	Course Name	L	T	P	Credit
F0260702 P	Practical Lab for Data Structure			4	2

On the recommendation of Board of Studies Internal/External Examiner allotment by the University. Practical will be based on the Theory Paper of Data Structure on whole Syllabus.

BCA 2nd Year

BCA III SEMESTER									
Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit
CC I	F0360701T	Java Programming and Dynamic Web Page Design	75	25	100	4			4
	F0360701P	Practical Lab for Java Programming and Dynamic Web Page Design			50	-		4	2
CC II	F0360702T	Introduction to DBMS	75	25	100	4			4
	F0360702P	Practical Lab for DBMS			50			4	2
MDE 02	F0360703T	Probability and Statistics	75	25	100	6			6
SEC 03		Hardware Technology & Networking	60	40	100	2		2	3
AECC 3		Physical Education and YOGA	75	25	100	2			2
Total					600				23

Course Code	Course Name	L	T	P	Credit
F0360701T	Java Programming and Dynamic Web Page Design	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of JAVA Programming and Dynamic Web Design.

CO2: Apply principles of JAVA Programming and Dynamic Web Design to solve computational problems.

CO3: Analyze and evaluate techniques related to JAVA Programming and Dynamic Web Design.

CO4: Develop solutions using tools and methodologies from JAVA Programming and Dynamic Web Design.

CO5: Demonstrate professional skills and ethical considerations in JAVA Programming and Dynamic Web Design applications.

UNIT-I	**Java Programming:** Feature Of Java, JVM Architecture, Data types, control structured, arrays, strings, and vector. Classes, Inheritance, Abstract Class, Interface, Package, Exception Handling, Multithreaded Programming. Synchronization in Java
UNIT-II	**Collection framework:** Hierarchy of Collection framework , Collections Framework advantages , Methods of Collection interface, Interfaces (Set, List, Queue, Deque) and Java ArrayList, Vector, LinkedList, PriorityQueue, HashSet, LinkedHashSet, TreeSet.
UNIT-III	Networking (datagram socket and TCP/IP based server socket) event handling. JDBC: Introduction, Drivers, Establishing Connection, Connection Pooling. Basic Hibernate.
UNIT-IV	Basic **HTML** and **HTML5**(use of commenting, headers, text styling, images, formatting text with <FONT>, special characters, horizontal rules, line breaks, table, forms, image maps, tags. **Java Servlets:** Introduction, HTTP Servlet Basics, The Servlet Lifecycle, Retrieving Information, Sending HTML Information, Session Tracking, Database Connectivity.
UNIT-V	**Java Server Pages:** Introducing Java Server Pages, JSP Overview, Setting Up the JSP Environment, Generating Dynamic Content, Using Custom Tag Libraries and the JSP Standard Tag Library, Processing Input and Output.

Books:

1. Patrick Naughton and Herbertz Schildt —Java-2 The Complete Reference 1999, TMH.
2. Shelley Powers—Dynamic Web Publishing 2nd Ed. Techmedia, 1998.
3. Ivor Horton —Beginning Java-2, SPD Publication.
4. Jason Hunter, —Java Servlet Programming, O' Reilly
5. Shelley Powers, —Dynamic Web Publishing, 2nd Ed. Techmedia, 1998
6. Hans Bergsten, —Java Server Pages, 3rd Ed. O' Reilly

CO–PO MATRIX:-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	3	1	3	1	0	1	2	0	1	1	1.50
CO2	3	3	3	1	3	1	0	1	2	1	1	1	1.67
CO3	2	3	2	3	2	1	0	1	2	1	1	3	1.75
CO4	3	3	3	2	3	1	1	2	2	1	1	2	2.00
CO5	2	1	2	1	2	3	1	2	3	1	2	2	1.83
Avg	2.6	2.4	2.6	1.6	2.6	1.4	0.4	1.4	2.2	0.8	1.2	1.8	1.75

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	2	1	1	1.75
CO2	3	3	1	1	2.00
CO3	3	2	2	0	1.75
CO4	3	3	2	0	2.00
CO5	1	0	0	3	1.00
Avg	2.6	2	1.2	1.0	**1.7**

Course Code	Course Name	L	T	P	Credit
F0360702T	Introduction to DBMS	4			4

Course Outcomes (COs):

CO1: Understand the fundamental concepts of Introduction to DBMS.

CO2: Apply principles of Introduction to DBMS to solve computational problems.

CO3: Analyze and evaluate techniques related to Introduction to DBMS.

CO4: Develop solutions using tools and methodologies from Introduction to DBMS.

CO5: Demonstrate professional skills and ethical considerations in Introduction to DBMS applications.

UNIT-I	**Introduction:** Characteristics of database approach, data models, DBMS architecture and data independence. **E-R Modeling:** Entity types, Entity set, attribute and key, relationships, relation types, roles and structural constraints, weak entities, enhanced E-R and object modeling, Sub classes; Super classes, inheritance, specialization and generalization.
UNIT-II	**File Organization:** Indexed sequential access files; implementation using B & B++ trees, hashing, hashing functions, collision resolution, extendible hashing, dynamic hashing approach implementation and performance.
UNIT-III	**Relational Data Model:** Relational model concepts, relational constraints, relational algebra, **SQL:** SQL queries, programming using SQL.
UNIT-IV	**EER and ER to relational mapping:** Data base design using EER to relational language.
UNIT-V	**Data Normalization:** Functional Dependencies, Normal form up to 3rd normal form. Concurrency Control: Transaction processing, locking techniques and associated, database recovery, security and authorization. Recovery Techniques, Database Security.

Books:

1. Abraham Silberschatz, Henry Korth, S. Sudarshan, —Database Systems Concepts, 4th Edition, McGraw Hill, 1997.
2. Jim Melton, Alan Simon, —Understanding the new SQL: A complete Guide, Morgan Kaufmann Publishers, 1993.
3. A.K. Majumdar, P. Bhattacharya, —Database Management Systems, TMH, 1996.
4. Bipin Desai, —An Introduction to database systems, Galgotia Publications, 1991.

CO–PO MATRIX (Java Programming):-

Scale: - 3 = High, 2 = [illegible], 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	A
CO1	3	3	2	1	3	1	0	1	2	0	1	1	1.
CO2	3	3	3	1	3	1	1	1	2	1	1	1	1.
CO3	2	3	2	3	2	2	0	1	2	0	1	3	1.
CO4	3	3	3	2	3	1	1	2	2	1	1	2	2.
CO5	3	1	2	1	2	3	1	2	3	1	2	2	1.
Avg	2.8	2.6	2.4	1.6	2.6	1.6	0.6	1.4	2.2	0.6	1.2	1.8	1.

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	2	1	1.75
CO2	3	2	2	1	2.00
CO3	3	1	3	0	1.75
CO4	3	2	3	0	2.00
CO5	1	0	0	3	1.00
Avg	2.6	1.2	2.0	1.0	1.70

Course Code	Course Name	L	T	P	Credit
F0360703T	Probability and Statistics	6			6

Course Outcomes (COs):

CO1: Understand the fundamental concepts of Elements of Statistics.

CO2: Apply principles of Elements of Statistics to solve computational problems.

CO3: Analyze and evaluate techniques related to Elements of Statistics.

CO4: Develop solutions using tools and methodologies from Elements of Statistics.

CO5: Demonstrate professional skills and ethical considerations in Elements of Statistics applications.

UNIT-I	**Population, Sample and Data Condensation:** Definition and scope of statistics, concept of population and simple with Illustration, Raw data, attributes and variables, classification, frequency distribution, Cumulative frequency distribution.
UNIT-II	**Measures of Central Tendency:** Concept of central Tendency, requirements of a good measures of central tendency, Arithmetic mean, Median, Mode, Harmonic Mean, Geometric mean for grouped and ungrouped data.
UNIT-III	**Measures of Dispersion:** Concept of dispersion, Absolute and relative measure of dispersion, range variance, Standard deviation, Coefficient of variation.
UNIT-IV	**Permutations and Combinations:** Permutations of 'n' dissimilar objects taken 'r' at a time (with or without repetitions). $nPr = n!/(n-r)!$ (without proof). Combinations of 'r' objects taken from 'n' objects. $nCr = n!/(r!(n-r)!)$ (without proof). Simple examples, Applications.
UNIT-V	**Probability Theory:** Experiments and random experiments, Ideas of deterministic and non- deterministic experiments; Definition of sample space, discrete sample space, events: Types of events, Union and intersections of two or more events, mutually exclusive events, Complementary event, Exhaustive event; Simple examples. Classical definition of probability, Addition theorem of probability without Proof (up to three events are expected). Conditional probability, independence of two events.

	Statistical Quality Control Introduction, control limits, specification limits, tolerance limits, process and product control

Books:

1. S.C. Gupta - Fundamentals of statistics - Sultan Chand & sons, Delhi.
2. D.N. Elhance - Fundamentals of statistics - Kitab Mahal, Allahabad.
3. Montogomery D.C. – Statistical Quality Control - John Welly and Sons
4. Goon, Gupta And Dasgupta - Fundamentals of statistics - The world press private ltd., Kolkata.
5. Hogg R.V. and Craig R.G. – Introduction to mathematical statistics Ed 4 (1989) – Macmillan Pub. Co. Newyork.
6. Gupta S.P. – Statistical Methods, Pub – Sultan Chand and sons New Delhi.

CO–PO MATRIX (Elements of Statistics):-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	1	0	0	1	1	0	2	2	1.17
CO2	3	3	1	2	1	0	0	1	1	0	2	2	1.33
CO3	2	3	1	3	1	0	0	1	1	0	2	3	1.42
CO4	3	2	2	3	2	0	0	2	1	1	2	2	1.67
CO5	1	1	1	1	1	3	1	1	1	1	2	1	1.25
Avg	2.4	2.2	1.2	2.0	1.2	0.6	0.2	1.2	1.0	0.4	2.0	2.0	1.37

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	0	3	1	1.25
CO2	2	1	3	1	1.75
CO3	2	0	3	1	1.50
CO4	2	0	3	0	1.25
CO5	1	0	2	3	1.50
Avg	1.6	0.2	2.8	1.2	1.45

Course Code	Course Name	L	T	P	Credit
F0360701P	Practical Lab for Java Programming			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on Paper Java Programming & Web Design: on Whole Syllabus

Course Code	Course Name	L	T	P	Credit
F0360702P	Practical Lab for DBMS			4	2

On the recommendation of Board of Studies Internal / External Examiner allotment by the University. Practical will be based on the Paper Introduction to DBMS: On whole Syllabus.

BCA IV SEMESTER									
Subject	**Paper Code**	**Paper Name**	**External Marks**	**Internal Marks**	**Total Mark**	**L**	**T**	**P**	**Credits**
CC I	F0460701T	Python Programming	75	25	100	4			4
	F0460701P	Lab for Python Programming			50			4	2
CC II	F0460702T	Operating System	75	25	100	4			4
	F0460702P	Practical Lab for Operating			50			4	2
Project/ Dissertation	F0460703	Project / Dissertation	50	50	100	2		1	3
AEC 04		Social Responsibility and Community Engagement as per university guide line	75	25	100	2			2
Total					500				17

Course Code	Course Name	L	T	P	Credit
F0460701T	Python Programming	4			4

COURSE OUTCOMES (COs)

CO1: Understand computer fundamentals, problem-solving approaches, and basic C/Python syntax.
CO2: Apply control structures, functions, arrays, strings, and file handling to develop programs.
CO3: Analyze algorithmic logic, modular programming techniques, and debugging strategies.
CO4: Design structured and Python-based solutions for real-world computational problems.
CO5: Demonstrate programming ethics, documentation skills, and use of modern IDEs/tools.

Unit-I	**Introduction to Python Programming:** Python interpreter/Python shell, indentation; identifiers and keywords; literals, numbers and strings; operators (Arithmetic, Relational, Boolean, Assignment, Ternary and Bitwise) and expressions.
Unit-II	**Creating Python Programs:** Input and output statements, control statements (conditional statements, loop control statements, break, continue and pass, exit), defining functions, default arguments, errors and handling exceptions.
Unit-III	**Strings and Lists:** String class, built-in functions for string, string traversal, string operators and operations; Lists creation, traversal, slicing and splitting operations, passing list to a function.
Unit-IV	**Object Oriented Programming:** Introduction to Object, Class and Method, Standard Libraries, File handling through libraries.
Unit V	**Built-in data structures:** Tuples, Sets, Dictionary, Stacks, and Queues; Sorting and Searching.

Books:

1. Downey, A.B., (2015), Think Python–How to think like a Computer Scientist, 3rd edition. O' Reilly Media.
2. Guttag, J.V. (2016), Introduction to computation and programming using Python. MIT Press.
3. Liang, Y.D. (2013), Introduction to programming using Python. Pearson Education.
4. Brown, M. C. (2001). The Complete Reference: Python, McGraw Hill Education.

CO–PO MATRIX (Semester–I):-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	0	1	2	0	1	1	1.25
CO2	3	3	2	1	3	1	0	1	2	1	1	1	1.58
CO3	3	3	2	2	2	1	0	1	2	1	1	2	1.67
CO4	3	3	3	2	3	1	0	2	2	1	1	2	1.92
CO5	2	1	1	1	2	2	1	2	3	1	2	2	1.67
Avg	2.8	2.4	1.8	1.4	2.4	1.2	0.2	1.4	2.2	0.8	1.2	1.6	1.62

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	1	1	1.50
CO2	3	1	1	1	1.50
CO3	3	0	1	1	1.25
CO4	3	2	2	1	2.00
CO5	2	0	0	3	1.25
Avg	2.8	0.8	1.0	1.4	1.5

Course Code	Course Name	L	T	P	Credit
F0460702T	Operating System	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Operating System.

CO2: Apply principles of Operating System to solve computational problems.

CO3: Analyze and evaluate techniques related to Operating System.

CO4: Develop solutions using tools and methodologies from Operating System.

CO5: Demonstrate professional skills and ethical considerations in Operating System applications.

UNIT-I	Introduction, what is an operating system, Simple Batch Systems, Multi-programmed Batch systems, Time- Sharing Systems, Personal – Computer Systems, Parallel systems, Distributed systems, Real- Time Systems. **Memory Management:** Background, Logical versus physical Address space, swapping, Contiguous allocation, Paging, Segmentation. **Virtual Memory:** Demand Paging, Page Replacement, Page-replacement Algorithms, Performance of Demand Paging, Allocation of Frames, Thrashing, Other Considerations.
UNIT-II	**Processes:** Process Concept, Process Scheduling, Operation on Processes. **CPU Scheduling:** Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple – Processor Scheduling. **Process Synchronization:** Background, The Critical – Section Problem, Synchronization Hardware, Semaphores, Classical Problems of Synchronization.
UNIT-III	**Deadlocks:** System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.
UNIT-IV	**Device Management:** Techniques for Device Management, Dedicated Devices, Shared Devices, Virtual Devices; Input or Output Devices, Storage Devices, Buffering, Secondary Storage Structure: Disk Structure, Disk Scheduling, Disk Management, Swap- Space Management, Disk Reliability.

UNIT-V	**Information Management:** Introduction, A Simple File system, General Model of a File System, Symbolic File System, Basic File System, Access Control Verification, Logical File System, Physical File system File – System Interface; File Concept, Access Methods, Directory Structure, Protection, Consistency Semantics File – System Implementation: File – System Structure, Allocation Methods, Free-Space Management.

Referential Books:

1. Silbersachatz and Galvin — Operating System Conceptsl, Person, 5th Ed. 2001.
2. Madnick E., Donovan J. — Operating Systems,Tata McGraw Hill,2001.
3. Tannenbaum, —Operating Systemsl, PHI, 4th Edition, 2000.

