File Ref.No.233344/GA - IV - J1/2021/Admn

UNIVERSITY OF CALICUT

Abstract

General & Academic IV - Faculty of Science - Modified Scheme and Syllabus of Bachelor of Computer Applications Honours Programme with effect from 2024 admission - in tune with the CUFYUGP Regulations 2024, Approved by the Vice Chancellor - Implemented - Orders Issued

G & A - IV - J

U.O.No. 8818/2025/Admn Dated, Calicut University.P.O, 13.06.2025

Read:-1. U.O.No. 9925/2024/Admn dated: 22.06.2024
2. U.O Note No. 90738/EX-III-ASST-3/2024/PB dated: 08.10.2024
3. Minutes of the Board of Studies in Computer Science and Application (UG) held on 24.05.2025
4. Remarks of the Dean, Faculty of Science dated: 09.06.2025
5. Orders of the Vice Chancellor in the file of even No. dated: 10.06.2025

ORDER

1. Vide paper read as (1), the Scheme and Syllabus of Bachelor of Computer Applications Honours Programme in tune with the Model Curricular frame work for UG Degree in Bachelor of Computer Application (BCA) programme issued by All India Council for Technical Education (AICTE) and CUFYUGP Regulations 2024, has been implemented with effect from 2024 admission.
2. Vide paper read as (2), Pareeksha Bhavan had pointed out certain discrepancies in the syllabus of Bachelor of Computer Applications Honours programme.
3. Accordingly, the Board of Studies in Computer Science and Application (UG), vide paper read as (3), incorporated the corrections pointed out by Pareeksha Bhavan and recommended to approve the modified scheme and syllabus of Bachelor of Computer Applications Honours programme with effect from 2024 admission, in tune with CUFYUGP Regulations 2024.
4. The Dean, Faculty of Science, vide paper read as (4), approved the minutes of the meeting of Board of Studies in Computer Science and Application (UG).
5. Considering the above, the Vice Chancellor has approved the minutes of the meeting of the Board of Studies in Computer Science and Application (UG) and accorded sanction to implement the modified scheme and syllabus of Bachelor of Computer Applications Honours programme with effect from 2024 admission, under section 10(13) of Calicut University Act 1975.
6. The modified Scheme and Syllabus of Bachelor of Computer Applications Honours programme in tune with CUFYUGP Regulations 2024, is thus implemented with effect from 2024 admission.
7. The U.O vide paper read as (1) stands modified to this extent.
8. Orders are issued accordingly. (Syllabus appended)

Ajayakumar T.K

Assistant Registrar

To

Principals of all Affiliated Colleges
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Section Officer

UNIVERSITY OF CALICUT

BACHELOR OF COMPUTER APPLICATIONS HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS

w.e.f. 2024 admission onwards

(CUFYUGP Regulations 2024)

BACHELOR OF COMPUTER APPLICATIONS

HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at Calicut University, a student would:

PO1	Knowledge Acquisition: Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2	Communication, Collaboration, Inclusiveness, and Leadership: Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	Professional Skills: Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
PO4	Digital Intelligence: Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	Scientific Awareness and Critical Thinking: Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	Human Values, Professional Ethics, and Societal and Environmental Responsibility: Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	Research, Innovation, and Entrepreneurship: Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the BCA Honours programme at Calicut University, a student would:

PSO1	Identify the relevance and applications of computers in other disciplines
PSO2	Understand the concepts of system architecture, hardware, software and network configuration
PSO3	Acquire logical thinking and problem-solving skills to find solutions in the software domain
PSO4	Design, analyse and develop code-based solutions for the algorithms
PSO5	Address the industry demands and assimilate technical, logical and ethical skills needed for the industry
PSO6	Adapt to emerging trends and tackle the challenges in the software field.

BCA (HONOURS) PROGRAMME COURSE STRUCTURE

Single Major

Semester	Course Code	Course Title	Total Hours	Hours/ Week			Credit	Marks		
				T	P	T		Internal	External	Total
1	BCA1CJ101	Core Course 1 in Major Fundamentals of Computers and Computational Thinking	60	4	0	4	4	30	70	100
	BCA1CJ 102/ BCA1MN 101	Core Course 2 in Major Mathematical Foundation for Computer Applications	60	4	0	4	4	30	70	100
	BCA1CJ 103/ BCA1MN 102	Core Course 3 in Major Discrete Structures for Computer Applications	60	4	0	4	4	30	70	100
	BCA1FM 105	MDC 1 Digital Marketing (for other disciplines)	45	3	0	3	3	25	50	75
	BCA1FS111	Skill Enhancement Course 1 Introduction to Computers and Office Automation	45	3	0	3	3	25	50	75
	ENG1FA101(2)	Ability Enhancement Course 1 English	60	2	2	4	3	25	50	75
		Ability Enhancement Course 2 Additional Language	45	3	0	3	0	-	-	-
		Total		**25**			**21**			**525**
2	BCA2CJ101	Core Course 4 in Major Fundamentals of Programming (C Language)	75	3	2	5	4	30	70	100
	BCA2CJ102/ BCA2MN 101	Core Course 5 in Major Statistical Foundation for Computer Applications	60	4	0	4	4	30	70	100
	BCA2CJ103/ BCA2MN102	Core Course 6 in Major Numerical methods and Optimization Techniques	60	4	0	4	4	30	70	100
	BCA2FS112	Skill Enhancement Course 2 Data Analysis using Spread Sheet	60	2	2	4	3	25	50	75
	ENG2FA103(2)	Ability Enhancement Course 3 English	60	2	2	4	3	25	50	75

		Ability Enhancement Course 4 Additional Language	45	3	0	3	-	-	-	-
		Total		**24**			**18**			**450**
3	BCA3CJ201	Core Course 7 in Major Data Structures and Algorithms	75	3	2	5	4	30	70	100
	BCA3CJ202	Core Course 8 in Major Computer Networks	75	3	2	5	4	30	70	100
	BCA3CJ203/ BCA3MN201	Core Course 9 in Major Introduction to Data Science	60	4	0	4	4	30	70	100
	BCA3CJ204/ BCA3MN202	Core Course 10 in Major Foundations of Artificial Intelligence	60	4	0	4	4	30	70	100
	BCA3FS113	Skill Enhancement Course 3 Website Designing using Content Management System	60	2	2	4	3	25	50	75
		MDC 2 - (E/AL) Kerala Knowledge System	45	3	0	3	3	25	50	75
		Total		**25**			**22**			**550**
4	BCA4CJ205	Core Course 11 in Major Database Management System	75	3	2	5	4	30	70	100
	BCA4CJ206	Core Course 12 in Major Python Programming	75	3	2	5	4	30	70	100
	BCA4CJ207	Core Course 13 in Major Software Engineering	60	4	0	4	4	30	70	100
	BCA4CJ208	Core Course 14 in Major Automation and Robotics	60	4	0	4	4	30	70	100
	BCA4FV108	Value-Added Course 1 Introduction to Cyber Laws	45	3	0	3	3	25	50	75
	ENG4FV109(2)	Value-Added Course 2 English	45	3	0	3	3	25	50	75
		Total		**24**			**22**			**550**
5	BCA5CJ301	Core Course 15 in Major Object Oriented Programming (Java)	75	3	2	5	4	30	70	100
	BCA5CJ302	Core Course 16 in Major Progressive Web Application using PHP	75	3	2	5	4	30	70	100
	BCA5CJ303	Core Course 17 in Major Digital Electronics and Computer Architecture	60	4	0	4	4	30	70	100
	BCA5EJXXX	Elective Course 1 in Major	60	4	0	4	4	30	70	100
	BCA5EJXXX	Elective Course 2 in Major	60	4	0	4	4	30	70	100

	BCA5FS114	Skill Enhancement Course 4 Professional Skill Development for IT Career Excellence	45	3	0	3	3	25	50	75
	BCA5FS115	Skill Enhancement Course Internship 1	-	-			4	100	-	100
		Audit Course 1	-	-			-	-	-	-
		Total		**25**			**27**			**675**
6	BCA6CJ304/ BCA8MN304	Core Course 18 in Major Introduction to Artificial Intelligence and Machine Learning	75	3	2	5	4	30	70	100
	BCA6CJ305/ BCA8MN305	Core Course 19 in Major Principles of Operating Systems	75	3	2	5	4	30	70	100
	BCA6EJXXX	Elective Course 3 in Major	60	4	0	4	4	30	70	100
	BCA6EJXXX	Elective Course 4 in Major	60	4	0	4	4	30	70	100
	BCA6FV110	Value-Added Course 3 Business Intelligence and Innovation	45	3	0	3	3	25	50	75
	BCA6FS 116	Skill Enhancement Course Project 1	60	4	0	4	4	30	70	100
		Audit Course 2	-	-			-	-	-	-
		Total		**25**			**23**			**575**
Total Credits for Three Years							**133**			**3325**
7	BCA7CJ401	Core Course 20 in Major Advanced Data Structures and Algorithms	75	3	2	5	4	30	70	100
	BCA7CJ402	Core Course 21 in Major Data Science Programming using R	75	3	2	5	4	30	70	100
	BCA7EJXXX	Elective Course 5 in Major	60	4	0	4	4	30	70	100
	BCA7EJXXX	Elective Course 6 in Major	60	4	0	4	4	30	70	100
	BCA7EJXXX	Elective Course 7 in Major (in Honours with Research Programme)	60	4	0	4	4	30	70	100
	BCA7OEXXX	Open Elective in Major (in Honours programme)	60	4	0	4	4	30	70	100
	BCA7FS117	Skill Enhancement Course Internship 2	-	-			4	100	-	100
		Total		**22**			**24**			**600**
8	BCA8EJXXX	Elective Course 8 in Major (in Honours Programme)	60	4	0	4	4	30	70	100
	BCA8EJXXX	Elective Course 9 in Major (in Honours Programme)	60	4	0	4	4	30	70	100

	BCA8EJXXX	Elective Course 10 in Major (in Honours Programme)	60	4	0	4	4	30	70	100
	BCA8FS118	Skill Enhancement Course Project 2 (in Honours Programme)	120	8	0	8	8	60	140	200
	OR									
	BCA8FS119	Skill Enhancement Course Research Project (in Honours with Research Programme)	300	20	0	20	20	150	350	500
		Total		**20**			**20**			**500**
Total Credits for Four Years							**177**			**4425**

Note

1. Core Courses 2, 5, & 9 can be offered to students of other Major disciplines as Minor courses of Group 1, and Core courses 3, 6 &10 can be offered to them as Minor courses of Group II. 1. Core Courses 18 & 19 can be offered to eighth semester students of other Major disciplines as Minor courses.
2. There will be no pathway for BCA students.
3. Students from other disciplines can choose Minor Groups in BCA.
4. If a student from other department chooses Minor Group I in BCA, then the title of the Minor will be **Data Science**.
5. If a student from other department chooses Minor Group II in BCA, then the title of the Minor will be **Artificial Intelligence**.
6. If a student from other department chooses two Minor groups in BCA (Major with Minor Pathway), then the title of the Minor will be **Data Science and Artificial Intelligence**.
7. The minor courses mentioned above are offered by the BCA Department to students from other departments. These students must attend the minor course classes along with BCA students (core courses), subject to the intake capacity of the BCA Department as per University regulations.
8. MDC 1 in this syllabus is intended for students from other disciplines.
9. BCA students are required to take the MDC 1 course offered by other departments.

Audit Courses

There are four mandatory Audit Courses or zero-credit courses that the students must attend in different semesters. Two of them are Ability Enhancement Courses offered by Additional Languages in the first and second semesters. The other two are Discipline Specific Elective courses in the fifth and sixth semesters. Students need to complete 75% attendance in Ability Enhancement Courses offered by Additional Languages in the first and second semesters, but need not appear for the internal and external evaluation of these courses. Discipline Specific Elective courses in the fifth and sixth semesters are not meant for class room study. The students can choose any course in Computer Science/Application/IT discipline and attend these courses online in platforms like SWAYAM, MOOC etc.

CREDIT DISTRIBUTION

Semester	Major Core Courses	Major DSE	General Foundation Courses					Total
			AEC	MDC/ MDE	VAC	SEC	Internship/ Project	
1	4+4+4		3	3		3	-	21
2	4+4+4		3			3	-	18
3	4+4+4+4			3		3	-	22
4	4 + 4 + 4 +4				3 + 3		-	22
5	4 + 4 + 4	4 + 4				3	4	27
6	4 + 4	4 + 4			3		4	23
Total for Three Years	**76**	**16**	**6**	**6**	**9**	**12**	**8**	**133**
7	4 + 4	4 + 4 + 4		4*			4	24
8		4 + 4 +4					8 / 20**	20
* Instead of Major DSE Course; **Instead of Three Major DSE & 8 Credit Project								
Total for Four Years	**76+8 = 84**	**16+24= 40**	**6**	**6**	**9**	**12**	**20**	**177**

DISTRIBUTION OF MAJOR COURSES IN BCA

Semester	Course Code	Course Title	Hours/ Week	Credits
1	BCA1CJ101	Core Course 1 in Major – Fundamentals of Computers and Computational thinking	4	4
	BCA1CJ 102/ BCA1MN101	Core Course 2 in Major- Mathematical Foundation for Computer Applications	4	4
	BCA1CJ 103/ BCA1MN102	Core Course 3 in Major -Discrete Structures for Computer Applications	4	4
2	BCA2CJ101	Core Course 4 in Major –Fundamentals of Programming (C Language)	5	4
	BCA2CJ102/ BCA2MN101	Core Course 5 in Major -Statistical Foundation for Computer Applications	4	4
	BCA2CJ103/ BCA2MN102	Core Course 6 in Major - Numerical methods and Optimization Techniques	4	4
3	BCA3CJ201	Core Course 7 in Major – Data Structures and Algorithms	5	4

	BCA3CJ202	Core Course 8 in Major –Computer Networks	5	4
	BCA3CJ203/ BCA3MN201	Core Course 9 in Major - Introduction to Data Science	4	4
	BCA3CJ204/ BCA3MN202	Core Course 10 in Major - Foundations of Artificial Intelligence	4	4
4	BCA4CJ205	Core Course 11 in Major – Database Management System	5	4
	BCA4CJ206	Core Course 12 in Major – Python Programming	5	4
	BCA4CJ207	Core Course 13 in Major - Software Engineering	4	4
	BCA4CJ208	Core Course 14 in Major – Automation and Robotics	4	4
5	BCA5CJ301	Core Course 15 in Major – Object Oriented Programming (Java)	5	4
	BCA5CJ302	Core Course 16 in Major – Progressive Web Application using PHP	5	4
	BCA5CJ303	Core Course 17 in Major – Digital Electronics and Computer Architecture	4	4
	BCA5EJXXX	Elective Course 1 in Major	4	4
	BCA5EJXXX	Elective Course 2 in Major	4	4
6	BCA6CJ304/ BCA8MN304	Core Course 18 in Major – Introduction to Artificial Intelligence and Machine Learning	5	4
	BCA6CJ305/ BCA8MN305	Core Course 19 in Major – Principles of Operating Systems	5	4
	BCA6EJXXX	Elective Course 3 in Major	4	4
	BCA6EJXXX	Elective Course 4 in Major	4	4
Total for the Three Years				**92**
7	BCA7CJ401	Core Course 20 in Major – Advanced Data Structures and Algorithms	5	4
	BCA7CJ402	Core Course 21 in Major – Data Science Programming using R	5	4
	BCA7EJXXX	Elective Course 5 in Major	4	4
	BCA7EJXXX	Elective Course 6 in Major	4	4
	BCA7EJXXX	Elective Course 7 (in Honours with Research Programme)	4	4
	OR			
	BCA7OEXXX	Open Elective in Major (in Honours Programme)	4	4
	BCA8EJXXX	Elective Course 8 (in Honours Programme)	4	4

8	BCA8EJXXX	Elective Course 9 (in Honours Programme)	4	4
	BCA8EJXXX	Elective Course 10 (in Honours Programme)	4	4
Total for the Four Years				124

ELECTIVE COURSES IN BCA WITH SPECIALISATION

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**Image Processing**								
	1	BCA5EJ301(1)	Fundamentals of Digital Image Processing	5	60	4	4	30	70	100
	2	BCA5EJ302(1)	Pattern Recognition	5	60	4	4	30	70	100
	3	BCA6EJ301(1)	Advanced Digital Image Processing and Computer Vision	6	60	4	4	30	70	100
	4	BCA6EJ302(1)	Applied Digital Image Processing	6	60	4	4	30	70	100
2		**Computer Networks**								
	1	BCA5EJ303(2)	Wireless Communication	5	60	4	4	30	70	100
	2	BCA5EJ304(2)	Cryptography and Network Security	5	60	4	4	30	70	100
	3	BCA6EJ303(2)	Storage Area Network	6	60	4	4	30	70	100
	4	BCA6EJ304(2)	Internet of Things	6	60	4	4	30	70	100
3		**Cloud Computing**								
	1	BCA5EJ305(3)	Cloud Computing	5	60	4	4	30	70	100
	2	BCA5EJ306(3)	Security and Privacy in Cloud	5	60	4	4	30	70	100
	3	BCA6EJ305(3)	Storage Technologies	6	60	4	4	30	70	100
	4	BCA6EJ306(3)	Virtualization	6	60	4	4	30	70	100
4		**Data Science and AI**								
	1	BCA5EJ307(4)	Data Analytics and Visualization	5	60	4	4	30	70	100
	2	BCA5EJ308(4)	Knowledge Engineering	5	60	4	4	30	70	100
	3	BCA6EJ307(4)	Advanced Python for Data Science	6	60	4	4	30	70	100
	4	BCA6EJ308(4)	Neural Networks and Deep Learning	6	60	4	4	30	70	100

ELECTIVE COURSES IN BCA WITH NO SPECIALISATION

Semester	Elective No.	Course Code	Title	Total Hrs	Hrs/ Week	Credits	Marks		
							Internal	External	Total
7	EL-5	BCA7EJ401	Theory of Computation	60	4	4	30	70	100
		BCA7EJ402	Expert Systems and Fuzzy Logic	60	4	4	30	70	100
		BCA7EJ403	Modern Cryptography	60	4	4	30	70	100
	EL-6	BCA7EJ404	Client Server Architecture	60	4	4	30	70	100
		BCA7EJ405	Blockchain Technology	60	4	4	30	70	100
		BCA7EJ406	Data Mining	60	4	4	30	70	100
	EL-7	BCA7EJ407	Research Methodology in Computer Science	60	4	4	30	70	100
	OE-1	BCA7OE401	Ethical Hacking	60	4	4	30	70	100
		BCA7OE402	Cyber Forensics	60	4	4	30	70	100
8	EL-8	BCA8EJ408	Compiler Design	60	4	4	30	70	100
		BCA8EJ409	Mixed Reality	60	4	4	30	70	100
	EL-9	BCA8EJ410	Mastering Java Web Development	60	4	4	30	70	100
		BCA8EJ411	Social Network Analysis	60	4	4	30	70	100
	EL-10	BCA8EJ412	System Security	60	4	4	30	70	100
		BCA8EJ413	Parallel Computing	60	4	4	30	70	100

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN BCA

Sl. No.	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	BCA1FM 105	MDC 1 Digital Marketing	45	3	3	25	50	75
2	BCA4FV108	Value-Added Course 1 Introduction to Cyber Laws	45	3	3	25	50	75
3	BCA6FV110	Value-Added Course 3 Business Intelligence and Innovation	45	3	3	25	50	75
4	BCA1FS111	Skill Enhancement Course 1 Introduction to Computers and Office Automation	45	3	3	25	50	75
5	BCA2FS112	Skill Enhancement Course 2 Data Analysis using Spread Sheet	60	4	3	25	50	75
6	BCA3FS113	Skill Enhancement Course 3 Website Designing using Content Management System	60	4	3	25	50	75
7	BCA5FS114	Skill Enhancement Course 4 Professional Skill Development for IT Career Excellence	45	3	3	25	50	75

8	BCA5FS115	Internship 1	60	-	4	100		100
9	BCA6FS116	Project 1	60	4	4	30	70	100
10	BCA7FS117	Internship 2	60	-	4	100		100
11	BCA8FS118/ BCA8FS119	Project 2 (in Honours Programme)/ Research Project (in Honours with Research programme)	200/ 500	8/20	8/20	60/ 150	140/ 350	200/ 500

GROUPING OF MINOR COURSES IN BCA

(For Other Departments)

(Title of the Minor: **Data Science and Artificial Intelligence)**

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**Data Science**								
	1	BCA1MN 101	Mathematical Foundation for Computer Applications	1	60	4	4	30	70	100
	2	BCA2MN 101	Statistical Foundation for Computer Applications	2	60	4	4	30	70	100
	3	BCA3MN201	Introduction to Data Science	3	60	4	4	30	70	100
2		**Artificial Intelligence**								
	1	BCA1MN 102	Discrete Structures for Computer Applications	1	60	4	4	30	70	100
	2	BCA2MN 102	Numerical methods and Optimization Techniques	2	60	4	4	30	70	100
	3	BCA3MN202	Foundations of Artificial Intelligence	3	60	4	4	30	70	100

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**4th Year Minor Courses**								
	1	BCA8MN304	Introduction to Artificial Intelligence and Machine Learning	8	75	5	4	30	70	100
	2	BCA8MN305	Principles of Operating Systems	8	75	5	4	30	70	100

1. EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.
2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.
    - In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
    - In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.
3. 3-credit courses (General Foundational Courses) in BCA are of two types: (i) courses with only theory and (ii) courses with 2-credit theory and 1-credit practical.
    - In 3-credit course with only theory out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks. theory
    - In 3-credit courses with 2-credit and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practicals. The practical component is internally evaluated for 15 marks. The internal evaluation of the 4 theory modules is for 10 marks.

Sl. No.	Nature of the Course		Internal Evaluation in Marks (about 30% of the total)		External Exam on 4 modules (Marks)	Total Marks
			Open-ended module / Practical	On the other 4 modules		
1	4-credit course	only theory (5 modules)	10	20	70	100
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75
4	3-credit course	Theory (4 modules) + Practical	15	10	50	75

1. MAJOR AND GENERAL FOUNDATION COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor Course	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
		Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
		20	10	10	20*
	Total	30		30	

* Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

Sl. No.	Evaluation of Practical Component of Credit-1 in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practical/ exercise performed in practical classes by the students	10	50%
2	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
3	Evaluation of the Practical records submitted for the end semester viva–voce examination by the teacher-in-charge and additional examiner	3	15%
	Total Marks	20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR MAJOR COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10
				Total Marks	70

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
1.5 Hours	Short Answer	10	8 – 10	2	16
	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
				Total Marks	50

2. INTERNSHIP

- All students should undergo **TWO** Internship of 4-credits during the FIFTH and SEVENTH semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

1. Internship can be in Computer Science/Application/IT or allied disciplines.
2. There should be minimum 120 hrs. of engagement from the student in the Internship.
3. An internship may consist of either 120 hours with a single organization, 60 hours with two organizations, or 40 hours with three organizations.
4. Summer vacations and other holidays can be used for completing the Internship.

5. Institute/ industry visit is a requirement for the completion of Internship. Visit to minimum one national research institute or research laboratory or IT industry or place of scientific importance should be part of the industry visit. A brief report of the industry visit has to be submitted with photos and analysis.
6. The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
7. The log book and the typed report must be submitted at the end of the Internship.
8. The institution at which the Internship will be carried out should be prior-approved by the Department Council of the college where the student has enrolled for the UG (Honours) programme.
9. The fifth-semester internship can be started from the first semester (preferably after the second semester), and evaluation will take place at the end of the fifth semester. The seventh-semester internship can be started after the fifth semester, and evaluation will take place at the end of the seventh semester.

2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG (Honours) programme.
- The credits and marks for the Internship will be awarded only at the end of. semester 5 & semester 7.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

Sl. No.	Components of Evaluation of Internship		Marks for Internship 4 Credits	Weightage
1	Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council	Acquisition of skill set	20	40%
2		Interim Presentation and Viva-voce	10	
3		Punctuality and Log Book	10	
4	Report of Institute/Industry Visit		10	10%
5	End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council	Quality of the work	12	35%
6		Presentation of the work	10	
7		Viva-voce	12	
8	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council		16	15%
	Total Marks		100	

The model of the Internship and Industrial Visit Log Book is given below:

INTERNSHIP AND INDUSTRIAL VISIT LOG BOOK

Name of Student: _____

Internship Title(s):

_____

_____

_____

1. Daily Log of Activities

(Use separate pages/tables for each organization if needed)

Organization Name: _____

Date	Hours	Task Description	Industry Supervisor Signature	Internship Supervisor Signature
DD/MM/YYYY				
DD/MM/YYYY				

2. Organizations Involved

Sl. No.	Name of Organization	Duration (From–To)	Hours Involved
1.			
2.			
3.			

3. Industry Visit Record

Date & Place Visited: _____

Purpose of Visit: _____

Major Observations:

1.

2.

3.

Faculty-in-Charge Signature: _____

4. Final Summary and Certification

Total Hours Completed (Internship): _____

Internship Experience Summary:

- Key Skills Acquired
- Tools/Technologies Used
- Suggestions for Future Interns

Student Signature: _____

Industry Supervisor Signature & Seal (for each organization):

1. _____
2. _____
3. _____

Internship Supervisor Signature and Seal: _____

HOD Signature and Seal: _____

The model of the Internship Report Format is given below:

INTERNSHIP REPORT

General Guidelines

- Typed, double-spaced, using Times New Roman, size 12, with 1” margins.
- Length: 10–15 pages
- Internship may be completed in 1 to 3 organizations
- A faculty member will serve as the internship supervisor
- Submit both hard and soft copies

Report Structure

1. **Title Page**
    - Student name, Reg. No., Program, College
    - Organization(s) and hours completed
    - Name of Internal and Industry Supervisors

2. **Evaluation Page**
    - Space for examiners signature

Acknowledgement

- Thanks to internal and external supervisors and host organizations

3. **Executive Summary**
    - Brief one-page overview of activities, tools used, and key learnings
4. **Internship Certificate(s)**
    - Scanned or attached certificate(s) from each organization
5. **Table of Contents**

Main Chapters

Chapter 1: Organization Profiles

- Brief background of each company/institution

Chapter 2: Internship Overview

- Duration, objectives, departments/teams worked in, tools and platforms used

Chapter 3: Internship Experience

- Summary of tasks, key contributions, challenges faced
- Personal learning and observations

Chapter 4: Recommendations

- Suggestions for improvement in the work environment/processes (if applicable)

Chapter 5: Learning Reflection

- Contrast between academic knowledge and practical experience
- Role and support received from the internal supervisor

Appendices

- Photos
- Logbook summary etc.

The model of the IV Report Format is given below:

INDUSTRIAL VISIT REPORT

- Front Page
- College certificate certified by IV coordinator and HOD. Separate space required for the date of evaluation, internal and external examiner signature.
- Company Certificate
- Declaration by the Student

- Acknowledgement
- Index Page
- **PART I: Company Profile**
    - History
    - Organization Chart
    - Vision, Mission and Values
    - Products
    - Services
- **PART II: Visit Day Report**
- **PART III: Supporting Geotagged Photographs**

3. PROJECT

3.1 MINI PROJECT WORK (Skill Enhancement Course BCA6FS116)

A mandatory mini-project is scheduled in the VI Semester of the BCA Honours program. It is designed to cultivate students' research and software development skills. It will serve as a capstone experience, allowing students to bridge the gap between theoretical knowledge acquired in the classroom and its practical application to real-world problems.

Project Selection and Approval:

- Student groups (at most four members) can propose projects in Information Technology or related disciplines.
- Projects can be experimental (building a prototype), theoretical (a research paper), or computational (implementing an algorithm).
- Project proposals must be submitted for prior approval from the Department Council.
- Each project team will be assigned a project supervisor for guidance.

Project Duration:

- The mini-project duration is one semester.
- Minimum engagement: 90 hours per student.

Project Deliverables:

- Two hard copies and one softcopy of a well-structured typed report outlining:
    - Project objectives and requirements analysis
    - System design and architecture
    - Implementation details (including sample code snippets)
    - Test cases and results
    - Conclusion and future work
- A signed undertaking by the student declaring the originality of the work and the absence of plagiarism.
- A certificate from the project supervisor confirming the same.

Evaluation Criteria and Rubrics:

1. **Internal Evaluation (30%) -** Conducted by the project supervisor throughout the semester. This could involve:

- **Project Proposal and Planning (10%):**
  - Clarity of project goals and objectives.
  - Feasibility of the chosen approach.
  - Quality of system study/literature review and proposed methodology.
  - Clarity of project schedule and division of tasks within the team.
- **Project Progress and Implementation (10%):**
  - Regular code reviews and adoption of feedback provided by the supervisor.
  - Attendance and active participation in project meetings.
  - Completion of project milestones as planned.
  - Quality of code documentation and adherence to coding standards.
- **Interim Presentations (10%):**
  - Effectiveness of communication and presentation skills.
  - Clarity of technical details and progress made.
  - Ability to answer questions about the project effectively.

2. **External Evaluation (70%) -** Conducted by an internal examiner appointed by the Department Council and the project supervisor. This will take place at the end of the VI th semester:

- **Project Report (25%):**
  - Content: Completeness, organisation, clarity, and technical accuracy.
  - Structure: Introduction, System Design/literature review, methodology, implementation details, results, discussion, conclusion, future work, and references.
  - Presentation: Quality of writing, grammar, and formatting.
- **Project Demonstration (25%):**
  - Demonstration: Ability to showcase the functionality of the project or present the research findings effectively.
- **Viva-voce (20%):**
  - Viva-voce: Understanding of project concepts, ability to answer questions confidently, and critical thinking skills

3.2. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 8-credits along with three Core Courses in Major in semester 8.
- The Project can be done in the same institution or any other higher educational institution (HEI) or research centre.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.3. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- In Honours with Research programme, the student has to do a mandatory Research Project of 20-credits in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum one faculty member with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximum four students in Honours with Research stream.

3.4. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Computer Science/Application/IT or allied disciplines.
2. Project should be done individually.
3. Project work can be of experimental/ theoretical/ computational in nature.
4. There should be minimum 240 hrs. of engagement from the student in the Project work in Honours programme.
5. There should be minimum 360 hrs. of engagement from the student in the Project work in Honours with Research programme.
6. The various steps in project works are the following:
    - Wide review of a topic.
    - Investigation on a problem in systematic way using appropriate techniques.
    - Systematic recording of the work.
    - Reporting the results with interpretation in a standard documented form.
    - Presenting the results before the examiners.
7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.

8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG (Honours) programme.

3.5. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme will be evaluated for 200 marks. Out of this, 60 marks is from internal evaluation and 140 marks, from external evaluation.
- The Project in Honours with Research programme will be evaluated for 500 marks. Out of this,150 marks is from internal evaluation and 350 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG (Honours) programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	Marks for the Research Project (Honours with Research)	Marks for the Optional Project (Honours)	Weightage
	20 Credits	8 Credits	
Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council	150	60	30%
End-semester viva-voce examination to be conducted by the external examiner appointed by the university	250	100	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner	100	40	20%
Total Marks	500	200	

INTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Research Project (Honours with Research programme) 20 credits	Marks for the Optional Project (Honours programme) 8 credits
1	Skill in doing project work	50	20
2	Interim Presentation and Viva-Voce	35	15
3	Punctuality and Log book	35	15
4	Scheme/ Organization of Project Report	30	10
	Total Marks	150	60

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Research Project (Honours with Research programme) 20 credits	Marks for the Optional Project (Honours programme) 8 credits
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	100	40
2	Presentation of the Project	75	30
3	Project Report (typed copy), Log Book and References	100	40
4	Viva-Voce	75	30
	Total Marks	350	140

4. LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl. No.	Percentage of Marks (Internal & External Put Together)	Description	Letter Grade	Grade Point	Range of Grade Points	Class
1	95% and above	Outstanding	O	10	9.50 – 10	First Class with Distinction
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9. 49	
3	75% to below 85%	Very Good	A	8	7.50 – 8.49	
4	65% to below 75%	Good	B+	7	6.50 – 7.49	First Class
5	55% to below 65%	Above Average	B	6	5.50 – 6.49	
6	45% to below 55%	Average	C	5	4.50 – 5.49	Second Class
7	35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation	Pass	P	4	3.50 – 4.49	Third Class
8	Below an aggregate of 35% or below 30% in external evaluation	Fail	F	0	0 – 3.49	Fail
9	Not attending the examination	Absent	Ab	0	0	Fail

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree (Honours) or UG Degree (Honours with Research), as the case may be.

4.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA):

  The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

  $$\text{i.e. SGPA } (Si) = \Sigma i\ (Ci \times Gi) / \Sigma i\ (Ci)$$

  where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

ILLUSTRATION – COMPUTATION OF SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	4 x 7 = 28
I	Course 3	3	B	6	3 x 6 = 18
I	Course 4	3	O	10	3 x 10 = 30
I	Course 5	3	C	5	3 x 5 = 15
I	Course 6	4	B	6	4 x 6 = 24
	Total	20			139
	SGPA				139/20 = 6.950

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.

  CGPA for the three-year programme in CUFYUGP shall be calculated by the following formula.

  CGPA for the four-year programme in CUFYUGP shall be calculated by the following formula.
- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

5. STUDY TOUR

A study tour to an IT or related firm is recommended as an optional component of the BCA curriculum, preferably during the fifth or sixth semester. The primary objective of the study tour is to provide students with practical exposure to the working environment of IT companies and to help them understand the real-world application of concepts learned in the classroom. The study tour will be conducted under the supervision of faculty members. After the study tour, students are required to prepare a detailed report outlining the firm visited, technologies observed, and key insights gained. This report must be submitted to the Head of the Department and may be considered as an assignment for one of the courses in the respective semester. Where applicable, the study tour may also be combined with the industry visit arranged as part of the internship programme in the fifth semester.