CO–PO MATRIX (Operating System):-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	0	1	1	0	1	1	1.17
CO2	3	3	2	2	2	1	0	1	1	1	1	2	1.58
CO3	2	3	2	3	2	1	0	1	1	1	1	3	1.67
CO4	3	3	3	2	3	1	0	2	2	1	1	2	1.92
CO5	1	1	1	1	2	3	1	2	2	1	2	1	1.50
Avg	2.4	2.4	1.8	1.8	2.2	1.4	0.2	1.4	1.4	0.8	1.2	1.8	1.57

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	0	1	1.25
CO2	3	2	1	1	1.75
CO3	3	2	1	1	1.75
CO4	3	2	1	1	1.75
CO5	2	1	0	3	1.50
Avg	2.8	1.6	0.6	1.4	**1.60**

Course Code	Course Name	L	T	P	Credit
F0460701P	Practical Lab for Python Programming			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Python Programming: On whole syllabus.

Course Code	Course Name	L	T	P	Credit
F0460702P	Practical Lab for Operating System			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Operating System: On whole syllabus.

3rd Year

BCA V SEMESTER									
Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit
CC I	F0560701T	Android Programing	75	25	100	4			4
	F0560701P	Practical Lab for Android Programing			50			4	2
	F0560702T	Software Engineering	75	25	100	4			4
CC II	F0560703T	Web & Internet Technologies	75	25	100	4			4
	F0560703P	Practical Lab for Web & Internet Technologies			50			4	2
	F0560704T	Computer Networks	75	25	100	4			4
Total					500				20

Course Code	Course Name	L	T	P	Credit
F0560701T	Android Programing	4			4

Course Outcomes (COs)

CO1: Understand the Android operating system and application architecture.
CO2: Design simple and interactive user interfaces for Android applications.
CO3: Develop Android applications using activities and intents.
CO4: Implement data storage and basic networking features in Android apps.
CO5: Build, test, and deploy simple Android applications.

Unit I	**Introduction to Android** -Introduction to mobile application development, history and features of Android, Android architecture, Android versions, Android application framework, setting up Android Studio, SDK tools, project structure, application lifecycle, creating and running a basic Android application.
Unit II	**User Interface Design-** Android views and view groups, layouts such as LinearLayout, RelativeLayout and ConstraintLayout, UI widgets like TextView, EditText, Button and ImageView, event handling, resources, styles and themes, menus and dialogs, basics of material design.
Unit III	**Application Components and Navigation-** Activities and activity lifecycle, intents and intent types, explicit and implicit intents, fragments introduction, navigation between activities, handling permissions, introduction to services and broadcast receivers, basic content provider concepts.
Unit IV	**Data Storage and Networking-** Data storage in Android, shared preferences, internal and external storage, introduction to SQLite database, basic CRUD operations, introduction to Room library, basics of networking, connecting Android apps to web services, JSON parsing.
Unit V	**Advanced Features and App Deployment-** RecyclerView and adapters, background tasks basics, notifications, multimedia handling, location and sensor basics, debugging and testing Android apps, performance optimization basics, packaging and signing applications, publishing apps on Google Play Store, best practices in Android development.

Books

1. Deitel P. & Deitel H., *Android for Programmers*, Pearson.
2. Phillips B., Stewart C. & Hardy K., *Android Programming: The Big Nerd Ranch Guide*, /Pearson.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = [illegible], 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	1	1	1	0	1	1	1.25
CO2	2	2	3	1	3	1	1	1	2	1	1	1	1.58
CO3	3	3	3	1	3	1	1	1	2	1	1	1	1.75
CO4	3	3	3	2	3	1	1	1	2	1	1	2	1.91
CO5	2	2	3	2	3	2	1	2	2	2	2	1	2.00
Avg	2.6	2.4	2.6	1.4	2.8	1.2	1	1.2	1.8	1.0	1.2	1.2	1.69

CO-PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	0	1	1.25
CO2	3	1	0	1	1.25
CO3	3	2	0	1	1.50
CO4	3	2	1	1	1.75
CO5	3	1	0	2	1.50
Avg	3	1.4	0.2	1.2	1.45

Course Code	Course Name	L	T	P	Credit
F0560702 T	Software Engineering	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Software Engineering.

CO2: Apply principles of Software Engineering to solve computational problems.

CO3: Analyze and evaluate techniques related to Software Engineering.

CO4: Develop solutions using tools and methodologies from Software Engineering.

CO5: Demonstrate professional skills and ethical considerations in Software Engineering applications.

UNIT-I	**Software Engineering:** Definition and paradigms, A generic view of software engineering. **Requirements Analysis:** Statement of system scope, isolation of top-level processes and entities and their allocation to physical elements, refinement and review. Analyzing a problem, creating a software specification document, review for correctness, consistency, and completeness.
UNIT-II	**Designing Software Solutions:** Refining the software Specification; Application of fundamental design concept for data, architectural and procedural designs using software blue print methodology and object-oriented design paradigm; Creating design document: Review of conformance to software requirements and quality.
UNIT-III	**Software Implementation:** Relationship between design and implementation, Implementation issues and programming support environment, Coding the procedural design, Good coding style and review of correctness and readability.
UNIT-IV	**Software Maintenance:** Maintenance as part of software evaluation, reasons for maintenance, types of maintenance (Perceptive, adoptive, corrective), designing for maintainability, techniques for maintenance.
UNIT-V	Comprehensive examples using available software platforms/case tools, Configuration Management.

Books:

1. K.K. Aggarwal & Yogesh Singh —Software engineeringl, 2nd Ed., New Age International 2005.
2. I. Sommerville, —Software Engineeringl, Addison Wesley, 2002.
3. James Peter, W. Pedrycz, —Software Engineering: An Engineering Approachl John Wiley & Sons.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	2	1	1	1	1	1	1	2	1	1.42
CO2	3	3	3	2	3	1	2	2	2	2	2	2	2.25
CO3	2	3	3	3	2	1	2	1	2	2	2	3	2.17
CO4	2	2	3	2	3	1	2	3	2	3	2	2	2.25
CO5	1	2	2	1	2	3	3	3	3	2	3	1	2.17
Avg	2.2	2.4	2.4	2.0	2.2	1.4	2.0	2.0	2.0	2.0	2.2	1.8	2.05

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	0	1	1.25
CO2	3	1	1	1	1.50
CO3	3	1	1	2	1.75
CO4	3	2	1	2	2.00
CO5	2	0	0	3	1.25
Avg	2.8	1.0	0.6	1.8	1.45

Course Code	Course Name	L	T	P	Credit
F0560703 T	Web & Internet Technologies	4			4

Course Outcomes (COs):

CO1: Understand the fundamental concepts of Web & Internet Technologies.

CO2: Apply principles of Web & Internet Technologies to solve computational problems.

CO3: Analyze and evaluate techniques related to Web & Internet Technologies.

CO4: Develop solutions using tools and methodologies from Web & Internet Technologies.

CO5: Demonstrate professional skills and ethical considerations in Web & Internet Technologies applications.

Unit-I	**Introduction:** Network address translation, Subnet Masking, Difference between Intranet and Internet, Working of Internet, Dynamic and Static Routing, Domain Name Server, networking tools - ipconfig, ping, netstat, traceroute.
Unit-II	**Introduction to Internet Protocols:** HTTP, HTTPS, FTP, SMTP, IMAP, POP3, VoIP.
Unit-III	**Web Servers:** Introduction, Working, Configuring, Hosting and Managing a Web server, Proxy Servers: Introduction, Working, Type of Proxies, setting up and managing a proxy server Client-side Technologies, Server-side Technologies and hybrid technologies.
Unit-IV	Javascript, jQuery, JSON, NODE.js, BOOTSTRAP, Introduction to forums, blogging, portfolio, developing a responsive website, Combining Web Applications and Mobile Applications.
Unit-V	**Search Engines** - components, working, optimization, Crawling, BOTS. Introduction to cookies and sessions, Introduction to e-commerce websites and e-carts.

Books:

1. DComer. (2018). The Internet Book: Everything You need to know about Computer networking and how the internet works. 5th edition. CRC Press.
2. Patel, B & Barik, L.B, Internet & Web Technology, Acme Learning Publisher

53

3. Bayross, I. (2013). Web enabled commercial application development using ... JavaScript, DHTML and PHP. 4th edition. BPB Publication.
4. Godbole, A. S.& Kahate A (2008). Web Technologies. Tata McGraw-Hill.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	1	1	1	1	0	1	0	0	0	2	1	0.92
CO2	3	3	2	2	3	1	2	1	1	1	2	2	1.92
CO3	2	3	2	3	2	1	2	1	2	1	1	3	1.92
CO4	2	2	3	2	3	1	2	3	2	3	2	2	2.25
CO5	0	1	1	1	1	3	3	3	3	2	2	1	1.75
Avg	2.0	2.0	1.8	1.8	2.0	1.2	2.0	1.6	1.6	1.4	1.8	1.8	1.75

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	3	1	2	2.00
CO2	3	3	1	2	2.25
CO3	2	3	2	2	2.25
CO4	3	3	1	2	2.25
CO5	1	2	1	3	1.75
Avg	2.2	2.8	1.2	2.2	2.10

Course Code	Course Name	L	T	P	Credit
P0560704 T	Computer Networks	4			4

Course Outcomes (COs):

CO1: Understand the fundamental concepts of Computer Network.

CO2: Apply principles of Computer Network to solve computational problems.

CO3: Analyze and evaluate techniques related to Computer Network.

CO4: Develop solutions using tools and methodologies from Computer Network.

CO5: Demonstrate professional skills and ethical considerations in Computer Network applications.

UNIT-I	**Basic Concepts:** Components of data communication, distributed processing, standards and organizations. Line configuration, topology, Transmission mode, and categories of networks. **OSI and TCP/IP Models:** Layers and their functions, comparison of models. Digital Transmission: Interfaces and Modems: DTE-DCE Interface, Modems, Cable modems.
UNIT-II	**Transmission Media:** Guided and unguided, Attenuation, distortion, noise, throughput, propagation speed and time, wavelength, Shannon capacity, comparison of media.
UNIT-III	**Telephony:** Multiplexing, error detection and correction: Many to one, one to many, WDM, TDM, FDM, Circuit switching, packet switching and message switching. Data link control protocols: Line discipline, flow control, error control, synchronous and asynchronous protocols, character and bit-oriented protocols, Link access procedures. **Point to point controls:** Transmission states, PPP layers, LCP, Authentication, NCP. **ISDN:** Services, Historical outline, subscriber's access, ISDN Layers and broadcast ISDN.
UNIT-IV	**Devices:** Repeaters, bridges, gateways, routers, The Network Layer; Design issues, Routing algorithms, Congestion control Algorithms, Quality of service, Internetworking, Network- Layer in the internet
UNIT-V	**Transport and upper layers in OSI Model:** Transport layer functions, connection management, functions of session layers, presentation layer and application layer.

Books:

1. A.S. Tanenbaum —Computer Networksl; Pearson Education Asia, 4th Ed. 2003.
2. Behrouz A. Forouzan —Data Communication and Networking, 3rd Ed. Tata McGraw Hill, 2004.
3. William Stallings —Data and computer communications, Pearson education Asia, 7th Ed., 2002.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	1	0	1	0	0	0	2	1	1.0
CO2	3	3	2	2	3	0	2	1	1	1	1	2	1.75
CO3	2	3	2	3	2	0	2	1	2	1	1	3	1.83
CO4	2	2	3	2	3	0	2	3	2	3	1	2	2.08
CO5	1	1	1	1	1	3	3	3	3	1	2	1	1.75
Avg	2.2	2.2	1.8	1.8	2.0	0.6	2.0	1.6	1.6	1.2	1.4	1.8	1.68

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	3	1	2	2.00
CO2	3	3	1	2	2.25
CO3	2	3	2	2	2.25
CO4	3	3	1	2	2.25
CO5	1	2	1	3	1.75
Avg	2.2	2.8	1.2	2.2	2.10

Course Code	Course Name	L	T	P	Credit
F0560701 P	Practical Lab for Android Programing			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Android Programing: On whole syllabus.

Course Code	Course Name	L	T	P	Credit
F0560703 P	Practical Lab for Web & Internet Technologies			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Web & Internet Technologies: On whole syllabus.

BCA VI SEMESTER									
Subject	**Paper Code**	**Paper Name**	**External Marks**	**Internal Marks**	**Total Marks**	**L**	**T**	**P**	**Credits**
CC I	F0660701 T	Artificial Intelligence	75	25	100	4			4
	F0660701 P	Practical Lab for Artificial Intelligence			50			4	2
	F0660702 T	Information Security	75	25	100	4			4
CC II	F0660703 T	Cloud Computing	75	25	100	3	1		4
	F0660704 T	Machine Learning	75	25	100	3	1		4
	F0660704 P	Practical Lab for Machine Learning			50			4	2
Total					500				20

Course Code	Course Name	L	T	P	Credit
F0660701 T	Artificial Intelligence	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Artificial Intelligence.

CO2: Apply principles of Artificial Intelligence to solve computational problems.

CO3: Analyze and evaluate techniques related to Artificial Intelligence.

CO4: Develop solutions using tools and methodologies from Artificial Intelligence.

CO5: Demonstrate professional skills and ethical considerations in Artificial Intelligence applications.

Unit-I	**Introduction:** Introduction to artificial intelligence, background and applications, Turing test, rational agents, intelligent agents, structure, behavior and environment of intelligent agents, Ethics in AI.
Unit-II	**Knowledge Representation:** Propositional logic, first order predicate logic, resolution principle, unification, semantic nets, conceptual dependencies, frames, scripts, production rules, conceptual graphs.
Unit-III	**Reasoning with Uncertain Knowledge:** Uncertainty, non-monotonic reasoning, truth maintenance systems, default reasoning and closed world assumption, Introduction to probabilistic reasoning, Bayesian probabilistic inference, introduction to fuzzy sets and fuzzy logic, reasoning using fuzzy logic.
Unit-IV	**Problem Solving and Searching Techniques:** Problem characteristics, production systems, control strategies, breadth first search, depth first search, hill climbing and its variations, heuristics search techniques: best first search, A* algorithm, constraint satisfaction problem, means-end analysis.
Unit-V	**Game Playing:** introduction to game playing, min-max and alpha-beta pruning algorithms. Prolog Programming: Introduction to Programming in Logic (PROLOG), Lists, Operators, basic Input and Output.

Books:

1. Russell, S.J. & Norvig, P. (2015) Artificial Intelligence - A Modern Approach. 3rd edition. Pearson Education
2. Rich, E. & Knight, K. (2012). Artificial Intelligence. 3rd edition. Tata McGraw Hill.
3. Patterson, D.W. (2015). Introduction to Artificial Intelligence and Expert Systems. 1st edition. Pearson Education.
4. Bratko, I. (2011). Prolog Programming for Artificial Intelligence. 4th edition. Pearson Education

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	1	1	1	1	0	1	0	1	0	2	1	1.00
CO2	3	3	2	2	1	1	1	1	1	1	2	2	1.67
CO3	2	3	2	3	1	1	1	0	1	0	1	3	1.50
CO4	3	3	2	2	1	0	1	1	1	1	1	2	1.50
CO5	2	2	2	1	1	1	1	2	2	1	1	2	1.50
Avg	2.6	2.4	1.8	1.8	1.0	0.6	1.0	0.8	1.2	0.6	1.4	2.0	1.43

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	1	3	2	2.00
CO2	3	1	3	2	2.25
CO3	2	1	3	2	2.00
CO4	3	1	3	2	2.25
CO5	1	1	2	3	1.75
Avg	2.2	1.0	2.8	2.2	2.05

Course Code	Course Name	L	T	P	Credit
F0660702 T	Information Security	4			4

Course Outcomes (COs):

CO1: Understand the fundamental concepts of Information Security.

CO2: Apply principles of Information Security to solve computational problems.

CO3: Analyze and evaluate techniques related to Information Security.

CO4: Develop solutions using tools and methodologies from Information Security.

CO5: Demonstrate professional skills and ethical considerations in Information Security applications.

Unit-I	**Introduction:** Security Concepts, Challenges, Security architecture, Security attacks, security services, security mechanisms. National Cyber Security Policy, Digital India & Cyber Security Challenges. Ransomware Attacks on Global Organizations
Unit-II	**Error detecting/correction:** Block Codes, Generator Matrix, Parity Check Matrix, Minimum distance of a Code, Error detection and correction, Standard Array and syndrome decoding, Hamming Codes.
Unit-III	**Cryptography:** Encryption, Decryption, Substitution and Transposition, Confusion and diffusion, Symmetric and Asymmetric encryption, Stream and Block ciphers, DES, cryptanalysis. Public-key cryptography, Diffie-Hellman key exchange, man-in-the-middle attack Digital signature, Steganography, Watermarking.
Unit-IV	**Malicious software's:** Types of malwares (viruses, worms, trojan horse, rootkits, bots), Memory exploits - Buffer overflow, Integer overflow.
Unit-V	**Security in Internet-of-Things:** Security implications, Mobile device security - threats and strategies.Internet of Things (IoT) Security Challenges

Books:

1. Stallings, W. (2018). Cryptography and network security. 7th edition. Pearson Education.
2. Pfleeger, C.P., Pfleeger, S.L., & Margulies, J. (2015). Security in Computing. 5th edition. Prentice Hall
3. Whitman M.E., & Mattord H.J. (2017). Principle of Information Security. 6th edition. Cengage Learning.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1:	3	2	1	2	1	2	1	1	1	1	2	2	1.58
CO2:	2	3	2	2	2	1	1	1	1	1	1	2	1.58
CO3:	2	3	2	3	2	2	1	2	1	1	1	3	1.92
CO4:	2	2	3	2	3	1	1	2	1	2	1	3	1.92
CO5:	1	1	1	1	1	3	2	2	2	2	2	1	1.58
Avg	2.0	2.2	1.8	2	1.8	1.8	1.2	1.6	1.2	1.4	1.4	2.2	1.72

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	2	1	3	2.00
CO2	3	2	1	3	2.25
CO3	2	2	2	3	2.25
CO4	3	2	1	3	2.25
CO5	1	1	1	3	1.50
Avg	2.2	1.8	1.2	3.0	2.05

Course Code	Course Name	L	T	P	Credit
F06607O3 T	Cloud Computing	3	1		4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Cloud Computing.

CO2: Apply principles of Cloud Computing to solve computational problems.

CO3: Analyze and evaluate techniques related to Cloud Computing.

CO4: Develop solutions using tools and methodologies from Cloud Computing.

CO5: Demonstrate professional skills and ethical considerations in Cloud Computing applications.

UNIT-I	Client-Server Computing, Cluster Computing, Grid Basics, Distributed Computing. Introduction to Cloud Computing, Introduction to Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS).
UNIT- II	Understanding Google Cloud, Google Apps, Google Compute Engine (GCE), Google App.
UNIT-III	Engine. Amazon Services, Amazon Web Services, Amazon EC2.
UNIT-IV	IBM Cloud Computing with its PaaS, IBM as Saas and IBM as IaaS. Red hat Cloud Computing with its PaaS.
UNIT-V	Microsoft Azure Cloud Computing Service- Windows azure platform Services, Windows Azure storage, Windows Azure fabrics, Salesforce Cloud Computing Services Pass, SaaS and IaaS. Heroku and Force.com as PaaS.

Books:

1. Mastering Cloud Computing, Buyya, R., Vecchiola, C., Selvi, S.T., McGraw Hill Education; First edition (2017)
2. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra and Geoffrey Fox, Morgan Kaufmann, 2011.

CO–PO MATRIX 0:-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	2	1	1	1	2	1	1.5
CO2	2	3	2	2	3	1	2	1	1	1	2	2	1.8
CO3	2	3	2	3	2	1	2	1	1	1	2	2	1.8
CO4	2	2	3	2	3	1	2	2	1	2	2	2	2.0
CO5	1	1	1	1	1	3	2	2	2	2	3	2	1.75
Avg	2.0	2.2	1.8	1.8	2.2	1.4	2.0	1.4	1.2	1.4	2.2	1.8	1.78

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	3	1	2	2.00
CO2	3	3	1	2	2.25
CO3	2	3	2	2	2.25
CO4	3	3	1	2	2.25
CO5	1	2	1	3	1.75
Avg	2.2	2.8	1.2	2.2	2.10

Course Code	Course Name	L	T	P	Credit
F0660704 T	Machine Learning	3	1		4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Machine Learning.

CO2: Apply principles of Machine Learning to solve computational problems.

CO3: Analyze and evaluate techniques related to Machine Learning.

CO4: Develop solutions using tools and methodologies from Machine Learning.

CO5: Demonstrate professional skills and ethical considerations in Machine Learning applications.

Unit-I	**Introduction to Machine Learning:** What is human learning? Human learning versus machine learning, Types of machine learning, Applications of machine learning, Tools for machine learning, Preparing to Model. **Feature Engineering:** Machine Learning activities, Basic Types of data in Machine Learning, Structures of data, Data Quality and Remediation, Data Pre-Processing, Introduction to Feature Engineering, Feature Transformation, Feature Subset Selection
Unit-II	**Introduction:** Basic definitions, Hypothesis space and inductive bias, Bayes optimal classifier and Bayes error, Occam's razor, Curse of dimensionality, dimensionality reduction, feature scaling, feature selection methods.
Unit-III	**Regression:** Linear regression with one variable, linear regression with multiple variables, gradient descent, logistic regression, over-fitting, regularization. Performance evaluation metrics, validation methods.
Unit-IV	**Classification:** Decision trees, Naive Bayes classifier, k-nearest neighbor classifier, perceptron, multilayer perceptron, neural networks, back-propagation algorithm, Support Vector Machine (SVM), Kernel functions.
Unit-V	**Clustering:** Approaches for clustering, distance metrics, K-means clustering, expectation maximization, hierarchical clustering, performance evaluation metrics, validation methods.

Books:

1. Mitchell, T.M. (2017). Machine Learning. McGraw Hill Education.
2. Flach, P. (2015). Machine Learning: The Art and Science of Algorithms that Make Sense of Data. Cambridge University Press.
3. Haykins, S.O. (2010). Neural Networks and Learning Machines. 3rd edition. PHI.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	1	0	1	0	2	1	1.25
CO2	3	3	2	2	3	1	1	1	1	1	2	2	1.83
CO3	2	3	2	3	2	1	1	1	1	1	2	3	1.83
CO4	2	2	3	2	3	1	1	2	2	2	2	2	2.00
CO5	1	1	1	1	2	3	3	2	2	1	2	1	1.67
Avg	2.2	2.2	1.8	1.8	2.4	1.4	1.4	1.2	1.4	1.0	2.0	1.8	1.72

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	1	3	2	2.00
CO2	3	1	3	2	2.25
CO3	2	1	3	2	2.00
CO4	3	1	3	2	2.25
CO5	1	1	2	3	1.75
Avg	2.2	1.0	2.8	2.2	**2.05**

Course Code	Course Name	L	T	P	Credit
F0660701 P	Practical Lab for Artificial Intelligence			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Artificial Intelligence: On whole syllabus.

Course Code	Course Name	L	T	P	Credit
F0660704 P	Practical Lab for Machine Learning			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Machine Learning: On whole syllabus.

BCA4th Year

BCA VII SEMESTER									
Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit
CC	xxxx	Professional Elective-I	75	25	100	4			4
	xxxx	Professional Elective-II	75	25	100	4			4
	xxxx	Professional Elective-III	75	25	100	4			4
	F0760707T	Python for Data Science	75	25	100	4			4
	F0760707 P	Practical Lab for Data Science Using Python	50	50	100			4	4
		Total			500				20

Course Code	Course Name	L	T	P	Credit
F0760707 T	Python for Data Science	4			4

Course Outcomes (COs)

CO1: Apply advanced Python programming techniques for efficient data handling and processing.

CO2: Perform numerical computation and data manipulation using Python libraries.

CO3: Analyze datasets using visualization and exploratory data analysis techniques.

CO4: Build and evaluate machine learning models using Python.

CO5: Apply advanced data science techniques to real-world datasets.

Unit I	**Advanced Python Programming Fundamentals** Python programming architecture and execution model, advanced data types and collections, functional programming concepts including lambda expressions and higher-order functions, advanced list, dictionary and generator comprehensions, iterators and generators, closures and decorators for reusable code, exception handling and custom exceptions, logging and debugging techniques, regular expressions for data preprocessing, file handling for CSV, JSON and Excel formats, virtual environments and Python package management.
Unit II	**Numerical Computing and Data Manipulation** Introduction to numerical computing using NumPy, multidimensional arrays and array operations, indexing, slicing and broadcasting, vectorized computation and performance optimization, linear algebra and statistical operations, Pandas Series and DataFrame operations, advanced indexing and filtering, data cleaning including handling missing values, duplicates and outliers, data aggregation and transformation, merging and reshaping datasets, time-series data handling.
Unit III	**Data Visualization and Exploratory Data Analysis** Principles of data visualization, Matplotlib plotting and customization, statistical visualization using Seaborn, heatmaps and pair plots, interactive visualization using Plotly, exploratory data analysis workflow, descriptive statistics, correlation analysis, hypothesis testing, interpretation of results, visualization of multivariate and high-dimensional data.
Unit IV	**Machine Learning Using Python** Introduction to machine learning concepts and workflow, supervised and unsupervised learning techniques, data preprocessing for machine learning, regression models, classification algorithms, clustering techniques, model evaluation metrics, confusion matrix and ROC curve, cross-validation techniques, hyperparameter tuning and performance optimization.
Unit V	**Advanced Data Science Techniques** Feature engineering and feature selection methods, dimensionality reduction techniques, introduction to natural language processing, text preprocessing and vectorization, time-series analysis and forecasting, anomaly detection techniques, introduction to neural networks and deep learning, overview of TensorFlow and Keras, real-world data science case studies.

Books

1. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media, 2017.
2. Wes McKinney, *Python for Data Analysis*, O'Reilly Media, 3rd Edition, 2022.
3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, O'Reilly Media, 2023.
4. Joel Grus, *Data Science from Scratch*, O'Reilly Media, 2019.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	2	1	3	1	0	1	1	0	2	1	1.42
CO2	3	3	2	2	3	1	0	1	1	1	2	2	1.75
CO3	2	3	1	3	3	1	1	1	2	1	2	3	1.92
CO4	2	3	3	3	3	1	1	1	2	2	2	3	2.17
CO5	2	2	3	2	3	2	3	2	2	2	3	2	2.33
Avg	2.4	2.6	2.2	2.2	3.0	1.2	1.0	1.2	1.6	1.2	2.2	2.2	**1.92**

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	2	2	2.00
CO2	3	1	3	2	2.25
CO3	2	1	3	2	2.00
CO4	3	1	3	2	2.25
CO5	2	1	3	3	2.25
Avg	2.6	1.0	2.8	2.2	**2.15**

Course Code	Course Name	L	T	P	Credit
P0760707 P	Practical Lab for Data Science Using Python			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Data Science Using Python: On whole syllabus.

BCA VIII SEMESTER

Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits
CC	xxxx	Professional Elective-I	75	25	100	4			4
	xxxx	Professional Elective-II	75	25	100	4			4
	xxxx	Professional Elective-III	75	25	100	4			4
	F0860705T	Advanced Data Base Management System	75	25	100	4			4
	F0860705P	Lab for Advanced Data Base Management System	50	50	100			4	4
		Total			500				20

BCA VIII SEMESTER

Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits
CC	XXXX	Professional Elective-I	75	25	100	4			4
	XXXX	Professional Elective-II	75	25	100	4			4
	XXXX	Professional Elective-III	75	25	100	4			4
	F0860705T	Advanced Data Base Management System	75	25	100	4			4
	F0860705 P	Lab for Advanced Data Base Management System	50	50	100			4	4
		Total			500				20

Course Code	Course Name	L	T	P	Credit
F0860705 T	Advanced Data Base Management System	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Advanced DBMS.

CO2: Apply principles of Advanced DBMS to solve computational problems.

CO3: Analyze and evaluate techniques related to Advanced DBMS.

CO4: Develop solutions using tools and methodologies from Advanced DBMS.

CO5: Demonstrate professional skills and ethical considerations in Advanced DBMS applications.

UNIT – I	History of Data base Systems. Data base System Applications, data base System VS file System. Data Models – the ER Model – Relational Model – Other Models – Database Languages – DDL – DML. Introduction to the Relational Model – Integrity Constraint Over relations – Enforcing Integrity constraints – Querying relational data – Logical data base Design – Introduction to Views – Destroying/altering Tables and Views. Introduction of Object Database Systems, Structured Data types, operations on structured data, Encapsulation and ADTS, Inheritance.
UNIT – II	Database design for ORDBMS, ORBMS implementation and challenges, OODBMS, comparison of RDBMS, OODBMS and ORDBMS. Introduction to Parallel databases, architectures for parallel databases, Parallel Query Evaluation – data partitioning and parallelizing sequential operator evaluation code, Parallelizing individual operations, and parallel Query optimization.
UNIT – III	Introduction to distributed databases; features of distributed databases vs. centralized databases, Why distributed databases, DDBMS, levels of transparency- reference architecture for DDB, types of data fragmentation, distribution transparency for read-only and update applications, distributed database access primitives, Integrity Constraints in Distributed databases.
UNIT – IV	Distributed database design: framework for distributed database design, the design of database fragmentation, allocation of fragments; Distributed Query processing: Equivalence of transformations for queries, transforming global queries into fragment queries, distributed grouping and aggregation functions, parametric queries.

UNIT - I	A framework for query optimization, join queries in a distributed DBMS, joins in a distributed DBMS, cost-based query optimization. DBMS Vs. IR systems, Introduction to Information retrieval, indexing for text search, web search engine, managing text in a DBMS, a data model for XML, Querying XML data, and efficient evaluation of XML queries.

Books:

1. Raghuramakrishnan and Johannes Gehrke, "Database Management Systems", 3rd Edition, TMH, 2006.
2. S. Ceri and G. Pelagatti, "Distributed databases principles and systems", 1st Edition, TMH, 2008.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	0	0	1	0	2	1	1.17
CO2	3	3	2	2	3	1	0	1	1	1	2	2	1.75
CO3	2	3	2	3	2	1	0	1	1	1	2	3	1.75
CO4	2	2	3	2	3	1	0	2	2	2	2	2	1.92
CO5	1	1	1	1	2	3	2	2	2	1	2	1	1.58
Avg	2.2	2.2	1.8	1.8	2.4	1.4	0.4	1.2	1.4	1	2	1.8	1.63

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	1	2	2	1.75
CO2	3	1	2	2	2.00
CO3	2	1	3	2	2.00
CO4	3	1	2	2	2.00
CO5	1	1	1	3	1.50
Avg	2.2	1	2	2.2	1.85

Course Code	Course Name	L	T	P	Credit
P0860705P	Lab for Advanced Data Base Management System			4	2

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Advanced Data Base Management System: On whole syllabus.

Students Who Secure 75% Marks In each semester May Opt Bachelor of Computer Application (Honors with Research)

BCA VII SEMESTER

Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit
CC	F0760708T	Research Methodology	75	25	100	3	1		4
	F0760709T	Advanced Data Analysis Tools	75	25	100	3	1		4
	F0760710T	Python for Data Science	75	25	100	3	1		4
	F0760710P	Practical Lab for Data Science Using Python	50	50	100			8	4
	F0760711R	Research Project/ Dissertation	50	50	100			4	4
		Total			500				20

Course Code	Course Name	L	T	P	Credit
F07607087	Research Methodology	3	1		4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Research Methodology.

CO2: Apply principles of Research Methodology to solve computational problems.

CO3: Analyze and evaluate techniques related to Research Methodology.

CO4: Develop solutions using tools and methodologies from Research Methodology.

CO5: Demonstrate professional skills and ethical considerations in Research Methodology applications.