Major Courses

Semester I

Programme	BCA				
Course Title	Fundamentals of Computers and Computational Thinking				
Type of Course	Major				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Fundamentals of electronic components 2. Basic mathematical operations				
Course Summary	This course provides a comprehensive overview of computing, covering historical milestones, hardware components, software systems, and computational thinking principles. Students will explore the evolution of computing systems, from early pioneers to modern processors and quantum units. The curriculum delves into hardware intricacies, software distinctions, and essential concepts in computer science, emphasizing problem-solving skills and algorithmic thinking. Practical aspects include hands-on experiences with hardware assembling, operating system installation, algorithm and flowchart visualization.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Develop a foundational knowledge of computing systems, encompassing their historical development, evolutionary milestones, and the notable contributions of key figures in the field.	U	F	Instructor-created exams / Quiz
CO2	Acquire familiarity with diverse hardware components constituting a computer system.	U	C	Practical Assignment / Observation of Practical Skills
CO3	Gain practical expertise by engaging in hands-on activities focused on the installation and configuration of diverse hardware components within a computer system.	Ap	P	Practical Assignment / Observation of Practical Skills
CO4	Explore the spectrum of software types, and actively participate in the partitioning, installation, and configuration of operating systems to	Ap	P	Practical Assignment / Observation of Practical Skills

	cultivate a comprehensive understanding of software systems.			
CO5	Develop a foundational understanding of computer science as a discipline, examining problems through the lens of computational thinking and cultivating analytical skills to address challenges in the field.	An	C	Instructor-created exams / Quiz
CO6	Represent complex problems using algorithmic approaches and enhance problem-solving skills by visualizing solutions through the utilization of various software tools.	Ap	P	Practical Assignment / Observation of Practical Skills
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**History and Evolution of Computing System**		**10**	**15**
	1	**Evolution of Computers** – History, Generations	2	
	2	**Overview of Computer System**- Von Neumann Model, Number Systems (Binary, Hexa, Octal, Decimal)	2	
	3	**Number Conversion and Digital Codes** - Conversion from one number system to another, Digital Codes (Gray, Excess-3, BCD)	2	
	4	**Pioneers and Contributors of Computing Systems** - First Mechanical computer - Charles Babbage, Stored-Program Architecture - John von Neumann, Turing machine - Alan Turing, First General-Purpose Electronic Digital Computer - John Mauchly and J. Presper Eckert, Artificial Intelligence- John McCarthy (Contributions only).	2	
	5	**Computing Systems: Past to Present** - Single Core, Dual-Core and Multi-Core Processors, Graphics Processing Unit (GPU), Accelerated Processing Unit, Quantum Processing Units (QPU) (Concept only).	2	
II	**Hardware**		**11**	**20**
	6	**Electronic Components** – Active Components - Diode, Transistor, Integrated Circuits (Definition, Symbol and Function).	1	
	7	**Electronic Components** - Passive Components – Resistors, Capacitors, Inductors (Definition, Symbol and Function).	1	
	8	**Motherboard Components –** CPU and Cooling Fan, RAM, Expansion Slots (PCIe), Input/Output Ports, Chipset (Concept only).	2	
	9	**Motherboard Components –** BIOS/UEFI Chip, SATA/NVMe Slots, Network Interface, Ports- Ethernet, VGA, HDMI, USB (Concept only).	3	
	10	**Computer Components** – SMPS, Motherboard, Storage Devises (HDD, SSD, NVMe (Concept only).	2	
	11	**Computer Components** – RAM (DRAM, SRAM, DDR SDRAM),	2	

		ROM, Cache (Concept only).		
III	**Software**		**12**	**15**
	12	**Software** - Application Software, System Software, Examples	2	
	13	**Operating System** – Need of OS, Types – Proprietary and Open Source, Hardware Software Compatibility, POST, Booting.	4	
	14	**OS Installation –** Bootable Media, UEFI/Legacy BIOS, Disk Partitioning, Dual Booting, Boot Manager – BOOTMGR, Grub, File Systems- FAT, NTFS, ext4.	4	
	15	**Device Drivers –** Need of Device Drivers, Driver Interactions (Basic concept only).	2	
IV	**Computer Science and Computational Thinking**		**15**	**20**
	16	**Computer Science**- Role of Computer Science in the Modern Era.	1	
	17	**Problem Solving -** Defining the Problem, Systematic Approach.	2	
	18	**Computational Thinking** – Problem Decomposition, Pattern Identification, Abstraction, Generalization.	2	
	19	**Logical Thinking** – Inductive and Deductive Reasoning, Logical Expressions.	2	
	20	**Algorithmic Thinking** – Intuition vs Precision, Defining algorithms.	2	
	21	**Algorithm** – Need of Algorithm, Qualities of a Good Algorithm, Examples.	3	
	22	**Flowchart** - Flowchart Symbols, Examples. Raptor.	3	
V	**Open Ended Module – Application Level**		**12**	
		1. Identify, categorize and list out specifications of given **electronic components**. 2. Identify and list out specifications of given **motherboard components**. 3. Identify and Describe various **ports and connectors on motherboard**. 4. Installation of various **components on motherboard** (Processor, Fan, Heat Sink, RAM etc.) 5. Hands-on experience in **assembling and disassembling** a computer system (SMPS, Motherboard, Storage Device etc.). 6. Accessing and configuring the **Basic Input/Output System (BIOS) or Unified Extensible Firmware Interface (UEFI)** settings. 7. Preparation of **Bootable media** with software like ***Rufus***. 8. Check the hardware compatibility and **Install operating system** (single booting) on given computer. 9. Check the hardware compatibility and **Install operating systems** (dual booting – Windows and Linux) on given computer. **Develop algorithms and implement** the solutions using ***RAPTOR*** flowchart execution tool for the following problems. 10. Read and print a number. 11. Read the price of three items and print the total bill amount. 12. Read ages of two persons and print the elder one. 13. Read the number of units of electricity consumed and print the bill amount for various slabs.		

		14. Read a year and check whether it is a leap year. 15. Print first N numbers (using loop).		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	-	-	-	1						
CO 2	1	3	-	-	1	-						
CO 3	1	3	-	-	2	2						
CO 4	1	3	-	-	2	2						
CO 5	2	1	3	1	1	-						
CO 6	2	1	3	2	2	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4		✓	✓	✓
CO 5		✓		✓
CO 6	✓	✓	✓	✓

References:

1. Gary B. Shelly, Thomas J. Cashman, and Misty E. Vermaat. “Introduction to Computers”, Cengage Learning, 2008.

2. Pradeep K. Sinha and Priti Sinha, Computer Fundamentals: Concepts, Systems & Applications. BPB Publications.

3. Kevin Wilson, Computer Hardware: The Illustrated Guide to Understanding Computer Hardware. Amazon Digital Services LLC – KDP, 2018.

4. John Hanna, OS Installation 101: A Step-by-Step Approach for Newbies.

5. David Riley and Kenny Hunt, Computational thinking for modern solver, Chapman & Hall/CRC, 2014.

6. R.G. Dromey, How to solve it by Computer, PHI, 2008.

Programme	BCA				
Course Title	Mathematical Foundation for Computer Applications				
Type of Course	Major				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic Mathematics is required (Algebra, Arithmetic)				
Course Summary	This course provides a fundamental exploration of mathematical concepts essential for computer science. Students will explore into key topics including Linear Algebra, Differential and Integral Calculus. The course aims to equip students with the mathematical tools and reasoning skills necessary for creating and analyzing algorithms, understanding and solving computational problems in various areas of computer science like Data science, Artificial Intelligence.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Reflect the concept of matrices and determinants as a way to depict and streamline mathematical ideas to perform basic operations.	U	C	Instructor- created exams / Quiz/Assignment/ Seminar

CO2	Able to find the inverse of square matrices using different methods and demonstrate a solid understanding of eigen values.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO3	Proficiency in solving linear equations using different techniques and understanding the geometric interpretation of solutions.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO4	Gain proficiency in representing vectors geometrically and algebraically, understanding vector addition, dot and cross products.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO5	Able to apply differential and integral calculus to various functions encountered in computer applications such as polynomials, exponentials and logarithmic functions.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO6	Represent various mathematical problems using algorithmic approaches and enhance problem-solving skills by visualizing solutions through the utilization of software tools.	U, Ap	C, P	Practical Assignment / Observation of Practical Skills

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Contents	Hrs (48+12)	Marks
I		**Matrices and Determinants**	**14**	**18**
	1	Matrices: Definition, Order of a matrix, Types of matrices	2	
	2	Operations on matrices: Addition, Subtraction, Multiplication	3	
	3	Transpose of a matrix, Symmetric and Skew Symmetric Matrices	2	
	4	Determinants, Minors, Cofactors, Inverse of a matrix	3	
	5	Elementary Transformations of Matrices	2	
	6	Rank of a Matrix	2	
II		**Linear Algebra and Vector Calculus**	**13**	**18**
	7	Linear Independence, Characteristic equations	1	
	8	Eigen Values, Eigen Vector	3	

	9	Solving system of linear equations: Gauss Elimination Method, Gauss Jordan method, Gauss Siedel Method	3	
	10	Vectors: Definition, Magnitude of a vector, Types of Vectors	2	
	11	Vectors in 2D and 3D space, Vector addition	2	
	12	Dot products and Cross products	2	
III	**Differentiation**		**11**	**17**
	13	Limits; Definition (concept only), Derivative at a Point, Derivative of a Function	2	
	14	Differentiation: Definition, Differentiation by first principle, Derivatives of important functions	3	
	15	Product rule, Quotient rule	3	
	16	Derivative of function of a function	1	
	17	Logarithmic differentiation	2	
IV	**Integration**		**10**	**17**
	18	Integral as Anti-derivative, Indefinite integral & Constant of integration	1	
	19	Integral of different functions	1	
	20	Methods of Integration- Substitution, Partial fractions, Parts	4	
	21	Definite Integrals, Properties of definite integrals	2	
	22	Evaluation of definite integrals	2	
V	**Open Ended Module – Application Level**		**12**	
	1	Discuss topics from the following: • Differential Equation. • Concept of First Order ODE's. • Concept of Second Order ODE's. • Application of Logarithm. • Combinatorics. • Trigonometric concept. • Applications of Matrices in various field of computer like image processing, cryptography etc. • Real-world examples for using eigen values and eigen vectors. • Vectors assist in GPS technology to provide accurate navigation data. • 3D vectors enhancement in virtual reality experiences. • Discuss the importance of differentiation and integration in various computer fields, such as Machine Learning, Robotics, Quantum Computing, etc.	10	
	2	Case Study	2	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	1	1	-	-						
CO 2	2	-	2	2	-	-						
CO 3	2	-	2	2	-	-						
CO 4	2	-	2	2	-	-						
CO 5	2	-	2	2	-	-						
CO 6	2	-	2	2	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley
2. Higher Engineering Mathematics, John Bird, Elsevier Direct

3. Skills in Mathematics: Algebra, S.K.Goyal
4. Higher Engineering Mathematics, B S Grewal, Khanna Publishers
5. Higher Engineering Mathematics, Ramana, Tata McGraw Hill
6. Engineering Mathematics, P Kandasamy, S. Chand Group
7. Gilbert Strang, "Introduction to Linear Algebra", Wellesley-Cambridge Press, 2023.
8. Kenneth Hoffman, Ray Kunze, " Linear Algebra", Prentice Hall India Learning, 2015.
9. Gilbert Strang, " Calculus", Wellesley-Cambridge Press, 2023.
10. Joseph Edwards, "Differential Calculus for Beginners", Arihant Publications, 2016.
11. Joseph Edwards, " Integral Calculus for Beginners", Arihant Publications, 2016.

Programme	BCA				
Course Title	Discrete Structures for Computer Applications				
Type of Course	Major				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	No pre-requisites required				
Course Summary	This course provides a foundational understanding of essential concepts that are fundamental to computer science and various branches of mathematics. The course explores topic related to Propositional Logic, Sets and Relations, Graphs and Trees. This helps the students to equip with the analytical and problem-solving skills necessary for applications in computer science and algorithm design.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Acquire a comprehensive understanding of propositional logic and its applications, with a focus on constructing and interpreting truth tables.	U	C	Instructor- created exams / Quiz/Assignment/ Seminar

CO2	Able to proficiently define and manipulate sets, analyse relations and functions and their representation by Venn diagrams	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO3	Acquire a basic understanding of graph theory including representations, types of graphs, their properties such as connectivity, cycles, paths and degrees.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO4	Able to demonstrate a deep understanding of advanced graph theory concepts, focusing on Euler's graph, Hamiltonian graphs, Isomorphism and Homeomorphism.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO5	Able to proficiently understand the tree data structures, spanning trees and associated algorithms for solving problems such as Prim's and Kruskal.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO6	Represent various mathematical problems using algorithmic approaches and enhance problem-solving skills by visualizing solutions through the utilization of software tools.	U, Ap	C, P	Practical Assignment / Observation of Practical Skills
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Contents	Hrs (48+12)	Mark
I		**Mathematical Logic**	**09**	**17**
	1	Propositional Logic: Definition, Logical Operators (Negation, Disjunction, Conjunction, Implication, Biconditional), Truth Table	2	
	2	Law of Logic: Tautology, Contradiction, Contingency, Logical equivalence	2	
	3	Algebra of Propositions, Solving logic with and without truth table	2	
	4	Validity of Arguments, Logical implication	2	
	5	Quantifiers: Universal and Existential	1	
II		**Set Theory and Relations**	**12**	**17**
	6	Set Theory: Definition, Concept of Set Theory, Cardinality, Types of sets	1	
	7	Properties of Set: Subsets, Power set, Venn Diagrams, Set operations, Partition	2	

	8	Relation: Definition and Examples, Type of Relations with example,	2	
	9	Equivalence relation, Equivalence Class and Di-Graph and problems	3	
	10	Functions: Introduction, type of function, Composition function	2	
	11	One-to-one function, Onto function, One-to-one correspondence	2	
III	**Introduction to Graphs**		**16**	**20**
	12	Graph: Definition, Properties of Graph, Simple Graph, Regular Graph, Null Graph, Subgraph and Isomorphism	2	
	13	Walk, Path, Trail, Circuit, Cycle, Complete Graph, Hand-Shaking Theorem	2	
	14	Connected Graph, Complete Graph, Euler Graph, Hamiltonian graph, Travelling Sales Man Problem, Operations on Graph, Homeomorphism	3	
	15	Planar Graph, Kuratowski's two graph, Matrix Representation of Graph	3	
	16	Bi-Partite Graph, Graph colouring, Chromatic number	2	
	17	Basic theorems on Graph, Hand-Shaking Theorem	4	
IV	**Trees and Applications**		**11**	**16**
	18	Tress: Definition, Properties, Pendant vertex, Distance, Eccentricity and Center of Tress	2	
	19	Rooted Tress, Binary Tress and Its Properties	2	
	20	Basic Theorems on Tress	3	
	21	Minimum Spanning Tree: Definition, Prim's Algorithm and Kruskal's Algorithm (Algorithm and Problem Based)	2	
	22	Cut-Set and Cut-Vertices, Connectivity of Graph and Weighted Graph	2	
V	**Open-Ended Module – Application Level**		**12**	
	1	Discuss topics from the following: • First Order Logic. • Application of Logic in Intelligence System. • Set theory in Computer Applications. • POSET and Hasse Diagram. • Di-Graph of the relation.	10	

		• Application of Graphs like Königsberg Bridge Problem, Utilities Problem, Electrical Network Problems, Seating Problem. • Different type of Binary Tree and their applications. • BFS and DFS Algorithm. • Directed Graphs and Directed Trees. • Application of Graphs in Computer fields. • Basic Concept of Group and Ring.		
	2	Case Study	2	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	1	1	-	-						
CO 2	2	-	2	2	-	-						
CO 3	2	-	2	2	-	-						
CO 4	2	-	2	2	-	-						
CO 5	2	-	2	2	-	-						
CO 6	2	-	2	2	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓

CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓

References:

1. C L Liu, D P Mohapatra, "Elements of Discrete Mathematics", McGraw Hill Education (India) Private Limited, 2008.
2. Seymour Lipscutz, Marc Lars Lipson, " Discrete Mathematics", Tata McGraw Hill Education Private Limited, 2015.
3. Kenneth A Ross, Charles R B Wright, "Discrete Mathematics", 5th Edition, Pearson Education India, 2012.
4. Swapan Kumar Sarkar, "Discrete Mathematics", 9th Edition, S Chand & Co Ltd, 2016.
5. Elements of Discrete Mathematics, C. L. Liu, TMH Edition
6. Discrete Mathematical Structures with applications to Computer Science, J.K. Tremblay and R Manohar, McGraw Hill
7. Discrete mathematical Structures, Kolman, Busby, Ross, Pearson
8. Graph theory, Harry, F., Addison Wesley.

Semester II

Programme	BCA				
Course Title	Fundamentals of Programming (C Language)				
Type of Course	Major				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamentals of Algorithms and Flowcharts 2. BCA1CJ104 – Fundamentals of Computers and Computational Thinking				

Course Summary	The objectives of this course are to make the student understand programming language, programming, concepts of Loops, reading a set of Data, stepwise refinement, Functions, Control structure, Arrays, Structures, Unions, and Pointers. After completion of this course the student is expected to analyze the real-life problem and write a program in 'C' language to solve the problem. The main emphasis of the course will be on problem solving aspect i.e. developing proper algorithms.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Remember the program structure of C with its syntax and semantics	U	C	Instructor-created exams / Quiz
CO2	Use the various constructs of a programming language viz. conditional, iteration and recursion.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Implement the algorithms in C language.	Ap	P	Practical Assignment / Observation of Practical Skills
CO4	Use simple data structure like array in solving problems.	Ap	C	Practical Assignment / Observation of Practical Skills
CO5	Handling pointers and memory management functions in C.	Ap	P	Practical Assignment / Observation of Practical Skills
CO6	Develop efficient programs for solving a problem.	Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I	**Introduction to C Language**		**10**	**15**
	1	History of C, Importance of C, and sample programs	2	
	2	Character set, Tokens, Constants, Variables, and Data types	2	
	3	Operators – Arithmetic, Relational, logical, assignment, increment, decrement, conditional, bitwise and special operators. Arithmetic expressions, operator precedence, type conversions, mathematical functions	3	
	4	Managing Input and Output Operators: Reading and writing a character, formatted input, formatted output.	3	
II	**Decision Making Branching and Looping**		**10**	
	5	Decision making with If - simple If, If else, nested If else, else	3	

		If ladder		
	6	Switch statement, conditional operator, Goto statement	2	**15**
	7	Loops: while, do while, for statements and nested loops	3	
	8	Jumps in loops – break, continue	2	
III	**Arrays and Functions**		**15**	
	9	One dimensional array – declaration, initialization and accessing	2	
	10	Two-dimensional array – declaration, initialization and accessing	2	
	11	Multi dimensional array, dynamic array	1	
	12	Strings – Reading, Writing. Arithmetic operations on characters, Comparisons and string handling functions	2	**20**
	13	Functions – Need, Elements of user defined functions and definition	2	
	14	Return values and their types, function call and declaration, call by value and call by reference	2	
	15	Categories of functions, Nesting of functions	1	
	16	Recursion and command line arguments	1	
	17	Passing arrays to functions and passing strings to functions	2	
IV	**Storage Classes, Structure and Union, Pointers**		**10**	
	18	Storage classes – The scope, visibility and lifetime of variables. Auto, Extern, Static and Register storage classes. Storage classes in a single source file and multiple source files	2	
	19	Structure and Union - Defining, giving values to members, initialization and comparison of structure variables, arrays of structure, arrays within structures, structures within structures, structures and functions, unions	2	**20**
	20	Pointers definition, declaring and initializing pointers, accessing a variable through address and through pointer, pointer expressions, pointer increments and scale factor	2	
	21	Pointers and arrays, pointers and functions, pointers and structure	2	
	22	Dynamic memory allocation and memory management functions	2	
V	**Hands-on Problem-Solving Using C** **Practical Applications, Case Study and Course Project**		**30**	
	1	Implement the following: **1. Variables, Data types, Constants and Operators:** 1.Evaluation of expression ex: ((x+y) ^2 * (x+z))/w 2.Temperature conversion problem (Fahrenheit to Celsius) 3.Program to convert days to months and days (Ex: 364 days = 12 months and 4 days) 4. Salesman salary (Given: Basic Salary, Bonus for every item sold, commission on the total monthly sales) **2. Decision making (Branch / Loop) Statements:** 5.Solution of quadratic equation 6.Maximum of three numbers 7.Calculate Square root of five numbers (using goto statement) 8.Pay-Bill Calculation for different levels of employee (Switch statement)	30	

		9. Fibonacci series 10.Armstrong numbers 11.Pascal ‘s Triangle **3. Arrays, Functions and Strings:** 12.Prime numbers in an array 13.Sorting data (Ascending and Descending) 14.Matrix Addition and Subtraction 15.Matrix Multiplication 16.Transpose of a matrix 17Function with no arguments and no return value 18. Functions with argument and return value 19.Functions with argument and multiple return values 20.Function that convert lower case letters to upper case 21. Factorial using recursion. 22. Perform String Operations using Switch Case 23. Largest among a set of numbers using command line argument **4. Structures and Union:** 24. Structure that describes a hotel (name, address, grade, avg room rent, number of rooms) Perform some operations (list of hotels of a given grade etc.) 25. Using Pointers in Structures. 26. Cricket team details using Union. **5. Pointers:** 27.Evaluation of Pointer expressions 28.Function to exchange two pointer values 29. Reverse a string using pointers 30.Insertion, deletion, and searching in an array		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	-	1	1	-	-						
CO 2	-	1	2	2	-	-						
CO 3	-	1	3	3	-	-						
CO 4	-	1	2	2	-	-						
CO 5	-	2	2	2	-	-						
CO 6	-	1	3	3	1	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6			✓	

References:

1. Kernighan, B. W., & Ritchie, D. M. (1988). The C Programming Language (2nd ed.). Prentice Hall. ISBN: 978-0131103627
2. King, K. N. (2008). C Programming: A Modern Approach (2nd ed.). W. W. Norton & Company. ISBN: 978-0393979503
3. Schildt, H. (2000). C: The Complete Reference (4th ed.). McGraw-Hill. ISBN: 978-0072121247
4. Kochan, S. G. (2004). Programming in C (3rd ed.). Sams Publishing. ISBN: 978-0672326660
5. Griffiths, D., & Griffiths, D. (2012). Head First C. O'Reilly Media. ISBN: 978-1449399917
6. Kanetkar, Y. (2008). Let Us C (8th ed.). BPB Publications. ISBN: 978-1934015256
7. Prata, S. (2004). C Primer Plus (5th ed.). Sams Publishing. ISBN: 978-0672326967

Programme	BCA				
Course Title	Statistical Foundation for Computer Applications				
Type of Course	Major				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60

Pre-requisites	1. A strong foundation in algebra 2. Fundamentals of Set theory and logic
Course Summary	The course on probability and statistics covers fundamental topics including descriptive statistics (measures of central tendency and dispersion), probability theory (events, sample spaces, probabilitylaws, random variables, and distributions), inferential statistics (regression analysis), and applications in various fields such as science, engineering, economics, and social sciences, emphasizing critical thinking, data analysis, and problem-solving skills.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Apply fundamental statistics concepts	Ap	C	Quizzes, Homework, Exams
CO2	Analyze data using descriptive statistics	An	P	Projects, Midterm, Exams
CO3	Perform regression analysis	An	P	Projects, Exams
CO4	Apply probability and statistics in real-world situations	Ap	C	Projects, Exams
CO5	Develop critical thinking and problem-solving skills	E	M	Homework, Projects
CO6	Communicate statistical findings effectively	E	M	Presentations, Reports

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Mark
I		**DESCRIPTIVE STATISTICS**	**10**	**15**
	1	Concept of primary and secondary data, Methods of collection, Population, Sample	1	
	2	Measures of Central tendencies (Mean, Median, Mode, HM, GM)	4	
	3	Measures of Dispersion, Relative Measures and Absolute Measures	2	
	4	Range, Quartile deviation, Mean deviation, Standard deviation, Variance	3	

II	**PROBABILITY THEORY**		**12**	**20**
	5	Random experiment, Sample point, Sample Space	1	
	6	Events, Types of events with examples	2	
	7	Operation of events (Union, Intersection, Complement of Events)	1	
	8	Classical approach to probability, Axiomatic definition of probability	2	
	9	Addition Theorem of probability	1	
	10	Conditional probability, Multiplication Theorem of probability	2	
	11	Baye's Theorem, Inverse probability	1	
	12	Expectation- moments, mean, variance, moment generating function	2	
III	**ADVANCED PROBABILITY DISTRIBUTION**		**10**	**15**
	13	Discrete and Continuous random variables, Probability distributions, Distribution functions, Problems	3	
	14	Binomial distribution: Definition, Expectation, Variance, Moment Generating Function and Problems	2	
	15	Poisson distribution: Definition, Expectation, Variance, Moment Generating Function and Problems	2	
	16	Normal distribution: Definition, Expectation, Variance, Moment Generating Function, Standard normal curve and Problems	3	
IV	**STATISTICAL INFERENCE AND REGRESSION ANALYSIS**		**16**	**20**
	17	Principles of Least Squares and Fitting of Straight Line	2	
	18	Correlation, Pearson's Coefficient of Correlation, Rank Correlation, Regression	3	
	19	Estimation Theory- Statistic, Parameter, Estimator, Point estimation, Maximum Likelihood Estimation (MLE), Method of moments, Confidence intervals for population parameters	3	
	20	Testing of Hypothesis: General principles of testing, Two types of errors	2	
	21	Type of Testing: T-Test, ANOVA-Test, Chi-square test (Concept only)	3	
	22	Simple Linear regression and Multiple Linear regression, Logistic regression (Concept only)	3	
V	**Open Ended module- Application Level**		**12**	
	1	Discuss topics from the following: • Reliability and Validity of Different Data Sources. • Highlighting the use of Measures Mean, Median and Mode in Real-World Scenarios. • Significance of Measures of Dispersion in Data Analysis. • Interpretation of EDA plots.	10	

		• Importance of Correlation and Regression in numerous Computer fields. • Problem sets involving real-world applications of probability theorems. • Central Limit Theorem. • Real-world scenario of Binomial, Poisson and Normal Distribution. • Difference between of Binomial, Poisson and Normal Distribution. • Advanced Concept of T-Test, ANOVA-Test, Chi-square test, Z-Test. • Markov-Chain-Montee-Carlo Method and it's use.		
	2	Case Study	2	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	-	1	1	1						
CO 2	1	3	-	-	1	-						
CO 3	1	3	-	-	2	2						
CO 4	1	3	-	-	2	2						
CO 5	2	1	-	1	1	-						
CO 6	2	1	1	2	2	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations

CO 1	✓	✓	✓	✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Introduction to Mathematical Statistics, Hogg R V Craig A T, Macmillan
2. Mathematical Statistics, Freund J E, Waple R E, Prentice Hall of India.
3. Probability and Statistics for Engineers, Miller I Freund J E, Prentice Hall of India.
4. Statistics for Management, Levin R I, Prentice Hall of India
5. Introduction to Mathematical Statistics, Hogg R V Craig A T, Macmillan
6. Mathematical Statistics, Freund J E, Waple R E, Prentice Hall of India.
7. Probability and Statistics for Engineers, Miller I Freund J E, Prentice Hall of India.
8. Gupta, S.P. Statistical Methods. Sultan Chand and Sons: New Delhi.
9. Mood, A.M., Graybill, F.A and Boes, D.C. Introduction to Theory of Statistics. 3rd Edition Paperback – International Edition.

Programme	BCA				
Course Title	Numerical methods and Optimization Techniques				
Type of Course	Major				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Understanding of algebraic concepts, including solving equations and inequalities. 2. Familiarity with the concept of derivatives and integrals.				
Course Summary	This course covers foundational concepts in numerical methods and operations research, emphasizing error analysis and solution techniques for algebraic and transcendental equations. Students will develop skills in				

	polynomial interpolation, numerical integration, and explore fundamental principles of operations research, including linear programming.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Develop a solid foundation in numerical methods, acquiring the skills to analyze and solve algebraic and transcendental equations, and gaining a practical understanding of the sources and management of errors in numerical computations.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO2	Cultivate both a comprehensive grasp and practical proficiency in polynomial interpolation techniques, alongside acquiring expertise in numerical methods for the solution of definite integrals.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	Establish a robust groundwork in Operations Research, nurturing a discerning capability to critically evaluate its applications across diverse problem-solving scenarios.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO4	Develop expertise in Linear Programming, mastering the art of employing sophisticated optimization techniques for the effective resolution of Linear Programming problems.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Impart a comprehensive understanding of transportation problems and cultivate an appreciation for the methods used in finding basic feasible solutions.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Develop proficiency in addressing assignment problems and employ the method to attain optimal solutions, providing a holistic skill set for logistical optimization.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Numerical Analysis I**		**10**	**15**
	1	Errors in numerical calculations - Sources of errors	1	
	2	Solution of Algebraic and Transcendental Equations - Bisection method	3	
	3	Method of false position	3	

	4	Newton Raphson method	3	
II	**Numerical Analysis II**		**12**	**15**
	5	Polynomial Interpolation - Lagrange interpolation	3	
	6	Newton's forward and backward difference interpolation	3	
	7	Numerical Solution of Definite Integral - Simpson's 1/3rd rule	2	
	8	Simpson's 3/8 Rule	2	
	9	Trapezoidal method	2	
III	**Operations Research I**		**13**	**20**
	10	Introduction to Operations Research – Definition, Advantages and Limitations of Operations Research	1	
	11	Linear Programming Problem – Definition, Formulation of LPP, Feasible solution and Optimal solution	2	
	12	Dual of LPP	2	
	13	Graphical solution of LPP	2	
	14	Simplex Method	3	
	15	Big-M method	3	
IV	**Operations Research II**		**13**	**20**
	16	Transportation Problem – Definition, Balanced and unbalanced Transportation problems	1	
	17	Finding basic feasible solutions – Northwest corner method	2	
	18	Least cost method	1	
	19	Vogel's approximation method	2	
	20	Optimized (MODI) method	3	
	21	Assignment model - Definition, Balanced and unbalanced Assignment problems	1	
	22	Hungarian method for optimal solution	3	
V	**Open Ended Module – Other Numerical and Optimization Methods**		**12**	
	1	• Any other two methods to solve Algebraic and Transcendental Equations • Any other two methods for Polynomial Interpolation • Any other two methods to solve Solution of Definite Integral • Any other method to solve LPP	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	1	-	3	-						
CO 2	1	-	1	-	3	-						
CO 3	3	-	1	-	3	-						
CO 4	3	-	1	-	3	-						
CO 5	3	-	1	-	3	-						
CO 6	3	-	1	-	3	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Sastry S.S., Introductory Methods of Numerical Analysis, Prentice Hall India.

2. E. Carl Froberg and Erik Carl Frhoberg, Introduction to Numerical Analysis, Addition Wesley.

3. Hamdy A. Taha, Operations Research an Introduction, Pearson Education Limited.

4. P. Sankara Iyer, Operations Research, Tata McGraw-Hill, 2008.

5. A.M. Natarajan, P. Balasubramani, A. Tamilarasi, Operations Research, Pearson Education, 2005.

Semester III

Programme	BCA				
Course Title	Data Structures and Algorithms				
Type of Course	Major				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamental Mathematics Concepts: Set, Functions, Logic 2. BCA2CJ101 – Fundamentals of Programming				
Course Summary	This course explores implementations of linked list and array-based data structures, delving into the inner workings of basic data structures including lists, stacks, queues, trees, and graphs.				

Course Outcomes (CO)

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Differentiate basic data structures (arrays, linked lists, stacks, queues) based on their characteristics, operations, and real-world applications.	U	C	Instructor-created exams / Quiz
CO2	Perform basic operations (e.g., insertion, deletion, search) on fundamental data structures using a chosen programming language.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Identify the properties and applications of advanced data structures (trees, graphs).	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Investigate the properties of various searching and sorting Techniques	U	C	Practical Assignment / Seminar
CO5	Demonstrate critical thinking and problem-solving skills by applying data structures and algorithms to address complex computational challenges.	Ap	P	Viva Voce/ Observation of Practical Skills
CO6	Implement and analyse different data structure algorithms (to solve practical problems.	Ap	P	Case study/ Project
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I		**Introduction to Data Structures and Basic Algorithms**	**9**	**15**
	1	Overview of Data Structures: Data type Vs. Data structure, ADT, Definition of Data structure, Data structure Classification – Linear, Non Linear (Array, Linked List, Stack, Queue, Tree, Graph)	1	
	2	Introduction to Arrays: Definition, Types (1 Dimensional, 2 Dimensional, Multi-Dimensional, Sparse matrix), Different Array Operations with Algorithm (insertion, deletion, traversal)	3	
	3	Structures and Self-referential structures	1	
	4	Introduction to Linked list: Definition, Types (Single linked list, Doublelinked list, Circular linked list- concept only).	2	
	5	Singly Linked List Operations with Algorithm (insertion, deletion, traversal)	2	
II		**Stack and Queue**	**10**	**20**
	6	Introduction to Stack: Definition, stack operations with Algorithm, Applications: recursion, infix to postfix - example and Algorithm	3	
	7	Implementation of Stack: using array (overflow & underflow) and Linkedlist (with algorithm)	2	
	8	Introduction to Queue: Definition, queue operations with Algorithm, Types: Double ended queue (Input Restricted and Output restricted), Circularqueue, Applications	2	
	9	Implementation of Queue: using array and Linked list (with algorithm)	3	
III		**Non- Linear Data Structures**	**16**	**20**
	10	Introduction to Trees: Basic terminology, Types (Binary tree- complete,full, skewed etc., Expression Tree)	2	
	11	Properties of Binary tree, Applications.	2	
	12	Binary tree representations- using array and linked list	2	
	13	Operations on Binary tree- Insertion, Deletion, Traversal- inorder, preorder, postorder - (concepts with examples)	3	
	14	Algorithm of non-recursive Binary tree traversal	3	
	15	Introduction to Graph: Definition, Basic terminology, Types (Directed, Undirected, Weighted).	2	
	16	Graph representation –Adjacency list and Adjacency Matrix, Applications.	2	
IV		**Sorting and Searching**	**10**	**15**
	17	Introduction to Sorting: Definition, Classification (Internal, External)	1	
	18	Internal Sorting Algorithms: Selection sort- Selection sort algorithm, Exchange sort- Bubble sort algorithm	2	
	19	External Sorting Algorithms: Merge sort- Demonstrate with example (NoAlgorithm needed)	1	
	20	Advanced sorting Algorithm-: Quick sort- Demonstrate with example. (NoAlgorithm needed)	1	
	21	Introduction to Searching: Linear search and Binary search (Algorithm needed) with example.	2	

	22	Hashing: Hash Tables, Hash Functions, Different Hash Functions – Division method, Multiplication method, Mid square method, Folding Method, Collision and Collision resolution Techniques: Open hashing- Chaining, Closed hashing- Probing	2	
V	**Hands-on Programming in Data Structures: Practical Applications, Case Study and Course Project**		**30**	
	1	**Implement the following:** **1.** Basic Operations in a single linked list (Menu driven) **2.** Sort the elements in given singly linked list **3.** Stack using array. **4.** Stack using Linked list **5.** Queue using Array **6.** Queue using Linked list **7.** Sorting algorithms- Selection, Bubble Sort **8.** Searching Algorithms- Linear and Binary search	25	
	2	Project/ Case study	5	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	1	-	-	-						
CO 2	2	1	2	3	-	-						
CO 3	2	1	2	3	-	-						
CO 4	2	-	2	3	-	-						
CO 5	1	1	2	3	1	-						
CO 6	1	1	3	3	1	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Seymour Lipschutz, "Data Structures with C", McGraw Hill Education (Schaum's Outline Series).
2. Reema Thareja, "Data Structures Using C", Oxford University Press.