Unit-I	**Philosophical Underpinnings of Research:** **Introduction to Research:** Novelty, Originality, Organized Method of Investigation, and Communication of Problem, Data, Method, and Results for Peer Group Verification; Paradigm and paradigm shift. **Types of Research:** Theoretical, Empirical, Experimental, and Design and Characterization of New Materials, Components, Processes, and Systems. **Broad Objectives of Research:** Problem-oriented—Defining Problems and Problem Issues, Analyzing Data, Predicting, and Designing; Technique-oriented-Improving Performance and Expanding Scope. **Modes of Inquiry and Inquiring Systems:** Hypothetical-deductive and Empirical-inductive modes; Scientific Method, and Inquiring Systems of Locke, Kant, Leibnitz, Hegel, and Singer, Continuum of Connections among Facts, Data, Laws, Hypotheses, Theory, Models, and Experiments; Criteria of a Theory, Research Topic, Problem, Questions, Objectives, and Scope, Methodology, Methods, Tools, and Techniques, Research Ethics, Plagiarism, and Their Prevention.
Unit-II	Measurement, Data, and Analytics, Structured and Unstructured Data, Scales of Measurement, Population and Sample, Descriptive Statistics, Data Visualization, Probability and Random Variables, Sampling and Estimation, Hypothesis Testing, ANOVA, Correlation, and Regression. Data Analytics: Elements of Association, Clustering, and Classification.
Unit-III	Elements of Theoretical Research, Model and Model Building: Classification of Models, Exogenous and Endogenous Variables, Variable Relationships, Model Boundary, and Predictive and Prescriptive Models.
Unit-IV	Research Methods for Computer Science, Formal Methods: Formal Specification, Algorithm, and Complexity, Building Artefacts: Proof of Performance, Proof of Concept, and Proof of Existence, Process Methodology: Methods for Software Engineering and Human-Computer Interaction, Cognitive Processes, Interactive Games, Social Networks, and Web Analytics.

Unit-V	Research Documentation, Elements of Paper – Title, Abstract, Keywords, Acknowledgements, Symbols and Abbreviations, Introduction, Literature Review. Materials and Methods, SI Units, Mathematical Materials, Graphical and Tabular Presentation, Results and Discussion, Conclusion, Interpretation, Generalization, Scope for Future Work, Citations and List of References, and Appendixes, Elements of Good English Writing: Signposts, Paraphrasing—Unity, Coherence, and , and Topic Sentence, and Transitions.

Books

1. Kothari, C. R. and G. Garg (2019), Research Methodology: Methods and Techniques, Fourth MultiColour Edition, New Age International Publishers.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	2	1	2	1	1	1	1	2	2	1.58
CO2	2	3	2	2	2	1	1	1	1	1	2	2	1.67
CO3	2	3	2	3	1	2	1	1	1	1	2	3	1.83
CO4	2	2	3	2	3	1	1	2	1	2	2	2	1.92
CO5	1	1	1	1	1	3	2	2	2	2	3	2	1.75
Avg	2	2.2	1.8	2	1.6	1.8	1.2	1.4	1.2	1.4	2.2	2.2	1.75

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	2	3	1.75
CO2	2	1	2	3	2.00
CO3	1	1	3	3	2.00
CO4	2	1	2	3	2.00
CO5	1	1	1	3	1.50
Avg	1.4	1	2	3	1.85

Course Code	Course Name	L	T	P	Credit
F0760709T	Advanced Data Analysis Tools	3	1		4

Course Outcomes (COs)

CO1: Understand the role of modern tools in data analysis.
CO2: Use advanced tools to collect, clean, and manage data.
CO3: Perform data analysis and visualization using industry-standard tools.
CO4: Apply basic analytical and modeling features available in data analysis tools.
CO5: Interpret analytical results and generate professional reports.

Unit I	**Overview of Data Analysis Tools-** Introduction to data analysis and decision-making, evolution of data analysis tools, comparison of traditional and modern tools, overview of spreadsheet-based tools, statistical tools, programming-based tools, open-source and commercial analytics platforms, criteria for selecting appropriate data analysis tools, basic workflow of data analysis using tools.
Unit II	**Spreadsheet and Statistical Analysis Tools-** Advanced spreadsheet features for data analysis, data cleaning and validation, pivot tables and pivot charts, advanced formulas and functions, introduction to statistical analysis tools, descriptive statistics, correlation and regression basics using tools, generating analytical reports using spreadsheets and statistical software.
Unit III	**Programming and Open-Source Analytics Tools-** Introduction to Python and R for data analysis, data manipulation using libraries and packages, exploratory data analysis using programming tools, basic visualization techniques, introduction to notebooks and integrated development environments, advantages of open-source tools in analytics.
Unit IV	**Business Intelligence and Visualization Tools-** Introduction to business intelligence tools, data connectivity and integration, building reports and dashboards, interactive visualization features, key performance indicators, data storytelling using BI tools, comparison of popular BI platforms, real-world business analytics examples.
Unit V	**Big Data, Cloud and Emerging Analytics Tools-** Introduction to big data analytics tools, overview of Hadoop and Spark, cloud-based data analysis tools, analytics as a service, collaboration and version control in analytics, data security

	and privacy issues, ethical considerations in using data analysis tools, emerging trends in analytics software.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	2	1	1	1	3	1	1	0	1	0	2	1	1.17
CO2	2	3	1	2	3	1	1	1	1	1	2	1	1.58
CO3	2	3	2	3	3	1	1	1	2	1	2	2	1.92
CO4	2	3	3	2	3	1	1	1	2	2	2	2	2.00
CO5	1	2	1	2	2	2	2	2	3	2	2	1	1.83
Avg	1.8	2.4	1.6	2.0	2.8	1.2	1.2	1.0	1.8	1.2	2.0	1.4	1.7

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	3	2	1.75
CO2	2	1	3	2	2.00
CO3	2	1	3	2	2.00
CO4	2	1	3	2	2.00
CO5	1	1	2	3	1.75
Avg	1.6	1	2.8	2.2	1.9

Course Code	Course Name	L	T	P	Credit
F07607107	Python for Data Science	3	1		4

Course Outcomes (COs)

CO1: Apply advanced Python programming techniques for efficient data handling and processing.
CO2: Perform numerical computation and data manipulation using Python libraries.
CO3: Analyze datasets using visualization and exploratory data analysis techniques.
CO4: Build and evaluate machine learning models using Python.
CO5: Apply advanced data science techniques to real-world datasets.

Unit I	**Advanced Python Programming Fundamentals** Python programming architecture and execution model, advanced data types and collections, functional programming concepts including lambda expressions and higher-order functions, advanced list, dictionary and generator comprehensions, iterators and generators, closures and decorators for reusable code, exception handling and custom exceptions, logging and debugging techniques, regular expressions for data preprocessing, file handling for CSV, JSON and Excel formats, virtual environments and Python package management.
Unit II	**Numerical Computing and Data Manipulation** Introduction to numerical computing using NumPy, multidimensional arrays and array operations, indexing, slicing and broadcasting, vectorized computation and performance optimization, linear algebra and statistical operations, Pandas Series and DataFrame operations, advanced indexing and filtering, data cleaning including handling missing values, duplicates and outliers, data aggregation and transformation, merging and reshaping datasets, time-series data handling.
Unit III	**Data Visualization and Exploratory Data Analysis** Principles of data visualization, Matplotlib plotting and customization, statistical visualization using Seaborn, heatmaps and pair plots, interactive visualization using Plotly, exploratory data analysis workflow, descriptive statistics, correlation analysis, hypothesis testing, interpretation of results, visualization of multivariate and high-dimensional data.
Unit IV	**Machine Learning Using Python** Introduction to machine learning concepts and workflow, supervised and unsupervised learning techniques, data preprocessing for machine learning, regression models, classification algorithms, clustering techniques, model evaluation metrics, confusion matrix and ROC curve, cross-validation techniques, hyperparameter tuning and performance optimization.
Unit V	**Advanced Data Science Techniques** Feature engineering and feature selection methods, dimensionality reduction techniques, introduction to natural language processing, text preprocessing and vectorization, time-series analysis and forecasting, anomaly detection techniques, introduction to neural networks and deep learning, overview of TensorFlow and Keras, real-world data science case studies.

Books

1. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media, 2017.
2. Wes McKinney, *Python for Data Analysis*, O'Reilly Media, 3rd Edition, 2022
3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, O'Reilly Media, 2023.
4. Joel Grus, *Data Science from Scratch*, O'Reilly Media, 2019.
5. Sebastian Raschka and Vahid Mirjalili, *Python Machine Learning*, Packt Publishing, 2021.

CO–PO MATRIX 0:-

Scale: - 3 = High, 2 = Moderate, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	3	1	0	1	1	0	2	1
CO2	3	3	2	2	3	1	0	1	1	1	2	2
CO3	2	3	1	3	3	1	1	1	2	1	2	3
CO4	2	3	3	3	3	1	1	1	2	2	2	3
CO5	2	2	3	2	3	2	3	2	2	2	3	2
Avg	2.4	2.6	2.2	2.2	3	1.2	1.0	1.2	1.6	1.2	2.2	2.2

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	2	2	2.00
CO2	3	1	3	2	2.25
CO3	2	1	3	2	2.00
CO4	3	1	3	2	2.25
CO5	2	1	3	3	2.25
Avg	2.6	1.0	2.8	2.2	2.15

Course Code	Course Name	L	T	P	Credit
F0760710 P	Practical Lab for Data Science Using Python			8	4

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Data Science Using Python: On whole syllabus

Course Code	Course Name	L	T	P	Credit
F0760711 R	Research Project/Dissertation				4

Presentation/Seminar based on Research Project will be evaluated by internal/external examiner appointed by university on the recommendation of Board of Studies.

BCA VIII SEMESTER									
Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits
CC	xxxxx	Professional Elective-I	75	25	100	4			4
	xxxxx	Professional Elective-II	75	25	100	4			4
	F0860706T	Advanced Data Base Management System	75	25	100	3	1		4
	F0860707P	Lab for Advanced Data Base Management System	50	50	100			4	4
	F0860708 R	Research Project/ Dissertation	50	50	100				4
Total					500				20

Course Code	Course Name	L	T	P	Credit
F08601706T	Advanced Data Base Management System	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Advanced DBMS.

CO2: Apply principles of Advanced DBMS to solve computational problems.

CO3: Analyze and evaluate techniques related to Advanced DBMS.

CO4: Develop solutions using tools and methodologies from Advanced DBMS.

CO5: Demonstrate professional skills and ethical considerations in Advanced DBMS applications.

UNIT – I	History of Data base Systems. Data base System Applications, data base System VS file System. Data Models – the ER Model – Relational Model – Other Models – Database Languages – DDL – DML. Introduction to the Relational Model – Integrity Constraint Over relations – Enforcing Integrity constraints - Querying relational data – Logical data base Design – Introduction to Views – Destroying/altering Tables and Views. Introduction of Object Database Systems, Structured Data types, operations on structured data, Encapsulation and ADTS, Inheritance.
UNIT – II	Database design for ORDBMS, ORBMS implementation and challenges, OODBMS, comparison of RDBMS, OODBMS and ORDBMS. (chapter 23 from text book 1) Introduction to Parallel databases, architectures for parallel databases, Parallel Query Evaluation – data partitioning and parallelizing sequential operator evaluation code, Parallelizing individual operations, and parallel Query optimization.
UNIT – III	Introduction to distributed databases; features of distributed databases vs centralized databases, Why distributed databases, DDBMS, levels of transparency- reference architecture for DDB, types of data fragmentation, distribution transparency for read-only and update applications, distributed database access primitives, Integrity Constraints in Distributed databases.
UNIT - IV	Distributed database design: framework for distributed database design, the design of database fragmentation, allocation of fragments; Distributed Query processing: Equivalence of transformations for queries, transforming global queries into fragment queries, distributed grouping and aggregation

	functions, parametric queries.
UNIT - V	A framework for query optimization, join queries and general queries, disjoint queries in a distributed DBMS, joins in a distributed DBMS, cost-based query optimization. DBMS Vs IR systems, Introduction to Information retrieval, indexing for text search, web search engine, managing text in a DBMS, a data model for XML, Querying XML data, and efficient evaluation of XML queries.

Books:

1. Raghuramakrishnan and Johannes Gehrke, "Database Management Systems", 3rd Edition, TMH, 2006.
2. S. Ceri and G. Pelagatti, "Distributed databases principles and systems", 1st Edition, TMH, 2008.

CO–PO MATRIX 0:-

Scale: - 3 = High, 2 = [illegible], 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	0	0	1	0	2	1	1.17
CO2	3	3	2	2	3	1	0	1	1	1	2	2	1.75
CO3	3	3	2	3	2	1	0	1	1	1	2	3	1.75
CO4	2	3	2	3	2	1	0	1	1	1	2	2	1.92
CO5	2	2	3	2	3	1	0	2	2	2	2	2	1.58
Avg	1	1	1	1	2	3	2	2	2	2	1	2	1.63
	2.2	2.2	1.8	1.8	2.4	1.4	0.4	1.2	1.4	1.0	2.0	1.8	

CO -PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	1	2	2	1.75
CO2	3	1	2	2	2.00
CO3	2	1	3	2	2.00
CO4	3	1	2	2	2.00
CO5	1	1	1	3	1.50
Avg	2.2	1.0	2	2.2	1.85

Course Code	Course Name	L	T	P	Credit
F0860706 P	Lab for Advanced Data Base Management System			8	4

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Advanced Data Base Management System: On whole syllabus

Course Code	Course Name	L	T	P	Credit
F0860708 R	Research Project/ Dissertation				4

Presentation/Seminar based on Research Project will be evaluated by internal/external examiner appointed by university on the recommendation of Board of Studies.

Professional Electives

Proposed Professional Electives for BCA 7th Semester

[illegible]	Semester	Course Code	Professional Electives
1	VII	F07607017	Business Intelligence and Analytics
2	VII	F07607027	Cloud Computing for Data Analytics
3	VII	F07607037	Advanced Software Engineering
4	VII	F07607047	Explainable AI
5	VII	F07607057	Research Methodology
6	VII	F07607067	Advanced Data Analysis Tools

Professional Electives

Course Code	Course Name	L	T	P	Credit
F0760701T	Business Intelligence and Analytics	4			4

Course Outcomes (COs)

CO1: Understand basic concepts and components of business intelligence systems.
CO2: Explain data sources and simple data preparation techniques.
CO3: Perform descriptive analytics and basic reporting.
CO4: Create simple dashboards and visualizations for business decisions.
CO5: Apply introductory predictive analytics concepts and understand ethical issues.

Unit I	**Introduction to Business Intelligence:-** Introduction to business intelligence and analytics, role of BI in organizations, data, information and knowledge, decision-making process, components of BI systems, BI architecture, difference between traditional reporting and business intelligence, overview of analytics, types of analytics, applications of BI in business.
Unit II	**Data Sources and Data Preparation:-** Types of data sources, structured and unstructured data, operational databases, data warehouses and data marts, basics of ETL process, data extraction, data transformation and data loading, data quality issues, data cleaning techniques, handling missing and duplicate data, introduction to data integration.
Unit III	**Descriptive Analytics and Reporting:-** Concept of descriptive analytics, basic statistical measures, summary statistics, data aggregation, trend analysis, introduction to business reports, types of reports, charts and graphs, key performance indicators, basics of dashboards, interpretation of reports for decision-making.
Unit IV	**Data Visualization and Dash boarding:-** Importance of data visualization, principles of effective visualization, basic charts such as bar, line, pie and histogram, overview of visualization tools, interactive dashboards, filtering and drill-down concepts, storytelling with data, best practices for dashboard design.
Unit V	**Introduction to Predictive Analytics and Ethics:-** Introduction to predictive analytics, basic forecasting concepts, correlation and simple regression, classification overview, business applications of predictive analytics, introduction to prescriptive analytics, ethical issues in analytics, data privacy and security, responsible use of business data, future trends in business intelligence and analytics.

Text Books

1. Sharda R., Delen D. and Turban E., *Business Intelligence, Analytics and Data Science*, Pearson, 2022.
2. Camm J. D. et al., *Business Analytics*, Cengage Learning, 2019.
3. Stephen Few, *Information Dashboard Design*, Analytics Press, 2013.
4. Ralph Kimball, *The Data Warehouse Toolkit*, Wiley, 2013.