Programme	BCA				
Course Title	Computer Networks				
Type of Course	Major				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Knowledge in fundamentals of Computer Systems. 2. Familiarity with at least one programming language				
Course Summary	This course covers the concepts of data communication and computer networks. It comprises of the study of the standard models for the layered protocol architecture to communicate between autonomous computers in a network and also the main features and issues of communication protocols for different layers. Topics covered comprise of introduction to OSI and TCP/IP models also.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamentals of computer networks including concepts like data communication, network topologies and the	U	C	Instructor-Create Exams or Quiz

	reference models			
CO2	Proficiency in Transmission Media and Multiplexing Techniques:	A	P	Discussions and Quizzes
CO3	To familiarise with the common networking protocols and standards	U	F	Instructor created exams or Home assignments
CO4	Describe, analyse and compare different data link, network and transport layer protocols	A, E	P	Discussions, Quizzes
CO5	Design/implement data link and network layer protocols in simulated networking environment	Ap	P	Viva Voce Observation of practical skills
CO6	To understand the need of various Application layer protocols	U	M	Instructor Created - Exams, Assignments
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I	**Introduction to Computer networks and Network models**		**12**	**17**
	1	Types of computer networks, Internet, Intranet, Network topologies, Network classifications.	2	
	2	Network Architecture Models: Layered architecture approach, OSI Reference Model, TCP/IP	2	
	3	Physical Layer: Analog signal, digital signal, Analog to Digital, Digital to Analog, maximum data rate of a channel transmission	4	
	4	Transmission media (guided transmission media, wireless transmission, satellite communication).	2	
	5	multiplexing (frequency division multiplexing, time division multiplexing, wavelength division multiplexing	2	
II	**Data Link Layer**		**11**	**18**
	6	Data link layer services, error-detection Types of errors, Single bit error and Burst error, Vertical redundancy check (VRC), longitudinal redundancy Check (LRC), Cyclic Redundancy Check (CRC), Check sum Error correction - Single bit error correction, Hamming code	2	
	7	Error correction techniques, error recovery protocols (stop and wait, go back n, selective repeat),	3	
	8	Multiple access protocols, (TDMA/FDP, CDMA/FDD/CSMA/CD, CSMA/CA),	2	
	9	Datalink and MAC addressing, Ethernet, Polling	1	
	10	IEEE Standards- Wireless LANS, Ethernet, Bluetooth	3	
III	**Network layer**		**11**	**18**
	11	Networking and Internetworking devices - Repeaters, Bridges, Routers, Gateways, Firewall	2	

	12	Logical addressing - IPv4 & IPv6 addresses, Network Address Translation (NAT), Internet protocols, internetworking, Datagram,	2	
	13	Transition from IPv4 to IPv6	1	
	14	Address Mapping-Error reporting and multicasting - Delivery,	2	
	15	Forwarding and Routing algorithms, Distance Vector Routing,	2	
	16	Link State Routing. Dijkstra	2	
IV	**Transport Layer and Application layer**		**11**	**17**
	17	Transport layer, Process-to-process Delivery: UDP, TCP	2	
	18	Congestion control and Quality of Service,	2	
	19	Domain Name Systems-Remote Login, Email	2	
	20	FTP, WWW, HTTP	2	
	21	Introductory concepts on Network management& Mail transfer: SNMP	2	
	22	SMTP	1	
V	**Hands-on Computer Networks: Practical Applications,**		**30**	
	1	LAB1: identifying Networking Hardware components (Jacks, Cables, Tools) Lab 2: IP address - configuring. Lab3: Crimping Lab 4: Configuring network host - setting hostname - assigning IP address Lab 5: configuring the Network Interface card – Lab 6: Setup a Wired LAN with more than two systems Lab 7: Setup a Wireless LAN with more than two systems Lab 8: Setting up Internet services File Transfer Protocol (FTP), Lab 9: Simple Mail Transfer Protocol (SMTP) and Post Office Protocol (POP) Lab 10: Setting up Intranet Services - Network File System (NFS),	20	
	2	Case study	3	
	3	**Capstone (/Course) Project:** Build a practical application using Wired Network	7	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	-	-	-	-						
CO 2	2	2	1	-	-	-						
CO 3	-	2	1	-	-	-						
CO 4	-	2	1	1	1	-						
CO 5	1	1	2	2	-	-						
CO 6	1	2	1	3	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓			✓
CO 5		✓	✓	✓
CO6			✓	

References:

1. Behurouz A Forozan, Introduction to Data Communications & Networking, TMH
2. Andrew S. Tanenbaum, Computer Networks, PHI
3. William Stallings, Data and Computer Communications, VIIth Edition, Pearson Education

Programme	BCA				
Course Title	Introduction to Data Science				
Type of Course	Major				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of computer science concepts. 2. Familiarity with data handling. 3. simple mathematical analysis.				
Course Summary	Data science is the domain of study that deals with vast volumes of data using modern tools and techniques to find unseen patterns, derive meaningful information, and make business decisions.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify the relevance and applications of computers in other disciplines with various data science applications.	R	C	Assignment / Instructor-created exams / Quiz
CO2	understanding of data science concepts and be capable of applying data science skills and interpret data science results	U	C	Assignment / Instructor-created exams / Quiz
CO3	Acquire logical thinking about evolution of data science	U	C	Assignment / Instructor-created exams / Quiz
CO4	How to use tools for acquiring, cleaning, analyzing, exploring, and visualizing data	Ap	P	Assignment / Instructor-created exams / Quiz
CO5	Learn to make data-driven inferences and decisions	Ap	P	Assignment / Instructor-created exams / Quiz
CO6	Able to perform data science processing, such as data import, data analysis, data visualization, and data modelling	Ap	P	Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Mark
I	**Introduction to Data Science**		**10**	**15**
	1	Introduction to Data Science-Definition	2	
	2	Evolution of Data Science	2	
	3	Data Science Roles	3	
	4	Application of data sciences.	3	
II	**Data Collection and Data Pre-Processing**		**12**	**15**
	5	Data Collection Strategies	2	
	6	Data Pre-Processing Overview	2	
	7	Data Cleaning	2	
	8	Data Integration and Transformation	3	
	9	Data Reduction and Descretization	3	
III	**Data Analytics**		**12**	**20**
	10	Descriptive Statistics	2	
	11	Mean, Standard Deviation	2	
	12	Skewness and Kurtosis	2	
	13	Box Plots	2	
	14	Pivot Table	2	
	15	Correlation Statistics	2	
IV	**Data Model Development and Evaluation**		**14**	**20**
	16	Simple and Multiple Regression	2	
	17	Model Evaluation using Visualization	2	
	18	Residual plot and distributional plot	2	
	19	Prediction and Decision Making	2	
	20	Model Evaluation techniques-	3	
	21	Supervised learning techniques	2	
	22	unsupervised learning techniques	1	
V	**Open Ended Module**		**12**	
	• Out of samples evaluation metrics • Cross validation in Model evaluation • Over fitting and under fitting concepts • Appropriate model selection. • Prediction and decision-making concepts. • Prediction by ridge regression.		12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	1	-	2	-						
CO 2	3	-	1	-	1	-						
CO 3	3	-	2	-	1	-						
CO 4	2	-	2	-	2	-						
CO 5	1	-	2	-	2	-						
CO 6	1	-	2	1	2	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3		✓	✓	✓
CO 4		✓	✓	✓
CO 5		✓	✓	✓
CO 6	✓	✓		✓

References:

1. Jojo Moolayil, “Smarter Decisions: The Intersection of IoT and Data Science”, PACKT, 2016.
2. Cathy O’Neil and Rachel Schutt, “Doing Data Science”, O'Reilly, 2015.
3. David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big data Analytics”, EMC 2013
4. Introduction to Data Science a Python approach to concepts, Techniques and Applications, Igual, L;Seghi’, S. Springer, ISBN:978-3-319-50016-4 2.
5. Data Analysis with Python A Modern Approach, David Taieb, Packt Publishing, ISBN-9781789950069

Programme	BCA				
Course Title	Foundations of Artificial Intelligence				
Type of Course	Major				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	A course on Discrete Mathematics is recommended				
Course Summary	This course provides an introduction to the field of Artificial Intelligence covering fundamental concepts, problem solving methods such as search algorithms and heuristics approaches and different knowledge representation techniques. The course addresses the ethical dimensions of AI and their societal impacts.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Able to gain insight into the evolution of key ideas and technologies by exploring the Artificial Intelligence history and its foundational concepts.	U	C	Instructor-created exams / Quiz/Assignment/ Seminar
CO2	Able to acquire knowledge and skills to understand, design, implement intelligent agents to perceive, reason and act within their environments.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar

CO3	Proficiency in various uninformed and informed search strategies along with constraint satisfaction problem solving methods.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO4	Ability to design and implement logical agents and construct ontologies that capture the semantics of a domain, facilitating knowledge representation.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO5	Understand the ethical considerations of AI and their societal impacts and gain insights into the future trajectory of AI by analysing the emerging trends.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO6	Represent various AI problems using algorithmic approaches and enhance problem-solving skills by visualizing solutions through the utilization of software tools.	U, Ap	C, P	Practical Assignment / Observation of Practical Skills
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Contents	Hrs (48+12)	Marks
I		**Introduction to AI**	**11**	**18**
	1	Artificial Intelligence: Definition and Applications	2	
	2	Foundations of Artificial Intelligence	1	
	3	History of Artificial Intelligence, State of the Art	2	
	4	Intelligent Agents: Agents and Environments	1	
	5	The Concept of Rationality, Nature of Environments: Specifying the Task Environment, Properties of Task Environment	3	
	6	Structure of Agents: Agent Programs, Simple Reflex Agent, Model Based Reflex Agent, Goal Based Agent, Utility Based Agent, Learning Agent (Concept Only, No Algorithm required)	2	
II		**AI Problem Solving**	**15**	**20**
	7	Problem Solving Agents (Concept Only), Examples Problems: Toy problems, Real world problems	3	
	8	Solutions for searching: Tree Search and Graph Search and Measuring Problem Solving Performance (Concept Only)	2	

	9	Uninformed Search Strategies: Breadth First Search, Uniform Cost Search, Depth First Search,	4	
	10	Informed search strategies: Greedy Best First search, A* Search, Heuristic Search (Concept Only)	2	
	11	Constrain Satisfaction Problems: Definition, Examples: Map colouring, Job-Shop scheduling	2	
	12	Constraint Propagation: Node Consistency, Arc Consistency, Path Consistency and K-Consistency	2	
III	**Knowledge Representation**		**13**	**20**
	13	Logical agents: Knowledge based agents, The Wumpus world	2	
	14	Logic: Definition, Propositional logic, Syntax and Semantics, Simple Knowledge Base	3	
	15	First Order Logic: Definition, Syntax and Semantic (Models, Symbols and Interpretations, Terms, Atomic Sentences, Complex Sentences, Quantifiers, Equality)	3	
	16	Ontological Engineering: Definition	1	
	17	Categories and Objects: Physical Composition, Measurements, Objects: Things and Stuff, Process, Time Intervals, Fluent and Objects Quantifying Uncertainty (Concept Only)	4	
IV	**AI: Philosophical Foundations and Future**		**9**	**12**
	18	Weak AI: Can machines act intelligently?	1	
	19	Strong AI: Can machines really think?	2	
	20	Ethics and risks of developing Artificial Intelligence	2	
	21	Agent components and architectures	2	
	22	Are we going in the right direction? What if AI succeed?	2	
V	**Open-Ended Module – Application Level**		**12**	
		Discuss topics from the following: • Discuss on evolution of AI • Analyzing different agent types and environments • Building a simple Reflex Agent • Identifying Problem-Solving agents in everyday applications • Implementation of Tree Search • Algorithmic implementation of A* Search and Heuristic Search	10	

		• Discussion on the effectiveness of heuristic methods • Real-world applications of CSP • Building a knowledge-based agent for the Wumpus World • Discussion on uncertainty in AI		
		Case Study: Provide students with case studies or examples of AI applications in different domains (e.g., healthcare, finance, marketing).	2	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-						
CO 2	2	-	2	2	2	2						
CO 3	2	-	2	2	2	2						
CO 4	2	-	2	2	2	2						
CO 5	2	-	2	2	-	-						
CO 6	1	-	1	1	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓

CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓

References:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2010.

2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education, 2017.

3. Elaine Rich, Kevin Knight, & Shivashankar B Nair, "Artificial Intelligence", McGraw Hill, 3rd Edition, 2009.

Semester IV

Programme	BCA				
Course Title	Database Management System				
Type of Course	Major				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Discrete Mathematics, Data structures and Programming Basics				
Course Summary	This course provides an introduction to database management systems. The topics covered include the concept of Database Management System, ER Model, Relational model, SQL, Database design, Transactions, concepts of other data model-NoSQL and practical session to implement Database Concepts.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	A comprehensive understanding of fundamental concepts in database management systems and its application	U	C	Instructor-created exams / Quiz
CO2	Understand concepts of Relational Data Model	U	C	Instructor-

	and Normalization Techniques			created exams / Quiz
CO3	Apply principles of entity-relationship modeling and normalization techniques to design efficient and well-structured databases that meet specified requirements.	Ap	P	Practical Assignment / Observation of Practical Skills
CO4	Acquire expertise in crafting and executing SQL queries for the retrieval, updating, and manipulation of data, showcasing adept skills in database querying and data manipulation	Ap	p	Practical Assignment / Observation of Practical Skills
CO5	Comprehend and apply strategies for managing transactions and implementing mechanisms for controlling concurrency, ensuring the database's consistency and reliability in environments with multiple users.	Ap	P	Practical Assignment / Observation of Practical Skills
CO6	Explore and analyze recent trends in database management systems, with a focus on unstructured databases, NoSQL technologies	An	P	Practical Assignment / Observation of Practical Skills
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Mark
I	**Database System- Concept**		**10**	**15**
	1	Introduction, Characteristics of the Database Approach	2	
	2	Actors on the Scene, Workers behind the Scene, Advantages of Using the DBMS Approach, File system vs Database	2	
	3	Data Models, Schemas, and Instances, Three-Schema Architecture and Data Independence	3	
	4	Database Languages and Interfaces	2	
	5	Structured, Semi Structured and Unstructured Database	1	
II	**Database Design**		**14**	**20**
	6	ER Model- Basic concepts, entity set & attributes, notations	2	
	7	Relationships and constraints, cardinality, participation, notations, weak entities	2	
	8	Relational Model Concepts-Domains, Attributes, Tuples, and Relations, Values and NULLs in the Tuple	2	
	9	Relational Model Constraints and Relational Database Schemas	2	
	10	Relational Database Design- Atomic Domain and Normalization- INF, 2NF,3NF, BCNF	4	
	11	4NF,5NF	2	
III	**Query Languages**		**11**	**20**
	12	SQL-, introduction to Structured Query Language (SQL)	1	
	13	Data Definition Language (DDL), Table definitions and operations	2	
	14	SQL DML (Data Manipulation Language) - SQL queries on	4	

		single and multiple tables		
	15	Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types.		
	16	Introduction to NoSQL Databases	2	
	17	Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB)	2	
IV	**Transaction Processing, Concurrency Control**		**10**	**15**
	18	Transaction Processing: Introduction, Transaction and System Concepts	3	
	19	Desirable Properties of Transactions	1	
	20	Characterizing Schedules Based on Recoverability & Serializability	2	
	21	Transaction Support in SQL.	1	
	22	Introduction to Concurrency Control: Two-Phase Locking Techniques	3	
V	**DBMS LAB**		**30**	
	1	Students should decide on a case study and formulate the problem statement.	3	
	2	Based on Identified problem Statement, Design ER Diagram (Identifying entities, attributes, keys and relationships between entities, cardinalities, generalization, specialization etc.) Note: Student is required to submit a document by drawing ER Diagram to the Lab teacher.	3	
	3	Converting ER Model to Relational Model (Represent entities and relationships in Tabular form, Represent attributes as columns, identifying keys) Note: Student is required to submit a document showing the database tables created from ER Model.	2	
	4	Normalization -To remove the redundancies and anomalies in the above relational tables, Normalize up to Third Normal Form	3	
	5	Creation of Tables using SQL- Overview of using SQL tool, Data types in SQL, Creating Tables (along with Primary and Foreign keys), Altering Tables and Dropping Tables	3	
	6	Practicing DML commands-Insert, Select, Update, Delete	2	
	7	Experiment 7: Practicing Queries using ANY, ALL, IN, EXISTS, NOT EXISTS, UNION, INTERSECT, CONSTRAINTS etc.	2	
	8	Practicing Sub queries (Nested, Correlated) and Joins (Inner, Outer and Equi).	2	
	9	Practice Queries using COUNT, SUM, AVG, MAX, MIN, GROUP BY, HAVING, VIEWS Creation and Dropping.	4	
	10	Install and Configure MongoDB to execute NoSQL Commands.	6	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	-	-	-	-						

CO 2	2	2	1	-	-	-						
CO 3	-	-	2	3	-	-						
CO 4	-	-	-	3	3	-						
CO 5	-	-	-	3	3	-						
CO 6	2	-	-	-	2	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3		✓	✓	✓
CO 4		✓	✓	✓
CO 5	✓	✓		✓
CO 6		✓	✓	✓

References:

1. Database System Concepts (Sixth Edition) Avi Silberschatz, Henry F. Korth, S. Sudarshan McGraw-Hill 2011 ISBN 978-0071325226/ 0-07-352332-1.

2. Database Management Systems, Third Edition Raghu Ramakrishnan and Johannes Gehrke McGraw-Hill ©2003 ISBN: 978-0072465631/ 0-07-246563-8.

Programme	BCA				
Course Title	Python Programming				
Type of Course	Major				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Knowledge in Fundamentals of Programming				
Course Summary	This course explores the versatility of Python language in programming and teaches the application of various data structures using Python. The course also introduces fundamental concepts of object-oriented programming and insights into leveraging Python packages.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic concepts of Python programming language.	U	C	Instructor-created exams / Quiz
CO2	Apply problem-solving skills using the basic constructs in Python programming	Ap	P	Coding Assignments/ Code reading and review
CO3	Apply modular programming using functions in Python	Ap	P	Coding Assignments/ Code reading and review
CO4	Analyse the various data structures and operations on it using Python	An	C	Instructor-created exams / Case studies
CO5	Apply various packages available in Python	Ap	P	Coding Assignments/ Case studies
CO6	Apply visualization tools in Python	Ap	P	Coding Assignments/ Case studies
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I		**Introduction to Python and Control Flow Statements**	**10**	**15**

	1	Tokens in Python	2	
	2	Operators Precedence & Associativity & Type Conversion	1	
	3	Built-in functions	1	
	4	Decision-making Structures	3	
	5	Looping Structures	3	
I	**Introduction to Functions & Modules**		**12**	**20**
I	6	Introduction to functions	2	
	7	Scope and lifetime of variables	1	
	8	Types of arguments	3	
	9	Types of functions – recursive, anonymous, returning more than onevalue	3	
	10	Introduction to Modules	1	
	11	User-defined modules and packages	2	
III			**12**	**20**
	12	Introduction to Strings and traversal	2	
	13	Slicing, splitting, and joining methods on Strings	1	
	14	Introduction to Lists and traversal	1	
	15	List methods	2	
	16	Introduction to Dictionaries and traversal	1	
	17	Dictionaries methods	2	
IV	**Introduction to Scientific Computing in Python**		**11**	**15**
	18	Basics of NumPy Arrays	2	
	19	Computation on NumPy Arrays	2	
	20	Basics of Pandas objects	3	
	21	Basics of Matplotlib	1	
	22	Plotting in Matplotlib	3	
V	**Hands-on Data Structures: Practical Applications, Case Study and Course Project**		**30**	
	1	**Introduction to Python** • Running instructions in Interactive interpreter and a PythonScript. • Generate output with print statements • Read input, including casting that input to the appropriate type • Perform calculations involving integers and floating point numbers using Python operators like +, -, *, /, //, %, and ** • Call functions residing in the math module	20	
	2	**If Statement** • Make a decision with an if statement • Select one of two alternatives with an if-else statement • Select from one of several alternatives by using an if-elif or if-elif-else statement Construct a complex condition for an if statement that includes theBoolean operators and, or and not		
	3	**Loops** • Iterate over a sequence using a for loop		

		• Use the range () function in a form loop • Create a while loop to repeat a block of code • Use the break and continue statement • Nested loops For loop with else clause • While loop with else clause		
	4	**Function** • Define a function for later use • Pass one or more values into a function • Perform a complex calculation within a function • Return one or more results from a function • Call a function that you have defined previously		
	5	**Strings** • Create a string • String Indexing • Looping through a String • String Slicing		
	6	**Lists** • Create a list • List Indexing • Looping through a list • Adding items to a list • Modifying items of a list • Removing elements • List Slicing		
	7	**Tuples** • Create a tuple • Tuple Indexing • Looping through a tuple • Adding items to a tuple • Tuple Slicing		
	8	**Dictionary** • Create a dictionary and access values with key • Adding a key-value pair • Adding to an empty dictionary • Modifying values in a dictionary • Removing key-value pair • Looping through a dictionary- Looping through all key-valuepairs, Looping through all the keys, Looping through all the values		
	9	**NumPy** • Create NumPy(1 D, 2D, and 3D) arrays from a sequence • Create NumPy Arrays using functions • Arithmetic Computations using Universal Functions • Broadcasting • Fancy Logic		
	10	**Pandas** • Create a data frame from a dictionary • Create an explicitly indexed series object from an array or list • Create Index objects of various types		

		• Perform set operations on Index objects		
	11	**Matplotlib** • Create and format a simple line plot • Create and format a simple scatter plot • Create and format a simple histogram • Create and format a contour plot		
	12	Case study	3	
	13	Capstone (/Course) Project: Build a practical application using any onepackage and implement the visualization tools	7	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	-						
CO2	1	-	2	-	1	-						
CO3	1	-	2	1	-	-						
CO4	1	-	1	-	-	-						
CO5	3	2	2	2	2	2						
CO6	3	2	2	-	2	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓

CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Jose, Jeeva. Taming Python by Programming. Khanna Book Publishing, 2017. Print.
2. S, Gowrishankar, and A, Veena. Introduction to Python Programming. Chapman & Hall/CRC Press, 2018.
3. Downey, Allen. Think Python. Green Tea Press, 2nd ed. 2009
4. VanderPlas, Jake. Python Data Science Handbook: Essential Tools for Working with Data. United States, O'Reilly Media, 2016.
5. Stephenson, Ben. The Python Workbook. SPRINGER INTERNATIONAL PU, 2016.

Programme	Bachelor of Computer Applications (BCA)				
Course Title	Software Engineering				
Type of Course	Major				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Understanding fundamental computer science concepts, data structures, and algorithms. 2. Basic knowledge of project planning and scheduling				
Course Summary	After completing the course students may be engaged in practical exercises, projects, and teamwork to apply theoretical concepts to real-world scenarios. The goal is to equip students with the knowledge and skills needed to develop high-quality software solutions and contribute effectively to the software development lifecycle.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To learn and understand the Concepts of Software Engineering	Ap	C	Practical Assignment / Instructor-created exams / Quiz
CO2	To Learn and understand Software Development Life Cycle. Identify and apply appropriate SDLC models and methodologies.	Ap	P	Practical Assignment / Instructor-created exams / Quiz

CO3	To apply the project management and analysis principles to software project development.	Ap	C	Practical Assignment / Instructor-created exams / Quiz
CO4	To apply principles of software design to create high-quality software architectures. Demonstrate proficiency in programming languages and coding standards.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO5	To apply testing techniques to ensure software quality and identify and perform different types of software maintenance activities.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Prepare and deliver effective project presentations.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**THE SOFTWARE PROCESS**		**10**	**15**
	1	Software Engineering: Nature of Software, Software Engineering, Software Process, Software Development Life Cycle	1	
	2	Prescriptive Process Models – Waterfall, Incremental, Evolutionary	3	
	3	Agile Process: What is Agility, What is agile Process?	2	
	4	Extreme Programming: XP Values, XP Process, Industrial XP, XP Debate	1	
	5	Other Agile Process Models: Adaptive Software Development, , Scrum, Dynamic Systems Development Method, Crystal	3	
II	**REQUIREMENT ENGINEERING**		**10**	**15**
	6	Introduction to Requirement Engineering: Functional and non-functional requirement (Types)	2	
	7	Requirement engineering process	2	
	8	Requirement Elicitation: Concept of Requirement Elicitation, Elicitation Technique, Stories and Scenarios,	2	
	9	Requirement Specification: Concept, Natural Language Specification, Structured Specification, Use Cases, Software Requirement Document,	2	
	10	Requirement Validation: Concept, Requirement Change,	2	
III	**SYSTEM MODELLING, ARCHITECTURAL DESIGN**		**14**	**20**
	11	Context models: Detailed Concept	2	
	12	Interaction models: Concept, Use case modelling, Sequence Diagram,	2	
	13	Structural Models: Concept, Class Diagram, Generalization, Aggregation,	2	

	12	Behavioural Models: Concept, Data driven modelling, Event driven modelling, Model driven engineering,	2	
	13	Architectural design decisions: Detailed concept	2	
	14	Architectural views: Detailed concept, Layered Architecture, Repository Architecture, Client-Server architecture, Pipe and Filter Architecture.	2	
	14	Architectural patterns: Transaction Processing Systems, Information Systems, Language Processing System,	2	
IV	**TESTING, MAINTANENCE AND RE ENGINEERING**		**14**	**20**
	16	Strategic Approach to Software Testing: Verification and Validation, Organizing for Software Testing, Software Testing Strategy	2	
	17	Strategies for Conventional Software: Unit and Integration Testing	2	
	18	Strategies for Object Oriented Software: Unit Testing and Integration Testing in OO Context.	2	
	19	Validation Testing, System Testing, White Box Testing and Black Box Testing	2	
	20	Software Maintenance - Software Supportability, Reengineering	2	
	21	Business Process Reengineering: Business Process, BPR Model	2	
	22	Software Reengineering and Reverse Engineering	2	
V	**Open Ended Module- Trends in Software Engineering**		**12**	
		1. Case Study. 2. Engage in a substantial project that integrates knowledge from various areas of software engineering. 3. Explore the process of creating a software startup. 4. Apply critical thinking skills to software design and implementation.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	-	-	2	-						
CO 2	1	1	-	-	2	-						
CO 3	1	1	2	-	3	-						
CO 4	1	1	2	-	3	-						
CO 5	1	1	2	-	3	3						
CO 6	1	1	-	-	3	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Sommerville, I. (2016). Software Engineering (10th ed.). Pearson Education.

2. Pressman, R. S. (2010). Software Engineering: A Practitioner's Approach (7th ed.).

3. Van Vliet, H. (2008). Software Engineering: Principles and Practices.

4. Fairley, R. E. (2008). Software Engineering Concepts.

5. Khurana, R. (n.d.). Software Engineering: Principles and Practices (2nd ed.). Vikas Publishing House Pvt Ltd.

6. Jalote, P. (n.d.). An Integrated Approach to Software Engineering (3rd ed.). Narosa Publishing House.

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Programme	BCA				
Course Title	Automation and Robotics				
Type of Course	Major				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	No pre-requisites required				
Course Summary	This course provides a comprehensive overview of automation which includes their production systems, elements, automation functions and usage of discrete and continuous control system. The course also explores the fundamentals of robotics, including anatomy, process control and how these functions could be improved by the integration of Artificial Intelligence.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the production systems and automation, enabling them to analyse, optimize and evaluate the different levels of automation.	U	C	Instructor- created exams / Quiz/Assignment/ Seminar
CO2	Able to recognize the difference between the process industries, manufacturing industries, continuous and discrete control system.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO3	Proficiency in understanding the various forms of process control which includes the direct digital control, programmable logic control, distributable control systems etc.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO4	Familiarize with the various hardware components used for automation and process control such as sensors, actuators analog-digital converters etc.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO5	Understand the present developments in the field of automation and robotics and how integrating artificial intelligence can contribute to the future of these systems.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar

CO6	Represent various problems using algorithmic approaches and enhance problem-solving skills by visualizing solutions through the utilization of software tools.	U, Ap	C, P	Practical Assignment / Observation of Practical Skills

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Contents	Hrs (48+12)	Mark
I		**Introduction to Automation**	**11**	**15**
	1	Production systems - Facilities, Manufacturing support systems	2	
	2	Automation in production systems – Automated manufacturing system, Computerized manufacturing support systems, Reasons for automating	3	
	3	Manual labour in production systems	1	
	4	Elements of automation - power to accomplish the process, Program of instructions, control system	3	
	5	Advanced automation functions – safety monitoring, maintenance and repair diagnostics, error detection and recovery	1	
	6	Levels of automation	1	
II		**Control Systems**	**14**	**15**
	7	Process industries versus Discrete manufacturing industries, Continuous versus Discrete control	2	
	8	Continuous control system	3	
	9	Discrete control system	1	
	10	Computer process control, Control requirements, Capabilities of computer control	2	
	11	Forms of computer process control - Computer process monitoring, Direct digital control, Computer numerical control and robotics, Programmable logic controllers, Supervisory control and data acquisition, Distributed control systems	3	
	12	Hardware for automation and process control (Concept only) - Sensors, Actuators, Analog to Digital converters Digital to Analog converters, Input/output devices for discrete data.	3	
III		**Industrial Robotics**	**15**	**25**

	13	Robot anatomy – Joints and links, Common robot configurations, Joint drive systems, Sensors in robotics	4	
	14	Robot control systems – Limited sequence control, Playback with point-to-point control, Playback with continuous path control, Intelligent control	2	
	15	End effectors – Grippers, Tools	1	
	16	Robot Programming – Lead through programming, Powered lead through, Motion programming, Advantages and disadvantages	2	
	17	Discrete process control – logic control, sequence control	4	
	18	Programmable Logic Controllers, Components of PLC	2	
IV	**Automation and Robotics: Present and Future**		**8**	**15**
	19	Machine Intelligence, Computer and Robotics	2	
	20	Flexible automation vs Robotics technology	2	
	21	Artificial Intelligence and Automated Manufacturing, AI and Robotics	2	
	22	Robotics in India, Future of Robotics	2	
V	**Open Ended Module – Application Level**		**12**	
	1	Discuss topics from the following: • Role of manual labour in modern manufacturing. • Benefits and challenges of automation. • Developing a simple automated process with control instructions. • Types of error detection and recovery system. • Discussion on the impact of automation levels on production efficiency. • Exploring the role of computer process control in modern manufacturing • Implementing basic computer process control using simulation software. • Visioning the future of robotics in India.	10	
	2	Host a discussion session on the intersection of Artificial Intelligence (AI) and Robotics in automated manufacturing.	2	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-						

CO 2	2	2	-	-	2	-						
CO 3	2	2	-	-	2	-						
CO 4	2	2	-	-	2	-						
CO 5	1	-	-	-	-	1						
CO 6	-	-	2	2	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓

References:

1. Mikell P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, 4th edition, Pearson Education, 2017.

2. S.R. Deb, S. Deb “ Robotics Technology and flexible automation,” Tata McGraw-Hill Education, 2017.

3. Mikell P. Groover, “ "Industrial Robots - Technology, Programming and Applications", McGraw-Hill Education, 2017.

Semester V

Programme	BCA				
Course Title	Object Oriented Programming (Java)				
Type of Course	Major				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Knowledge in basic programming 2. Knowledge in OOP Concepts				
Course Summary	The aim of this course is to provide students with an understanding of the basic concepts in Java programming. This course will help students create GUI applications in Java and establish database connectivity.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the concepts and features of Object-Oriented Programming (OOPs)	U	C	Practical Assignment / Instructor-created exams / Quiz
CO2	To practice programming in Java	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	To learn java's exception handling mechanism, I/O operations and multithreading.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO4	To learn java's O operations and multithreading.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Implement programs using Java Database Connectivity	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Students will be capable of	Ap	P	Practical

	developing Graphical User Interface (GUI) applications using Swing, understanding layout management, and implementing basic event handling.			Assignment / Instructor-created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I	**Review of OOPs and Introduction to Java**		**17**	**20**
	1	Overview of OOPs Concept	1	
	2	History of Java and Java Virtual Machine	1	
	3	Basic Structure of Java Programming: Data Types, Operators, Expression and Control Statement	2	
	5	Arrays and String: One Dimensional Array, Multidimensional Array, String Operations	2	
	6	Scanner, Type Conversion and Casting	2	
	7	Introduction to Class and Objects: Definition of Class and Objects, Access Modifier	2	
	8	Constructor and Inheritance: Types of Constructors, Types of Inheritance, use of extends, super, final, this keyword	3	
	9	Method Overriding, Method Overloading and Dynamic Method Dispatch: Programming implementation of Method Overriding and Overloading	2	
	10	Interface, Abstract Class and Packages; Programming implementation of Interface, Abstract class and Packages	2	
II	**Exception and I/O Operations**		**8**	**15**
	11	Exception: Baic Concept of exception and Exception Hierarchy	2	
	12	Managing Exception: Use of try….catch ….. finally blocks, throw and throws keyword	2	
	13	Managing Input/Output files in Java: Importance of I/O Operations, BufferedInputStream, BufferedOutputStream	2	
	14	File Operations: Programming implementation of FileInputStream, FileOutputStream, FileReader, FileWriter	2	
III	**Multithreading and Database Connectivity**		**9**	**20**
	15	Thread: Concept of Thread and Thread state	2	

	16	Programming Implementation of Thread: Using extending thread class and Runnable interface, Thread Priorities	2	
	17	Database Programming: Basic Concept of Database and JDBC Driver, Connecting with Database	2	
	18	Querying Database: Programming implementation of creating table, insert and update values to the table using preparedStatement, Statement object and querying the values using ResultSet and ResultSetMetadata	3	
IV	**GUI Programming**		**11**	**15**
	19	Introduction to GUI Application: AWT Basics, Introduction to IDE	2	
	20	Swing Programming: Introduction of Model-View-Controller Pattern	2	
	21	Introduction to layout Management: Fundamental controls used in SWING	4	
	22	Event Handling: Basic Knowledge of Event Handling (Event Class and Event Listener)	3	
V	**Hands-on Programming in Java(Using IDE NetBeans, Eclipse, VSCode):**		**30**	**30**
	Practical Applications, Case Study and Course Project			
	1	Implement the following:		
		1. String and Arrays:	20	
		Write a program to perform various String operations in Java (Hint: charAt, substring, concat, equals,, isEmpty..)		
		Write a program to implement Multi-Dimensional Array (Hint : Matrix multiplication)		
		2. Object Oriented Programming Concept:		
		Write a program to implement the concept of class and object (Hint: Complex Number addition)		
		Write a program to demonstrate the order in which constructors are invoked in multilevel inheritance.		
		Write a program to implement method overloading		
		Write a program to implement method overriding.		
		3. Exception Handling and Multithreading:		
		Write a program to implement try…cath, finally block (Hint: Arithmetic and ArrayOutOfBoundException)		
		Write a multi thread java program for displaying odd numbers and even numbers up to a limit (Hint: Create thread by inheriting Thread class).		
		Write a multi thread java program for displaying odd numbers and even numbers up to a limit (Hint: Implement thread using Runnable interface).		
		4. GUI Application with Database:		

		Write a swing program to track mouse & key events		
		Write a swing program to fetch data from TextFiled and display it in Label		
		Write a swing program to perform form validation		
		Write a swing program to display data in tabular form		
		Write a simple login program without database connectivity		
		Write a swing program to create a registration form (Hint: Create table student in any database and link the registration form with database using JDBC)		
	2	Case Study	2	
	3	**Project:** Build a application for shop management system (Eg: Admin Login, Product registration, stock management, product selling, employee salary)	8	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	3	3	-	-						
CO 2	1	-	3	3	-	-						
CO 3	-	-	3	3	2	3						
CO 4	-	-	2	3	-	-						
CO 5	-	-	3	3	2	3						
CO 6			3	3	3							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓

References:

1. Herbert Scheldt, Java: The Complete Reference, 12th Edition, Tata McGraw-Hill Edition, ISBN: 9781260463415.

2. C. Thomas Wu, An introduction to Object-oriented programming with Java, 5e, McGraw-Hill, 2009.
3. Y. Daniel Liang, Introduction to Java programming, Comprehensive Version, 10e, Prentice Hall India, 2013.
4. K. Arnold, J. Gosling, David Holmes, The JAVA programming language, 4e, Addision-Wesley, 2005.