Professional Electives

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	2	1	1	1	2	1	1	0	1	0	2	1	1.08
CO2	2	3	1	2	3	1	1	1	1	1	2	1	1.58
CO3	2	3	1	3	3	1	1	1	2	1	2	2	1.83
CO4	2	2	2	3	3	1	1	1	2	2	2	2	1.92
CO5	1	2	2	2	2	3	2	1	2	1	2	2	1.83
Avg	1.8	2.2	1.4	2.2	2.6	1.4	1.2	0.8	1.6	1	2	1.6	1.65

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	3	2	1.75
CO2	1	1	3	2	1.75
CO3	1	1	3	2	1.75
CO4	1	1	3	2	1.75
CO5	1	1	3	3	2.00
Avg	1	1	3	2.2	1.80

Course Code	Course Name	L	T	P	Credit
P0760702T	Cloud Computing for Data Analytics	4			4

Course Outcomes (COs)

CO1: Understand fundamental concepts of cloud computing and cloud service models.
CO2: Explain cloud architectures and data storage solutions for analytics.
CO3: Use cloud platforms for basic data processing and analytics tasks.
CO4: Apply cloud-based tools for batch and real-time data analytics.
CO5: Understand security, cost, and ethical issues related to cloud-based data analytics.

Unit I	**Introduction to Cloud Computing-** Introduction to cloud computing, evolution of computing, need for cloud computing, characteristics of cloud computing, cloud service models including IaaS, PaaS and SaaS, cloud deployment models such as public, private, hybrid and community clouds, advantages and limitations of cloud computing, overview of cloud computing in data analytics, basic use cases.
Unit II	**Cloud Architecture and Data Storage-** Cloud computing architecture, virtualization concepts, containers and virtual machines, cloud data centers, cloud storage types including object, block and file storage, distributed storage systems, data ingestion in cloud, data lakes and cloud-based data warehouses, comparison of traditional storage and cloud storage for analytics.
Unit III	**Cloud Platforms for Data Analytics-** Overview of popular cloud platforms such as AWS, Microsoft Azure and Google Cloud, cloud-based analytics services, managed databases, cloud ETL tools, introduction to serverless computing, using cloud notebooks and analytics environments, simple data analytics workflows on the cloud.
Unit IV	**Big Data and Analytics in the Cloud-** Introduction to big data concepts, challenges of big data analytics, cloud-based big data processing frameworks, basics of Hadoop and Spark on the cloud, batch processing and stream processing concepts, real-time analytics overview, use of cloud services for large-scale data analysis.
Unit V	**Security, Cost Management and Use Cases-** Cloud security fundamentals, data privacy and compliance issues, identity and access management, secure data storage and processing, cost models in cloud computing, pay-as-you-go concept, cost optimization strategies, ethical issues in cloud-based analytics, business and industry use cases of cloud data analytics, future trends in cloud analytics.

Text Books

1. Buyya R., Broberg J. and Goscinski A., *Cloud Computing: Principles and Paradigms*, Wiley, 2019.
2. Erl T., Puttini R. and Mahmood Z., *Cloud Computing: Concepts, Technology & Architecture*, Pearson, 2018.

CO-PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	1	1	1	2	1	1	0	1	0	2	1	1.17
CO2	3	2	2	2	3	1	1	0	1	1	2	2	1.67
CO3	2	3	2	2	3	1	1	1	1	1	2	2	1.75
CO4	2	3	3	3	3	1	1	1	2	2	2	3	2.17
CO5	1	1	1	1	2	3	2	2	2	1	2	1	1.58
Avg	2.2	2	1.8	1.8	2.6	1.4	1.2	0.8	1.4	1	2	1.8	1.67

CO-PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	3	2	2	2.00
CO2	1	3	2	2	2.00
CO3	2	3	3	2	2.50
CO4	2	3	3	2	2.50
CO5	1	2	1	3	1.75
Avg	1.4	2.8	2.2	2.2	**2.15**

Professional Electives

Course Code	Course Name	L	T	P	Credit
F07607037	Advanced Software Engineering	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Advanced Software Engineering.

CO2: Apply principles of Advanced Software Engineering to solve computational problems.

CO3: Analyze and evaluate techniques related to Advanced Software Engineering.

CO4: Develop solutions using tools and methodologies from Advanced Software Engineering.

CO5: Demonstrate professional skills and ethical considerations in Advanced Software Engineering applications.

Unit-I	**Introduction:** FAQs about Software Engineering; Professional and Ethical Responsibility; Software Process: Models; Process Iteration, Specification, Software Design and Implementation; Verification & Validation; Software Evolution; Automated Process Support. **Project Management:** Management Activities, Project Pl Software Project Management and Requirements Project Management: Management Activities, Project Planning, Project Scheduling, Risk Management; Software Requirements: Functional and Non-Functional Requirements, User Requirements, System Requirements, Requirements Document; Requirements Engineering Process: Feasibility Studies, Requirements Elicitation and Analysis, Requirements Validation, Requirements Management.
Unit-II	**Architectural Design;** System Models, Software Prototyping and Specifications System models: Context, Behavioral, Data, and Object models, CASE Workbenches; Software Prototyping: Prototyping in the Software Process, Rapid Prototyping Techniques, User Interface Prototyping; Specifications: Formal Specification in the Software Process, Interface Specification, Behavioral Specification. **Advanced Design:** Introduction: System Structuring; Control Models; Modular Decomposition; Domain- Specific Architectures; Distributed Systems Architectures: Multiprocessor Architectures; Client-Server Architectures, Distributed Object Architectures; CORBA (Common Object Request Broker Architecture).
Unit-III	**Software Design:** Object Oriented Design: Objects and Object Classes, Object-Oriented Design Process, Design Evolution; Real Time Software

	Design: Systems Design, Real-Time Executives, Monitoring and Control Systems, Data Acquisition Systems; Design with Reuse: Component-Based Development, Application Families, Design Patterns; User Interface Design: Principles, User Interaction, Information Presentation, User Support, Interface Evaluation.
Unit-IV	**Verification, Validation and Testing:** Verification and Validation (V & V): Static and Dynamic V & V, V & V Goals, V & V vs. Debugging, Software Inspections / Reviews, Clean-Room Software Development; Software Testing: Defect Testing, Integration Testing, Interface Testing, Object-Oriented Testing, Testing Workbenches. **Managing People:** Introduction; Limits to Thinking; Memory Organization; Knowledge Modeling; Motivation; Group Working; Choosing and Keeping People; the People Capability Maturity Model.
Unit-V	**Software Cost Estimation and Quality Management:** Software Cost Estimation: Productivity, Estimation Techniques, Algorithmic Cost Modelling, Project Duration and Staffing. Quality Management: Quality Assurance and Standards, Quality Planning, Quality Control, Software Measurement and Metrics; Process Improvement: Process and Product Quality, Process Analysis and Modelling, Process Measurement, the SEI Process Maturity Model, and Process Classification. **Evolution:** Legacy Systems: Structures, Design, and Assessment; Software Change: Program Evolution Dynamics, Software Maintenance, Architectural Evolution; Software Re- Engineering: Source Code Translation, Reverse Engineering, Program Structure Improvement, Program Modularization. Data Re-Engineering; Configuration Management.

Books

1. Software Engineering: An Engineering Approach, by J.F. Peters and W. Pedryez, Publisher John Wiley and Sons.
2. Software Engineering: A Practitioner's Approach by Roger Pressman, Publisher: McGraw-Hill.
3. Fundamentals of Software Engineering by Ghezzi, Jayazeri, and Mandrioli, Publisher: Prentice Hall.

Professional Electives

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	2	1	0	1	0	2	1	1.3
CO2	3	3	2	2	3	1	1	1	1	1	2	2	1.8
CO3	2	3	2	3	2	1	1	1	1	1	2	3	1.8
CO4	2	2	3	2	3	1	1	2	2	2	2	2	2.0
CO5	1	1	1	1	2	3	2	2	2	1	2	1	1.5
Avg	2.2	2.2	1.8	1.8	2.4	1.6	1.2	1.2	1.4	1.0	2.0	1.8	1.7

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	1	2	1.75
CO2	3	1	1	2	1.75
CO3	2	1	1	2	1.50
CO4	3	1	1	2	1.75
CO5	1	1	1	3	1.50
Avg	2.4	1.0	1.0	2.2	1.65

Proposed Professional Electives

Course Code	Course Name	L	T	P	Credit
F07607047	Explainable AI	4	1		4

Course Outcomes (COs)

CO1: Understand the importance and need for explainable AI systems.
CO2: Explain how machine learning models make decisions.
CO3: Apply basic explainability techniques to AI models.
CO4: Analyze fairness, bias, and transparency in AI systems.
CO5: Understand ethical, legal, and social implications of explainable AI.

Unit I	**Introduction to Explainable Artificial Intelligence-** Introduction to artificial intelligence and machine learning, black-box nature of AI models, need for explainability and transparency, definition of explainable AI, importance of trust and accountability in AI systems, stakeholders of explainable AI, real-world examples where explainability is critical, challenges and limitations of explainable AI.
Unit II	**Machine Learning Models and Interpretability-** Overview of common machine learning models, interpretable models versus black-box models, decision trees and rule-based models, linear and logistic regression models, model complexity and interpretability trade-off, feature importance concepts, global and local interpretability, understanding predictions and model behavior.
Unit III	**Explainability Techniques and Methods-** Introduction to model-agnostic and model-specific explainability techniques, feature importance methods, partial dependence plots, local interpretable model-agnostic explanations (LIME), SHAP values concept, rule extraction techniques, visualization-based explanations, comparison of different explainability methods.
Unit IV	**Fairness, Bias and Transparency in AI-** Understanding bias in data and models, sources of bias in AI systems, fairness concepts and metrics, bias detection techniques, mitigating bias in machine learning models, transparency and accountability in AI systems, role of explainability in fair decision-making, case studies related to biased AI systems.
Unit V	**Ethics, Regulations and Applications of XAI-** Ethical principles in artificial intelligence, responsible and trustworthy AI, privacy and data protection issues, overview of AI regulations and guidelines, explainable AI in healthcare, finance, education and government applications, challenges in deploying explainable AI systems, future trends in explainable artificial intelligence.

Books

1. Molnar C., *Interpretable Machine Learning*, Leanpub, 2022.
2. Doshi-Velez F. and Kim B., *Towards a Rigorous Science of Interpretable Machine Learning*, arXiv Notes.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = [illegible], 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	2	1	1	1	1	2	1	0	1	0	2	1	1.08
CO2	2	3	2	2	2	1	1	1	1	1	2	2	1.67
CO3	2	3	2	3	3	1	1	1	2	1	2	3	2.00
CO4	1	2	1	2	2	3	3	1	2	1	2	2	1.83
CO5	1	1	1	1	1	3	3	2	2	1	2	1	1.58
Avg	1.6	2.0	1.4	1.8	1.8	2.0	1.8	1.0	1.6	0.8	2.0	1.8	1.63

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	2	3	1.75
CO2	2	1	3	2	2.00
CO3	2	1	3	2	2.00
CO4	1	1	3	3	2.00
CO5	1	1	2	3	1.75
Avg	1.4	1.0	2.6	2.6	1.90

Course Code	Course Name	L	T	P	Credit
P07607057	Research Methodology	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Research Methodology.

CO2: Apply principles of Research Methodology to solve computational problems.

CO3: Analyze and evaluate techniques related to Research Methodology.

CO4: Develop solutions using tools and methodologies from Research Methodology.

CO5: Demonstrate professional skills and ethical considerations in Research Methodology applications.

Unit-I	**Philosophical Underpinnings of Research:** **Introduction to Research:** Novelty, Originality, Organized Method of Investigation, and Communication of Problem, Data, Method, and Results for Peer Group Verification; Paradigm and paradigm shift. **Types of Research:** Theoretical, Empirical, Experimental, and Design and Characterization of New Materials, Components, Processes, and Systems. **Broad Objectives of Research:** Problem-oriented—Defining Problems and Problem Issues, Analyzing Data, Predicting, and Designing; Technique-oriented-Improving Performance and Expanding Scope. **Modes of Inquiry and Inquiring Systems:** Hypothetical-deductive and Empirical-inductive modes; Scientific Method, and Inquiring Systems of Locke, Kant, Leibnitz, Hegel, and Singer, Continuum of Connections among Facts, Data, Laws, Hypotheses, Theory, Models, and Experiments; Criteria of a Theory, Research Topic, Problem, Questions, Objectives, and Scope, Methodology, Methods, Tools, and Techniques, Research Ethics, Plagiarism, and Their Prevention.
Unit-II	Measurement, Data, and Analytics, Structured and Unstructured Data, Scales of Measurement, Population and Sample, Descriptive Statistics, Data Visualization, Probability and Random Variables, Sampling and Estimation, Hypothesis Testing, ANOVA, Correlation, and Regression. Data Analytics: Elements of Association, Clustering, and Classification.
Unit-III	Elements of Theoretical Research, Model and Model Building: Classification of Models, Exogenous and Endogenous Variables, Variable Relationships, Model Boundary, and Predictive and Prescriptive Models.
Unit-IV	Research Methods for Computer Science, Formal Methods: Formal Specification, Algorithm, and Complexity, Building Artefacts: Proof of Performance, Proof of Concept, and Proof of Existence, Process Methodology: Methods for Software Engineering and Human-Computer Interaction, Cognitive Processes, Interactive Games, Social Networks, and Web Analytics.

Unit-V	Research Documentation, Elements of Preparing a Paper and a Thesis: Title, Abstract, Keywords, Acknowledgements, Symbols and Abbreviations, Introduction, Literature Review, Materials and Methods, SI Units, Mathematical Materials, Graphical and Tabular Presentation, Results and Discussion, Conclusion, Interpretation, Generalization, Scope for Future Work, Citations and List of References, and Appendixes, Elements of Good English Writing: Signposts, Paraphrasing—Unity, Coherence, and , and Topic Sentence, and Transitions.

Books

1. Kothari, C. R. and G. Garg (2019), Research Methodology: Methods and Techniques, Fourth MultiColour Edition, New Age International Publishers.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = [illegible], 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	2	1	2	1	1	1	1	2	2	1.58
CO2	2	3	2	2	2	1	1	1	1	1	2	2	1.67
CO3	2	3	2	3	1	2	1	1	1	1	2	3	1.83
CO4	2	2	3	2	3	1	1	2	1	2	2	2	1.91
CO5	1	1	1	1	1	3	2	2	2	2	3	2	1.75
Avg	2	2.2	1.8	2	1.6	1.8	1.2	1.4	1.2	1.4	2.2	2.2	1.75

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	2	3	1.75
CO2	2	1	2	3	2.00
CO3	1	1	3	3	2.00
CO4	2	1	2	3	2.00
CO5	1	1	1	3	1.50
Avg	1.4	1.0	2.0	3.0	1.85

Course Code	Course Name	L	T	P	Credit
F07607067	Advanced Data Analysis Tools	4			4

Course Outcomes (COs)

CO1: Understand the role of modern tools in data analysis.
CO2: Use advanced tools to collect, clean, and manage data.
CO3: Perform data analysis and visualization using industry-standard tools.
CO4: Apply basic analytical and modeling features available in data analysis tools.
CO5: Interpret analytical results and generate professional reports.