Programme	BCA				
Course Title	Progressive Web Application using PHP				
Type of Course	Major				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Knowledge in basic programming 2. Basic Knowledge in HTML				
Course Summary	main objective of this course is to develop dynamic web pages. To implement server-side scripting and client-side scripting, data base connectivity to develop dynamic web page.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used

CO1	To familiar with the concept HTML5	U	P	Practical Assignment / Instructor-created exams / Quiz
CO2	To familiar with the concept CSS, Javascript, Server-Side Scripting	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	To learn the PHP programming environment	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO4	To learn how to develop a dynamic website using PHP and PostgreSQL	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Students will acquire knowledge of common security vulnerabilities in web applications and understand best practices for writing secure PHP code.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Students will be equipped to develop modular and scalable PHP applications using object-oriented techniques.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I	**Introduction to Web Document**		**10**	**22**
	1	Introduction to the Web Programming, Client and Server Side Scripting	1	
	2	HTTP, HTTPS, URLs, request/response cycle, Difference between static and dynamic websites	1	
	3	HTML5 Essentials: HTML5 document structure (<!DOCTYPE>, <html>, <head>, <body>), Semantic tags (<header>, <section>, <article>, <footer>)	2	
	5	HTML forms (inputs, buttons, validation attributes), Multimedia elements: <video>, <audio>, <canvas>, <svg>	2	
	6	CSS3 Styling and Layout: CSS syntax, selectors (class, ID, group, descendant), Box model, margins, padding, borders, fonts, text shadows, line height.	2	
	7	Colors, gradients, background images, Layouts using Flexbox and CSS Grid, Responsive design with media	2	

		queries		
II	**Exploring Scripting Language**		**10**	**13**
	8	Modern JavaScript (ES6+): Introduction, Variables (let, const), data types	2	
	9	Functions (declaration, expression, arrow functions), Arrays, objects, destructuring,	2	
	10	DOM manipulation: selecting, updating, creating elements, Event handling (click, submit, change)	2	
	11	Fetch API for HTTP requests, Promises and async/await	2	
	12	jQuery Basics (for legacy projects): jQuery syntax, Event handling, animations, and DOM manipulation	2	
III	**Introduction to PHP**		**16**	**20**
	13	PHP Basics: Introduction to PHP 8 features, Variables, constants, data types, Operators, control structures (if, loops, switch)	3	
	14	Arrays (indexed, associative), string functions, Superglobals: $_GET, $_POST, $_SESSION, $_COOKIE, Form creation, data validation & sanitization	2	
	15	File upload handling, Sessions and cookies management	2	
	16	PHP & MySQL Integration: Basic MySQL operations (CREATE, SELECT, INSERT, UPDATE, DELETE), MySQLi & PDO connections in PHP	3	
	17	Fetching data (fetch_assoc, fetch_array, fetch_object), Prepared statements & SQL injection prevention	3	
	18	AJAX and Dynamic Content: Introduction to AJAX and XMLHttpRequest, Live form handling or search examples	3	
IV	**Laravel Framework and Deployment Essentials**		**9**	**15**
	19	Laravel Basics: What is Laravel? Why use it?, MVC Concept (Model-View-Controller), Installing Laravel using Composer, Folder structure: routes/, app/Http/Controllers, resources/views	2	
	20	Routing, Controllers & Blade: Defining web routes, Creating controllers using Artisan, Blade templating basics (layout, sections, data display)	2	
	21	Laravel + MySQL Database: .env file configuration, Running migrations to create tables, Creating models and interacting with MySQL database	3	
	22	Creating a CRUD interface (e.g., Task List, Student Records), Form creation with CSRF protection, Basic server-side validation using Laravel, Overview of deployment options: shared hosting, XAMPP, Laragon	2	

V	**Hands-on Programming in PHP (Using IDE NetBeans, Notepad++, VS Code):**		**30**	**30**
	Practical Applications, Case Study and Course Project			
	1	Implement the following:		
		1. HTML and CSS	20	
		Design a webpage that illustrates the use of the following form controls: (i) Input controls: single-line text, password, radio-button, multi-line text. (ii) Buttons: submit and reset		
		Design a webpage that illustrates the use of the following form controls: (i) Input controls: data list, multi-select box, grouped select box (ii) Buttons: submit and reset		
		Design a webpage that illustrates the use of field sets and legends		
		Design a web page to demonstrate Text alignment and Border colours using internal CSS		
		Using HTML, CSS create a custom hover and focus effect for navigation items, using CSS transformations		
		Design a web page to demonstrate inline CSS.		
		2. JavaScript and JQuery		
		Write a JavaScript program to calculate multiplication and division of two numbers (input from the user).		
		Write a JavaScript program to convert a number in bytes to a human-readable string.		
		Write a JavaScript program that implements a "form" validation that displays an error message if a required field is left empty when submitting the form.		
		Write a JavaScript program to compare two objects to determine if the first contains equivalent property values to the second one.		
		3. Database Programming		
		Create a php program to display the bio data of a person by reading the personal details using an HTML page.		
		Create a login page using database.		
		Create a MySQL table student with fields roll no, name, mark, grade. Write a PHP program to insert and display the mark list of a student by accepting the register no of the student.		
		Design a PHP page to implement a login screen using sessions. Login details are to be verified from the server side with values stored in a database.		
		Design a PHP page to illustrate the use of file upload – uploading files of a type with a specified size to the webserver		
		Design sample application using Laravel		

	2	Case Study	2	
	3	**Project:** Build a web application for shop management system (Eg: Admin Login, Product registration, stock management, product selling, employee salary)	8	

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	3	3	-	-						
CO 2	1	-	3	3	-	-						
CO 3	-	-	3	3	2	3						
CO 4	-	-	2	3	-	-						
CO 5	-	-	3	3	2	3						
CO 6			3	3	3							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓

CO 4		✓		✓
CO 5		✓		✓

References:

1. Dreamtech Press. (2016). HTML 5 Blackbook. ISBN 9879351199076.

2. Gilmore, W. (n.d.). Beginning PHP and PostgreSQL 8: From Novice to Professional. Goels Computer Hut. ISBN: 9788181286000.

3. Duckett, J. (n.d.). Beginning Web Programming with HTML, XHTML, CSS. Wrox.

4. Converse, J., & Park, J. (n.d.). PHP & MySQL Bible. Wiley.

5. PostgreSQL. (n.d.). Official Documentation Online.

Programme	BCA				
Course Title	Digital Electronics and Computer Architecture				
Type of Course	Major				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic understanding of mathematical concepts, especially areas like algebra				
Course Summary	This course provides a comprehensive introduction to the fundamentals of digital systems, covering topics related to binary arithmetic, basic computer logic, combinational and sequential logic circuits, as well as basic computer organization and design. Throughout the course, students will gain a solid understanding of digital systems, from the basic building blocks of logic circuits to the design and organization of processors and memory				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand Basic Binary Arithmetic Techniques	U	C	Instructor-created exams / Quiz
CO2	Implement logic operations using basic gates and Boolean algebra, design and optimise logic expressions using	Ap	P	Instructor-created exams/ Home

	Karnaugh maps and design combinational logic circuits			Assignments
CO3	Understand the operation of latches and flipflops and the design of sequential logic circuits	U	C	Instructor-created exams
CO4	Learn the basic computer organization by understanding the role of registers, buses, ALU and control unit and the concepts like parallel processing and pipelining	U	C	Instructor-created exams
CO5	Understand how instructions represented, addressed and executed and how a microprogrammed control unit work	U	C	Instructor-created exams
CO6	Understand the concepts of memory and IO organization	U	C	Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Number systems and Boolean Algebra**		**10**	**15**
	1	Binary arithmetic: Addition, Subtraction, Concepts of 1's and 2's complement, 1's and 2's complement addition	2	
	2	Logic Gates: AND, OR, NOT, NOR, NAND, XOR, XNOR, Universal Property of NAND and NOR gates	3	
	3	Boolean algebra: Boolean operations, laws and rules, Demorgan's theorem	2	
	4	Boolean Expression Simplification using K Map up to 4 variables	3	
II	**Combinational and Sequential Logic Circuits**		**12**	**20**
	5	Combinational Circuits: Half Adder, Full Adder, Ripple Carry Adder	1	
	6	Combinational Circuits: Encoder and Decoder (Basic Circuit Only)	1	
	7	Combinational Circuits: Multiplexer and Demultiplexer (Basic Circuit Only)	1	
	8	Concepts of Latches and Flipflops, Types of Flipflops (SR, D, JK, T): Truth Table and Circuit	3	
	9	Sequential Circuits: Synchronous and Asynchronous Counters	4	
	10	Johnsons and Ring counter, Shift Registers	2	
III	**Basic Computer Organization and Micro Programmed Control**		**10**	**15**
	11	Instruction codes, Registers and Common Bus system	2	
	12	Computer Instructions	1	
	13	Timing and Control: Concepts of hardwired and microprogrammed control	1	
	14	Instruction Cycle	1	
	15	Microprogrammed Control: Control memory & Address Sequencing	3	
	16	Micro Instruction Format and Symbolic Micro Instruction	2	
IV	**Processor, Memory and I/O Organization**		**16**	**20**

	17	Processor Organisation: General Register organization and stack organization, Instruction formats and addressing modes	4	**15**
	18	Processor Organisation: RISC vs CISC, Parallel Processing	2	
	19	Pipelining: General Considerations, Arithmetic Pipeline, Instruction Pipeline	3	
	20	Memory Organisation: Memory Hierarchy, Main Memory	1	
	21	Associative Memory, Cache Memory Mapping	4	
	22	IO Organisation: Modes of transfer: programmed IO, Interrupt initiated IO, DMA (Concepts Only)	2	
V	**Open Ended Module: Computer Arithmetic & Types of Instruction**		**12**	
	1	Computer Arithmetic: Addition and Subtraction, Multiplication Algorithms, Division Algorithms	7	
	2	Examples for Memory Reference, Register Reference, Input Output Instructions, Data Transfer Instructions, Data Manipulation Instructions, Arithmetic Instructions, Logical and Bit Manipulation Instructions, Shift Instructions, Program Control Instruction, Conditional Branch Instructions Subroutine Call and Return	5	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	-	-	-	-	-						
CO 2	-	3	-	-	-	-						
CO 3	-	3	-	-	-	-						
CO 4	-	2	-	-	-	-						
CO 5	-	3	-	-	-	-						
CO 6	-	3	-	-	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓			✓

References:

1. "Digital Fundamentals", Thomas L. Floyd
2. "Computer System Architecture", M. Morris Mano
3. "Computer Organization", Carl Hamacher, Zvonko Vranesic

Semester VI

Programme	BCA				
Course Title	Introduction to Artificial Intelligence and Machine Learning				
Type of Course	Major				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamental Mathematics Concepts: Sets 2. Fundamentals of Python Programming				
Course Summary	This course provides an introduction to the ideas, techniques, and applications of artificial intelligence (AI) is given in this course. The fundamentals of knowledge representation, machine learning, and problem solving will be taught to the students.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Differentiate various knowledge representation methods, AI operations, Machine learning approaches and real-world applications.	U	C	Instructor-created exams / Quiz
CO2	Master Problem-Solving Techniques (search algorithms, heuristic approaches, and informed search strategies). Analyse and evaluate its efficiency.	U	P	Practical Assignment / Observation of Practical Skills
CO3	Investigate the properties and applications of various machine learning techniques	Ap	P	Seminar Presentation / Group Tutorial Work/ Viva Voce
CO4	Evaluate Artificial Intelligence Search algorithms and Machine learning approaches' efficiency.	U	C	Instructor-created exams / Home Assignments
CO5	Implement and analyse Machine learning algorithms to solve practical problems.	Ap	P	One Minute Reflection Writing assignments
CO6	Apply Concepts in Real-World Projects	Ap	P	Case Study/ mini Project
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I	**Introduction to Artificial Intelligence & Problem Solving and Searching**		**15**	**15**
	1	Introduction to AI – AI problems, AI Techniques	2	
	2	Various AI Domains (Introduction only)	1	
	3	Problem Solving Techniques - Search Algorithms, Knowledge representation and reasoning, constraint satisfaction problems, Game playing, Machine learning, Simulated Annealing (Concepts only)	3	
	4	Uninformed search algorithms (breadth-first, depth-first)	3	
	5	Informed search algorithms (A*, heuristic search- Generate and Test, Hill Climbing, Best First Search)	6	
II	**Knowledge Representation & Reasoning**		**10**	**20**
	6	Knowledge representation using Propositional & Predicate Logic	3	
	7	Semantic Networks & Frames	3	
	8	Rule based system & Introduction to Expert System (Concepts	2	

		only)		
	9	Reasoning- Forward Vs Backward reasoning & logics for non-monotonic Reasoning	2	
III	**Introduction to Neural Networks**		**8**	**15**
	10	Introduction to Artificial Neural Network	1	
	11	Understanding Brain & Perceptron Model	1	
	12	Single Layer Perceptron Model & Learning in Single layer Perceptron Model	2	
	13	Multi-Layer Perceptron Model & Learning in Multi-layer Perceptron Model	2	
	14	Introduction to python packages- keras & sklearn	2	
IV		**Machine Learning Fundamentals**	**12**	**20**
	15	Introduction to Machine learning- Applications of Machine Learning	1	
	16	Supervised Machine learning- Classification & regression algorithms (Introduction: Linear Regression, Decision tree)	2	
	17	Unsupervised Machine Learning-Clustering & Dimensionality Reduction (Introduction: K means Clustering, PCA)	2	
	18	Reinforcement Learning: Elements of Reinforcement Learning	2	
	19	Feature Engineering & Feature Selection	2	
	20	Building a classification model by training with data	1	
	21	Classification model evaluation- Introduction to confusion matrix	1	
	22	Practical implementation to set up a machine learning model	1	
V	**Hands-on Artificial Intelligence & Machine Learning using Python: Practical Applications, Case Study and Course Project**		**30**	
	1	Implement the following: **1. Search algorithms** BFS DFS **2. Neural Network** Building a single layer perceptron using Keras **3. Multi-layer Neural Network** Setting up a multi-layer perceptron model **4. Supervised machine learning** Linear regression Decision tree **5. Unsupervised machine learning** K means clustering PCA **6. Feature Engineering** Feature selection from a dataset	20	
	2	Case study – AI tools / Use of AI in any movie	3	
	3	Implementation of Comparison of any two machine learning algorithms on a dataset	7	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	1	1	1	2	1						
CO 2	1	3	2	3	2	2						
CO 3	2	3	2	3	2	3						
CO 4	2	-	1	2	-	-						
CO 5	2	-	2	3	3	3						
CO 6	3	-	-	3	3	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓	✓	✓
CO 6		✓	✓	

References:

1. Elaine Rich, Kevin Knight, Shivsankar B Nair, "Artificial Intelligence", Third Edition, Tata McGraw Hill Publisher
2. Tom M. Mitchell, Machine Learning, McGraw-Hill, 1st Ed.
3. Ethem Alpaydin, Introduction to Machine Learning- 3rd Edition, PHI.

Programme	BCA				
Course Title	Principles of Operating Systems				
Type of Course	Major				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Knowledge in Basic System Architecture				
Course Summary	This course provides students with a comprehensive understanding of the fundamental principles, design concepts, and practical implementation aspects of operating systems. The course covers key topics such as Process Management, CPU Scheduling, Memory Management and Linux Shell Programming concepts.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Summarize the History, Objectives and Functions of an operating system	U	C	Instructor-created exams / Quiz
CO2	Understand process management concepts: Process Control Block, States, Scheduling, Operations, Inter process Communication	U	C	Instructor-created exams
CO3	Evaluate various processor scheduling strategies, algorithms	E	P	Seminar Presentation / Group Tutorial Work
CO4	Apply process synchronisation concepts for effective process management	Ap	P	Viva Voce
CO5	Analyse conditions for deadlock occurrence and methods of resolving.	An	C	Instructor-created exams/Assignments
CO6	Describe various memory management techniques, including paging , segmentation and virtual memory	U	C	Instructor-created exams / Home Assignments

CO7	Develop Shell Scripts using Linux	C	P	Practical Assignment / Observation of Practical Skills

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I	**Introduction to Operating Systems & Process Management**		**10**	**15**
	1	Operating System: History, Types, Objectives and Functions	2	
	2	Process Concepts: Process States, Process Control Block	2	
	3	Types of Process Schedulers and Operations on Process	2	
	4	Cooperating Processes	2	
	5	Inter Process Communication	2	
II	**CPU Scheduling, Process Synchronisation and Deadlocks**		**15**	**20**
	6	Basic Scheduling Concepts, Scheduling Criteria	1	
	7	CPU Scheduling Algorithms	2	
	8	Process Synchronisation: Critical Section	2	
	9	Semaphores	2	
	10	Classical Problems of Synchronisation: Reader Writer, Dining Philosopher	2	
	11	Introduction to Deadlock: Necessary Conditions, Resource Allocation Graph	2	
	12	Handling Deadlocks: Prevention, Avoidance, Detection & Recovery	4	
III	**Memory Management Techniques**		**10**	**20**
	13	Basic Concepts: Physical VS Logical Address, Continuous Memory Allocation	2	
	14	Fragmentation Problem and Solutions	1	
	15	Non contiguous Memory Allocation: Paging	2	
	16	Non contiguous Memory Allocation: Segmentation, Segmentation with Paging	2	
	17	Virtual Memory Concepts: Demand Paging and Page Replacement Algorithms, Thrashing	3	
IV	**Linux Shell Programming**		**10**	**15**
	18	Introduction: Types of Linux Shells, File Directory & File Management Commands: ls, cd, pwd, mkdir, rm, cp, mv, chmod, touch Input/Output Commands: read, echo, Text Processing Commands: grep, cat	2	
	19	Piping and Redirection operators: |, >, <, >>, << Arithmetic, Logical and Relational Operator	2	
	20	Iterative and Conditional Commands: if, while, for, break, continue, case	2	
	21	Arrays and functions	2	
	22	Command line arguments, Network commands: ipconfig, ping, date and time commands, Informative commands: random, w, ps, free,	2	

		uptime		
V	**Practical Applications using Linux Shell Programming**		**30**	
		Implement the following: 1. Write a Shell Script to find the roots of a quadratic equation. 2. Write a shell script for a menu driven program to perform file management (File creation, display content, remove, write content to a file). 3. Write a shell script to count no of line, words and characters of an input file. 4. Write a shell script to find the average of the number entered as command line arguments. 5. Write a shell script to copy the contents of file to another. Input file names through command line. The copy should not be allowed if second file exists. 6. Write a shell script to check network connectivity. 7. Write a shell script that analyzes a log file, extracting and summarizing relevant information such as error counts ,warning messages, info and debug messages using grep command. 8. Write a shell script to display current date and time, list all user account names, count of logged in user accounts, list all logged in user accounts with login time. 9. Write a simple game script using random function to implement number guessing game. 10. Write a shell script to display your system details (number of users, current processes, memory usage, system running time). 11. Write a shell script to implement and examine the effectiveness of the First Come First Serve \CPU Scheduling algorithm. Find the average waiting time and turnaround time. 12. Write a shell script program to implement Inter Process Communication.	30	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	1	-	-	-	-						
CO 2	-	2	-	-	-	-						
CO 3	-	3	-	1	-	-						
CO 4	-	2	2	-	-	-						

CO 5	-	3	-	-	-	-						
CO 6	-	3	-	-	-	-						
CO7	-	-	2	2	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5	✓			✓
CO 6	✓			✓
CO7			✓	

References:

1. Silberschatz, Galvin and Gagne, Operating System Concepts, John Willey & Sons
2. William Stallings, Operating Systems, Internals and Design Principles, PHI

Semester VII

Programme	BCA				
Course Title	Advanced Data Structures and algorithms				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamental Mathematics Concepts: Sets, matrices 2. Awareness of Data structures and operations like array, stack, queue 3. Fundamentals of Java, C Programming				
Course Summary	This course provides an introduction to the ideas, techniques, and applications of advanced data structures) is given in this course. The advanced data structures and its variants like tree, graph, heaps are covered in this syllabus.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the concepts of advanced data structures like tree, graphs, heaps.	U	C	Instructor-created exams / Quiz
CO2	Understand familiarity with algorithmic techniques such as brute force, greedy, and divide and conquer.	U	C	Practical Assignment / Observation of Practical Skills
CO3	Understand Asymptotic analysis (big-O notation, time and space complexity).	U	F	Seminar Presentation / Group Tutorial Work/ Viva Voce
CO4	Application of advanced abstract data type (ADT) and data structures in solving real world problems.	AP	P	Instructor-created exams / Home Assignments
CO5	Effectively combine fundamental data structures and algorithmic techniques in building a complete algorithmic solution to a given problem	Ap	P	Writing assignments/ Instructor-created exams/ practicals
CO6	Apply Concepts of data structures in real world problem solving	Ap	P	Case Study/ mini Project/ practicals

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I	**Introduction to Data Structures and Analysis of Quality of an Algorithm**		**9**	**15**
	1	Data structure - definition - types & operations, characteristics of data structures	2	
	2	Abstract Data Type (ADT) – algorithms - concepts - definition - objectives of algorithms -	1	
	3	Quality of an algorithm - space complexity and time complexity of an algorithm.	2	
	4	Growth of Functions: Asymptotic notations, Cost estimation based on key operations- Big Oh, Big Omega, Little Oh, Little Omega and Theta notations	3	
	5	Algorithm Design: Introduction, Steps in developing algorithm, Methods of specifying an algorithm	1	
II	**Basic Technique for Design of Efficient Algorithm**		**11**	**17**
	6	Brute Force approach (String pattern matching)	1	
	7	Divide-and-Conquer approach (Merge sort)	1	
	8	Branch-and-Bound technique (Knapsack problem)	2	
	9	Greedy approach (Kruskal's algorithm and Prim's Algorithm)	3	
	10	Dynamic Programming (Longest Common Subsequence)	2	
	11	Backtracking (Sum of subsets problem)	2	
III	**Linked lists - operations and implementations**		**12**	**18**
	12	Introduction to Singly Linked list and its operations	2	
	13	Circular Linked list and its operations	3	
	14	Doubly Linked list and its operations	2	
	15	Circular Doubly Linked list and its operations	2	
	16	Recursive lists, heterogeneous lists, deterministic skip lists- Creation & Searching	3	
IV		**Non-linear Data Structures**	**13**	**20**
	17	Binary search trees - traversals and operations on BST	3	
	18	AVL tree, Red Black Tree (concept only)	2	
	19	Balanced trees - M-way trees - B Tree (Concepts only)	1	
	20	Graphs - representation of graphs	1	
	21	Graphs- operations - traversals and their implementation.	2	
	22	Heap structures- Min-Max heaps - Deaps - leftist heaps - binomial heaps (concepts only) - Applications	3	
V	**Practical Implementations of Data Structures and its Operations in Java or C Programming Language**			**30**
	1	• Implementation of linear linked list • Implementation of circular linked list • Implementation of doubly linked list • Implementation of BST operations • Implementation of Depth First Search using graph • Implementation of Breadth First Search using graph	25	

		• Implementation of max heap and delete a node from it. • Sort a set of data using Heap tree		
	2	Case Study/ Project	5	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	3	3	2	1						
CO 2	1	1	3	3	2	1						
CO 3	1	1	3	3	2	1						
CO 4	1	1	3	3	-	-						
CO 5	1	1	3	3	3	1						
CO 6	1	1	3	3	3	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	

References:

1. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Addison-Wesley, ISBN: 978-0201000238.

2. Horowitz E and Sahni S, Fundamentals of Data Structures, Computer Science Press, ISBN: 9780716780427.

3. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Silicon Press, ISBN: 0929306406.

4. Thomas H Cormen, Charles E Leiserson, and Ronald L Rivest, Introduction to Algorithms, 3rd Edition, Prentice Hall of India Private Limited, New Delhi, ISBN: 9780262033848

5. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, The Design and Analysis of Computer Algorithms, 1st Edition. Addison Wesley, ISBN: 0534915728

Programme	BCA				
Course Title	Data Science Programming using R				
Type of Course	Major				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1.Basic knowledge about Data Science 2. Basic knowledge about Programming languages				
Course Summary	The R programming course offers a comprehensive overview of the R language, encompassing fundamental principles and practical abilities essential for data analysis and statistical computing.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate how to install and configure RStudio	U	C	Instructor-created exams / Quiz

CO2	Apply OOP concepts in R programming	U	C	Practical Assignment / Group Tutorial Work
CO3	Explain the use of data structure and loop functions	U	C	Practical Assignment / Group Tutorial Work
CO4	Understand the concept of data frames	U	C	Instructor-created exams / Home Assignments
CO5	Implement the DPLYR package and Data Visualization	Ap	P	Practical assignments and practical tests
CO6	Implementation of R Programming concepts	Ap	M	Practical assignments and practical tests

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks
I	**Fundamentals Of R**		**10**	**10**
	1	Installation of R & R Studio	2	
	2	Features of Variables, Constants	2	
	3	Operators	2	
	4	Datatypes and R Objects	2	
	5	Accepting Input from keyboard, Important Built-in functions	2	
II	**Vectors, Matrices and Lists**		**15**	**20**
	6	Vectors-Accessing elements of a Vector, Operations on Vectors	3	
	7	Vector Arithmetic	2	
	8	Matrices-Accessing elements of a Matrix	2	
	9	Operations on Matrices, Matrix transpose	3	

	10	Creating lists, manipulating list elements, Merging lists	3	
	11	Converting lists to vectors	2	
III	**Control Statements, Functions and Arrays In R**		**10**	**20**
	12	If statement, if…else statement, if else () function, switch () function	1	
	13	repeat loop, while loop, for loop, break statement, next statement	2	
	14	Formal and Actual arguments, Named arguments	1	
	15	Global and local variables, Argument and lazy evaluation of functions	2	
	16	Recursive functions, String and string functions	2	
	17	Creating arrays, Accessing array elements, Calculations across array elements	2	
IV	**Data Manipulation -Dplyr Package And Data Visualization In R**		**10**	**20**
	18	R factors and Data Frames, Load data into dataframe	2	
	19	Viewing the data Selecting columns, selecting rows, Reordering the rows	2	
	20	Pipe operator, Group operations	2	
	21	Data Visualization-Bar plot, Plotting categorical data, Stacked bar plot, Histogram	2	
	22	Plot () function and line plot, pie chart / 3D pie chart, Scatter plot, Box plot	2	
V	**Practical Applications**		**30**	
	Implement the following: • Implementation of Vectors, Matrices and Lists • Implementation of Control statements, functions and Arrays • Usage of DPLYR package and data Visualization • Analyze the mtcars dataset by selecting specific columns and visualizing the data using bar plots, histograms, and scatter plots.		30	

	• Perform vector and matrix operations, including element access, arithmetic operations, and transposition. • Implement control statements and loops to check number properties and iterate through sequences. • Define and use functions with named arguments, handle global and local variables, and create a recursive function to calculate factorials. • Utilize the dplyr package for data manipulation with the iris dataset and perform various list operations including merging and converting lists to vectors. Case Study with any Data Set (MNIST/IRIS)		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	-	-	-	-						
CO 2	1	2	1	-	-	-						
CO 3	2	2	2	2	-	1						
CO 4	2	2	2	2	1	2						
CO 5	3	3	2	2	2	2						
CO6	3	3	3	3	3	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1		✓		
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5			✓	
CO6			✓	

References:

1. “The Book of R” by Tilman M. Davies, no starch press (San Francisco)

2. “The Art of R programming” by Norman Matloff, no starch press (San Francisco)

Basket of Electives (for V, VI Semesters)

1. Image Processing

Programme	BCA				
Course Title	Fundamentals of Digital Image Processing				
Type of Course	Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of mathematics concepts involved in digital image processing algorithms and transformations. 2. Familiarity with programming languages such as MATLAB or Python				
Course Summary	This course provides a comprehensive understanding of digital image processing fundamentals, covering topics such as pixel structure, image formation, and types of images. Students will learn a range of image processing techniques including intensity transformations, spatial filtering, and frequency domain filtering, along with their applications in various industries such as medical imaging and multimedia systems.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Develop a comprehensive understanding of the principles underlying digital image processing, including image representation and fundamental processing techniques.	U	C	Assignment / Instructor-created exams / Quiz
CO2	Develop proficiency in basic digital image processing techniques, including intensity transformations, spatial filtering, and histogram processing, to manipulate and enhance digital images effectively.	Ap	C	Practical Assignment / Instructor-created exams / Quiz
CO3	Analyze the components of digital image processing systems and their functions in image sensing and acquisition, including the use of single sensing elements, sensor strips, and sensor arrays	An	C	Practical Assignment / Instructor-created exams / Quiz
CO4	Develop skills in implementing image processing algorithms, including spatial filtering techniques like smoothing and	Ap	P	Practical Assignment / Instructor-

	sharpening, as well as frequency domain filtering methods.			created exams / Quiz
CO5	Analyze and interpret digital images to extract meaningful information and insights, facilitating informed decision-making in diverse application domains.	An	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Explore advanced concepts and emerging trends in digital image processing, fostering a deeper understanding of the field's evolving landscape and potential future directions.	Ap	C	Practical Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Digital Image and Digital Image Processing**		**10**	**15**
	1	Digital image and Digital image processing system, Pixels, Resolution of an image, Types of Images – Gray Scale, Binary and Color Images	1	
	2	Fundamentals steps in digital image processing	3	
	3	Applications of digital image processing	3	
	4	Image processing system components	3	
II	**Image Sensing and Acquisition**		**12**	**15**
	5	Image acquisition using a single sensing element, Image acquisition using sensor strips, Image acquisition using sensor arrays	3	
	6	A simple image formation model	3	
	7	Basic Concepts in Sampling and Quantization	2	
	8	Representing digital images	2	
	9	Some basic relationships between pixels - neighbors of a pixel, adjacency, connectivity, regions, and boundaries	2	
III	**Intensity Transformation and Spatial Filtering**		**13**	**20**
	10	Basics of intensity transformations and spatial filtering	1	
	11	Some basic intensity transformation functions - Image negatives, Log transformations	1	
	12	Piecewise linear transformation functions - Contrast stretching, Intensity-level slicing	2	
	13	Histogram processing, Histogram equalization	2	
	14	Fundamentals of spatial filtering - The mechanics of linear spatial filtering	1	
	15	Spatial correlation and convolution	2	
	16	Smoothing (lowpass) spatial filters - box filter kernels, order-statistic (nonlinear) filters	2	
	17	Sharpening (highpass) spatial filters – The Laplacian, Unsharp masking and highboost filtering, gradient filter	2	
IV	**Frequency Domain Filtering and Image Restoration**		**13**	**20**

	18	Filtering in Frequency Domain - The Discrete Fourier Transformation (DFT)	1	
	19	Steps for filtering in the frequency domain, Ideal and Butterworth Low pass and High pass filters	2	
	20	Image Restoration - degradation model, Properties	1	
	21	Noise models, Mean Filters – Order Statistics	2	
	22	Inverse Filtering – Wiener filtering	3	
V	**Open Ended Module**		**12**	
	1	• Relationships between pixels • Intensity transforms • Spatial and Frequency Domain Filtering	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	1	-	2	2						
CO 2	1	-	1	-	2	2						
CO 3	1	1	1	-	2	2						
CO 4	3	3	2	1	2	1						
CO 5	1	-	1	-	2	2						
CO 6	3	3	1	1	2	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓

CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Gonzalez, Rafael C., and Woods, Richard E. "Digital Image Processing." Pearson Education, Inc., 2008.