Unit I	**Overview of Data Analysis Tools-** Introduction to data analysis and decision-making, evolution of data analysis tools, comparison of traditional and modern tools, overview of spreadsheet-based tools, statistical tools, programming-based tools, open-source and commercial analytics platforms, criteria for selecting appropriate data analysis tools, basic workflow of data analysis using tools.
Unit II	**Spreadsheet and Statistical Analysis Tools-** Advanced spreadsheet features for data analysis, data cleaning and validation, pivot tables and pivot charts, advanced formulas and functions, introduction to statistical analysis tools, descriptive statistics, correlation and regression basics using tools, generating analytical reports using spreadsheets and statistical software.
Unit III	**Programming and Open-Source Analytics Tools-** Introduction to Python and R for data analysis, data manipulation using libraries and packages, exploratory data analysis using programming tools, basic visualization techniques, introduction to notebooks and integrated development environments, advantages of open-source tools in analytics.
Unit IV	**Business Intelligence and Visualization Tools-** Introduction to business intelligence tools, data connectivity and integration, building reports and dashboards, interactive visualization features, key performance indicators, data storytelling using BI tools, comparison of popular BI platforms, real-world business analytics examples.
Unit V	**Big Data, Cloud and Emerging Analytics Tools-** Introduction to big data analytics tools, overview of Hadoop and Spark, cloud-based data analysis tools, analytics as a service, collaboration and version control in analytics, data security and privacy issues, ethical considerations in using data analysis tools, emerging trends in analytics software.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	2	1	1	1	3	1	1	0	1	0	2	1	1.17
CO2	2	3	1	2	3	1	1	1	1	1	2	1	1.58
CO3	2	3	2	3	3	1	1	1	2	1	2	2	1.91
CO4	2	3	3	2	3	1	1	1	2	2	2	2	2.00
CO5	1	2	1	2	2	2	2	2	3	2	2	1	1.83
Avg	1.8	2.4	1.6	2	2.8	1.2	1.2	1.0	1.8	1.2	2.0	1.4	1.75

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	3	2	1.75
CO2	2	1	3	2	2.00
CO3	2	1	3	2	2.00
CO4	2	1	3	2	2.00
CO5	1	1	2	3	1.75
Avg	1.6	1.0	2.8	2.2	**1.90**

Professional Electives for BCA 8th Semester

S. No.	Semester	Course Code	Professional Electives
7	VIII	F0860701T	Security Aspects of ML
8	VIII	F0860702T	Digital Image Processing
9	VIII	F0860703T	Data Mining and Warehousing
10	VIII	F0860704T	Advanced Data visualization

Professional Electives

Course Code	Course Name	L	T	P	Credit
F0860701T	Security Aspects of ML	4			4

Course Outcomes (COs)

CO1: Understand security concerns and vulnerabilities in machine learning systems.
CO2: Identify common attacks on machine learning models and data.
CO3: Explain basic defense strategies for securing ML models.
CO4: Analyze privacy, robustness, and reliability issues in ML applications.
CO5: Understand ethical, legal, and professional aspects of secure machine learning.

Unit I	**Introduction to Machine Learning Security-** Introduction to machine learning systems, importance of security in ML applications, difference between traditional software security and ML security, threat landscape in machine learning, attack surface of ML systems, data-driven vulnerabilities, real-world examples of ML security failures, overview of secure and trustworthy AI.
Unit II	**Attacks on Machine Learning Systems-** Types of adversaries and threat models, data poisoning attacks, label manipulation, evasion attacks, adversarial examples, model extraction attacks, model inversion attacks, membership inference attacks, impact of attacks on model accuracy and reliability, basic case studies of ML attacks.
Unit III	**Defense Mechanisms and Robust Machine Learning-** Introduction to defensive strategies in machine learning, secure data collection and preprocessing, robust training techniques, regularization and validation, adversarial training basics, anomaly detection for attack detection, model hardening techniques, and monitoring ML systems in production.
Unit IV	**Privacy and Trust in Machine Learning-** Privacy risks in machine learning, data leakage issues, privacy-preserving machine learning concepts, anonymization and data masking, introduction to differential privacy, secure model sharing, federated learning overview, trust, transparency, and explain ability in secure ML systems.
Unit V	**Ethics, Regulations and Secure ML Applications-** Ethical challenges in machine learning security, responsible and trustworthy AI, legal and regulatory considerations, data protection laws overview, security best practices for ML deployment, secure ML applications in healthcare, finance, autonomous systems and cyber security, future trends in machine learning security.

Text Books

1. Goodfellow I., Bengio Y. and Courville A., *Deep Learning*, MIT Press.
2. Barreno M. et al., *The Security of Machine Learning*, Machine Learning Journal.
3. Papernot N. et al., *Practical Black-Box Attacks against Machine Learning*, ACM CCS.
4. Biggio B. and Roli F., *Wild Patterns: Ten Years After the Rise of Adversarial Machine Learning*, Pattern Recognition.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	2	2	2	2	1	1	1	2	2	1.7
CO2	3	3	2	2	2	2	2	1	1	1	2	2	1.9
CO3	3	3	3	2	2	2	2	1	1	2	2	2	2.(
CO4	3	3	2	3	2	3	3	1	1	1	2	2	2.1
CO5	2	2	1	2	2	3	3	2	2	2	2	1	2.(
Avg	2.8	2.6	1.8	2.2	2.0	2.4	2.4	1.2	1.2	1.4	2.0	1.8	1.9

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	2	3	3	2.25
CO2	1	2	3	3	2.25
CO3	2	2	3	2	2.25
CO4	1	2	3	3	2.25
CO5	1	1	2	3	1.75
Avg	1.2	1.8	2.8	2.8	**2.15**

Course Code	Course Name	L	T	P	Credit
F0860702T	Digital Image Processing	4			4

Professional Electives

Course Outcomes (COs)

CO1: Understand the fundamental concepts of Digital Image Processing.

CO2: Apply principles of Digital Image Processing to solve computational problems.

CO3: Analyze and evaluate techniques related to Digital Image Processing.

CO4: Develop solutions using tools and methodologies from Digital Image Processing.

CO5: Demonstrate professional skills and ethical considerations in Digital Image Processing applications.

Unit-I	**Introduction:** Digital Image Fundamentals: Brightness, Adaptation and Discrimination, Light and Electromagnetic Spectrum, Image Sampling and Quantization, Some Basic Relationships between Pixels Types of images.
Unit-II	**Spatial Domain Filtering:** Some Basic Intensity Transformation Functions, Histogram Equalization, Spatial Correlation and Convolution, Smoothening Spatial Filters: Low pass filters, Order Statistics filters; Sharpening Spatial Filters: Laplacian filter.
Unit-III	**Filtering in Frequency Domain:** The Discrete Fourier Transformation (DFT), Frequency Domain Filtering: Ideal and Butterworth Low pass and High pass filters, DCT Transform (1D, 2D).
Unit-IV	**Image Restoration:** Image Degradation/Restoration Process, Noise models, Noise Restoration Filters Image Compression: Fundamentals of Image Compression, Huffman Coding, Run Length Coding, JPEG.
Unit-V	**Morphological Image Processing:** Erosion, Dilation, Opening, Closing, Hit-or-Miss Transformation, Basic Morphological Algorithms, Point, Line and Edge Detection, Thresholding, Region Based Segmentation.

Books:

1. Gonzalez, R. C., & Woods, R. E. (2017). Digital Image Processing. 4th edition. Pearson Education.

162

2. Jain, A. K. (1988). Fundamentals of Digital Image Processing. 1st edition Prentice Hall of India.
3. Castleman, K. R. (1995.). Digital Image Processing. 1st edition. Pearson Education
4. Gonzalez, R. C., Woods, R. E., & Eddins, S. (2004). Digital Image Processing using MATLAB. Pearson Education Inc.

CO-PO MATRIX ():-

Scale: - **3** = High, **2** = [illegible], **1** = Low, **0** = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	1	1	0	1	0	0	2	1	1.08
CO2	2	3	2	2	3	1	1	0	1	1	2	2	1.66
CO3	2	3	1	3	2	1	1	1	1	0	2	3	1.67
CO4	2	2	3	2	3	1	1	1	1	2	2	2	1.83
CO5	1	1	1	1	2	3	2	2	2	1	2	1	1.58
Avg	2	2.2	1.6	1.8	2.2	1.4	1	1	1	0.8	2	1.8	1.57

CO PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	1	3	2	2.00
CO2	3	1	3	2	2.25
CO3	2	1	3	2	2.00
CO4	3	1	3	2	2.25
CO5	1	1	2	3	1.75
Avg	2.2	1.0	2.8	2.2	2.05

Course Code	Course Name	L	T	P	Credit
F0860703T	Data Mining and Warehousing	4			4

Course Outcomes (COs)

CO1: Understand the fundamentals of data warehousing and data mining.
CO2: Explain data warehouse architecture and data preparation techniques.
CO3: Apply basic data mining techniques to analyze large datasets.
CO4: Interpret patterns and knowledge discovered from data.
CO5: Understand applications and ethical issues related to data mining.

Unit I	**Introduction to Data Warehousing and Data Mining-** Introduction to data warehousing, need for data warehousing, operational databases versus analytical databases, data warehouse concepts and characteristics, basic components of a data warehouse, introduction to data mining, data mining tasks, knowledge discovery in databases process, applications of data mining. Data Pre-processing - aggregation, sampling, dimensionality reduction, Feature Subset Selection, Feature Creation, Discretization and Binarization, Variable Transformation.
Unit II	**Data Warehouse Architecture and Data Preparation-** Data warehouse architecture, data sources, data marts, metadata, ETL process, data extraction, transformation and loading, data cleaning and integration, data quality issues, introduction to OLAP, OLAP operations, multidimensional data model.
Unit III	**Data Mining Techniques-** Data preprocessing, data reduction and transformation, classification concepts, decision tree classification, naïve Bayes classification, clustering concepts, k-means clustering, hierarchical clustering, association rule mining, market basket analysis, frequent itemset generation.
Unit IV	**Association rule mining:** Transaction data-set, Frequent Itemset, Support measure, Apriori Principle, Apriori Algorithm, Computational Complexity, Rule Generation, Confidence association rule.
Unit V	**Applications, Issues and Trends-** Applications of data mining in business, healthcare, education and finance, data mining for customer relationship management, ethical and privacy issues in data mining, data security concerns, challenges in data warehousing and data mining, future trends in data analytics and mining.

Text Books

1. Han J., Kamber M. and Pei J., *Data Mining: Concepts and Techniques*, Morgan Kaufmann.
2. Kimball R. and Ross M., *The Data Warehouse Toolkit*, Wiley.
3. Inmon W. H., *Building the Data Warehouse*, Wiley.
4. Tan P.-N., Steinbach M. and Kumar V., *Introduction to Data Mining*, Pearson.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 – None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	1	0	1	1	1	0	0	0	0	2	1	0.83
CO2	2	2	1	2	3	1	0	0	1	1	2	1	1.33
CO3	2	3	2	2	3	1	1	0	1	1	2	2	1.67
CO4	2	3	1	3	2	1	1	0	1	0	2	3	1.58
CO5	1	1	0	1	1	3	2	1	2	1	2	1	1.33
Avg	2	2	0.8	1.8	2	1.4	0.8	0.2	1	0.6	2	1.6	1.33

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	3	2	1.75
CO2	1	1	3	2	1.75
CO3	2	1	3	2	2.00
CO4	1	1	3	2	1.75
CO5	1	1	2	3	1.75
Avg	1.2	1.0	2.8	2.2	**1.80**

Course Code	Course Name	L	T	P	Credit
F0860704T	Advanced Data visualization	4			4

Course Outcomes (COs)

CO1: Understand principles and importance of advanced data visualization.
CO2: Create effective visualizations for different types of data.
CO3: Design interactive dashboards and visual analytics solutions.
CO4: Apply data storytelling techniques for business and analytical insights.
CO5: Understand ethical and professional issues in data visualization.

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
Unit II	**Advanced Visualization Techniques**-Advanced charts and plots, multivariate and multidimensional visualization, heatmaps, treemaps, sunburst charts, network graphs, geographic and spatial visualization, time-series visualization, visualizing uncertainty, comparison of different visualization techniques.
Unit III	**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
Unit IV	**Designing Effective Visualizations-** Principles of Good Visualization Design - Understanding and Using Color in Visualizations – Importance of Data Modelling in Visualization.
Unit V	**Ethics, Evaluation and Emerging Trends-**Ethical issues in data visualization, misleading visualizations and bias, accessibility and inclusive design, data privacy considerations, evaluation methods for visualizations, usability testing, future trends in data visualization, immersive analytics, augmented and virtual reality in visualization.

Book:-

1. **The Visualization Handbook** by *Charles D. Hansen & Christopher R. Johnson*
2. **Data Sketches** by *Nadieh Bremer & Shirley Wu*
3. **The Functional Art: An Introduction to Information Graphics and Visualization** by *Alberto Cairo*

CO–PO MATRIX 0:-

Scale: - 3 = High, 2 = [illegible], 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	1	0	1	1	1	0	0	0	0	2	1	0.83
CO2	2	2	2	1	3	1	0	0	1	0	2	1	1.25
CO3	2	2	3	2	3	1	1	1	2	1	2	2	1.83
CO4	2	3	1	3	2	1	1	0	3	1	2	2	1.75
CO5	1	1	0	1	1	3	2	1	2	1	2	1	1.33
Avg	2.0	1.8	1.2	1.6	2.0	1.4	0.8	0.4	1.6	0.6	2.0	1.4	1.39

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	3	2	1.75
CO2	2	1	3	2	2.00
CO3	2	1	3	2	2.00
CO4	1	1	3	2	1.75
CO5	1	1	2	3	1.75
Avg	1.4	1.0	2.8	2.2	1.80

BCA (2026-27) Syllabus semester wise with Marks Break-up

Sem	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credit	(Cumulative Minimum Credits) Required for Awards of Certificate /Diploma/Degree/Master Degree Program
IX	CC	xxxx	Professional Elective-I	75	25	100	4			4	
		xxxx	Professional Elective-II	75	25	100	4			4	
		F09607 05T	Advance Java Programing	75	25	100	4			4	
		F09607 05P	Practical Lab for Advance Java Programing	50	50	100			8	4	
		F09607 06 R	Internship/Project	50	50	100	3		2	4	
			Total			500				20	

Sem	Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits	
X	CC	xxxx	Professional Elective-I	75	25	100	4			4	(160 Credits) Bachelor of Computer Applicatic (Honors with Research) + (40 Credits)Master i Faculty
		xxxx	Professional Elective-I	75	25	100	4			4	
		F10607 05T	Data Science	75	25	100	4			4	
		F10607 05P	Practical Lab for Data Science	50	50	100			8	4	
		F10607 06 R	Summer Training/ Project	50	50	100				4	
	Total					500				20	

Course Code	Course Name	L	T	P	Credit
F0960705T	Advance Java Programing	4		4	4

Course Outcomes (COs)

CO1: Understand advanced Core Java concepts and object-oriented programming principles.
CO2: Develop multithreaded and concurrent Java applications.
CO3: Use Java Collections and I/O streams for efficient data handling.
CO4: Build database applications using JDBC and Hibernate.
CO5: Design web and enterprise applications using Servlets, JSP, and Spring Boot.

Unit-I	**Advanced Core Java Concepts**-Features of the Java programming language and object-oriented design. Topics include Java architecture and Java Virtual Machine, package creation and access control, and detailed discussion of inheritance, polymorphism, abstraction, and encapsulation. Abstract classes and interfaces are explained along with different types of inner classes such as member, static, anonymous, and local inner classes. Wrapper classes, autoboxing and unboxing, and annotation basics are introduced. Exception handling is discussed in depth, including checked and unchecked exceptions, user-defined exceptions, multiple catch blocks, exception propagation, and assertions.
Unit-II	**Multithreading and Concurrency-** Difference between processes and threads, thread lifecycle, and techniques for creating threads using the Thread class and the Runnable interface. Thread scheduling, priorities, daemon threads, and synchronization mechanisms using synchronized methods and blocks are covered. Inter-thread communication, deadlock, starvation, and race conditions are discussed. The unit also introduces concurrency utilities such as the Executor framework, Callable and Future interfaces, locks, and synchronizers.
Unit-III	**Collections Framework and I/O Streams-** Java Collections Framework including List, Set, and Map interfaces and their implementations such as ArrayList, LinkedList, HashSet, TreeSet, HashMap, TreeMap, and LinkedHashMap. Concepts of Comparable and Comparator interfaces and the use of generics. File handling concepts are covered using byte streams, character streams, buffered streams, and object streams. Serialization and deserialization techniques are discussed along with an introduction to Java NIO.
Unit-IV	**Database Programming using JDBC and Hibernate-** JDBC architecture, types of JDBC drivers, and steps to establish database connectivity. Statement, PreparedStatement, and CallableStatement interfaces, handling ResultSet and ResultSetMetaData, batch processing, transaction management, and stored procedures. The second part of the unit introduces Hibernate as an Object-Relational Mapping (ORM) framework, explaining ORM concepts, Hibernate architecture, configuration files, and mapping between Java classes and database tables. Session, SessionFactory, and Transaction management are discussed along with CRUD operations, HQL basics, caching concepts, and comparison between JDBC and Hibernate.

Unit-V	**Web Programming using Servlets, JSP & Spring Boot Framework** - Fundamentals of web applications, client–server architecture, servlet architecture, and servlet lifecycle. Handling HTTP requests and responses, request dispatching, and session tracking techniques such as cookies, URL rewriting, and HttpSession are explained. JSP architecture, JSP elements including directives, scriptlets, expressions, implicit objects, and JavaBeans are discussed. The Model–View–Controller (MVC) architecture is introduced for building structured web applications. Spring framework architecture, including core concepts such as Inversion of Control and Dependency Injection. Spring Boot fundamentals, advantages, auto-configuration, starters, and application setup are discussed. The unit covers the development of RESTful web services using Spring Boot, including REST principles, controllers, request mapping, and HTTP methods. Database integration using Spring Data JPA, entity mapping, repositories, and CRUD operations. Exception handling, validation, logging, security overview, and an introduction to microservices architecture are also included.

Book

1. **Advanced Java Programming by Uttam K. Roy**
2. **Advanced Topics in Java: Core Concepts in Data Structures by Noel Kalicharan**

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	2	1	1	1	1	1	1	1	1	0	1.25
CO2	2	3	3	2	2	1	0	1	1	0	1	0	1.33
CO3	3	2	3	1	3	1	1	0	0	1	1	1	1.41
CO4	2	3	3	2	3	1	0	1	1	0	1	0	1.42
CO5	2	3	3	2	3	2	1	2	2	2	1	1	2.00
Avg	2.4	2.6	2.8	1.6	2.4	1.2	0.6	1.0	1.0	0.8	1.0	0.4	1.48

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	3	1	1	2	1.75
CO2	3	1	1	2	1.75
CO3	3	1	1	2	1.75
CO4	3	1	1	2	1.75
CO5	3	3	1	2	2.25
Avg	3.0	1.4	1	2.0	1.85

Course Code	Course Name	L	T	P	Credit
F0960705P	Practical Lab for Advance Java Programing			8	4

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Advance Java Programing: On whole syllabus

Course Code	Course Name	L	T	P	Credit
F0960706 R	Internship/Project	3		2	4

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University for Internship/Project report.

3-Years Master of Computer Application (MCA)

10th Semester

Subject	Paper Code	Paper Name	External Marks	Internal Marks	Total Marks	L	T	P	Credits
CC	XXXXX	Professional Elective-I	75	25	100	4			4
	XXXXX	Professional Elective-I	75	25	100	4			4
	F1060705T	Data Science	75	25	100	4			4
	F1060705P	Practical Lab for Data Science	50	50	100			4	4
	F1060706R	Summer Training/ Project	50	50	100	3		2	4
Total					500				20

Course Code	Course Name	L	T	P	Credit
F1060705T	Data Science	4			4

Course Outcomes (COs)

CO1: Understand the fundamental concepts and lifecycle of data science.
CO2: Apply data preprocessing and exploratory data analysis techniques to real datasets.
CO3: Use statistical methods to analyze and interpret data.
CO4: Implement basic machine learning models for data analysis tasks.
CO5: Utilize data science tools and platforms for practical problem solving.

Unit- I	**Introduction to Data Science**-Introduction to Data Science, evolution and importance of data science in the modern world, role of data science in business and industry, data science lifecycle, stages of data science projects, types of data – structured, semi-structured and unstructured data, data science vs data analytics vs big data, challenges in data science, applications of data science in healthcare, finance, education, marketing and social media, overview of data science tools and platforms.
Unit- II	**Data Collection, Data Preprocessing and Exploratory Data Analysis-** Data sources and data acquisition methods, web data, databases, APIs and open data repositories, data cleaning techniques, handling missing values, noise removal, outlier detection, data transformation and normalization, feature scaling, data integration, data reduction, exploratory data analysis (EDA), descriptive statistics, measures of central tendency and dispersion, data visualization techniques, use of plots and charts for understanding data patterns.
Unit- III	**Statistical Foundations for Data Science**– Introduction to probability theory, basic probability rules, random variables, probability distributions, discrete and continuous distributions, normal distribution, binomial and Poisson distributions, hypothesis testing, confidence intervals, correlation and covariance, regression analysis, simple and multiple linear regression, statistical inference and its role in data science decision-making.
Unit- IV	**Machine Learning for Data Science-** Introduction to machine learning concepts, supervised and unsupervised learning, classification and regression techniques, k-Nearest Neighbors (KNN), decision trees, naïve Bayes classifier, linear and logistic regression, clustering techniques – k-means and hierarchical clustering, model evaluation metrics, overfitting and underfitting, cross-validation, feature selection, introduction to ensemble methods.
Unit- v	**Data Science Tools, Big Data and Applications-** Introduction to Python and R for data science, data analysis using NumPy, Pandas and Matplotlib, overview of Jupyter Notebook, introduction to big data concepts, Hadoop ecosystem overview, HDFS and MapReduce basics, introduction to Spark, real-world data science case studies, ethical issues in data science, data privacy and security, future trends and career opportunities in data science.

Book

1. **Data Science from Scratch: First Principles with Python by Joel Grus**
2. **Python for Data Analysis by Wes McKinney**
3. **Doing Data Science: Straight Talk from the Frontline by Cathy O'Neil & Rachel Schutt**

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	1	1	0	0	0	2	0	1.08
CO2	2	3	2	2	3	0	0	0	0	0	2	0	1.16
CO3	3	3	0	3	2	0	0	0	0	0	2	2	1.25
CO4	2	3	3	2	3	0	0	0	0	0	2	2	1.41
CO5	2	2	2	0	3	2	2	1	1	1	2	0	1.50
Avg	2.4	2.6	1.6	1.6	2.6	0.6	0.6	0.2	0.2	0.2	2	0.8	1.28

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	1	1	3	2	1.75
CO2	2	1	3	2	2.00
CO3	1	1	3	2	1.75
CO4	2	1	3	2	2.00
CO5	2	1	3	2	2.00
Avg	1.6	1.0	3.0	2.0	1.85

Course Code	Course Name	L	T	P	Credit
F1060705 P	Practical Lab for Data Science			8	4

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University. Practical will be based on the Paper Data Science: On whole syllabus

Course Code	Course Name	L	T	P	Credit
F1060706 R	Summer Training/ Project	3		2	4

On the recommendation of Board of Studies, Internal / External Examiner appointed by the University for Summer Training/ Project report.

Proposed Professional Electives for MCA

S. No.	Semester	Course Code	Professional Electives
1	IX	F0960701T	Internet of Things
2	IX	F0960702T	Data Mining
3	IX	F0960703T	Cloud Computing
4	IX	F0960704T	Data Analysis & Algorithm
1	X	F1060701T	Advance Computer Network
2	X	F1060702T	Theory of Computation
3	X	F1060703T	Deep Learning
4	X	F1060704T	Machine Learning

Course Code	Course Name	L	T	P	Credit
7090701T	Internet of Things	4			4

Course Outcomes (COs)

CO1: Understand the basic concepts, characteristics, and architecture of Internet of Things systems.
CO2: Explain IoT hardware components including sensors, actuators, and embedded platforms.
CO3: Analyze communication models and protocols used in IoT environments.
CO4: Design and implement IoT applications using cloud platforms and data analytics tools.
CO5: Develop practical IoT-based solutions for real-world applications.

UNIT – I	**Introduction to Internet of Things-** Definition, characteristics, and enabling technologies of IoT. The unit explains IoT architecture, including perception, transport, processing, and application layers. IoT ecosystem, IoT design methodology, and comparison of IoT with traditional internet and M2M communication. Various real-world IoT applications such as smart homes, smart cities, healthcare, agriculture, and industrial automation are introduced.
UNIT – II	**IoT Hardware and Embedded Systems -**IoT hardware components and embedded platforms. It explains sensors, actuators, transducers, and their interfacing. The unit covers microcontrollers and microprocessors used in IoT systems, such as Arduino, Raspberry Pi, ESP8266/ESP32, and ARM-based boards. Basics of embedded programming, real-time operating systems (RTOS), power management, and hardware communication interfaces like GPIO, UART, SPI, and I2C are discussed.
UNIT – III	**IoT Communication and Networking-** IoT communication models such as device-to-device, device-to-cloud, and device-to-gateway. The unit covers short-range and long-range communication technologies including RFID, NFC, Bluetooth, ZigBee, Wi-Fi, LoRaWAN, and cellular networks. IoT protocols such as MQTT, CoAP, HTTP/HTTPS, and AMQP are explained along with IP addressing, IPv6, and 6LoWPAN.
UNIT – IV	**IoT Data Management and Cloud Integration-** Data handling and cloud integration in IoT systems. Data acquisition, storage, and processing of sensor data. The unit explains IoT middleware, RESTful web services, and APIs. Integration of IoT with cloud platforms such as AWS IoT, Microsoft Azure IoT, and Google Cloud IoT is discussed. Basics of edge computing, fog computing, data analytics, and visualization dashboards.
UNIT – V	**IoT Security, Applications & Societal Impact-** Security challenges such as authentication, authorization, data privacy, secure communication, and device management. Covers encryption techniques, key management, and secure firmware updates. Case studies of IoT applications in smart healthcare, smart grid, smart transportation, environmental monitoring, and industrial IoT are discussed along with ethical, legal, and social issues in IoT.

t Books

1. Arshdeep Bahga and Vijay Madisetti, *Internet of Things: A Hands-On Approach*, Universities Press.
2. Raj Kamal, *Internet of Things: Architecture and Design Principles*, McGraw-Hill.

CO-PO MATRIX :-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	2	0	1	0	0	0	2	0	1.00
CO2	3	2	2	1	3	0	0	0	0	0	2	0	1.08
CO3	2	3	1	2	3	0	0	0	0	0	2	1	1.16
CO4	2	3	3	2	3	0	1	1	1	1	2	2	1.75
CO5	2	3	3	2	3	2	3	2	2	2	2	1	2.25
Avg	2.4	2.6	2.0	1.6	2.8	0.4	1.0	0.6	0.6	0.6	2.0	0.8	1.4

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1:	2	2	1	1	1.5
CO2:	3	1	0	1	1.25
CO3:	2	3	1	0	1.5
CO4:	3	3	2	2	2.5
CO5:	3	2	2	3	2.5
Avg	2.6	2.2	1.2	1.4	1.85

Course Code	Course Name	L	T	P	Credit
P09607702T	Data Mining	4			4

Course Outcomes (COs)

CO1: Understand the concepts, process, architecture, tools, and applications of data mining and knowledge discovery in databases.

CO2: Apply data preprocessing techniques including data cleaning, integration, transformation, and reduction to prepare quality data for mining.

CO3: Analyze transactional datasets using association rule mining techniques such as Apriori, FP-Growth, and ECLAT to discover frequent patterns.

CO4: Build and evaluate classification and prediction models using decision trees, Bayesian methods, k-NN, SVM, and regression techniques.

CO5: Perform clustering and outlier analysis using appropriate algorithms and assess real-world data mining applications with ethical and privacy considerations.

UNIT – I	**Introduction to Data Mining:** Introduce the concept of data mining and knowledge discovery in databases (KDD), need for data mining, types of data, data mining functionalities, and applications, data mining process, architecture of data mining systems, and challenges in data mining. Differences between data mining, machine learning, statistics, and database systems, data mining tools.
UNIT – II	**Data Preprocessing:** Data preparation techniques, Data cleaning methods such as handling missing values, noisy data, and inconsistencies. Data integration from multiple sources, data transformation techniques such as normalization, aggregation, and discretization, and data reduction techniques including dimensionality reduction and sampling, Importance of data preprocessing in improving mining results.
UNIT – III	**Association Rule Mining:** Association analysis and frequent pattern mining, basic concepts such as support, confidence, and lift. Algorithms such as Apriori, FP-Growth, and ECLAT, generation of strong association rules, multilevel and multidimensional association rules, and applications such as market basket analysis and recommendation systems.
UNIT – IV	**Classification and Prediction:** Introduce classification and prediction techniques used in data mining, decision tree induction, Bayesian classification, rule-based classification, k-Nearest Neighbor (k-NN), and support vector machines (SVM), model evaluation techniques such as confusion matrix, accuracy, precision, recall, F-measure, and cross-validation. Regression analysis for prediction.
UNIT – V	**Clustering, Outlier Analysis and Applications:** Focuses on clustering techniques such as partitioning methods (k-means, k-medoids), hierarchical clustering, and density-based clustering (DBSCAN), cluster validity and evaluation, introduction to outlier detection methods and their importance. Real-world applications of data mining in business intelligence, healthcare, finance, web mining, and social network analysis with ethical and privacy issues in data mining.

Books

1. Jiawei Han, Micheline Kamber, and Jian Pei, *Data Mining: Concepts and Techniques*, Morgan Kaufmann.
2. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, *Introduction to Data Mining*, Pearson.

CO–PO MATRIX ():-

Scale: - 3 – High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	2	2	3	2	2	0	2	0	2	2	1.83
CO2	3	3	2	3	3	2	2	0	2	0	2	2	2.00
CO3	3	3	3	3	3	2	2	0	2	0	2	2	2.08
CO4	3	3	3	3	3	2	2	0	2	0	2	3	2.16
CO5	3	3	3	3	3	3	3	2	2	0	2	3	2.50
Avg	3.0	2.8	2.6	2.8	3	2.2	2.2	0.4	2.0	0	2.0	2.4	2.11

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	1	3	1	1.75
CO2	2	1	3	1	1.75
CO3	2	0	3	0	1.25
CO4	3	1	3	1	2.00
CO5	2	0	3	3	2.00
Avg	2.2	0.6	3.0	1.2	1.75

Course Code	Course Name	L	T	P	Credit
E0960703T	Cloud Computing	4			4

Course Outcomes (COs)

CO1: Understand the fundamentals, evolution, and architecture of cloud computing.
CO2: Explain cloud service models, deployment models, SLAs, and cloud economics.
CO3: Apply virtualization, cloud infrastructure, and DevOps practices on cloud platforms.
CO4: Design and deploy cloud-based applications using modern cloud services.
CO5: Analyze cloud security, privacy, legal, and real-world application issues.

UNIT – I	**Introduction to Cloud Computing:** Basic concepts and evolution of cloud computing, definitions, characteristics, benefits, and challenges of cloud computing, cloud computing architecture, enabling technologies, and comparison with traditional computing models. Concepts such as utility computing, grid computing, and distributed computing are also discussed. Real-world applications and use cases of cloud computing.
UNIT – II	**Cloud Service and Deployment Models:** Cloud service models including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), features, advantages, and limitations of each model with examples, deployment models such as public cloud, private cloud, hybrid cloud, and community cloud. Service Level Agreements (SLAs) and cloud economics.
UNIT – III	**Virtualization and Cloud Infrastructure:** Introduction to application development and deployment on cloud platforms, cloud programming models, APIs, and web services, deployment and management of applications on popular cloud platforms such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). Concepts of DevOps, continuous integration and continuous deployment (CI/CD), microservices, and serverless computing.
UNIT – IV	**Cloud Platforms and Application Development:** Introduce classification and prediction techniques used in data mining, decision tree induction, Bayesian classification, and rule-based classification, k-Nearest Neighbor (k-NN), and support vector machines (SVM), model evaluation techniques such as confusion matrix, accuracy, precision, recall, F-measure, and cross-validation. Regression analysis for prediction.
UNIT – V	**Cloud Security, Management and Applications:** Define security management, and advanced topics in cloud computing, cloud security threats, identity and access management, data encryption, and secure cloud architectures. Cloud monitoring, billing, and resource management, cloud applications in areas such as big data analytics, Internet of Things (IoT), artificial intelligence, and disaster recovery, along with legal, ethical, and compliance issues.