2. Jain, Anil K. "Fundamentals of Digital Image Processing." Prentice Hall, 1989.

3. Sonka, Milan, Hlavac, Vaclav, and Boyle, Roger. "Image Processing, Analysis, and Machine Vision." Cengage Learning, 2014.

4. Pratt, William K. "Digital Image Processing: PIKS Scientific Inside." John Wiley & Sons, 2007.

5. Burger, Wilhelm, and Burge, Mark J. "Digital Image Processing: An Algorithmic Approach with MATLAB." Springer, 2017.

6. Woods, Richard E., and Eddins, Steven L. "Digital Image Processing using MATLAB." Gatesmark Publishing, 2010.

Programme	BCA				
Course Title	Pattern Recognition				
Type of Course	Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of probability theory and statistics. 2. Prior knowledge of data structures and algorithms.				
Course Summary	This course provides a comprehensive overview of pattern recognition, covering fundamental concepts such as statistical decision-making, non-parametric techniques, clustering, and feature selection. Students will develop practical skills in designing and evaluating pattern recognition systems through hands-on implementation of algorithms and analysis of real-world applications.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate an understanding of the core principles and concepts of pattern recognition, as well as their diverse applications across various domains.	U	C	Assignment / Instructor-created exams / Quiz
CO2	Apply statistical decision-making methodologies effectively to design and develop robust pattern recognition systems.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	Implement and evaluate various pattern recognition models, employing statistical measures for performance assessment.	E	P	Practical Assignment / Instructor-created exams / Quiz
CO4	Explore and employ non-parametric decision-making approaches in pattern recognition tasks to enhance system accuracy and adaptability.	U	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Utilize clustering techniques for data grouping and feature selection, optimizing pattern recognition system efficiency.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Evaluate the performance of pattern recognition systems through comprehensive analysis of error rates, population composition estimation, and other relevant metrics.	E	P	Practical Assignment / Instructor-created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Introduction**		**8**	**15**
	1	Pattern Recognition - Basic concepts, Applications	2	
	2	Fundamental problems in pattern recognition system design	2	
	3	Design concepts and methodologies	2	
	4	Simple pattern recognition model	2	
II	**Statistical Decision Making**		**15**	**20**
	5	Statistical Decision Making: Introduction, Baye's theorem	3	
	6	Multiple features, Conditionally independent features	2	
	7	Decision boundaries	2	
	8	Unequal cost of error, Estimation of error rates	2	
	9	Leaving-one-out-techniques	2	

	10	Characteristic curves	2	
	11	Estimating the composition of populations	2	
III	**Non-Parametric Decision Making**		**10**	**15**
	12	Histogram, Kernel and window estimation,	2	
	13	Nearest neighbour classification techniques	2	
	14	Adaptive decision boundaries	2	
	15	Adaptive discriminant functions	2	
	16	Minimum squared error discriminant functions	2	
IV	**Clustering and Feature Selection**		**15**	**20**
	17	Clustering and Feature Selection - Introduction	2	
	18	Aagglomerative clustering algorithm	3	
	19	the single-linkage, Complete-linkage and average-linkage algorithm	3	
	20	K-Means's algorithm	3	
	21	Clustering in feature selection through entropy minimization	2	
	22	Features selection through orthogonal expansion.	2	
V	**Open Ended Module**		**12**	
	1	• Implement a simple pattern recognition model using a programming language/tool (e.g., Python, MATLAB etc.) and write a research paper.	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	2	2	2	1						
CO 2	1	2	1	2	2	1						
CO 3	2	2	2	3	1	1						
CO 4	1	2	2	2	2	1						
CO 5	2	2	2	2	2	1						
CO 6	1	2	2	2	2	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Bishop, C. M. Pattern Recognition and Machine Learning. Springer, 2006.

2. Theodoridis, S., & Pikrakis, A. Introduction to Pattern Recognition: A Matlab Approach. Academic Press, 2010.

3. Duda, R. O., Hart, P. E., & Stork, D. G. Pattern Classification. Wiley-Interscience, 2000.

4. Murphy, K. P. Machine Learning: A Probabilistic Perspective. MIT Press, 2012.

5. Han, J., Kamber, M., & Pei, J. (2011). Data Mining: Concepts and Techniques. Morgan Kaufmann.

6. Hastie, T., Tibshirani, R., & Friedman, J. The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer, 2009.

Programme	BCA				
Course Title	Advanced Digital Image Processing and Computer Vision				
Type of Course	Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of mathematics concepts involved in digital image processing algorithms and transformations.				

	2. Familiarity with programming languages such as MATLAB or Python
Course Summary	This course provides a comprehensive understanding of digital image processing fundamentals, covering topics such as pixel structure, image formation, and types of images. Students will learn a range of image processing techniques including intensity transformations, spatial filtering, and frequency domain filtering, along with their applications in various industries such as medical imaging and multimedia systems.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand principles and techniques of morphological image processing.	U	C	Assignment / Instructor-created exams / Quiz
CO2	Gain proficiency in image segmentation methods.	U	P	Practical Assignment / Instructor-created exams / Quiz
CO3	Master thresholding techniques for converting grayscale images into binary images and extracting relevant features.	U	P	Practical Assignment / Instructor-created exams / Quiz
CO4	Acquire knowledge of feature extraction methods for pattern recognition and classification.	U	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Understand fundamentals of color image processing, including color models.	U	C	Practical Assignment / Instructor-created exams / Quiz
CO6	Develop proficiency in image compression techniques for reducing storage space and transmission bandwidth while preserving visual quality.	U	C	Practical Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Morphological Image Processing and Image Segmentation**		**13**	**20**
	1	Morphological Image Processing - Structuring element, Erosion and Dilation	2	

	2	Opening and Closing	2	
	3	Thinning and Thickening	2	
	4	Image Segmentation – Fundamentals, Point, Line, and Edge Detection	3	
	5	Segmentation by Region Growing	2	
	6	Segmentation by Region Splitting and Merging	2	
II	**Thresholding, Feature Extraction and Color Image Processing**		**14**	**20**
	7	Thresholding - Basics of Intensity Thresholding, Basic Global Thresholding	2	
	8	Otsu's algorithm	2	
	9	Feature Extraction – Definition, Statistical Features	2	
	10	Color Image Processing - Color Fundamentals	2	
	11	Color Models – RGB	2	
	12	CMY and CMYK Color Models	2	
	13	Basics of Full-Color Image Processing	2	
III	**Image Compression**		**10**	**15**
	14	Image Compression – Fundamentals	2	
	15	Types of data redundancies - Coding Redundancy, Spatial and Temporal Redundancy, Irrelevant Information	2	
	16	Huffman Coding	2	
	17	Run-length Coding	2	
	18	Neural Networks Machine Learning and Deep Learning (Definitions only)	2	
IV	**Computer Vision**		**11**	**15**
	19	Computer Vision – Introduction to Computer Vision	2	
	20	Feature Detection and Matching – Points and Patches, Edges, Lines	3	
	21	Recognition – Object Detection, Face Recognition	3	
	22	Instance Recognition, Category Recognition, Motion Detection	3	
V	**Open Ended Module**		**12**	
	1	• Image segmentation algorithms • Thresholding algorithms • Image Compression methods • Face Recognition methods	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	2	1	2	2	1						
CO 2	1	2	1	2	2	1						
CO 3	1	2	1	2	2	1						
CO 4	3	2	2	2	2	1						
CO 5	1	2	1	2	2	1						
CO 6	2	2	1	2	2	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Gonzalez, Rafael C., and Woods, Richard E. "Digital Image Processing." Pearson Education, Inc., 2008.

2. Jain, Anil K. "Fundamentals of Digital Image Processing." Prentice Hall, 1989.

3. Sonka, Milan, Hlavac, Vaclav, and Boyle, Roger. "Image Processing, Analysis, and Machine Vision." Cengage Learning, 2014.

4. Pratt, William K. "Digital Image Processing: PIKS Scientific Inside." John Wiley & Sons, 2007.

5. Burger, Wilhelm, and Burge, Mark J. "Digital Image Processing: An Algorithmic Approach with MATLAB." Springer, 2017.

6. Szeliski, R. Computer vision: Algorithms and applications. Springer Science & Business Media, 2010.

7. Forsyth, D. A., & Ponce, J. Computer vision: A modern approach. Prentice Hall, 2011.

Programme	BCA				
Course Title	Applied Digital Image Processing				
Type of Course	Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Foundation in mathematics and statistics, including linear algebra, calculus, probability theory, and signal processing. 2. Proficiency in programming languages such as MATLAB or Python				
Course Summary	The course covers a comprehensive study of medical, document, forensic, and satellite image processing, including techniques such as multimodal fusion, image registration, reconstruction, and enhancement, emphasizing the role of advanced algorithms and software tools in diagnosis, treatment planning, document analysis, forensic investigations, and geographic information systems applications. Students will gain practical skills in image processing, programming, and analytical thinking, essential for addressing real-world challenges in healthcare, document management, law enforcement, and environmental monitoring.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Develop a comprehensive understanding of various medical imaging modalities and their applications, facilitating informed decision-making in healthcare.	U	C	Assignment / Instructor-created exams / Quiz
CO2	Acquire proficiency in implementing medical image processing techniques to integrate and analyze multiple imaging modalities for enhanced medical image interpretation.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	Understand the importance of document and text image processing across diverse fields, enhancing productivity and efficiency in information management and retrieval.	U	F	Practical Assignment / Instructor-created exams / Quiz
CO4	Master advanced image processing techniques to enhance clarity and interpretability of digital evidence in forensic investigations.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Develop a thorough understanding of image processing techniques applicable to satellite and aerial imagery, allowing	U	C	Practical Assignment / Instructor-

	for their effective utilization in diverse applications.			created exams / Quiz
CO6	Master advanced image processing methods to enhance the quality of satellite and aerial imagery, enabling detailed analysis and interpretation for environmental monitoring, urban planning, and other spatial applications.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I		**Medical Image Processing**	**14**	**20**
	1	Medical Images – Functional Modality - X- Ray, CT, MRI, Ultrasound, Anatomical Modality - fMRI, SPECT, PET (Concept only)	3	
	2	Multimodal Medical Image Fusion, Medical Image Registration	2	
	3	Architecture of CAD System - Image pre-processing, Region(s) of Interest (ROI), Feature Extraction Segmentation and Classification	3	
	4	Image Reconstruction and Enhancement	2	
	5	3D and 4D medical image visualization	2	
	6	Role of Medical Image Processing in diagnosis and treatment planning	2	
II		**Document and Text Image Processing**	**10**	**15**
	7	Importance of Document and Text Image Processing, Document image acquisition, Optical Character Recognition (OCR)	3	
	8	Document structure and layout analysis, Handwriting recognition, Text classification	3	
	9	Document summarization, Content-based document image retrieval, Text indexing	3	
	10	Applications of Document and Text Image Processing.	1	
III		**Forensic Image Processing**	**14**	**20**
	11	Types of forensic images - Physical image, Logical image, Targeted image	2	
	12	Contrast enhancement and Noise reduction, Sharpness and edge enhancement,	2	
	13	Geometric and Photometric corrections of forensic images	2	
	14	Color balancing and Calibration, Foreground and Background Segmentation	2	
	15	Detection of sophisticated tampering, Alterations, and Manipulations	2	
	16	Image metadata, Identification of cloned regions, Splicing, and Retouching, Hidden information analysis	3	
	17	Legal considerations and ethical issues in forensic image processing	1	
IV		**Satellite and Aerial Image Processing**	**10**	**15**
	18	Remote Sensing, Satellites and Image acquisition, Sensors types - optical, radar and LiDAR	2	

	19	Radiometric and Geometric corrections, Orthorectification and georeferencing of aerial and satellite images	2	
	20	Contrast stretching, Histogram equalization and Filtering techniques for noise reduction and feature enhancement	2	
	21	Multiscale image decomposition, Object-based image analysis, Image differencing, image rationing	2	
	22	Geographic Information Systems (GIS)	2	
V	**Open Ended Module**		**12**	
	1	• Write a review paper either from medical image processing or from Document and Text Image Processing or from Forensic Image Processing or from Satellite and Aerial Image Processing or from any other applied image processing area.	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	1	1	1	2	1						
CO 2	2	3	3	2	2	1						
CO 3	2	1	1	1	1	2						
CO 4	2	1	1	1	1	2						
CO 5	2	2	1	1	1	2						
CO 6	2	1	1	1	1	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations

CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. G.R. Sinha, Bhagwaticharan Patel, Medical Image Processing: Concepts and Applications, PHI Learning private limited.2014

2. KayvanNajarian and Robert Splinter, "Biomedical Signal and Image Processing", Second Edition, CRC Press, 2005

3. Document Image Analysis" by Lawrence O'Gorman and Rangachar Kasturi, 1995, IEEE Computer Society Press.

4. Handbook of Document Image Processing and Recognition" edited by David Doermann, 2014, CRC Press.

5. Digital Image Processing for Forensic Applications" by Rajkumar Kannan and E. Sreekumar, CRC Press, 2013

6. "Forensic Image Processing" by John C. Russ, SPIE Press, 2008.

7. Remote Sensing Digital Image Analysis: An Introduction" by John A. Richards and Xiuping Jia, Springer, 2006.

8. Remote Sensing and Image Interpretation" by Thomas Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, Wiley, 2014.

2. Computer Networks

Programme	BCA
Course Title	Wireless Communication
Type of Course	Elective
Semester	V
Academic Level	300-399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic computer science knowledge 2. Familiarity with networking fundamentals and Digital Communication basics.				
Course Summary	The Wireless Communications course is designed for the students to gain a comprehensive understanding of wireless communication technologies and their applications. The course covers fundamental concepts, protocols, and technologies that form the basis of modern wireless networks. It explores the evolution from 2G to 5G and beyond, as well as emerging trends such as Internet of Things (IoT) and 6G. Students will also delve into security and privacy considerations in wireless communications.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define the fundamental concepts of wireless communication technologies.	R	F	Practical Assignment / Instructor-created exams / Quiz
CO2	Explain the evolution and standards of wireless networks.	U	C	Practical Assignment / Instructor-created exams / Quiz
CO3	Apply knowledge of wireless protocols to design and configure wireless networks.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO4	Analyze the security threats in wireless communication systems and propose countermeasures.	An	M	Practical Assignment / Instructor-created exams / Quiz
CO5	Evaluate the impact of emerging trends in wireless communications on industry demands and ethical considerations.	E	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Design and develop innovative solutions for challenges in the field of wireless communications.	C	P	Practical Assignment / Instructor-created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Introduction to Wireless Transmission**		**13**	**18**
	1	Applications of wireless networks	1	
	2	History of wireless communication	2	
	3	Simplified Reference Model	2	
	4	Frequencies for radio transmission, signals, Antennas	3	
	5	Signal propagation and Multiplexing	2	
	6	Modulation, Spread Spectrum, Cellular systems	3	
II	**Medium Access Control & Telecommunications Systems**		**12**	**17**
	7	Motivation for specialized MAC	2	
	8	SDMA, FDMA	2	
	9	TDMA, CDMA	3	
	10	GSM-Mobile Services, Architecture, Protocols	3	
	11	DECT-System & Protocol Architecture	2	
III	**Satellite Systems & Wireless LANs**		**12**	**18**
	12	Satellite systems, Basics- GEO, LEO, MEO	2	
	13	Routing, Localization & Handover	2	
	14	Infra-red vs radio transmission	2	
	15	Infrastructure and ad-hoc network	2	
	16	IEEE 802.11	2	
	17	Bluetooth	2	
IV	**Mobile Network & Transport Layer**		**11**	**17**
	18	Mobile IP, DHCP	3	
	19	Mobile Ad-hoc networks	2	
	20	Traditional TCP	3	
	21	Classical TCP Improvements	2	
	22	TCP over 2.5/3G wireless networks	1	
V	**Open Ended Module – Support for Mobility**		**12**	
		• Various file systems such as NFS, AFS, Coda, Little Work, Ficus, Mio-NFS, Rover, etc. • World Wide Web- Problems and solutions when used in mobile and wireless environment. • Wireless Application Protocols, architecture, Wireless Transaction Protocols, Markup language, Session Protocol, etc. • 4G, 5G, 6G and beyond: Future wireless Technologies • IOT, Green Wireless Communications, Machine-to-Machine (M2M) communications.	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	-	-	-	1						
CO 2	1	2	-	-	-	1						

CO 3	2	3	3	2	2	2						
CO 4	2	3	3	-	2	2						
CO 5	3	2	2	-	3	3						
CO 6	2	3	3	1	3	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. "Mobile Communications" by Jochen H. Schiller, 2/e, Pearson Education, 2012.

2. "Wireless Communications: Principles and Practice" by Theodore S. Rappaport.

3. "Wireless Communications and Networks" by William Stallings.

4. “Wireless Communications” by Andrea Goldsmith, Cambridge University Press, 2005.

5. "5G NR: The Next Generation Wireless Access Technology" by Erik Dahlman, Stefan Parkvall, and Johan Skold.

Programme	BCA				
Course Title	Cryptography and Network Security				
Type of Course	Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic understanding of computer networks, cryptography, and programming concepts. Familiarity with OSI model, encryption algorithms, and network security mechanisms recommended.				
Course Summary	Cryptography and Network Security course provides a comprehensive overview of security principles and encryption techniques essential for securing computer networks. Upon completion, students will possess the knowledge and skills to analyse, implement, and maintain secure network environments, addressing contemporary security challenges effectively.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental principles of cryptography	U	F	Quizzes, Assignments/Instructor-created exams
CO2	Analyse security vulnerabilities in network systems	An	C	Case studies, Projects, Instructor-created exams
CO3	Design and implement secure communication protocols	Ap	P	Coding exercises, Projects
CO4	Evaluate cryptographic techniques for different applications	E	C	Research papers, Critical reviews, Instructor-created exams/Quizzes
CO5	Apply cryptographic principles to real-world scenarios	Ap	P	Simulations, Scenario-based assessments, Presentations, Quizzes
CO6	Critically assess emerging trends and technologies in cryptography and network security	E	C	Projects, Industry Internships, Instructor-created exams/Quizzes

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Mark
I	**Introduction To Security and Traditional Symmetric Key Encryption Techniques**		**11**	**15**
	1	**Introduction To Security:** The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Cryptology, A Model for Network Security.	3	
	2	**Symmetric Cipher Model-** Cryptography, Cryptanalysis and Brute-Force Attacks	2	
	3	**Substitution Techniques** - Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Ciphers, One Time Pad Cipher.	3	
	4	**Transposition Techniques –** Rail Fence	1	
	5	**Rotor Machines-** Basic Principle and Working	1	
	6	**Steganography-** Purpose, Techniques	1	
II	**Modern Symmetric Key Encryption Techniques**		**15**	**15**
	7	**Stream Ciphers and Block Ciphers**- Definitions, Difference, Block Cipher Structure - Feistel Cipher - Structure, Encryption and Decryption.	3	
	8	**Data Encryption Standard (DES) –** Encryption, Decryption, Example, Strength Of DES	3	
	9	**Advanced Encryption Standard (AES) –** Encryption and Decryption, Transformation functions, Key Expansion, Example	2	
	10	**Block Cipher Modes of Operations-** Electronic Code Mode, Book Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode	3	
	11	**Stream Cipher –** Structure, RC4	4	
III	**Asymmetric Cipher and Cryptographic Data Integrity Algorithms**		**11**	**20**
	12	**Public Key Cryptography (Asymmetric Cryptography) –** Encryption and Decryption	2	
	13	**RSA Algorithm –** Introduction, Encryption and Decryption, Example, Advantage and Disadvantage	2	
	14	**Cryptographic Hash Functions –** Concept, Applications	2	
	15	**Secure Hash Algorithm-** SHA 512	1	
	16	**Message Authentication Code –** Concept, Requirements, Security	1	
	17	**MACs based on Hash Functions-** HMAC	3	
IV	**Network and Internet Security**		**11**	**20**
	18	**Web Security Considerations-** Web Security Threats Web Traffic Security Approaches	1	

	19	**Secure Socket Layer and Transport Layer Security-** Concept, Working of SSL and TLS, Difference between SSL and TLS	3	
	20	**HTTPS -** Concept**,** Connection Initiation Connection Closure	1	
	21	**SSH-** Concept, Transport Layer Protocol User Authentication Protocol Connection Protocol	2	
	22	**Electronic Mail Security –** PGP, S/MIME	4	
V	**Open Ended Module- System Security**		**12**	
		• Intruders • Malicious Software • Firewalls		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	-	1	-						
CO2	1	1	2	3	-	-						
CO3	-	2	3	3	-	1						
CO4	-	-	1	2	2	2						
CO5	-	2	-	-	1	1						
CO6	-	2	-	2	-	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations

CO1	✓	✓	✓	✓
CO2	✓	✓	✓	✓
CO3		✓	✓	✓
CO4		✓		✓
CO5	✓	✓	✓	✓
CO6	✓	✓	✓	✓

References:

1. Cryptography And Network Security Principles and Practice, William Stallings, Pearson Education- Fifth Edition
2. Cryptography and Network Security, Behrouz A. Forouzan Tata, McGraw-Hill.
3. Cryptography and Network Security, Atul Kahate, Tata McGraw Hill,2019.
4. Cryptography: Theory and Practice by Douglas R. Stinson, CRC press.

Programme	Bachelor of Computer Applications (BCA)				
Course Title	Storage Area Network				
Type of Course	Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of computer networks 2. Familiarity with operating systems and file systems				
Course Summary	This course provides an in-depth understanding of Storage Area Networks (SANs) and their role in modern computing environments. Students will explore the fundamental concepts, architectures, protocols, and implementation strategies of SANs. Practical aspects of designing, managing, and troubleshooting SANs will also be covered.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define the fundamental concepts and components of Storage Area Networks	U	C	Practical Assignment / Instructor-

	(SANs), describe the evolution of storage architectures and the role of SANs in modern computing environments.			created exams / Quiz
CO2	Design a basic Storage Area Network (SAN) architecture, considering storage devices, Fibre Channel technology, and SAN fabric components, implement zoning and LUN masking for secure and efficient data access in a SAN.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	Evaluate and compare different SAN protocols, including Fibre Channel Protocol (FCP), iSCSI, FCIP, and FCoE, analyze and troubleshoot common issues in SANs, applying knowledge of SAN components and protocols.	An	P	Practical Assignment / Instructor-created exams / Quiz
CO4	Devise strategies for RAID configurations and data migration in a SAN, develop a comprehensive SAN security plan, integrating authentication, access control, and encryption.	R	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Assess the performance of a Storage Area Network, identifying bottlenecks and implementing optimization techniques, critically evaluate emerging trends in SANs, such as basic, advanced and Backup software.	E	F	Practical Assignment / Instructor-created exams / Quiz
CO6	Demonstrate practical skills in designing, managing, and troubleshooting a Storage Area Network through hands-on projects, communicate effectively about SAN concepts, protocols, and best practices in both written and oral formats.	C	P	Practical Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Networking and Storage Concepts**		**10**	**15**
	1	OSI reference model	1	

	2	Common network devices, Network Topologies	3	
	3	MAC standards	2	
	4	Need for Storage Networks, Storage Devices and Techniques	2	
	5	SAN Components and Building Blocks	2	
II	**Fibre Channel and SAN Fundamentals**		**12**	**20**
	6	Fibre Channel Topologies, Fibre Channel Layers	3	
	7	Classes of Services, SAN topologies	3	
	8	SAN Operating Systems, software and hardware	2	
	9	Types of SAN technology	2	
	10	SAN Protocols- FCP, iSCSI, FCIP, FCoE	2	
III	**Storage networking architecture**		**13**	**20**
	11	Storage in storage Networking- challenges, cost, performance	1	
	12	Keeping SAN storage Up & working	2	
	13	Network in storage Networking	2	
	14	Emerging SAN interconnect Technologies	2	
	15	Basic software for Storage Networking	3	
	16	File systems and Application Performances	3	
IV	**Advanced and Backup softwares for SAN**		**13**	**15**
	17	Advanced software for storage Networking- Data Replication	3	
	18	Synchronous & Asynchronous Replication	2	
	19	Cluster Data Models	2	
	20	Enterprise Backup Software for SAN	2	
	21	Enterprise Backup Architecture and Policies	3	
	22	Minimizing the Impact of Backup	1	
V	**Open Ended Module – Design and Building a SAN**		**12**	
	1	• Design considerations and business requirements • Physical layout, placement, storage, pooling • Data availability, connectivity, scalability, migration, manageability • Fault Tolerance and resilience, Prevention of Congestion • SAN security- basic security guidelines, future of SANS.	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	1	-	3	-						
CO 2	1	2	1	-	3	-						
CO 3	3	1	1	-	3	-						
CO 4	3	1	1	-	3	-						
CO 5	3	-	1	1	3	-						
CO 6	3	-	1	1	3	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Meeta Gupta, Storage Area Network Fundamentals, Cisco Press.

2. Richard Barker and Paul Massiglia, Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs, Wiley India Pvt Ltd.

3. John R. Vacca, The Essential Guide to Storage Area Networks, 1st Edition, Prentice Hall.

4. Christopher Poelke and Alex Nikitin, Storage Area Networks for Dummies, 2nd Edition.

5. Tom Clark, Designing Storage Area Networks: A Practical Reference for Implementing Fibre Channel and IP SANs, 2nd Edition, Addison Wesley Professional.

6. Robert Spalding, Storage Networks: The Complete Reference, 1st Edition, Tata McGraw-Hill Education.

Programme	BCA				
Course Title	Internet of Things				
Type of Course	Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of computer science concepts. 2. Familiarity with networking fundamentals. 3. Proficiency in a programming language (e.g., Python, Java).				
Course Summary	A course on the Internet of Things (IoT) typically covers a range of topics to provide students with a comprehensive understanding of this interdisciplinary field like Basic concepts and Components of an IoT system, IOT Architecture and communication protocols, IOT devices and Sensors, IOT security, Data management and Applications				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	The course enables student to understand the basics of Internet of things and protocols. It introduces some of the application areas where Internet of Things can be applied. Students will learn about the middleware for Internet of Things. To understand the concepts of Web of Things.	U	P	Assignment / Instructor-created exams / Quiz
CO2	Define and articulate the fundamental concepts and principles of the Internet of Things.	R	P	Assignment / Instructor-created exams / Quiz
CO3	Understand the role of edge computing and fog computing in IoT architectures.	U	P	Assignment / Instructor-created exams / Quiz
CO4	Identify and address security challenges in IoT systems.	An	P	Assignment / Instructor-created exams / Quiz
CO5	Manage data generated by IoT devices, including collection, storage, and processing.	Ap	P	Assignment / Instructor-created exams / Quiz
CO6	Identify and analyse industry-specific applications of IoT in areas such as	An	P	Assignment / Instructor-

	healthcare, smart cities, agriculture, and manufacturing			created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I		**Introduction to IoT**	**10**	**12**
	1	Definition and characteristics of IoT	2	
	2	Components of IoT	2	
	3	Embedded Systems	3	
	4	Basics of IoT Networking	3	
II		**IoT protocols**	**12**	**18**
	5	Protocol Standardization for IoT	3	
	6	SCADA and RFID Protocols	3	
	7	M2M and WSN Protocols	2	
	8	Issues with IoT Standardization	2	
	9	IOT security and Liability	2	
III		**IoT Architecture**	**13**	**20**
	10	Components of IOT architecture	1	
	11	Stages of IOT solutions Architecture	2	
	12	Layers of IOT Architecture	2	
	13	IoT Open-source architecture (OIC)	2	
	14	OIC Architecture & Design principles	3	
	15	IoT Devices and deployment models	3	
IV		**IoT Data Management**	**13**	**20**
	16	Data collection, storage, and processing in IoT	1	
	17	Data analytics techniques for IoT data.	2	
	18	Ethical considerations in IoT design and deployment.	1	
	19	Cloud Computing for IoT	2	
	20	Overview of cloud platforms for IoT solutions	3	
	21	IoT data management and analytics in the cloud.	1	
	22	Existing IoT platforms /middleware, IoT- A, Hydra etc	3	
V		**Open Ended Module** **Capstone Project: Case studies based on IOT APPLICATIONS**	**12**	
		▪ IoT applications for industry, Environment, Marketing ▪ Healthcare, smart cities, agriculture, and manufacturing.	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	1	-	3	-						
CO 2	1	-	1	-	3	-						
CO 3	3	-	1	-	3	-						

CO 4	3	-	1	-	3	-						
CO 5	3	-	1	-	3	-						
CO 6	3	-	1	-	3	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press,2012.

2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.

3. David Easley and Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning About a Highly Connected World”, Cambridge University Press, 2010.

4. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

5. David Hanes, Gonzalo Salgueiro, Patrick Grossetete “IOT Fundamentals: Networking Technologies, protocols and use cases for the internet of Things”

6. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”,1st Edition, VPT, 2014

3. Cloud Computing

Programme	BCA				
Course Title	Cloud Computing				
Type of Course	Elective				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic understanding of computer networks, operating systems, and programming.				
Course Summary	This course introduces students to the fundamental concepts, technologies, and practices of cloud computing. It covers the basics of cloud infrastructure, deployment models, and service models.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand fundamentals of cloud Computing	U	C	Instructor-created exams / Quiz
CO2	Describe and compare Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS)	U	C	Assignment / Seminar presentations/ Exams
CO3	Analyze various deployment models such as public, private, and hybrid clouds.	U	P	Seminar Presentation / Group Tutorial Work/ Viva Voce
CO4	Understand the principles of virtualization and its role in cloud computing.	U	C	Instructor-created exams / Home Assignments
CO5	Compare and contrast different virtualization technologies, including	U	P	Writing assignments/

	hypervisors and containerization.			Exams/ Seminar Presentations
CO6	Explore various cloud platforms in industry	U	F	Case Study/ Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I		**Introduction to Cloud Computing**	**8**	**12**
	1	Cloud computing in a glance	2	
	2	Historical context and evolution	1	
	3	Building cloud computing environments- Cloud components	2	
	4	Desired features of cloud	2	
	5	Advantages of Cloud	1	
II		**Cloud Computing Architecture**	**14**	**20**
	6	Cloud reference model	4	
	7	Types of cloud- private, public, hybrid, community	3	
	8	Cloud service models (IaaS)	2	
	9	Cloud service models (PaaS)	2	
	10	Cloud service models (SaaS)	2	
	11	Open Challenges	1	
III		**Virtualization Technologies**	**16**	**23**
	12	Virtual machine basics	2	
	13	hypervisor	2	
	14	Virtualisation structure	3	
	15	Implementation levels of virtualisation	2	
	16	Virtualisation types- Full Virtualisation, Para Virtualisation, Hardware Virtualisation	3	
	17	Virtualisation of CPU, Memory	2	
	18	Virtualisation of I/O devices	2	
IV		**Virtualisation Infrastructure & Dockers**	**10**	**15**
	17	Desktop Virtualisation, Network Virtualisation & Storage Virtualisation	2	
	18	Containers vs Virtual Machines	2	
	19	Basics of Dockers	2	
	20	Docker Components	2	
	21	Docker Containers	1	
	22	Docker Images and repositories	1	
V		**Open Ended Module**	**12**	
	1	Cloud platforms in Industry • **Amazon web services**- computation services, storage services, communication services • **Google AppEngine**- Architecture and core concepts • **Microsoft Azure**- Azure core concepts		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	--	2	--	-	1	1						
CO 2	-	2	-	-	1	1						
CO 3	-	1	-	-	1	1						
CO 4	-	1	-	-	2	1						
CO 5	1	1	-	-	2	1						
CO 6	-	1	-	-	2	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	✓
CO 5		✓	✓
CO 6		✓	

References

1. Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments, 2nd Edition, Willey Publications", William Voorsluys, James Broberg, Rajkumar Buyya.

2. "Cloud Computing: A Hands-On Approach" by Arshdeep Bahga and Vijay Madiset.