Books

1. Rajkumar Buyya, James Broberg, and Andrzej Goscinski, *Cloud Computing: Principles and Paradigms*, Wiley.
2. Kailash Jayaswal, *Cloud Computing: Black Book*, Dreamtech Press.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	1	0	1	0	0	0	2	0	0.92
CO2	2	3	1	1	2	0	1	0	0	1	2	0	1.08
CO3	2	3	3	2	3	0	0	1	1	1	2	1	1.58
CO4	2	3	3	2	3	0	1	2	2	2	2	1	1.92
CO5	2	2	1	1	2	3	3	1	1	1	2	1	1.67
Avg	2.2	2.6	1.8	1.4	2.2	0.6	1.2	0.8	0.8	1	2	0.6	1.43

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1:	2	3	1	1	1.75
CO2:	1	3	0	2	1.50
CO3:	3	3	1	1	2.00
CO4:	3	3	1	2	2.25
CO5:	1	2	0	3	1.50
Avg	2.0	2.8	0.6	1.8	1.80

Course Code	Course Name	L	T	P	Credit
F09607047	Data Analysis & Algorithm	4			4

Course Outcomes (COs)

CO1: Understand fundamental algorithm concepts and complexity analysis using asymptotic notations.

CO2: Design algorithms using standard paradigms such as divide and conquer, greedy, and dynamic programming.

CO3: Apply sorting, searching, and graph algorithms to solve computational problems.

CO4: Analyze and compare algorithm performance in terms of time and space efficiency.

CO5: Implement and test algorithms using appropriate data structures and programming techniques.

UNIT – I	**Introduction to Algorithms, Complexity Analysis & Communication:** Introduction to the concept of algorithms and their role in problem solving, algorithm characteristics, pseudocode representation, and problem-solving strategies, time and space complexity, best-case, average-case, and worst-case analysis. Asymptotic notations such as Big-O, Big-Ω, and Big-Θ, basic performance evaluation of algorithms.
UNIT – II	**Algorithm Design Techniques:** Fundamental algorithm design paradigms, divide-and-conquer techniques with examples such as binary search and merge sort, greedy algorithms with applications like activity selection and minimum spanning tree. Dynamic programming concepts including optimal substructure and overlapping subproblems with problems such as knapsack and matrix chain multiplication, Backtracking and branch-and-bound techniques.
UNIT – III	**Sorting and Searching Algorithms:** Searching and sorting techniques, linear search and binary search methods. Sorting algorithms such as bubble sort, selection sort, insertion sort, merge sort, quick sort, heap sort, and radix sort with their complexity analysis and use cases. Comparison between internal and external sorting methods.
UNIT – IV	**Graph Algorithms:** Graph theory concepts and graph representations, graph traversal algorithms such as Breadth First Search (BFS) and Depth First Search (DFS), shortest path algorithms including Dijkstra's and Bellman-Ford algorithms. Minimum spanning tree algorithms such as Prim's and Kruskal's, Applications of graph algorithms in networking, routing, and scheduling. Case studies on algorithms in healthcare, transport, finance & Social impact of optimization and automation.
UNIT – V	**Advanced Algorithms and Applications:** Advanced algorithmic topics and applications, string matching algorithms such as naïve string matching and Knuth-Morris-Pratt (KMP) algorithm, introduction to NP-completeness, P and NP problems, and basic approximation algorithms. Applications of algorithms in areas such as data analysis, optimization, and real-world computational problems. Responsible use of algorithms in decision systems.

Text Books

1. Thomas H. Cormen et al., *Introduction to Algorithms*, MIT Press.
2. Ellis Horowitz, Sartaj Sahni, and Sanguthevar Rajasekaran, *Fundamentals of Computer Algorithms*, Universities Press.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = [illegible], 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	2	1	1	0	0	1	0	1	1	1.08
CO2	3	3	3	1	1	0	1	0	1	1	1	1	1.33
CO3	3	3	3	2	2	0	2	1	1	1	1	1	1.67
CO4	3	3	2	3	1	1	1	0	1	0	1	2	1.50
CO5	3	2	3	1	3	1	1	2	2	2	1	1	1.83
Avg	3.0	2.6	2.4	1.8	1.6	0.6	1.0	0.6	1.2	0.8	1.0	1.2	1.48

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1:	3	0	2	1	1.5
CO2:	3	0	2	1	1.5
CO3:	3	1	2	0	1.5
CO4:	3	0	2	1	1.5
CO5:	3	1	2	1	1.75
Avg	3	0.4	2	0.8	1.55

Course Code	Course Name	L	T	P	Credit
F1060701T	Advance Computer Network	4			4

Course Outcomes (COs)

CO1: Understand advanced computer network architectures, models, and protocol stack evolution.
CO2: Analyze transport layer mechanisms including congestion control, flow control, and QoS.
CO3: Apply algorithmic and graph-based techniques for routing, scheduling, and traffic management.
CO4: Evaluate network performance using routing, shortest path, and optimization strategies.
CO5: Identify network security issues and apply advanced networking concepts to real-world applications.

UNIT – I	**Advanced Network Architecture and Protocols:** Overview of advanced network architectures and layered protocol design, OSI and TCP/IP models with emphasis on modern protocol stack evolution,Advanced transport layer concepts including TCP congestion control, flow control, error control, and Quality of Service (QoS) mechanisms are discussed. The unit also introduces Internet routing architecture and autonomous systems.
UNIT – II	**Algorithm Design Techniques**: Fundamental algorithm design paradigms, divide-and-conquer techniques with examples such as binary search and merge sort, greedy algorithms with applications like activity selection and minimum spanning tree. Dynamic programming concepts including optimal substructure and overlapping subproblems with problems such as knapsack and matrix chain multiplication, Backtracking and branch-and-bound techniques.
UNIT – III	**Sorting and Searching Algorithms:** Searching and sorting techniques, linear search and binary search methods. Sorting algorithms such as bubble sort, selection sort, insertion sort, merge sort, quick sort, heap sort, and radix sort with their complexity analysis and use cases. Comparison between internal and external sorting methods.
UNIT – IV	**Graph Algorithms**: Graph theory concepts and graph representations, graph traversal algorithms such as Breadth First Search (BFS) and Depth First Search (DFS), shortest path algorithms including Dijkstra's and Bellman-Ford algorithms. Minimum spanning tree algorithms such as Prim's and Kruskal's. Applications of graph algorithms in networking, routing, and scheduling.
UNIT – V	**Advanced Algorithms and Applications:** Advanced algorithmic topics and

	applications, string matching algorithms such as naïve string matching and Knuth-Morris-Pratt (KMP) algorithm, introduction to NP-completeness, P and NP problems, and basic approximation algorithms. Applications of algorithms in areas such as data analysis, optimization, and real-world computational problems.

Text Books

1. William Stallings, *High-Speed Networks and Internets*, Pearson.
2. Behrouz A. Forouzan, *Data Communications and Networking*, McGraw-Hill.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	1	0	0	0	0	0	1	1	0.83
CO2	3	3	1	2	1	0	0	0	0	0	1	1	1.00
CO3	3	3	3	2	2	0	1	1	0	1	1	2	1.58
CO4	3	3	2	3	1	0	1	0	0	0	1	2	1.33
CO5	3	2	2	1	2	2	2	1	1	1	1	1	1.58
Avg	3.0	2.6	1.8	1.8	1.4	0.4	0.8	0.4	0.2	0.4	1.0	1.4	1.26

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1:	1	3	0	1	1.25
CO2:	2	3	1	0	1.50
CO3:	3	3	1	0	1.75
CO4:	2	3	1	1	1.75
CO5:	1.0	2.0	0	3.0	**1.50**
Avg	1.8	2.8	0.6	1	**1.55**

Course Code	Course Name	L	T	P	Credit

F10060702T	Theory of Computation					

Course Outcomes (COs)

CO1: Understand the mathematical foundations and significance of the Theory of Computation.
CO2: Design and analyze finite automata and regular languages.
CO3: Explain context-free grammars and pushdown automata for language processing.
CO4: Analyze Turing machines and computability concepts including decidability.
CO5: Classify computational problems using complexity classes and reduction techniques.

UNIT – I	**Introduction to Theory of Computation and Finite Automata**-Theory of Computation and its significance **Languages:** Alphabets, string, language, basic operations on language, concatenation, union, Kleene star. Deterministic finite automata (DFA), nondeterministic finite automata (NFA), and their equivalence. Ethical limits of computation and decision problems
UNIT – II	**Regular Languages and Regular Expressions-** Regular languages and decision properties such as membership, emptiness, and equivalence. Minimization of finite automata and the pumping lemma.
UNIT – III	**Context-Free Grammars and Pushdown Automata-** Context-free grammars (CFGs) and context-free languages. Parse trees, ambiguity in grammars, and grammar simplification techniques. Pushdown automata (PDA), their operation, and equivalence with context-free grammars. Applications of CFGs in programming language syntax and compiler design.
UNIT – IV	**Turing Machines and Computability-** Structure and operation of Turing machines, variants of Turing machines, and the Church-Turing thesis. Recursive and recursively enumerable languages, halting problem, and undecidable problems. Reductions and their role in proving undecidability.
UNIT – V	**Computational Complexity Theory-** Time and space complexity, complexity classes such as P, NP, NP-Complete, and NP-Hard. Polynomial-time reductions and Cook's theorem. Introduction to approximation algorithms and the importance of complexity theory in practical computing

Text Books

1. Michael Sipser, *Introduction to the Theory of Computation*, Cengage Learning.
2. John E. Hopcroft, Rajeev Motwani, and Jeffrey D. Ullman, *Introduction to Automata Theory, Languages, and Computation*, Pearson.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = [illegible], 1 = Low, 0 – None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	1	0	1	1	0	1	0	1	2	1.08
CO2	3	3	2	1	1	0	1	1	1	0	1	1	1.25
CO3	3	3	2	1	1	0	1	1	1	0	1	1	1.25
CO4	3	3	1	2	0	1	1	0	1	1	1	3	1.42
CO5	3	3	1	2	0	1	2	1	1	1	1	3	1.58
Avg	3.0	2.8	1.4	1.4	0.4	0.6	1.2	0.6	1.0	0.4	1.0	2.0	1.32

CO-PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	0	1	1	1.00
CO2	3	1	1	0	1.25
CO3	3	0	1	0	1.00
CO4	3	0	2	0	1.25
CO5	3	0	2	1	1.50
Avg	2.8	0.2	1.4	0.4	**1.20**

Course Code	Course Name	L	T	P	Credit
F1060703T	Deep Learning	4			4

Course Outcomes (COs)

CO1: Understand neural network fundamentals and core deep learning principles.
CO2: Design and train deep neural networks using appropriate architectures and optimization methods.
CO3: Apply convolutional and recurrent neural networks to real-world data problems.
CO4: Analyze optimization, regularization, and evaluation techniques in deep learning models.
CO5: Implement deep learning solutions using modern frameworks with ethical considerations.

UNIT – I	**Introduction to Neural Networks and Deep Learning-**Introduces the basics of neural networks and deep learning. Biological inspiration, artificial neurons, activation functions, and perceptron models. Multilayer feed-forward neural networks, loss functions, gradient descent, and back propagation algorithm. Challenges in training deep networks and the evolution from traditional machine learning to deep learning
UNIT – II	**Deep Neural Network Architectures-**Deep feed-forward neural networks and training techniques. Weight initialization, optimization methods such as stochastic gradient descent, momentum, RMSProp, and Adam optimizer. Regularization techniques including L1/L2 regularization, dropout, and batch normalization. Hyperparameter tuning and model evaluation techniques
UNIT – III	**Convolutional Neural Networks (CNNs)-** Convolutional neural networks and their application in image and video processing. Convolution, pooling, padding, and stride operations. CNN architectures such as LeNet, AlexNet, VGG, ResNet, and Inception. Applications of CNNs in image classification, object detection, and face recognition
UNIT – IV	**Recurrent Neural Networks and Sequence Models-**RNN architecture, vanishing and exploding gradient problems, and advanced architectures such as Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRU). Applications of RNNs in natural language processing, speech recognition, time-series forecasting.
UNIT – V	**Advanced Topics and Applications of Deep Learning-**Auto encoders, deep belief networks, generative adversarial networks (GANs), and transfer learning. Deep learning frameworks such as TensorFlow and PyTorch. Ethical issues, bias in AI models, explainable AI, and future trends in deep learning

Books

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, MIT Press.
2. Charu C. Aggarwal, *Neural Networks and Deep Learning*, Springer.

CO–PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	2	2	1	1	1	1	1	2	2	1.58
CO2	3	3	3	2	3	1	1	2	1	2	2	2	2.08
CO3	3	3	3	2	3	1	2	2	1	2	2	2	2.17
CO4	3	3	2	3	2	1	1	1	1	1	2	3	1.91
CO5	3	2	3	2	3	3	2	2	2	2	2	2	2.33
Avg	3	2.6	2.4	2.2	2.6	1.4	1.4	1.6	1.2	1.6	2	2.2	2.01

CO–PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1	2	0	3	1	1.50
CO2	3	1	3	1	2.00
CO3	3	1	3	2	2.25
CO4	2	0	3	1	1.50
CO5	3	1	3	3	2.50
Avg	2.6	0.6	3.0	1.6	1.95

Course Code	Course Name	L	T	P	Credit
F1060704T	Machine Learning				

Course Outcomes (COs)

CO1: Understand fundamental machine learning concepts, workflows, and application areas.
CO2: Apply supervised learning algorithms for classification and regression problems.
CO3: Analyze unsupervised learning techniques for clustering and pattern discovery.
CO4: Evaluate machine learning models using appropriate performance metrics and validation methods.
CO5: Implement machine learning solutions using standard tools with ethical considerations.

UNIT – I	**Introduction to Machine Learning**-Concept of machine learning and its relationship with artificial intelligence, data mining, and statistics. Types of machine learning such as supervised, unsupervised, and reinforcement learning. Explains the machine learning workflow including data collection, preprocessing, model training, testing, and deployment. Applications of machine learning in healthcare, finance, e-commerce, and social media
UNIT – II	**Supervised Learning – Classification**-Supervised Learning – Classification, linear classifiers, logistic regression, k-nearest neighbor (k-NN), naive Bayes classifier, and decision tree learning. Explains ensemble methods such as bagging, boosting, and random forests. Model evaluation techniques including confusion matrix, accuracy, precision, recall, F1-score, and ROC curves
UNIT – III	**Supervised Learning – Regression**-Introduces regression techniques for predictive modeling. Simple and multiple linear regression, polynomial regression, and regularization techniques such as ridge and lasso regression. Explains support vector machines (SVM) for regression and basic concepts of bias–variance tradeoff. Performance metrics such as mean squared error, mean absolute error, and R^2 score
UNIT – IV	**Unsupervised Learning**-clustering methods such as k-means, hierarchical clustering, and DBSCAN. Explains dimensionality reduction techniques including Principal Component Analysis (PCA). Association rule learning concepts are introduced along with real-world applications of unsupervised learning.
UNIT – V	**Advanced Topics and Applications**-Basics of neural networks, introduction to deep learning, and reinforcement learning concepts. Explains model selection, hyperparameter tuning, and cross-validation techniques. Ethical issues, bias in machine learning models, interpretability, and future trends in machine learning.

Books

1. Tom M. Mitchell, *Machine Learning*, McGraw-Hill.
2. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press.

CO-PO MATRIX ():-

Scale: - 3 = High, 2 = Medium, 1 = Low, 0 = None

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	2	1	2	2	1	2	1	1	1	2	2	1.67
CO2	3	3	3	2	3	0	1	0	1	2	2	2	1.83
CO3	3	3	2	2	2	0	2	0	1	1	1	2	1.58
CO4	3	3	2	3	2	1	1	1	1	1	1	3	1.83
CO5	3	2	3	2	3	3	2	2	2	2	2	2	2.33
Avg	3	2.6	2.2	2.2	2.4	1	1.6	0.8	1.2	1.4	1.6	2.2	1.85

CO-PSO MATRIX:-

COs ↓ / PSOs →	PSO1	PSO2	PSO3	PSO4	Avg
CO1:	2	0	3	1	1.5
CO2:	3	1	3	1	2.0
CO3:	2	0	3	1	1.5
CO4:	2	0	3	1	1.5
CO5:	3	1	3	3	2.5
Avg	2.4	0.4	3	1.4	1.8