Programme	BCA				
Course Title	Security and Privacy in Cloud				
Type of Course	Elective				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic understanding of computer networks, operating systems, databases, Cloud computing				
Course Summary	This course explores the security and privacy challenges in cloud computing environments. Students will learn about the fundamental principles, technologies, and best practices for ensuring the confidentiality, integrity, and availability of data in the cloud. The course also covers legal and ethical considerations related to privacy in cloud computing.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand fundamentals of security concepts (encryption, decryption)	U	C	Instructor-created exams / Quiz
CO2	Understand security design principles.	U	C	Assignment / Seminar presentations/ Exams
CO3	Analyze various threats to cloud security	U	P	Seminar Presentation / Group Tutorial Work/ Viva Voce
CO4	Understand various cloud security design patterns.	U	C	Instructor-created exams / Home Assignments

CO5	Explore various access control mechanisms and management schemes to ensure security in cloud.	U	P	Writing assignments/ Exams/ Seminar Presentations
CO6	Explore various levels of security in cloud infrastructure	U	F	Case Study/ Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Fundamentals of Security in Cloud**		**14**	**22**
	1	Overview of Cloud Security- Security services- Confidentiality, Integrity, Authentication, Non repudiation, Access control	2	
	2	Basics of Cryptography	2	
	3	Conventional and public key cryptography	4	
	4	Hash functions	2	
	5	Authentications	2	
	6	Digital Signature	2	
II	**Security Design and Architecture for Cloud**		**12**	**18**
	7	Security design principles for cloud computing- comprehensive data protection, end to end access control	2	
	8	Common attack vectors and threats	1	
	9	Network and storage- Secure Isolation strategies, Virtualisation strategies, inter- tenant network segmentation strategies, data protection strategies	3	
	10	Data retention, detection and archiving procedures for tenant data	2	
	11	Encryption, Redaction, Tokenisation, Obfuscation	2	
	12	PKI and key	2	
III	**Access Control and Identity Management**		**12**	**18**
	13	Access control requirements for Cloud infrastructure- user identification, authentication and authorization	2	
	14	Role based access control- multi-factor authentication, single Sign-on	2	
	15	Identity providers and service consumers	2	
	16	Storage and network access control options- OS Hardening and minimization	3	
	17	Intruder detection and prevention	3	
IV	**Cloud Security Design patterns**		**10**	**12**
	18	Introduction to design patterns	2	
	19	Cloud bursting	2	
	20	Geo-tagging	2	
	21	Secure cloud interfaces	2	
	22	Cloud resource access control	2	
V	**Open Ended Module**		**12**	
	1	Infrastructure security: Network level, host level, application level	4	

	2	Security management in the cloud	4	
	3	Audit and compliance	4	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	2	--	-	1	1						
CO 2	-	2	-	-	1	1						
CO 3	-	1	-	-	1	1						
CO 4	-	1	-	-	2	1						
CO 5	1	1	-	-	2	1						
CO 6	-	1	-	-	2	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	✓
CO 5		✓	✓
CO 6		✓	

References:

1. "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" by Tim Mather, Subra Kumaraswamy, and Shahed Latif.

2. “Cloud computing: Principles and Paradigms”. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Willey Publications.

Programme	BCA				
Course Title	Storage Technologies				
Type of Course	Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic knowledge of computer systems and architecture Fundamental understanding of data structures and algorithms				
Course Summary	This course introduces students to various storage technologies, storage network technologies, storage and virtualization technologies. Course also discuss various back up and recovery strategies.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand fundamentals of Information storage	U	C	Instructor-created exams / Quiz
CO2	Examine features of various storage architectures	U	C	Assignment / Seminar presentations/ Exams
CO3	Understand features of Intelligent storage systems	U	P	Seminar Presentation / Group Tutorial Work/ Viva Voce
CO4	Identify features of various Storage technologies	U	C	Instructor-created exams / Home Assignments
CO5	Identify need of backup and recovery and various recovery mechanisms	U	P	Writing assignments/ Exams/ Seminar

				Presentations
CO6	Infer security needs and management needs for storage technologies	U	F	Case Study/ Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I		**Storage System**	**12**	**18**
	1	**Introduction to Information Storage-** Information Storage, Evolution of Storage Architecture	2	
	2	Data Center Infrastructure and characteristics	1	
	3	Third platform technologies- Cloud storage and its characteristics	2	
	4	Cloud services and deployment models	3	
	5	Storage Architectures- Direct-Attached Storage (DAS) Network-Attached Storage (NAS) (Introduction only)	2	
	6	Storage Area Network (SAN) Cloud storage architectures (Introduction only)	2	
II		**Intelligent Storage Systems & RAID**	**12**	**18**
	7	RAID Implementation Methods, RAID Array Components, RAID Techniques	2	
	8	RAID Levels, RAID Impact on Disk Performance	3	
	9	RAID Comparison	1	
	10	Components of an Intelligent Storage System	1	
	11	Storage Provisioning	2	
	12	Types of Intelligent Storage Systems	3	
III		**Storage Networking Technologies - Fibre Channel Storage Area Networks**	**12**	**18**
	13	Block based stored system, File based storage system, object oriented based storage system (Introduction)	2	
	14	Fibre Channel Storage Area Networks- Components of FC SAN,	2	
	15	Fibre Channel Architecture	2	
	16	Fabric Services	2	
	17	FC SAN Topologies	2	
	18	Virtualization in SAN	2	
IV		**Backup and Archive**	**12**	**16**
	19	Backup Purpose, Backup Considerations, Back up Granularity	3	
	20	Recovery Considerations, Backup Methods	3	
	21	Backup Architecture, Backup Topologies	3	
	22	Backup and Restore Operations	3	
V		**Open Ended Module**	**12**	
	1	Storage Security Domains	3	
	2	Security Implementations in Storage Networking	3	
	3	Securing Storage Infrastructure in Virtualized and Cloud Environments	3	
	4	Storage Infrastructure Management Activities	3	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	2	--	-	1	1						
CO 2	-	2	-	-	1	1						
CO 3	-	1	-	-	1	1						
CO 4	-	1	-	-	2	1						
CO 5	1	1	-	-	2	1						
CO 6	2	-	-	-	2	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓
CO 6	✓	✓	

References

1. Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments, 2nd Edition, Willey Publications

Programme	BCA				
Course Title	Virtualization				
Type of Course	Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic understanding of cloud computing				
Course Summary	This course introduces students to the fundamental concepts, technologies, virtualization, various virtualization tools and virtualization in storage, desktop, network and server				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand basics of virtualization	U	C	Instructor-created exams / Quiz
CO2	Understand how hypervisors work and their role in virtualization.	Ap	P	Assignment / Seminar presentations/ Exams
CO3	Understand Differences between various types of virtualization, including server virtualization, desktop virtualization, network virtualization, and storage virtualization	Ap	C	Seminar Presentation / Group Tutorial Work/ Viva Voce
CO4	Explore how virtualization technologies are used in the context of cloud services.	U	P	Instructor-created exams / Home Assignments
CO5	Understand the potential risks and vulnerabilities associated with virtualization and learn how to mitigate them.	U	P	Writing assignments/ Exams/ Seminar Presentations
CO6	Compare and analyse various virtualization tools	U	F	Case Study/ Exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I		**Introduction to Virtualisation**	**12**	**18**
	1	Virtualization and computing- need for virtualisation,	2	
	2	Cost, administration,	2	
	3	Fast deployment, reduce infrastructure cost	2	
	4	Limitations	1	
	5	Types of hardware virtualization: full virtualisation, partial virtualization, paravirtualization	3	
	6	Types of hypervisors	2	
II		**Server and Desktop Virtualization**	**14**	**20**
	7	Virtual machine basics	2	
	8	Types of virtual machines	2	
	9	Understanding server virtualisation- types of server virtualization	3	
	10	Business cases for server virtualization	2	
	11	Uses of virtual server consolidation,	2	
	12	Selecting server virtualisation platform	1	
	13	Desktop virtualisation- types of desktop virtualization	2	
III		**Network Virtualisation**	**12**	**18**
	14	Introduction to network virtualisation	2	
	15	Advantages, functions	2	
	16	Tools for network virtualization	3	
	17	VLAN-WAN architecture	2	
	18	WAN Visualization	3	
IV		**Storage Virtualization**	**10**	**16**
	19	Introduction to memory virtualization	2	
	20	Types of storage virtualization	3	
	21	Risk of storage virtualization	2	
	22	SAN-NAS-RAID	3	
V		**Open Ended Module- Virtualization tools (Any 3- 4 hours each)**	**12**	
		• VMWare-Amazon AWS • Microsoft HyperV • Oracle VM Virtual box • IBM PowerVM • Google Virtualization		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	2	--	-	1	1						
CO 2	-	2	-	-	1	1						

CO 3	-	1	-	-	1	1						
CO 4	2	1	-	-	2	1						
CO 5	-	1	-	-	2	1						
CO 6	1	1	-	-	2	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	✓
CO 5		✓	✓
CO 6	✓	✓	

References

1. Cloud Computing a practical approach- Anthony T Velte, Toby T Velte, Robert Elsenpeter, Tata McGraw Hill
2. Virtualization from Desktop to the Enterprise, Chris Wolf, Eric M Halter

4. Data Science and AI

Programme	BCA				
Course Title	Data Analytics and Visualization				
Type of Course	Elective				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1.Basics of Linear Algebra 2. Basics of Statistics				
Course Summary	The data analytics course delves into techniques for analyzing data and extracting valuable insights, preparing participants for effective decision-making based on data-driven evidence across various domains.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the basic concepts of data analytics	U	C	Instructor-created exams / Quiz
CO2	Understand the supervised learning algorithms and its application	U	C	Practical Assignment / Group Tutorial Work
CO3	Understand the unsupervised learning algorithms and its application	U	C	Practical Assignment / Group Tutorial Work
CO4	Enhance the idea of Big data Anaytics tools	U	C	Instructor-created exams / Home Assignments
CO5	Implementation of Predictive and non predictive algorithms	Ap	P	Practical assignments and practical tests
CO6	Apply data analytics techniques to real-world datasets and case studies from various domains.	Ap	P	Practical assignments and practical tests

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Mark
I	**Introduction to Data Analytics**		**10**	**10**
	1	Introduction to Data Analysis - Analytics, Analytics Process Model	2	
	2	Analytical Model Requirements.	2	
	3	Data Analytics, Life Cycle overview	2	
	4	Basics of data collection	2	
	5	Sampling, Pre-processing and dimensionality reduction	2	
II	**Supervised learning**		**16**	**20**
	6	Regression	3	
	7	Classification	3	
	8	Naive Bayes	3	
	9	KNN	3	
	10	Linear Regression	2	
	11	Application of supervised learning	2	
III	**Unsupervised learning**		**10**	**20**
	12	Hierarchical clustering	2	
	13	K-means clustering	2	
	14	Principal Component Analysis	2	
	15	Association- Apriori Algorithm	2	
	16	Application of unsupervised learning	2	
IV	**Big Data Analytics**		**12**	**20**
	17	Working of Big Data Analytics	2	
	18	Types of Big Data Analytics	2	
	19	Big Data Analytics Technologies and Tools	2	
	20	Big Data Analytics using Map Reduce and Apache Hadoop	2	
	21	Statistical Method for Visualization	2	
	22	Introduction to Big Data Analytics using Apache Cassandra, Mongo DB	2	
V	**Open Ended Module**		**12**	
	Implement the tasks from the following: • Apply the entire data analytics process to a real-world dataset. • Perform clustering and association rule mining on a market basket dataset. • Implement big data analytics using Hadoop and Apache Spark. • Create insightful visualizations and perform statistical analysis using advanced tools. • Develop and implement advanced machine learning models on a complex dataset. • Significance of activation function like linear,tanh ,Relu			

	• Dimensionality reduction for data analysis- E.g.: Principal Component Analysis		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	1	-	1	2						
CO 2	2	2	2	1	2	3						
CO 3	2	2	1	1	2	3						
CO 4	2	1	1	1	2	2						
CO 5	2	3	3	3	3	3						
CO6	2	-	1	-	2	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓

CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5			✓	
CO6			✓	

References:

1. Bart Baesens," Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends", John Wiley & Sons, 2013.

2. David Dietrich, "EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", John Wiley & Sons, 2015.

3. Jaiwei Han, MichelineKamber, "Data Mining Concepts and Techniques", Elsevier, 2006.

4. Christian Heumann and Michael Schomaker, "Introduction to Statistics and DataAnalysis", Springer, 2016

5. Margaret H. Dunham, Data Mining: Introductory and Advanced Topics. Pearson, 2012.

6. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.

Programme	BCA				
Course Title	Knowledge Engineering				
Type of Course	Elective				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Understanding of basic mathematics and statistics 2. Basic understanding of computer science concepts				
Course Summary	This course introduces students to the principles, techniques, and tools used in Knowledge Engineering. It covers the design and development of knowledge-based systems, including knowledge representation, reasoning, and acquisition.				

Course Outcomes (CO): .

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand basics of Knowledge Engineering	U	C	Instructor-created exams / Quiz
CO2	Apply methodologies and modelling for agent design and development	Ap	P	Assignment / Seminar presentations/ Exams
CO3	Design and develop ontologies	Ap	P	Seminar Presentation / Group Tutorial Work/ Viva Voce
CO4	Apply reasoning with ontologies and rules	Ap	P	Instructor-created exams / Home Assignments
CO5	Understand learning and rule learning	U	C	Writing assignments/ Exams/ Seminar Presentations
CO6	Develop theoretical knowledge to design a knowledge-based system	Ap	P	Case Study/ Group discussions/ Presentations

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Reasoning under uncertainity**		**15**	**15**
	1	Understanding the World through Evidence-based Reasoning: - Evidence, Data, and Information, Evidence and Fact, Evidence and Knowledge	2	
	2	Abductive Reasoning	1	
	3	Probabilistic Reasoning: - Enumerative Probabilities: Obtained by Counting, Subjective Bayesian View of Probability	2	
	4	Belief Functions	1	
	5	Baconian Probability, Fuzzy Probability	3	
	6	Evidence-based Reasoning	2	
	7	Artificial Intelligence: - Intelligent Agents, Mixed-Initiative Reasoning	2	
	8	Knowledge Engineering: - An Ontology of Problem-Solving Tasks, Building Knowledge-based Agents	2	
II	**Methodologies and Tools for Agent Design and Development, Modelling the Problem-Solving Process**		**12**	**20**
	9	A Conventional Design and Development Scenario	2	
	10	Development Tools and Reusable Ontologies	2	
	11	Agent Design and Development Using Learning Technology	2	
	12	Problem Solving through Analysis and Synthesis	1	

	13	Inquiry-driven Analysis and Synthesis for Evidence-based Reasoning	2	
	14	Evidence-based Assessment, Believability Assessment	3	
III	**Ontologies**		**11**	**20**
	15	What Is an Ontology? Concepts and Instances, Generalization Hierarchies	2	
	16	Object Features, Defining Features, Defining Features, Representation of N-ary Features	2	
	17	Transitivity, Inheritance, Ontology Matching	3	
	18	Ontology Design and Development Methodology- Steps in Ontology Development, Domain Understanding and Concept Elicitation, Modeling-based Ontology Specification	4	
IV	**Reasoning with Ontologies and Rules**		**10**	**15**
	19	Production System Architecture	1	
	20	Complex Ontology-based Concepts	1	
	21	Reduction and Synthesis Rules and the Inference Engine, Evidence-based Hypotheses Analysis, Rule for Ontology Matching	4	
	22	Partially Learned Knowledge, Reasoning with Partially Learned Knowledge	4	
V	**Open Ended Module- Learning for Knowledge-based Agents**		**12**	
	1	Generalization and Specialization Rules	4	
	2	Types of Generalizations and Specializations	4	
	3	Analogy-based Generalization	4	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	-	-	1	1						
CO 2	1	-	-	-	1	1						
CO 3	1	3	1	1	2	3						
CO 4	1	-	1	1	2	3						
CO 5	1	-	-	-	2	3						
CO 6	1	2	1	1	3	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓
CO 6	✓	✓	

References:

1. “Knowledge Engineering”, Gheorghe Tecuci, Dorin Marcu, Mihai Boicu, David A. Schum.
2. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig.
3. "Knowledge Representation and Reasoning" by Ronald J. Brachman and Hector J. Levesque.

Programme	BCA				
Course Title	Advanced Python for Data Science				
Type of Course	Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Data Science Concepts 2. Python basics				
Course Summary	This course provides insight into the basic concepts of Python required for Data Science. It includes array fundamentals, array transformations, and matrices				

	fundamentals. The analysis of data using Pandas will help the students to understand the basics of data analysis

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the concepts of arrays, matrices and their transformations	U	C	Instructor-created exams / Quiz
CO2	Create informative plots using Python packages	Ap	P	Modelling Assignments/ Case Studies
CO3	Understand the loading mechanism of different types of data and manipulate them	U	C	Instructor-created exams / Quiz
CO4	Analyse the data using Pandas and Data Frames	An	P	Modelling Assignments/ Case Studies
CO5	Understand the concepts of random tensors and generate tensors from various distributions	U	C	Instructor-created exams / Quiz
CO6	Familiarize with various TensorFlow operations needed for Data Science	U	C	Instructor-created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I		**Arrays, Matrix manipulation using NumPy**	**10**	**12**
	1	Array creation, sorting, concatenating	2	
	2	Shape and size of an array, basic arithmetic operations on an array, broadcasting	2	
	3	Aggregate functions on arrays, Unique and count operations	2	
	4	Matrices using NumPy	2	
	5	Transpose, reverse, flatten and ravel	2	
II		**Data Analysis and Manipulation using Pandas**	**12**	**18**
	6	Series - constructing from an array, using explicitly defined indices, using a dictionary.	2	
	7	Data Frame - constructing from arrays, dictionaries, structured arrays, and series, Indexing of data frames	3	
	8	Arithmetic and Binary operations on Data frame	3	
	9	Broadcasting operations	2	
	10	Universal functions, melt() and pivot()	2	
III		**Other Python packages for data science**	**10**	**14**
	11	Scipy, Scikit-learn, PyTorch, Seaborn, Scrapy, and Beautiful Soup.	3	

	12	Python Data Operations: Importing and Exporting Data, Data Cleansing	3	
	13	Processing CSV Data, Processing JSON Data, Processing XLS Data.	2	
	14	Data Analysis: Measuring Central Tendency, Measuring Variance, and Correlation in Python	2	
IV	**TensorFlow Fundamentals**		**16**	**26**
	15	Tensors, creation of tensors and random tensors, Tensors from the Normal distribution, Poisson distribution, set_seed()	2	
	16	Tensor attributes, size, rank and reshaping of a tensor	2	
	17	Tensor arithmetic, relational, logical operations. Shuffle()	2	
	18	Reduce operations on tensor Dimension-wise	2	
	19	Ragged tensors, TensorArray, dynamic arrays,	2	
	20	unique(), fill(), concat(), gather(), ones(), ones_like(), zeros(),	2	
	21	eye(), range(), repeat, reverse(), roll(), slice(), sort(),	2	
	22	split(), squeeze(), tile(), stack(), unstack(), tensordot()	2	
V	**Open Ended Module**		**12**	
	1	Use Pandas and NumPy to efficiently process and analyze CSV, Excel, or JSON data	4	
	2	Create compelling visual insights using Matplotlib, Seaborn, or Plotly	3	
	3	Case studies with Tensor flow	5	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	-	-	2	2	2						
CO 2	2	1	-	-	2	2						
CO 3	1	-	2	-	2	2						
CO 4	1	1	1	2	2	2						
CO 5	2	-	-	-	2	2						
CO 6	-	-	2	2	2	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium

3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓	✓	✓
CO 3	✓		✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓			✓
CO 6	✓			✓

References:

1. VanderPlas, Jake. Python Data Science Handbook: Essential Tools for Working with Data. United States, O'Reilly Media, 2016.
2. Rogel-Salazar, Jesus. Data Science and Analytics with Python. United Kingdom, CRC Press, 2018.
3. https://numpy.org/doc/
4. https://pandas.pydata.org/docs/
5. https://www.tensorflow.org/guide

Programme	BCA				
Course Title	Neural Networks and Deep Learning				
Type of Course	Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1.Mathematical Foundation for CS				

	2.Machine Learning
Course Summary	Explores core principles and advanced methodologies in neural networks and deep learning, spanning from foundational concepts like perceptrons to specialized architectures such as CNNs and RNNs. Students will gain comprehensive knowledge of neural network design, training, and optimization, equipping them to tackle various theoretical and computational challenges within these frameworks.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Illustrate the basic concepts of neural networks and its practical applications	Ap	P	Practical Assignment / Instructor created exams / Quiz
CO2	Implementing basic concept of neural networks	Ap	P	Practical Assignment / Instructor created exams / Quiz
CO3	Applying the optimization technique in neural networks	Ap	P	Practical Assignment / Instructor created exams / Quiz
CO4	Implement the foundation layer of CNN	Ap	P	Practical Assignment / Instructor created exams / Quiz
CO5	Implement a sequence model using recurrent neural network	Ap	P	Practical Assignment / Instructor- created exams / Quiz
CO6	Explore the application area of deep learning like NLP, Voice Recognition, Speech Recognition	Ap	P	Practical Assignment / Instructor created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I		**Neural Networks and Deep Learning**	**10**	**15**

	1	Introduction to neural networks -Single layer perceptrons, Multi-Layer Perceptrons (MLPs)	1	
	2	Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax	3	
	3	Risk minimization, Loss function, Training MLPs with backpropagation	3	
	4	The Problem of Overfitting, Vanishing and exploding gradient problems	3	
II	**Deep Learning and optimization technique**		**12**	**15**
	5	Introduction to deep learning, Deep feed forward network	3	
	6	Training deep models. Eigen value, Eigen vector concepts.	3	
	7	Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD	2	
	8	Regularization Techniques - L1 and L2 regularization, Early stopping	2	
	9	Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods.	2	
III	**Convolution Neural Networks**		**13**	**20**
	10	Convolution operation, Motivation	1	
	11	Pooling, Convolution and Pooling as an infinitely strong prior	3	
	12	Variants of convolution functions	2	
	13	Structured outputs	2	
	14	Data types	1	
	15	Efficient convolution algorithms	3	
IV	**Recurrent Neural Networks**		**13**	**20**
	16	Computational graphs	1	
	17	RNN design	1	

	18	Encoder – decoder sequence to sequence architectures	2	
	19	Deep recurrent networks	2	
	20	Recursive neural networks	3	
	21	Modern RNNs LSTM and GRU.	2	
	22	Practical use cases for RNNs.	2	
V	**Open Ended Module – Applications**		**12**	
	1	Implement the tasks from the following: • Implement and analyze single-layer and multi-layer perceptrons with activation functions, loss functions, and backpropagation. • Investigate overfitting, vanishing gradients, and exploding gradients in deep networks, and explore solutions. • Design and train a CNN for image classification, focusing on convolution, pooling, and efficient algorithms. • Implement and train RNNs, including LSTM and GRU, for sequence prediction, and analyze their performance. • Train a deep feed-forward network on a complex dataset, using eigenvalues and eigenvectors, and compare optimization techniques.	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	1	2	2	2	1						
CO 2	2	1	3	2	2	2						
CO 3	3	1	3	2	3	2						
CO 4	3	2	3	3	3	3						
CO 5	3	2	3	3	3	3						
CO 6	3	2	3	3	3	3						

Correlation Levels:

Level	Correlation
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.

2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

Basket of No Specialization Electives (for VII, VIII Semesters)

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Programme	BCA				
Course Title	Theory of Computation				
Type of Course	Elective				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Understanding of basic mathematical concepts such as sets, functions, relations, logic and discrete structures. 2. Understanding of fundamental programming constructs such as loops, conditionals, functions, and recursion.				
Course Summary	This course covers a comprehensive exploration of fundamental concepts in computer science, delving into computational models, formal language theory, and computational complexity. Students learn about various computational models such as finite automata, pushdown automata, and Turing machines, gaining insights into their capabilities and limitations. Through the study of formal languages and grammars, students understand the structure and properties of regular and context-free languages.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To learn and understand fundamental concepts in computational theory, including computational models such as finite automata, pushdown automata, and Turing machines.	U	P	Practical Assignment / Instructor-created exams / Quiz
CO2	To be able to classify formal language into regular, context-free, context sensitive and unrestricted languages.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	To design and analyse Turing machines, their capabilities and limitations	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO4	Construct the abstract machines including finite automata, pushdown automata, and Turing machines from their associated languages and grammar	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Gain insights into decidability and undecidability, and understand the	Ap	P	Practical Assignment /

	limitations of computation through the study of the halting problem and other undecidable problems.			Instructor-created exams / Quiz
CO6	Solve computational problems regarding their computability and complexity and prove the basic results of the theory of computation	E	P	Practical Assignment / Instructor-created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Mark
I	**FINITE AUTOMATA**		**10**	**16**
	1	Formal Language: Definition, Chomsky classification of Grammar, Language and Relation, Language and Automata	2	
	2	Finite Automata: DFA, NFA with and without €- moves	2	
	3	Equivalence of DFA and NFA	2	
	4	Equivalence of NFA and €-NFA	2	
	5	Mealy and Moore Models - Conversions	2	
II	**REGULAR LANGUAGE, REGULAR EXPRESSION**		**10**	**18**
	6	Regular Languages: Regular Expressions, Ardens Theorm	2	
	7	Conversion of Regular Expression to Finite Automata	2	
	8	Closure properties of RLs	2	
	9	Pumping lemma for RLs	2	
	10	Myhill-Nerode theorem	2	
III	**PUSH DOWN AUTOMATA, CONTEXT FREE LANGUAGE**		**14**	**18**
	11	Pushdown Automata - Instantaneous Description - Transition Diagram	3	
	12	Deterministic and Non Deterministic PDA	3	
	13	Equivalence of PDAs and CFGs, Pumping lemma for CFLs	2	
	14	Closure properties of CFLs, Simplification of CFLs	2	
	15	Chomsky Normal form (CNF) and Greibach Normal form (GNF)	2	
	16	CYK algorithm for CFL membership	2	
IV	**TURING MACHINE, UNDECIDABILITY**		**14**	**18**
	17	Turing Machine - Instantaneous Description - Transition Diagram	3	
	18	Variants of TMs - Equivalence of the various variants with basic model	3	
	19	Recursively Enumerable and Recursive languages	2	
	20	Church Turing hypothesis - Rices theorem	2	
	21	Undecidability of Posts correspondence problem	2	
	22	The Class P and NP	2	
V	**Open Ended Module- Application Level**		**12**	
		1. Application of regular expressions in pattern matching and text processing. 2. Analysis of context-free languages using pumping lemma		

		and closure properties. 3. Investigation of undecidability and un-solvability using the halting problem and Rice's theorem. 4. Notion of tractability: The Class P and NP, NP completeness of propositional satisfiability, other variants of satisfiability. NP-complete problems from other domains: graphs (clique, vertex cover, independent sets, Hamiltonian cycle), number problem (partition), set cover. 5. Discussion of practical implications and applications of complexity theory.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	2	1	-	-						
CO 2	1	1	2	1	-	-						
CO 3	-	3	1	1	-	-						
CO 4	-	3	3	2	-	-						
CO 5	-	1	3	3	1	-						
CO 6	-	1	3	3	1	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓

CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Reference:

1. J.E. Hopcroft, R. Motwani and J.D Ullman, ―Introduction to Automata Theory, Languages and Computations, Third Edition, Pearson Education, 2016.
2. Theory of Computer Science- Automata, Languages and Computation- K.L.P. Mishra, N Chandrasekaran, PHI
3. Theory of Computation, Sachin Agrawal, Vikas Publishing House
4. Micheal Sipser, ―Introduction of the Theory and Computation, Thomson Brokecole, 3rd Edition, 2013.
5. J. Martin, ―Introduction to Languages and the Theory of Computation, Third Edition, TMH, 2007.
6. An Introduction to Formal languages and Automata- Peter Linz.

Programme	BCA				
Course Title	Expert Systems and Fuzzy Logic				
Type of Course	Elective				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Familiarity with basic logic and set theories. 2. Understanding the fundamentals of computer science, such as algorithms and data structures, can be beneficial for the implementation aspects of expert systems. 3. A basic understanding of probability and statistics is often required.				
Course Summary	The Fuzzy logic and expert systems course introduce two interconnected fields in artificial intelligence: fuzzy logic and expert systems. Fuzzy logic deals with reasoning under uncertainty and imprecision, while expert systems involve the development of computer-based systems that emulate human expertise in specific domains.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the fundamental concepts of fuzzy set theory and interpret membership functions and linguistic variables.	U	F	Instructor-created exams / Quiz
CO2	Design and implement fuzzy controllers for decision-making. Develop fuzzy inference systems (FIS) for various applications and apply fuzzy clustering techniques for pattern recognition.	U	C	Practical Assignment / Observation of Practical Skills
CO3	Describe the role of expert systems in artificial intelligence and Understand knowledge representation techniques in expert systems.	Ap	P	Practical Assignment / Observation of Practical Skills
CO4	Explain the functioning of inference engines in rule-based systems.	Ap	P	Practical Assignment / Observation of Practical Skills
CO5	Acquire domain knowledge for expert system development.	An	C	Instructor-created exams / Quiz
CO6	Construct a knowledge base and define rules for an expert system and implement validation and refinement techniques for expert systems.	Ap	P	Practical Assignment / Observation of Practical Skills

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Mark
I		**Introduction to Fuzzy Logic**	**8**	**10**
	1	Overview of Fuzzy Logic	1	
	2	Fuzzy Sets and Membership Functions	2	
	3	Fuzzy Operations (Union, Intersection, Complement)	2	
	4	Basic principles of fuzzy logic. Fuzzification and defuzzification.	2	
	5	Linguistic variables and terms.	1	
II		**Fuzzy Inference Systems (FIS) and Fuzzy Logic Applications**	**12**	**20**
	6	Mamdani FIS-Rule-based systems in fuzzy logic, Rule base and implication methods.	2	
	7	Sugeno FIS-Structure and operation of Sugeno FIS. Comparison with Mamdani FIS.	2	
	8	Basic structure of fuzzy logic controllers (FLCs)	3	

	9	Rule-based systems and fuzzy inference	3	
	10	Applications of fuzzy logic controllers	2	
III	**Introduction to Expert Systems and Rule-Based Systems**		**12**	**20**
	11	Definition and characteristics of expert systems.	2	
	12	Knowledge representation and reasoning.	3	
	13	Expert system components: knowledge base, inference engine, user interface. Examples and applications of expert systems	3	
	14	Rule-based systems and production rules, Forward and backward chaining.	2	
	15	Inference mechanisms in expert systems, Examples of rule-based expert systems.	2	
IV	**Introduction to SCILAB/MATLAB Programming**		**16**	**20**
	16	SCILAB/MATLAB environment and basic navigation, Variables, data types, and basic operations, Script files and running SCILAB/MATLAB code. Introduction to functions and function files.	3	
	17	Introduction to functions and function files, Conditional statements (if, else, elseif), Loop structures (for, while).	2	
	18	Logical operators and relational expressions, Vectorized operations and element-wise operations.	2	
	19	Introduction to arrays, matrices, and vectors, Cell arrays and structures, Indexing and slicing in SCILAB/MATLAB, Working with multidimensional arrays.	2	
	20	Basic file input/output operations, Reading and writing data files (text, CSV, Excel), Data visualization using plotting functions.	2	
	21	Statistical analysis and plotting techniques, Fuzzy logic toolbox in SCILAB/MATLAB.	2	
	22	Expert system development tools in SCILAB/MATLAB, Building expert systems using SCILAB/MATLAB.	3	
V	**Open Ended Module**		**12**	
		Implement the tasks from the following: **Fuzzy logic using SCILAB/MATLAB** 1. Membership Functions: • Define triangular and trapezoidal membership functions for a variable representing temperature. Plot these membership functions. • Write SCILAB/MATLAB code to calculate the membership values for a given temperature. 2. Fuzzy Logic Operations: • Implement the operations AND, OR, and NOT using fuzzy logic. • Use SCILAB/MATLAB to perform fuzzy logic operations on two fuzzy sets representing temperature and humidity. 3. Rule-Based System: • Create a simple fuzzy rule-based system for a temperature control system. Define rules based on temperature and humidity inputs. • Implement the rule-based system using SCILAB/MATLAB and simulate different input scenarios. 4. Fuzzy Inference: • Implement Mamdani and Sugeno fuzzy inference systems for a traffic light control system.	6	

		• Evaluate the systems with different input values and compare their outputs.		
		Implement the tasks from the following: **Expert System using SCILAB/MATLAB** 1. Rule-Based System Initialization: • Define a knowledge base for a diagnostic expert system. Include rules that link symptoms to possible diseases. • Implement the rule-based system in SCILAB/MATLAB using if-else statements or switch-case constructs. 2. Rule Inference Engine: • Develop a rule inference engine that evaluates the rules in the knowledge base based on user input. Use SCILAB/MATLAB functions to implement rule-based inference and determine the likely diagnosis for a set of symptoms.	6	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	-	-	-	1						
CO 2	1	3	-	-	1	-						
CO 3	1	3	-	-	2	2						
CO 4	1	3	-	-	2	2						
CO 5	2	1	3	1	1	-						
CO 6	2	1	3	2	2	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations

CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4		✓	✓	✓
CO 5		✓	✓	✓
CO 6	✓	✓	✓	✓

References:

1. "Fuzzy Logic with Engineering Applications" by Timothy J. Ross
2. "Expert Systems: Principles and Programming" by Joseph C. Giarratano and Gary D. Riley
3. "Fuzzy Sets and Fuzzy Logic: Theory and Applications" by George J. Klir and Bo Yuan
4. "Expert Systems: Principles and Case Studies" by Efraim Turban, Jay E. Aronson, and Ting-Peng Liang
5. “Introduction to Fuzzy Logic using MATLAB” by S.N. Sivanandam, S. Sumathi, and S. N. Deepa.
6. Nagar, S. (2017). Introduction to Scilab: For Engineers and Scientists. Apress.
7. Sheth, T. (2016). Scilab: A Practical Introduction to Programming and Problem Solving. CreateSpace Independent Publishing Platform.
8. Gomez, C. (1999). Engineering and Scientific Computing with Scilab. Birkhäuser.

Programme	BCA				
Course Title	Modern Cryptography				
Type of Course	Elective				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of computer networks				
Course Summary	This course covers the essential concepts of computer security, including various security threats and attacks, as well as different cryptographic algorithms aimed at preserving confidentiality, integrity, and ensuring message authentication				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understanding the fundamentals of cryptography	U	C	Instructor-created exams / Quiz
CO2	Acquire a basic knowledge about the security threats and different types of attacks	U	C	Instructor-created exams / Quiz
CO3	Get a basic idea about traditional ciphers	U	C	Instructor-created exams / Home assignments
CO4	Familiarize the standard symmetric key algorithms	A	P	Instructor-created exams / Home assignments
CO5	Familiarize the concepts of public key cryptography	A	P	Instructor-created exams / Home assignments
CO6	Interpret data integrity, authentication, and digital signature	A	P	Instructor-created exams / Home assignments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Computer and Network Security**		**9**	**15**
	1	Computer Security Concepts – CIA triad, challenges of computer security	1	
	2	The OSI security architecture – Security attacks, mechanism and services	3	
	3	Fundamental security design principles	1	
	4	Attack surfaces and attack trees	2	
	5	A model for Network security and standards	2	
II	**Symmetric Key Cryptography**		**15**	**15**
	6	Symmetric Cipher model	3	
	7	Substitution and Transposition techniques	3	
	8	Traditional block cipher structure	2	
	9	Data Encryption standard- Algorithm, example, strength	3	
	10	Advanced Encryption standard- structure, Transformation function, example	3	
	11	Key channel establishment for symmetric cryptosystems	1	
III	**Public Key Cryptography**		**10**	**20**
	12	Principles of Public key crypto systems- public key crypto	4	

		systems, applications, requirements		
	13	RSA algorithm	2	
	14	Security of RSA algorithm	2	
	15	Diffie-Hellman key exchange	2	
IV	**Cryptographic Data Integrity Algorithms**		**14**	**20**
	16	Cryptographic hash functions- applications	2	
	17	Message Digest algorithm	2	
	18	Secure Hash Algorithm	2	
	19	Message Authentication Code -requirements, security	2	
	20	MACs based on Hash Functions	2	
	21	Digital Signature – properties, attacks and forgeries, requirements	2	
	22	RSA-PSS digital signature algorithm	2	
V	**Open Ended Module**		**12**	
	1	Email, IP and web security	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	2	-						
CO 2	3	2	-	-	-	-						
CO 3	1	2	-	-	-	-						
CO 4	1	3	1	2	-	-						
CO 5	1	3	1	2	-	-						
CO 6	3	2	1	1	1	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓	✓	✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓
CO 6	✓	✓	✓

References:

1. "Cryptography and Network Security- Principles and Practice", William Stallings.
2. "Modern Cryptography: Theory and Practice"- Wenbo Mao Hewlett-Packard Company.
3. Cryptography and Information Security"- V K Pachghare.

Programme	BCA				
Course Title	Client Server Architecture				
Type of Course	Elective				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Knowledge in Fundamentals of Network and Operating System				
Course Summary	The syllabus is prepared with the view of preparing the Bachelor of Computer Application Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basics of client/server systems and the driving force	U	C	Instructor-created exams / Quiz

	behind the development of client/server systems.			
CO2	Outline the architecture and classifications of client/server systems	U	C	Instructor-created exams / Quiz
CO3	Choose the appropriate client/server network services for a typical application	U	P	Instructor-created exams / Quiz
CO4	Describe management services	U	C	Instructor-created exams / Case studies
CO5	Describe issues in network	U	P	Instructor-created exams / Quiz Case studies
CO6	Apply various services and support	U	P	Instructor-created exams / Quiz /Case studies
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Introduction to Client/Server computing**		**12**	**15**
	1	Introduction to Client/Server computing - Driving forces behind Client/ Server, Client/ Server development tools	2	
	2	Development of client/server systems, Client/Server security	2	
	3	Organizational Expectations, Improving performance of client/server applications	2	
	4	Single system image, Downsizing and Rightsizing	3	
	5	Advantages of client server computing, Applications of Client/Server	3	
II	**Client/Server Application Components**		**12**	**15**
	6	Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing	2	
	7	Model View Controller (MVC)	1	
	8	Principles behind Client/Server Systems	3	
	9	Client/Server Topologies	3	
	10	Existing Client/Server Architecture.	1	
	11	Architecture for Business Information System	2	
III	**Client/ Server Systems Development**		**12**	**20**
	12	Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services.	2	
	13	Dynamic Data Exchange (DDE).	2	
	14	Object Linking and Embedding (OLE).	2	
	15	Common Object Request Broker Architecture (CORBA).	2	
	16	Server- Detailed server functionality	2	
	17	Network operating system, Available platforms, Server operating system.	2	
IV	**Client/ Server Systems Development**		**12**	**20**
	18	Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability.	2	
	19	Software Distribution, Performance, Network management.	2	
	20	Remote Systems Management- RDP, Telnet, SSH, Security.	3	
	21	LAN and Network Management issues, Training, Connectivity	2	
	22	Communication interface technology, Inter process communication	3	
V	**Open Ended Module**		**12**	
	CASE STUDY: Client Server Architecture Generic Client/Server Classes Client/Server Communication via Sockets The Server Protocol The Client Protocol A Two-Way Stream Connection			

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	-						
CO2	-	3	-	-	-	-						
CO3	-	2	1	-	-	-						
CO4	1	2	1	1	1	1						
CO5	-	2	1	-	-	-						
CO6	1	2	1	-	1	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Reference:

1. Patrick Smith & Steave Guengerich, “Client / Server Computing”, PHI.
2. Dawna Travis Dewire, “Client/Server Computing”, TMH.
3. Jeffrey D.Schank, “Novell’s Guide to Client-Server Application & Architecture” Novell Press.
4. Robert Orfali, Dan Harkey, Jeri Edwards, Client/Server Survival Guide, Wiley- India.

Programme	BCA				
Course Title	Blockchain Technology				
Type of Course	Elective				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	TotalHours
	4	4	-	-	60
Pre-requisites	Strong programming skills in at least one popular language, such as Java or Python. Knowledge of cryptography and data structures (like linked lists and arrays). Good understanding of networking concepts				
Course Summary	The syllabus is prepared with the view of preparing the Bachelor of Computer Application Graduates to create awareness and understanding among students on the foundation of blockchain technology. The course introduces the cryptographic principles behind blockchain and helps the students understand concepts like consensus, crypto-currency, smart contracts, use cases etc.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basics of cryptographic building blocks in blockchain technology.	U	C	Instructor-created exams / Quiz
CO2	Explain the fundamental concepts of blockchain technology.	U	C	Instructor-created exams / Quiz
CO3	Summarize the classification of consensus algorithms	U	P	Instructor-created exams / Quiz
CO4	Explain the concepts of first decentralized cryptocurrency bitcoin	U	C	Instructor-created exams / Case studies
CO5	Describe the use of smart contracts and its use cases	U	P	Instructor-created exams / Quiz Case studies
CO6	Develop simple block chain applications	U	P	Instructor-created exams / Quiz /Case studies
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I		**Fundamentals of Cryptography**	**12**	**15**
	1	Introduction to Cryptography, Symmetric cryptography – AES. Asymmetric cryptography –RSA. Elliptic curve cryptography,	3	
	2	Digital signatures – RSA digital signature algorithms.	2	
	3	Secure Hash Algorithms – SHA-256.	2	
	4	Applications of cryptographic hash functions – Merkle trees	3	
	5	Distributed hash tables	2	
II		**Fundamentals of Blockchain Technology**	**12**	**15**
	6	Blockchain – Definition, architecture, elements of blockchain, benefits and limitations.	2	
	7	Types of blockchain	1	
	8	Consensus – definition, types, consensus in blockchain,	3	
	9	Decentralization – Decentralization using blockchain	3	
	10	Methods of decentralization, Routes to decentralization,	1	
	11	Blockchain and full ecosystem decentralization	2	
III		**Consensus Algorithms and Bitcoin**	**12**	**20**
	12	Consensus Algorithms, Crash fault-tolerance (CFT) algorithms – Paxos, Raft. Byzantine fault tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT),.	2	
	13	Proof of work (PoW), Proof of stake (PoS), Types of PoS	2	
	14	Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses	2	
	15	Transactions –Lifecycle, Coinbase transactions, transaction validation Blockchain – The genesis block.	2	
	16	Mining – Tasks of miners, mining algorithm, hash rate	2	
	17	Wallets – Types of wallets.	2	
IV		**Smart Contracts and Use cases**	**12**	**20**
	18	Smart Contracts – Definition, Smart contract templates, Deploying smart contracts	2	
	19	Oracles, Types of oracles.	2	
	20	Decentralization terminology – Decentralized applications, Decentralized Autonomous Organizations	3	
	21	Use cases of Blockchain technology – Government, Health care, Finance, Supply chain management.	2	
	22	Blockchain and allied technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence	3	
V		**Open Ended Module**	**12**	
		CASE STUDY: BLOCKCHAIN TECHNOLOGY Solidity language Ethereum platform		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	-						
CO2	-	2	-	-	-	-						
CO3	1	2	3	3	-	-						
CO4	-	2	3	3	1	1						
CO5	-	1	1	-	2	3						
CO6	2	1	1	-	2	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Reference Books:

1.Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, Packt Publishing, Third edition, 2020.

2. Ritesh Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, Packt Publishing, First edition, 2018.

3. Kumar Saurabh, Ashutosh Saxena, Blockchain Technology: Concepts and Applications, First Edition, Wiley Publications, First edition, 2020.

4. Chandramouli Subramanian, Asha A George, et al, Blockchain Technology, Universities Press (India) Pvt. Ltd, First edition, August 2020

5. Lorne Lantz, Daniel Cawrey, Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, O'Reilly Media, First edition, 2020.

6. Andreas M. Antonopoulos, Gavin Wood, Mastering Ethereum: Building Smart Contracts and DApps, O'Reilly Media, First edition, 2018.

Programme	BCA
Course Title	Data Mining

Type of Course	Elective				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basics of statistics				
Course Summary	This course provides an introduction to the principles, techniques, and applications of data mining.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts and principles of data mining.	U	C	Instructor-created exams / Quiz
CO2	Demonstrate proficiency in preprocessing techniques such as cleaning, transformation, and reduction of data.	U	P	Assignment / Seminar presentations/ Exams
CO3	Understand popular data mining algorithms and models, such as decision trees, k-means clustering, and association rule algorithms.	U	P	Seminar Presentation / Group Tutorial Work/ Viva Voce
CO4	Explore various methods to Evaluate and interpret the results of data mining models using appropriate performance metrics.	U	C	Instructor-created exams / Home Assignments
CO5	Understand the role of data mining in extracting patterns and knowledge from large datasets.	U	P	Writing assignments/ exams/ Seminar
CO6	Apply data mining techniques to real-world problems and datasets, emphasizing practical applications in various domains	Ap	P	Case Study

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Introduction to Data Mining**		**10**	**15**
	1	Introduction- Data mining defining, KDD vs Data mining, DBMS vs data mining	2	
	2	What kind of data can be mined? - database data, data warehouse, transactional data, other types	2	
	3	What kind of patterns can be mined? - Class/Concept	3	

		Description: Characterization and Discrimination, Mining Frequent Patterns, Associations, and Correlations, Classification and Regression for Predictive Analysis, cluster analysis, outlier analysis		
	4	Technologies used- statistics, machine learning, data base systems and ware house, information retrieval (Introduction only)	3	
II	**Data Preprocessing**		**14**	**20**
	5	Data Preprocessing: An Overview	2	
	6	Data Cleaning- missing value, noisy data, Data Cleaning as a Process	2	
	7	Data Integration- Entity Identification Problem, Redundancy and Correlation Analysis, Tuple Duplication, Data Value Conflict Detection and Resolution	3	
	8	Data Reduction - Wavelet Transforms, Principal Components Analysis, Attribute Subset Selection, Regression and Log-Linear Models: Parametric Data Reduction, Histograms,	4	
	9	Data Transformation and and Data Discretization- Data Transformation by Normalization, Discretization by Binning	3	
III	**Association Rule Mining & Classification**		**10**	**15**
	10	Introduction to Association Rule Mining Frequent Itemset, Closed Itemset, and Association Rules	1	
	11	Frequent Itemset Mining Apriori Algorithm, Generating Association Rules from Frequent Itemsets	1	
	12	Introductio to classification: Decision tree	2	
	13	Attribute Selection measures in decision tree	2	
	14	Bayes Classification methods	2	
	15	Techniques to Improve Classification Accuracy	2	
IV	**Clustering, Outlier Detection**		**14**	**20**
	16	Introduction to unsupervised techniques: challenges	2	
	17	Clustering- K Means	2	
	18	Variants of k- Means	2	
	19	Hierarchical clustering	2	
	20	Density Based clustering- DBScan	2	
	21	Introduction to outliers and novelty detection	2	
	22	Recommender system	2	
V	**Open Ended Module: Case Studies**		**12**	
	1	• Real-world applications of data mining • Case studies and projects • Ethical considerations in data mining		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	1						
CO 2	1	-	-	-	1	1						
CO 3	1	-	2	-	2	2						

CO 4	1	-	1	-	1	1						
CO 5	1	-	1	-	1	1						
CO 6	-	-	1	1	2	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓
CO 6	✓	✓	

References:

1. "Han, J., Kamber, M., & Pei, J. (2011). Data mining: Concepts and techniques. Morgan Kaufmann."
2. Data Mining Techniques - Arun K. Pujari
3. Jiawei Han and Micheline Kamber, Data Mining Concepts & Techniques, Second Edition, Elsevier.
4. Pang Ning Tan, Michael Steinbach and Vipin Kumar, Introduction To Data Mining, Pearson Education, 2007.

Programme	BCA				
Course Title	Research Methodology in Computer Science				
Type of Course	Elective				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Knowledge of Planning a research project, problem formulation, framing objectives				
Course Summary	This course introduces and discusses approaches, strategies, and data collection methods relating to research. Students will consider how to select the appropriate methodology for use in a study to be performed. Additionally, these students will learn how to collect data based on different data collection methods, construct these tools, and pilot them before they become ready for use. To culminate this final stage, students will learn to write a comprehensive research proposal that may be conducted in the future				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the psychology of research which includes different perspectives and necessity of research.	U	C	Instructor-created exams / Quiz
CO2	Apply the research knowledge to formulate a suitable problem statement by adopting different research methods and models	U	C	Instructor-created exams / Quiz
CO3	Understand different methods of Collection, Validation and Testing of Data	U	P	Instructor-created exams / Quiz
CO4	To understand the data processing and analysis techniques	U	C	Instructor-created exams / Case studies
CO5	Analyze the research outcome by using suitable statistical tool.	U	P	Instructor-created exams / Quiz Case studies
CO6	To write or present a scientific report and research proposal	U	P	Instructor-created exams / Quiz /Case studies

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Introduction to Research Methodology**		**12**	**15**
	1	Research Methodology: An Introduction to the Meaning of Research and Objectives of Research	2	
	2	Motivation in Research, Types of Research	2	
	3	Research Approaches	2	
	4	Significance of Research	3	
	5	Research Methods versus Methodology	3	
II	**Identifying, Defining and Designing Research Problem**		**12**	**15**
	6	Defining the Research Problem What is a Research Problem? Selecting the Problem, Necessity of Defining the Problem	2	
	7	Technique Involved in Defining a Problem	1	
	8	Research Design: Meaning of Research Design, Need for Research Design	3	
	9	Research Methodology,Features of a Good Design	3	
	10	Important Concepts Relating to Research Design	1	
	11	Different Research Designs	2	
III	**Collection, Validation and Testing of Data**		**12**	**20**
	12	Sources of Data: Primary and Secondary, Validation of Data, Data Collection Methods: Questionnaire Designing	2	
	13	Construction Sampling Design & Techniques – Probability Sampling and Non-Probability Sampling Scaling Techniques:	2	
	14	Meaning & Types Reliability: Test – Retest Reliability	2	
	15	Alternative Form Reliability	2	
	16	Internal Comparison Reliability and Scorer Reliability	2	
	17	Validity: Content Validity, Criterion Related Validity and Construct Validity	2	
IV	**Data Processing and Analysis**		**12**	**20**
	18	Processing and Analysis of Data, Processing Operations, Some Problems in Processing, Elements/Types of Analysis	2	
	19	Statistics in Research Measures of Central Tendency	2	
	20	Measures of Dispersion Interpretation and Report Writing	3	
	21	Meaning of Interpretation Why Interpretation? Technique of Interpretation: Precaution in Interpretation	2	
	22	Significance of Report Writing Different Steps in Writing Report Layout of the Research Report	3	
V	**Open Ended Module**		**12**	
	CASE STUDY: RESEARCH METHODOLOGY Methods of Research Applications of Statistical tools & Methods Structure and components of scientific reports			

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	-	-	-						
CO2	-	-	1	-	-	-						
CO3	1	2	1	-	1	1						
CO4	1	2	2	2	1	2						
CO5	1	1	2	2	1	2						
CO6	-	-	-	-	-	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Reference:

1. C. R. Kothari, 'Research Methodology Methods & Techniques', Revised 2 nd Edn., New Age International Publishers.

2. Research Methodology and Scientific Writing by C George Thomas, Ane Books Pvt. Ltd.,

3. An Introduction to Research Methodology; Garg B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002., RBSA Publishers.

4. Research Methodology; Panneerselvam R., PHI, Learning Pvt. Ltd., New Delhi - 2009

5. Research Methodology: Concepts and cases, Chawala D. and N. Sondhi; Vikas Publishing House Pvt. Ltd.

Programme	BCA				
Course Title	Ethical Hacking				
Type of Course	Elective				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Understanding of the fundamental networking and protocols concepts. 2. Familiarity with various operating systems, file systems and basic system administration tasks.				
Course	This course provides the skills to identify, analyze, and address security				

Summary	vulnerabilities in systems, networks, and web applications. It aims to learn to perform penetration testing, conduct reconnaissance, exploit vulnerabilities, and maintain access ethically and legally.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamentals of Ethical Hacking	U	C	Instructor- created exams / Quiz
CO2	Learn the features of Foot Printing and Reconnaissance	Ap	P	Assignment / Seminar presentations/ Exams
CO3	Apply the System Hacking methods	Ap	P	Seminar Presentation/ Group Tutorial Work/ Viva Voce
CO4	Understand attacks and type of attacks Apply reasoning with ontologies and rules	U	C	Instructor- created exams / Home Assignments
CO5	Apply various Penetration Testing methods	Ap	C	Writing assignments/ Exams/ Seminar Presentations
CO6	Develop theoretical concept on various types of attacks and apply the platforms to explore them.	Ap	P	Case Study/ Group discussions/ Presentations
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Mark
I		**Fundamentals of Ethical Hacking**	**15**	**15**
	1	Information security overview, Introduction to Hacking, importance of Security – Elements of Security	2	
	2	Hacking Concepts and Hacker Classes - Phases of Hacking Cycle,	3	
	3	Ethical Hacking Tools - Threat and Threat Sources - Malware and Components of Malware -	4	
	4	Types of Malwares, Types of Hackers	3	
	5	Common Hacking Methodologies, Benefits and challenges of Ethical Hacking,	3	
II		**Foot Printing & Reconnaissance**	**12**	**20**
	6	Foot Printing & Reconnaissance: Foot printing concepts, Use of foot printing,	2	
	7	information gathering, Types of foot printing, Website Foot printing	2	
	8	Foot printing through Search Engines, Foot Printing through Social Networking sites	2	
	9	Foot Printing tools, Understanding the information gathering	2	

		process,		
	10	Website Foot printing, WHOIS Foot printing,	2	
	11	Network Scanning, Port scanning,	1	
	12	Tools used for the reconnaissance phase	1	
III	**System Hacking**		**11**	**20**
	13	Password Cracking - Types of Password Attacks	1	
	14	Password Cracking Tools and vulnerabilities	1	
	15	Identity Theft - Social Engineering and tools	2	
	17	Types of attacks and their common prevention mechanisms	2	
	17	Keystroke Logging, Denial of Service (DoS /DDoS),	2	
	18	Waterhole attack, brute force, phishing and fake WAP, Session Hijacking	3	
IV	**Penetration Testing**		**10**	**15**
	19	Introduction to Penetration Testing, Types of Penetration Testing-	2	
	20	Phases of Penetration Testing,	3	
	21	pen testing, type of pen testing.	3	
	22	Tools of Penetration Testing, Test web applications for vulnerabilities	2	
V	**Open Ended Module- Mobile, cloud and IoT Based attacks, Kali Linux**		**12**	
	1	Mobile Platform Attack	3	
	2	Cloud level Attacks and Tools	2	
	3	IoT based attacking Tools	3	
	4	Kali Linux	4	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	1	-	-	1	1						
CO 2	3	-	-	-	1	1						
CO 3	1	3	1	1	2	3						
CO 4	1	-	1	1	2	3						
CO 5	1	-	-	-	2	3						
CO 6	1	2	1	1	3	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓
CO 6	✓	✓	

Reference:

1. Stuttard, D., & Pinto, M. (2011). The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws (2nd ed.). Wiley. ISBN: 978-1118026472

2. Erickson, J. (2008). Hacking: The Art of Exploitation (2nd ed.). No Starch Press. ISBN: 978-1593271442

3. Baloch, R. (2017). Ethical Hacking and Penetration Testing Guide. CRC Press. ISBN: 978-1138197396

4. Harper, A., Regalado, D., & others. (2015). Gray Hat Hacking: The Ethical Hacker's Handbook (4th ed.). McGraw-Hill Education. ISBN: 978-0071832380

5. Kennedy, D., O'Gorman, J., Kearns, D., & Aharoni, M. (2011). Metasploit: The Penetration Tester's Guide. No Starch Press. ISBN: 978-1593272883

Programme	BCA				
Course Title	Cyber Forensics				
Type of Course	Elective				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Understanding concept Computer Hardware, Operating System 2. Knowledge of information security concepts, including confidentiality, integrity, and availability 3. Knowledge of legal and ethical issues surrounding digital evidence collection, preservation, and analysis is crucial for conducting forensic investigations in compliance with applicable laws and regulations.				
Course Summary	This course provides an overview of cyber forensics and cyber laws, focusing on the principles, techniques, and legal considerations involved in investigating cybercrimes, preserving digital evidence, and navigating legal frameworks governing cybersecurity.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts, principles, and methodologies of cyber forensics	Ap	C	Instructor-created exams / Quiz
CO2	To develop skills in acquiring preserving, and analysing digital evidence from various source	Ap	P	Assignment / Seminar presentations/ Exams
CO3	To learn and understand techniques and tools to investigate cybercrimes, security incidents, and data breaches.	Ap	P	Seminar Presentation/ Group Tutorial Work/ Viva Voce
CO4	Demonstrate proficiency in conducting network, disk, memory, and mobile device forensics examinations.	Ap	P	Instructor-created exams / Home Assignments
CO5	Evaluate ethical, legal, and privacy considerations in cyber forensics investigations and evidence handling.	E	M	Writing assignments/ Exams/ Seminar Presentations
CO6	Apply critical thinking, problem-solving, and decision-making skills to address challenges in cyber forensics and cybersecurity.	Ap	P	Case Study/ Group discussions/ Presentations
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**INTRODUCTION TO CYBER FORENSICS**		**10**	**15**
	1	Computer Forensics Fundamentals: What is Computer Forensics? Use of Computer Forensics in Law Enforcement, Computer Forensics Services	2	
	2	Computer Forensics Assistance: Human Recourses/Employment Proceedings, Benefits of professional Forensics Methodology, Steps taken by Computer Forensics Specialists	2	
	3	Computer Forensics Technology: Business Computer Forensic Technology, Military Computer Forensic Technology, Law Enforcement	2	
	4	Vendor and Computer Forensics Services: Types of services provided by vendors, Criteria for selecting a computer forensics vendor, Vendor Engagement and Contracts, Evaluation of vendor capabilities, expertise and reputation	2	
	5	Cyber forensics tools and case studies: Disk Imaging (EnCase, FTK), File Analysis (FileInsight and ExifTool),	2	
II	**COMPUTER FORENSICS EVIDENCE**		**10**	**15**
	6	Computer forensics evidence and capture: Why Collect Evidence, Types of Evidence, The Rules of Evidence, Volatile Evidence,	2	
	7	Data Recovery: Definition, Data Back-up and Recovery, The Role of Back-up in Data Recovery, The Data -Recovery Solution	2	
	8	General Procedure for Data Collection: Collection and Archiving, Methods of Collection	2	
	9	Identification of Data: Timekeeping, Forensic Identification and Analysis of Technical Surveillance Devices, Reconstructing Past Events.	2	
	10	Controlling Contamination: The Chain of Custody, Reconstructing the Attack, The digital crime scene, Investigating Cybercrime, Investigating Web attacks, Investigating network Traffic	2	
III	**FORENSIC ANALYSIS AND VALIDATION**		**14**	**20**
	11	Computer image Verification and Authentication: Special needs of Evidential Authentication,	2	
	12	Computer forensic analysis: Determining what data to collect and analyse, validating forensic data, addressing data-hiding techniques, performing remote acquisitions	2	
	13	Computer forensic validation: Validating forensic data, addressing data-hiding techniques, performing remote acquisitions	2	
	12	Network Forensics: Network forensic overview, Performing live acquisitions, Developing standard procedures for network forensics	2	
	13	Network Forensic Tools: Overview, Wireshark, tcpdump, and	2	

		NetworkMiner, Network Traffic Analysis Tools		
	14	Ethical Hacking: Essential Terminology, Windows Hacking, Malware, Scanning, Cracking.	2	
	15	Tactics of the Military, Tactics of Terrorist and Rogues, Tactics of Private Companies	2	
IV	**CYBER CRIME AND CYBER LAW**		**14**	
	16	Mobile device forensics: Understanding mobile device forensic, understanding acquisition procedures for cell phones and mobile devices.	2	**20**
	17	Cyber Crimes: Types of cybercrimes against individuals and institution, States-various offenses and punishments	2	
	18	Digital Signature: Concepts of public key and private key, Certification Authorities and their role, Creation and authentication of digital signature.	2	
	19	E-contracting: Features of E-contracts, Formation of E-contracts and types	2	
	20	E-governance: E-governance models, E-commerce- salient features and advantages.	2	
	21	Cyber Law: Understanding cyber space, Defining cyber law, Scope and jurisprudence	2	
	22	Indian Cyber Law: Overview of Indian legal system, Introduction to IT Act 2000, Amendment in IT Act.	2	
V	**Open Ended Module**		**12**	
		1. Case Study. 2. Simulate real-world cyber incidents and develop incident response plans. 3. An activity that emphasizes teamwork, communication, and decision-making under pressure. 4. Work on a comprehensive cyber forensics project that integrates concepts from multiple areas of study. 5. Apply forensic techniques to investigate a real or simulated cyber incident and produce a detailed report.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	2	1						
CO 2	2	-	-	-	2	1						
CO 3	2	-	-	-	3	2						
CO 4	1	-	-	-	1	1						
CO 5	2	--	-	--	3	1						
CO 6	3		-		2	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Computer Forensics: Computer Crime Scene Investigation, 2nd Edition, John R. Vacca, Charles River Media, 2005
2. Cyber Forensics - Concepts and Approaches, Ravi Kumar & B Jain,2006, ICFAI university press
3. Understanding Cryptography: A Textbook for Students and Practitioners, ChristofPaar, Jan Pelzl, 2010, Second Edition, Springer's.
4. Live Hacking: The Ultimate Guide to Hacking Techniques & Countermeasures for Ethical Hackers & IT Security Experts, Ali Jahangiri, First edition, 2009
5. Computer Forensics: Investigating Network Intrusions and Cyber Crime (Ec-Council Press Series: Computer Forensics), 2010.

Programme	BCA				
Course Title	Compiler Design				
Type of Course	Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1.Formal Languages & Automata Theory. 2.Data Structure and Algorithms				
Course Summary	This course covers the fundamental concepts of different phases of compilation such as lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation. Students can apply this knowledge in design and development of compilers.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To identify different phases in compilation process and model a lexical analyser.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO2	To model language syntax using Context Free Grammar and develop parse tree representation using leftmost and rightmost derivations.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	To compare different types of parsers and construct parser for a given grammar.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO4	To build Syntax Directed Translation for a context free grammar, compare various storage allocation strategies and classify intermediate representations.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Students will demonstrate the ability to design and implement lexical analyzers to recognize tokens in source programs.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Illustrate code optimization and code generation techniques in compilation	Ap	P	Practical Assignment /

				Instructor-created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Mark
I	**COMPILERS AND LEXICAL ANALYSIS**		**10**	**15**
	1	Analysis of the source program - Analysis and synthesis phases	2	
	2	Phases of a compiler, The grouping of Phases	2	
	3	Compiler writing tools. Bootstrapping.	2	
	4	Lexical Analysis: Parsing, Abstract stack machine, Role of Lexical Analyser	2	
	5	Input Buffering, Specification of Tokens, Recognition of Tokens.	2	
II	**SYNTAX ANALYSIS**		**18**	**25**
	6	Role of the Syntax Analyser, Role of the Parser	2	
	7	Context-free grammars, Prase Tree and Derivations, Eliminating Ambiguity	2	
	8	Basic Parsing Approaches – Eliminating left recursion, left factoring	3	
	9	Top Down parsing - Recursive Descent Parsing	2	
	10	Predictive Parsing – LL (1) Grammars	3	
	11	Bottom-up parsing -Handle Pruning - Shift Reduce Parsing - Operator Precedent Parsing	3	
	12	LR Parsers - SLR Parser- Canonical LR Parser - LALR Parser	3	
III	**SEMANTIC ANALYSIS AND INTERMEDIATE CODE GENERATION**		**10**	**15**
	13	Syntax directed translation - Syntax directed definitions	2	
	14	S-attributed definitions, L-attributed definitions, Bottom-up evaluation of S-attributed definitions. Run-Time Environments	2	
	15	Source Language issues, Storage organization, Storage-allocation strategies.	2	
	16	Intermediate Code Generation - Intermediate languages, Graphical representations,	2	
	17	Three-Address code, Quadruples, Triples.	2	
IV	**CODE OPTIMIZATION AND CODE GENERATION**		**10**	**15**
	18	Code Optimization - Principal sources of optimization	2	
	19	Machine dependent and machine independent optimizations,	2	
	20	Local and global optimizations.	2	

	21	Code generation - Issues in the design of a code generator,	2	
	22	Target Language, A simple code generator.	2	
V	**Open Ended Module – Application Level**		**12**	
		1. Learn the fundamentals of lexical analysis and parsing using Lex and Yacc, essential tools in compiler construction. 2. Apply the concepts learned to develop a small compiler, progressively enhancing its functionality while implementing error handling and optimization strategies. 3. Apply the concept of Bootstrapping and its significance in compiler construction. 4. Understanding of run-time environments and storage allocation strategies. 5. Development of a simple code generator for translating intermediate code into target code.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	1	2	2	2	-						
CO 2	-	1	2	2	2	-						
CO 3	1	1	2	3	3	-						
CO 4	1	-	2	3	3	-						
CO 5	1	-	2	2	2	-						
CO 6	-	-	2	1	2	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Aho A.V., Ravi Sethi and D. Ullman. Compilers – Principles Techniques and Tools, Addison Wesley, 2006.

2. D.M. Dhamdhere, System Programming and Operating Systems, Tata McGraw Hill &Company, 1996.

3. Kenneth C. Louden, Compiler Construction – Principles and Practice, Cengage Learning Indian Edition, 2006.

4. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company,1984.

5. Compiler Design in C, Allen I. Holub, Prentice Hall (Software Series).

6. Crafting a Compiler with C, C. N. Fischer and R. J. LeBlanc, Pearson Education.

7. Allen I Holub, Compiler Design in C, 1st Edition, PHI Learning Pvt Ltd.

Programme	BCA				
Course Title	Mixed Reality				
Type of Course	Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60

Pre-requisites	No pre-requisites required
Course Summary	This course explores the principles and applications of Mixed Reality-Virtual Reality (VR) and Augmented Reality (AR), covering topics including Tracking, Motion, Interaction and Navigation. Students will delve into the technical foundations, design considerations, and emerging techniques shaping the development and utilization of VR and AR technologies in various fields.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand about virtual reality, creation of immersive VR experiences and human physiology's interaction with the virtual environments.	U	C	Instructor- created exams / Quiz/Assignment/ Seminar
CO2	Able to proficiently define the geometry of the virtual world containing transformations and optics that define the human perception.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO3	Acquire a comprehensive understanding of different techniques used for visual perception and visual rendering for the creation of virtual world	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO4	Understand how the motion in virtual world happens, the experiments conducted, and how the evaluation of VR systems are carried out	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO5	Familiarize with the concept of Augmented Reality, their characteristics and various the tracking technologies used in the process.	U	C	Instructor-created exams/ Quiz/Assignment/ Seminar
CO6	A comprehensive understanding of the output and input modalities used for navigation, and the software engineering requirements needed for the development of AR technologies.	U	C	Instructor-created exams/ Quiz/Assignment / Seminar

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Contents	Hrs (48+12)	Mark
I		**Virtual Reality**	**16**	**20**
	1	What is Virtual Reality?	1	

	2	Modern VR experiences, History repeats	2	
	3	Hardware, Software	2	
	4	Human physiology and Perception	3	
	5	Geometry of virtual world- Geometric models, Changing position and orientation	3	
	6	Light and optics – Basic behavior light, Lenses	2	
	7	Optical aberrations, Human eye, Cameras, Displays	3	
II	**Implementation of Virtual World**		**16**	**20**
	8	Perception of Depth, Perception of Motion, Perception of Colour	4	
	9	Ray tracing and Shading models, Rasterization	4	
	10	Motion in real and virtual world – Velocities, Acceleration, The Vestibular system (no diagram required)	3	
	11	Physics in the virtual world, Mismatched motion and vection	3	
	12	Evaluating VR systems and experiences – Perceptual training, Experiments on human subjects - scientific method, Human subjects, Ethical standards	2	
III	**Augmented Reality**		**08**	**15**
	13	Introduction - Definition and scope	1	
	14	Tracking - Coordinate systems, Model transformation, View transformation, Projective transformation	1	
	15	Characteristics of tracking technology – Physical phenomena, Measurement principle, Measured geometric property, Sensor arrangement, Signal sources	2	
	16	Stationary tracking systems – Mechanical, Electromagnetic, Ultrasonic	2	
	17	Mobile sensors – GPS, Wireless networks, Magnetometer, Gyroscope	2	
IV	**Interaction, Navigation and Requirements**		**08**	**15**
	18	Output modalities - Augmentation Placement, Agile Displays, Magic Lenses	1	
	19	Input modalities- Tracking and Manipulation of Rigid Objects, Body Tracking, Gestures	1	
	20	Foundations of human navigation	2	
	21	Exploration and discovery, Route visualization	1	
	22	Software engineering requirements - Platform Abstraction, User Interface Abstraction, Reusability and Extensibility, Distributed Computing, Decoupled Simulation	3	
V	**Open Ended Module**		**12**	

		• Comparative analysis of VR applications in different industries such as healthcare, education, entertainment, and training. • Study of the impact of AR on social interaction and communication patterns. • Evaluation of AR games and entertainment experiences, including case studies of popular AR games and immersive storytelling experiences. • Case studies of successful or unsuccessful VR projects, analysing factors contributing to their outcomes. • Exploration of ethical considerations in VR development and usage, considering issues like privacy, safety, and psychological impact.	12	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-						
CO 2	2	-	-	-	-	-						
CO 3	2	2	-	-	-	-						
CO 4	2	2	-	-	2	1						
CO 5	1	-	-	-	2	-						
CO 6	2	2	-	-	-	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Steven M. LaValle, "Virtual Reality", Cambridge university Press, 2020.
2. Dieter Schmalstieg, Tobias Hollerer " Augmented Reality: Principles and Practice", Addison-Wesley, 2016.
3. Gregory C. Burdea & Philippe Coiffet "Virtual Reality Technology", John Wiley & Sons, 2017.

Programme	BCA				
Course Title	Mastering Java Web Development				
Type of Course	Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Knowledge in core concept of Java Programming 2. Knowledge of database concept and SQL 3. Knowledge in basic web concept like HTML, CSS, JavaScript				
Course Summary	The aim of this course is to provide students with a thorough understanding of building dynamic web applications using Java technologies. This course covers essential concepts, frameworks, and				

	tools necessary for developing robust, scalable, and secure web applications.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the concept of web development principles, including client-server architecture, HTTP protocol, and web application lifecycle.	U	C	Instructor-created exams / Home assignments
CO2	Acquire proficiency in Java web technologies as Java Server Page.	Ap	P	Instructor-created exams / Home assignments
CO3	Understand the Model-View-Controller (MVC) architecture pattern and its implementation in Java web applications using frameworks like Spring MVC.	Ap	P	Instructor-created exams / Home assignments
CO4	Gain knowledge of web services concepts, including RESTful web services and SOAP-based web services, and learn to develop and consume web services using Java technologies.	Ap	P	Instructor-created exams / Home assignments
CO5	Gain a deep understanding of the principles behind AJAX, including asynchronous communication.	Ap	P	Instructor-created exams / Home assignments
CO6	Understand how to handle AJAX requests on the server-side using technologies such as JSP and Spring MVC.	Ap	P	Instructor-created exams / Home assignments
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Over View of Core Java**		**7**	**9**
	1	Core Java Concept: Class, Inheritance, Constructor, Exception and Multithreading	3	
	2	Overview of JDBC: JDBC Concept, Execution of SQL Statements, Transaction Management	2	
	3	Introduction to Web Applications, Web Servers Overview of J2EE Technologies.	2	
II	**Introduction to JSP**		**12**	**15**

	3	Fundamental Concept of JSP: JSP & Servlet as Web Components, Servlets vs. JSP	2	
	4	Working with JSP: JSP Lifecycle, JSP Page Lifecycle Phases	2	
	5	General Rules of Syntax: JSP syntactic elements, JSP element syntax, Template content	3	
	6	JSP elements: Directives, Declarations, Expressions, Scriptlets, Actions	3	
	7	JSP Standard Actions: jsp:useBean, jsp:getPreoperty, jsp:setProperty, jsp:include, jsp:forward, jsp:plugin,jsp:param, Java Server Pages Standard Tag Library(JSTL).	2	
III	**Introduction to Spring MVC**		**16**	**23**
	8	Getting Started with Spring: Overview of the MVC Architecture, Spring Framework and its relevance in web development, Advantages and benefits of using Spring MVC for building web applications.	2	
	9	Initializing a Spring project with Spring Tool Suite: Simple Example and Sample example analysis, Spring Project Structure	2	
	10	Writing a Spring Application: Handling Web request, Defining the view, Testing the Controller, Building and Running application	2	
	11	Developing Web Application: Establishing the domain, creating the controller class, Designing the view, Form submission.	2	
	12	Working with View Controller: Declaring validation rule, Performing validation, Caching templates.	2	
	13	Working with Data: Working with JDBC, Defining the Schema and pre-loading data, Inserting data	2	
	14	Working with Spring Data JDBC: Adding Spring data JDBC, Defining the repository interface, Preloading data with CommandLineRunner	2	
	15	Exception Handling: Handling exceptions gracefully in Spring MVC applications, Implementing global exception handlers and custom error pages.	1	
	16	Securing Spring: Introduction to Spring Security, Configuring authentication, authorization, and access control.	1	
IV		**Integrated Spring and AJAX**	**13**	**23**
	17	Creating REST Service: Building RESTful APIs using Spring MVC controllers. Handling HTTP methods (GET, POST, PUT, DELETE) and request parameters.	2	
	18	Introduction to AJAX: Ajax Fundamentals, JavaScript Libraries, The Prototype Library, Technique Library, Form Completion	2	

	19	Validation: Realtime Validation, Propagating Client-Side View State, Direct Web Remoting	2	
	20	Handling Ajax Requests in Spring MVC: Mapping Ajax request URLs using @RequestMapping annotations. Parsing request parameters and payloads in Spring MVC controllers. Implementing server-side processing logic for Ajax requests.	3	
	21	Form Submission and Validation with Ajax: Submitting forms via Ajax requests in Spring MVC. Validating form inputs on the server-side using Spring's validation framework. Displaying validation errors and messages to the user without page reloads.	2	
	22	Advanced Ajax Technique: Cross-Origin Resource Sharing, CSRF protection, Content Security Policy, caching, throttling, lazy loading	2	
V	**Open Ended Module** **Practical Applications, Case Study and Course Project**		**12**	
	1	Discuss topics from the following: • Impact of Servlet • The version of Spring MVC. • Exception handling in Web Application. • RESTful API. • Basics of CRUD Operations	8	
	2	**Project:** Build a web application for library management system using Spring MVC (Eg: Admin Login, Inserting Book details, stock management, Book issue, display book catelog)	4	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	3	3	-	-						
CO 2	1	-	3	3	-	-						
CO 3	-	-	3	3	2	3						
CO 4	-	-	2	3	-	-						
CO 5	-	-	3	3	2	3						
CO 6			3	3	3							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓

References:

1. Spring in Action, Sixth Edition by Craig Walls - 2022
2. Introducing Spring Framework 6: Learning and Building Java-based Applications with Spring - 2022 by Felipe Gutierrez, Joseph B. Ottinger
3. Pro Spring 3 (Expert's Voice in Spring) – 2012 by Clarence Ho, Rob Harrop
4. Ajax: The Complete Reference by Thomas Powell

Programme	BCA				
Course Title	Social Network Analysis				
Type of Course	Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Knowledge in Fundamentals of Data Mining				

Course Summary	The syllabus is prepared with the view of preparing the BSc Computer Science Graduates to build a basic understanding of what social network analysis is and how it can be applied. Topics covered include network structure and methods for social network analysis, link analysis and network community detection, information propagation on the web and some applications.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic notation and terminology used in social network analysis.	U	C	Instructor-created exams / Quiz
CO2	Compare and interpret social network structure, size and its connectivity pattern.	U	C	Instructor-created exams / Quiz
CO3	Discover community structure in complex network using statistical techniques	U	P	Instructor-created exams / Quiz
CO4	Apply link prediction techniques to discover new links in the social network	U	C	Instructor-created exams / Case studies
CO5	Describe influence in social media, perform recommendations	U	P	Instructor-created exams / Quiz Case studies
CO6	Perform Social Influence Analysis	U	P	Instructor-created exams / Quiz /Case studies
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Introduction to Social Network Data Analytics**		**12**	**15**
	1	Introduction to Social Network Analysis	2	
	2	Online social networks Research Issues and Topics	2	
	3	Statistical properties of social networks: Preliminaries	2	
	4	Static properties, Dynamic properties	3	
	5	Challenges of Social Network Streams	3	
II	**Random Walks in Social Networks**		**12**	**15**
	6	Random walks on Graphics, Walks based on proximity measures	2	
	7	Other graph based proximity measures	1	
	8	Graph theoretic measures for semi supervised learning	3	
	9	Clustering with random walk based measures	3	
	10	Applications in computer vision Text Analysis, Evaluation and datasets	1	
	11	Link prediction and data sources	2	
III	**Community Discovery in Social Networks**		**12**	**20**
	12	Communities in Context	2	
	13	Core Methods – KL Algorithm, Special algorithms	2	
	14	Markov Clustering, other approaches	2	
	15	Emerging Fields and problems: Community Discovery in dynamic networks	2	
	16	Heterogeneous networks, Directed networks,	2	
	17	Coupling content and relationship information for community discovery	2	
IV	**Link Prediction in Social Networks**		**12**	**20**
	18	Background, Feature based Link Prediction, Bayesian Probabilistic Models	3	
	19	Probabilistic Relational Models	2	
	20	Linear Algebraic Methods	2	
	21	Link Predictions: The Katz Score, Hitting & Commute Time	2	
	22	Rooted PageRank, SimRank	3	
V	**Open Ended Module**		**12**	
	CASE STUDY: Social Influence Analysis Influence Related Statistics, Social Similarity and Influence, Influence Maximization in Viral Marketing			

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	1	1	3						
CO2	-	3	-	1	1	2						
CO3	1	3	-	1	1	1						
CO4	1	2	-	-	1	1						
CO5	-	1	1	-	1	1						
CO6	-	1	1	-	1	1						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Reference:

1. Charu.C. Aggarwal, Social Network Data Analytics, Springer Science+Business Media, LLC 2011.
2. R. Zafarani, M. A. Abbasi, and H. Liu, Social Media Mining: An Introduction, Cambridge University Press, 2014.
3. Krishna Raj P M, Ankith Mohan, K G Srinivasa, Practical Social Network Analysis with Python, Springer Liu, Bing. Web data mining. Springer-Verlag Berlin Heidelberg, 2007.
4. Chakrabarti, Soumen. Mining the Web: Discovering knowledge from hypertext data. Morgan Kaufmann, 2003.
5. Scime, Anthony, ed. Web mining: applications and techniques. IGI Global, 2005.

Programme	BCA				
Course Title	System Security				
Type of Course	Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Knowledge in Fundamentals of Network and Operating System and COA				
Course Summary	The syllabus is prepared with the view of preparing Bachelor of Computer Application (BCA) Graduates to build effective an understanding of the differences between various forms of computer system security, where they arise, and appropriate tools to achieve them				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the different types of securities in information and computer systems, security goals and confidentiality, integrity, availability	U	C	Instructor-created exams / Quiz
CO2	Outline computer system threats and various types of system attacks	U	C	Instructor-created exams / Quiz
CO3	Identify different issues associated with system attacks and how attacking occurs and various types of attackers	U	P	Instructor-created exams / Quiz

CO4	Provide knowledge in operating system security, file protections, security assurance	U	C	Instructor-created exams / Case studies
CO5	Understand important elements of Database security	U	P	Instructor-created exams / Quiz Case studies
CO6	Define security planning, various types of security policies and risk analysis	U	P	Instructor-created exams / Quiz /Case studies
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (48+12)	Marks
I	**Notion of Different types of Securities**		**12**	**15**
	1	Information security - computer security - security goals, relation between security, confidentiality, integrity, availability and authorization, vulnerabilities - principles of adequate protection.	3	
	2	Notions of operating security, database security, program security, network security attacks - threats, vulnerabilities and controls.	3	
	3	The kind of problems - interception, interruption, modification, fabrication.	2	
	4	Computer criminals - amateurs, crackers, career criminals.	2	
	5	Methods of defence control, hardware controls, software controls, effectiveness of controls.	2	
II	**Program Security**		**12**	**15**
	6	Secure programs - fixing faults, unexpected behaviour, types of flaws.	2	
	7	Non-malicious program errors - buffer overflows, incomplete mediation.	1	
	8	Viruses and other malicious code - kinds of malicious code, how viruses attach, how viruses gain control, prevention,	3	
	9	Control example - the brain virus, the internet worm, web bugs.	3	
	10	Targeted malicious code - trapdoors, Salami attack	1	
	11	Controls against program threats - development controls, peer reviews, hazard analysis	2	
III	**Operating System Security**		**12**	**20**
	12	Protected objects and methods of protection - memory address protection - fence, relocation, base/bounds registers, tagged architecture, segmentation, paging.	2	
	13	Control of access to general objects - directory, access control list	2	
	14	File protection mechanism - basics forms of protection, single permissions.	2	
	15	Authentication - authentication basics, password, authentication process challenge - response, biometrics	2	
	16	Trusted operating systems - security policies for operating systems	2	
	17	Models of security - requirement of security systems, multilevel security, access security, limitations of security systems	2	
IV	**Database Security**		**12**	**20**
	18	Security requirements - integrity, confidentiality and availability of database	2	
	19	Reliability and integrity of database	2	
	20	Sensitive data, interface	3	
	21	Multilevel database	2	
	22	Proposals for multilevel database security	3	
V	**Open Ended Module**		**12**	

	CASE STUDY: Administrating security Security planning – Contents of a security planning, team members, commitment to a security plan, business continuity plans. Risk analysis – the nature of risk, steps of risk analysis.	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	1	1						
CO2	-	3	1	-	1	1						
CO3	-	2	1	-	1	1						
CO4	-	2	1	-	1	1						
CO5	1	3	1	-	1	2						
CO6	1	2	1	1	1	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Reference:

1. C. P. Pfleeger and S. L. Pfleeger, Security in Computing, 4th Edition, Pearson India, ISBN: 9788131727256.
2. Matt Bishop, Computer Security: Art & Science, 1st Edition, Pearson, ISBN: 0201440997.
3. William Stallings, Cryptography and Network Security: Principles and Practice, 6th Edition, Pearson India, ISBN: 9332518777.
4. Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, 4th Edition, Ceneage Learning India Pvt Ltd, ISBN: 8131516458.

Programme	BCA				
Course Title	Parallel Computing				
Type of Course	Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Knowledge in Fundamentals of COA and Operating System				
Course Summary	The syllabus is prepared with the view of preparing the BSc Computer Science Graduates to understand basic and advanced concepts of parallel computing. It covers Principles of Parallel Algorithm Design, Communication operations, Programming Using the Message Passing Paradigm, Programming Shared Address Space Platforms, Thread Basics,				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Summarize the key parallel computational models	U	C	Instructor-created exams / Quiz
CO2	Appreciate and apply parallel and distributed algorithms in problem Solving	U	C	Instructor-created exams / Quiz
CO3	Appreciate the communication models for parallel algorithm development	U	P	Instructor-created exams / Quiz
CO4	Develop parallel algorithms using message passing paradigm	U	C	Instructor-created exams / Case studies
CO5	Formulate parallel algorithms for shared memory architectures	U	P	Instructor-created exams / Quiz Case studies
CO6	Understand thread management	U	P	Instructor-created exams / Quiz /Case studies

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Un it	Content	Hrs (48+12)	Marks
I	**Principles of Parallel Algorithm Design**		**12**	**15**
	1	Parallel Processing platforms. Preliminaries, Decomposition Techniques,	2	
	2	Characteristics of Tasks and Interactions	2	
	3	Mapping Techniques for Load Balancing	2	
	4	Methods for Containing Interaction Overheads	3	
	5	Parallel Algorithm Models.	3	
II	**Communication Operations**		**12**	**15**
	6	Basic Communication Operations - One-to-All Broadcast and All-to-One Reduction	2	
	7	All-to-All Broadcast and Reduction	1	
	8	All-Reduce and Prefix-Sum Operations	3	
	9	Scatter and Gather	3	
	10	All-to-All Personalized Communication, Circular Shift	1	
	11	Improving the Speed of Some Communication Operation	2	
III	**Programming Using the Message Passing Paradigm**		**12**	**20**
	12	Principles of Message-Passing Programming, The Building Blocks: Send Operations	2	
	13	Receive Operations	2	
	14	MPI: The Message Passing Interface	2	
	15	Overlapping Communication with Computation	2	
	16	Collective Communication and Computation Operations	2	
	17	Groups and Communicators	2	
IV	**Programming Shared Address Space Platforms Thread Basics**		**12**	**20**
	18	Thread Basics, Why Threads? The POSIX Thread Application Programme Interface, Synchronization Primitives in POSIX, Controlling Thread and Synchronization Attributes	2	
	19	Thread Cancellation, Composite Synchronization Constructs	2	
	20	OpenMP: a Standard for Directive Based Parallel Programming, Specifying Concurrent Tasks in OpenMP	3	
	21	Synchronization Constructs in OpenMP	2	
	22	OpenMP Applications: Parallel algorithm development for Matrix multiplication	3	

V	**Open Ended Module**	**12**	
	CASE STUDY: PARALLEL COMPUTING Heterogeneous Parallel Computing Data parallel computing Device Global Memory and Data Transfer Kernel Functions and Threading		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	-						
CO2	-	2	1	-	-	-						
CO3	-	2	1	-	1	1						
CO4	-	2	1	1	1	2						
CO5	-	3	1	1	-	2						
CO6	-	2	-	-	-	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓

CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Reference:

1.Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, 2nd Ed, Addison-Wesley, 2003

2. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 3rd Ed., Morgan Kaufman, 2016. References

3. Steven Brawer, Introduction to Parallel Computing, Academic Press, (1989)

4. Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP: Portable Shared Memory Parallel Programming, MIT Press, 2008.

5. William Gropp, Ewing Lusk, Anthony Skjellum Using MPI: Portable Parallel Programming with the Message-Passing Interface, 3rd Ed, MIT Press, 2014.

General Foundation Courses

Multi-Disciplinary Course (MDC)

Programme	BCA				
Course Title	Digital Marketing				
Type of Course	MDC (for other disciplines)				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	1. Basic Computer Literacy 2. Familiarity with Online Platforms				
Course Summary	This course provides students with a foundational understanding of key concepts and techniques in the rapidly evolving field of digital marketing. Through engaging lectures. Students will explore various digital marketing channels, including search engine optimization (SEO), social media marketing, email marketing, and content marketing.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the concept of digital marketing and its integration with traditional marketing	U	C	Instructor-Create Exams or Quiz
CO2	To understand customer value journey in digital context and behaviour of online consumers	A	P	Discussions and Quizzes
CO3	To examine various tactics for enhancing a website's position and ranking with search engines	U	F	Instructor created exams or Home assignments
CO4	To Identify and differentiate between various digital marketing channels, including SEO, social media, email, and content marketing.	A ,E	P	Discussions, Quizzes
CO5	To get overall idea in implementing basic digital marketing strategies to enhance online visibility and engagement.	Ap	P	Viva Voce Observation of practical skills
CO6	To get to know about ethical considerations and best practices in digital	U	M	Instructor Created -Exams,

	marketing, including privacy, data protection, and consumer trust			Assignments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (36+9)	Marks
I	**Digital Marketing Basics**		**9**	**12**
	1	Overview of digital marketing	2	
	2	Importance of digital marketing for businesses	2	
	3	Introduction to key digital marketing channels (SEO, social media, email marketing)	3	
	4	Basics of creating a digital marketing strategy	2	
II	**Content Marketing & Social Media**		**9**	**12**
	5	Content Marketing Fundamentals	2	
	6	Content Strategy Development	2	
	7	Content Creation for Different Platforms	2	
	8	Introduction to Social Media Marketing & keyword Optimization	2	
	9	Social Media Strategy & Community Management	1	
III	**Search Engine Optimization (SEO) & Paid Advertising**		**9**	**14**
	10	Introduction to Search Engine Optimization	2	
	11	On-page and Off-page SEO Techniques	2	
	12	Search Engine Marketing (SEM) Fundamentals	2	
	13	Pay-Per-Click (PPC) Advertising with Google Ads	2	
	14	Social Media Advertising Platforms	1	
IV	**Web Analytics & Emerging Trends**		**9**	**12**
	13	Introduction to Web Analytics & Key Metrics	2	
	14	Using Analytics Tools for Data-Driven Decision Making	2	
	15	Conversion Tracking & Optimization	2	

	16	Emerging Trends in Digital Marketing	2	
	17	The Future of Marketing	1	
V	**Open Ended Module** **Hands-on: Practical Applications, Case Study and Course Project**		**9**	
	1	**S**ocial Media Marketing-Social media Channels	2	
	2	Leveraging social media for brand conversions and buzz	2	
	3	Recent trends in digital marketing	3	
	4	Demonstrate how to use google web masters Indexing Using API	2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓			✓
CO 5		✓		✓
CO6				✓

References:

1. DeWald, R. (2021). Digital Marketing for Dummies.
2. Kotler, P., Kartajaya, H., & Setiawan, I. (2017). Marketing 4.0: Moving from Traditional to Digital.
3. Ryan, D. (2014). Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation. Kogan Page Limited.
4. Kumar, S., & Kaur, S. (2020). Digital Marketing. Taxmanns.
5. Hill, R. (2024). Social Media Marketing 2024: Mastering New Trends & Strategies for Online Success.

Value-Added Course (VAC)

Programme	BCA				
Course Title	Introduction to Cyber Laws				
Type of Course	VAC				
Semester	IV				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	1. Basic Computer Literacy 2. Familiarity with Online Platforms				
Course Summary	Introduction to Cyber laws provides students with a foundational understanding of various concepts Cyber Crimes and Cyber laws against them.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the concept of Cyber Space, Cyber Crimes and cyber laws	U	C	Instructor-Create Exams or Quiz
CO2	To understand details of cybercrimes and criminals	A	P	Discussions and Quizzes
CO3	To examine various provisions in IT Act 2000	U	F	Instructor created exams or home assignments
CO4	To Identify Intellectual Property right and E-commerce related issues.	A, E	P	Discussions, Quizzes
CO5	To get overall idea of cyber laws and its enforcement mechanisms in India	Ap	P	Viva Voce Observation of practical skills
CO6	To get to know about Penalties and legal implications associated with cybercrimes under Indian law	U	M	Instructor Created - Exams, Assignments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (36+9)	Marks
I		**Introduction to Cyber Space**	**9**	**12**
	1	Cyber Space- Fundamental definitions	2	

	2	Jurisprudence and-Jurisdiction in Cyber Space	2	
	3	Need for IT act - Enforcement agencies	3	
	4	Introduction to cyber law and its relevance in the Indian context	2	
II	**Cyber Crimes and Criminals**		**9**	**12**
	5	Cyber crimes	2	
	6	Cyber Criminals and their Objectives	2	
	7	Cyber stalking; cyber pornography	2	
	8	Forgery and fraud; crime related to IPRs;	2	
	9	Phishing and Identity Theft	1	
III	**Indian Cyber law**		**9**	**14**
	10	Introduction to Indian Cyber Law	2	
	11	Cyber Crime vs Conventional Crime	2	
	12	Electronic Commerce and related issues	2	
	13	Overview of Intellectual Property rights	2	
	14	Computer Software and related IPR Issues	1	
IV	**Basics of IT law and its regulatory mechanisms**		**9**	**12**
	13	Key provisions of the Information Technology Act, 2000 related to cybercrimes and offenses	2	
	14	Regulatory Mechanisms and Enforcement	2	
	15	Overview of the Cyber Crime Investigation Cell (CCIC)	2	
	16	Understanding the process of reporting cyber crimes	2	
	17	Penalties and legal implications associated with cybercrimes under Indian law (basics only)	1	
V	**Open Ended Module** **Hands-on: Practical Applications, Case Study and Course Project**		**9**	
	1	**S**ocial media based Cyber crimes	2	
	2	Discussion on Emerging issues	2	
	3	Recent trends in digital marketing	3	
	4	Demonstrate how to use google web masters Indexing Using API	2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓			✓
CO 5		✓		✓
CO6				✓

References:

1. Cyber law –The Indian perspective by Pavan Duggal
2. Justice Yatindra Singh: Cyber Laws, Universal Law Publishing Co., New Delhi
3. Farouq Ahmed, Cyber Law in India, New Era publications, New Delhi

Programme	BCA				
Course Title	Business Intelligence and Innovation				
Type of Course	VAC				
Semester	VI				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	1. Basic Understanding of Business Operations. 2. Foundational Knowledge of Data Analysis. 3. Awareness of IT Infrastructure				
Course Summary	This course offers a comprehensive exploration of Business Intelligence (BI), IT innovation, and startup culture. It covers fundamental concepts, tools, and strategies essential for navigating the modern business				

	landscape. Students delve into the importance of data-driven decision-making and learn about data collection, analysis, and visualization techniques. Additionally, the course delves into the dynamics of innovation ecosystems, lean startup methodologies, and funding strategies for entrepreneurial ventures.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Acquire a comprehensive understanding of Business Intelligence and its applications	Ap	C	Instructor-Create Exams or Quiz
CO2	Students can implement data-driven decision-making processes in various business contexts.	E	C	Discussions and Quizzes
CO3	Develop customised Business Intelligence solutions tailored to specific organisational needs.	Ap	C	Instructor created exams or home assignments
CO4	Evaluate emerging trends and technologies in IT for potential business impact.	Ap	C	Discussions, Quizzes
CO5	Lead entrepreneurial initiatives by applying lean startup methodologies and securing funding.	Ap	C	Viva Voce Observation of practical skills
CO6	Analyse case studies of successful IT innovations for practical insights and application.	Ap	C	Instructor Created -Exams, Assignments
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (36+9)	Marks
I		**Introduction to Business Intelligence (BI)**	**9**	**10**
	1	Overview of Business Intelligence concepts, Business Intelligence technologies	2	
	2	Importance of Business Intelligence in Decision-making Processes	2	
	3	Data-driven decision-making (Data Collection, Data Integration, Data Analysis, Data Visualisation, Decision Support), Benefits of Data-Driven Decision Making	2	
	4	Tools and techniques for data collection, processing, and analysis	3	
II		**Exploring BI Tools and Applications**	**9**	**15**
	5	Application of Business Intelligence in different business domains	2	
	6	Business Intelligence tools for Performance Monitoring (Tableau, Power BI, Qlik Sense, IBM Cognos Analytics, Oracle BI)	3	

	7	Use of Business Intelligence tools for performance monitoring	2	
	8	Data visualization techniques	2	
III	**IT Entrepreneurship and Startup Culture**		**9**	**15**
	9	Innovation in IT and Startup Culture, Understanding Innovation Ecosystems	2	
	10	Startup culture and lean startup methodology, Identifying opportunities for innovation in IT	2	
	11	Funding for Startups and Entrepreneurial Ventures, Sources of funding for startups	2	
	12	Venture capital investment process, Bootstrapping strategies	1	
	13	Financial modelling and valuation techniques, Legal and regulatory considerations	2	
IV	**IT Innovation: Trends, Successes, and Challenges**		**9**	**10**
	14	Innovations in IT, Entrepreneurial mindset and skills development	2	
	15	Emerging trends and technologies in IT	2	
	16	Case studies of successful IT innovations in India (Infosys, Tata Consultancy Services (TCS), Wipro Limited, HCL Technologies, Zoho Corporation)	3	
	17	Opportunities and challenges in adopting innovative technologies, Strategies for managing technological change.	2	
V	**Open Ended Module- Application Level**		**9**	
		Discuss from the following: • Strategic Role of Business Intelligence. • Next-generation Data Visualization Techniques and Tools. • Understanding Innovation Ecosystems. • Agile Methodologies and Lean Startup Principles for IT Innovation. • Ethical Considerations in Data-driven Decision-making and Innovation • Future Outlook: Anticipating Trends and Staying Ahead of the Curve	**9**	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	2	1	-	-						
CO 2	1	1	2	1	-	-						

CO 3	-	3	1	1	-	-						
CO 4	-	3	3	2	-	-						
CO 5	-	1	3	3	1	-						
CO 6	-	1	3	3	1	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Reference:

1. Business Intelligence Guidebook: From Data Integration to Analytics by Rick Sherman.
2. Business Intelligence: A Managerial Perspective on Analytics by Ramesh Sharda, Dursun Delen, and Efraim Turban.
3. Lean Analytics: Use Data to Build a Better Startup Faster" by Alistair Croll and Benjamin Yoskovitz.
4. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries.
5. Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist" by Brad Feld and Jason Mendelson.
6. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company" by Steve Blank and Bob Dorf.

Skill Enhancement Course (SEC)

Programme	BCA				
Course Title	Introduction to Computers and Office Automation.				
Type of Course	SEC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Basic knowledge of computers & Internet.				
Course Summary	This course focuses on the use of computer technology and software applications to automate routine office tasks and streamline business processes. Students will be able to use computer technology to enhance communication and data management.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamentals of computer Hardware and Software and Computer Networks.	U	C	Instructor-created exams / Quiz/ Assignment/ Seminar
CO2	Understand the fundamentals of word processing and its importance in office automation. Demonstrate proficiency in creating, editing, and formatting documents using word processing software. Explore advanced formatting options and features	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO3	Understand the fundamentals of electronic spreadsheets and their role in data analysis, manipulation, and presentation. Demonstrate proficiency in creating, saving, and editing workbooks and worksheets within electronic spreadsheet software. Utilize various data entry techniques. Handle operators in formulas and utilize a wide range of functions.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO4	Demonstrate proficiency in creating, manipulating, and enhancing slides within presentation software, including adding text, images, shapes, and multimedia elements. Expertise in utilizing organizational charts and	Ap	P	Practical Assignment / Instructor-created exams / Quiz

	various chart types to represent hierarchical structures and data trends effectively. Explore drawing tools to create custom shapes, diagrams, and illustrations.			
CO5	To empower students to design and implement automation solutions in real- world scenarios.	Ap	P	Case study/ Project
CO6	Gaining a deep understanding of emerging trends and technologies in the field of automation.	U, Ap	P	Assignment/ Seminar
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (36+9)	Marks
I	**Introduction To Computers**		**8**	**14**
	1	Types of Computers	1	
	2	Hardware: CPU, Input/Output Devices. Storage Devices, memory hierarchy, RAM, ROM, Secondary Memory,and Registers.	3	
	3	Software: Types of Software, computer languages, language translators, and Operating Systems.	2	
	4	Computer Networks: LAN, WAN, MAN, Client -Server	2	
II	**Documentation Using a Word Processor (OpenOffice Writer / M.S. Word)**		**8**	**12**
	5	Introduction to Office Automation, Word Processing Concepts - creating and editing documents, Formatting documents.	3	
	6	Finding and Replacing Text, Printing documents, Auto-text, Autocorrect, Spelling and Grammar Tools.	2	
	7	Document Dictionary, Graphics, Tables, Charts, Columns, Page Borders, Bookmark.	1	
	8	Advanced Features- Mail Merge, Macros, Tables, File Management, Printing, Styles, linking and embedding objects, Template.	2	
III	**Electronic Spread Sheet (Open Office Calc/MS- Excel)**		**10**	**12**
	9	Introduction to Spread Sheet, Spreadsheet Concepts, Creating, Saving, and Editing a Workbook.	2	
	10	Inserting, deleting worksheets, entering data in a Cell/Formula, Copying and moving data from selected Cells.	1	
	11	Handling Operators in Formula. Functions: Mathematical, Logical, Statistical, Text, Financial, Date and Time, Function Wizard.	1	
	12	Formatting a Worksheet, Formatting Cells, and Changing Data alignments. Changing date, Character, Number, Currency format, Changing font.	2	
	13	Adding borders and colors, Printing Worksheets, Charts and graphs, creating previewing and modifying charts, Conditional Formatting, and Filters.	3	
	14	Advanced features – Pivot table & Pivot Chart, Linking and Consolidation	1	
IV	**Presentation using (OpenOffice Impress/MS- Power Point)**		**10**	**12**
	15	Presentations, Creating, Manipulating & Enhancing Slides.	2	

	16	Organizational Charts, Charts, Drawing objects, clip arts, Word Art, Layering art Objects.	4	
	17	Inserting Animated Pictures or Accessing through Object, Inserting Recorded Sound Effect or In-Built Sound Effect.	4	
V	**Open Ended Module**		**9**	
	1	• Design and Implement Automation Solutions in real-world scenarios • Understand Future Trends in Automation	9	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	-						
CO 2	3	2	-	-	3	-						
CO 3	3	2	-	-	3	-						
CO 4	3	2	-	-	3	-						
CO 5	3	1	-	-	3	-						
CO 6	3	1	-	-	3	3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. P. K. Sinha and P. Sinha, "Foundations of Computing". BPB Publicaiion.
2. Russell A. Stultz, Learn Microsoft Office, BPB Publication.
3. S. Sagman. "Microsoft Office 2000 for Windows". Pearson Education.
4. Turban, Mclean and Wetherbe. "Information Technology and Management John Weily and Sons.
5. H.M.Deitel, P. J. Deitel, et al., Internet & World Wide Web - How to program, Prentice Hall.

Programme	BCA				
Course Title	Data Analysis using Spread Sheet				
Type of Course	SEC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	2	-	2	60
Pre-requisites	1. Familiarity with Spreadsheet Software. 2. Understanding of Basic Mathematical and Statistical Concepts				
Course Summary	After completing the course, students have a solid foundation in data analysis using spreadsheets, empowering them to analyze data with confidence, derive meaningful insights, and communicate their findings effectively to stakeholders.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will demonstrate proficiency in managing spreadsheets, including creating, formatting, and manipulating data within workbooks. They will be able to effectively navigate the spreadsheet interface and utilize toolbars.	Ap	P	Instructor-Create Exams or Quiz
CO2	Learners will understand the importance of data organization and cleansing in spreadsheets. They will be able to import, export, filter, sort, validate, and remove duplicates from datasets. Students will	U	C	Discussions and Quizzes

	develop skills to ensure data integrity and consistency, enhancing their ability to work with clean and organized datasets.			
CO3	Participants will acquire advanced data analysis skills like pivot tables, what-if analysis, and goal seek. They will be able to apply various spreadsheet functions and tools to perform complex calculations, analyze trends, and make informed decisions based on data analysis.	An	P	Instructor created exams or Home assignments
CO4	Students will gain proficiency in data visualization techniques using spreadsheets. They will be able to create a variety of charts, design pivot charts, and dashboards for effective data analysis.	C	P	Discussions, Quizzes
CO5	Learners will be able to implement form controls for interactive data manipulation in their visualizations, enhancing their ability to present and explore data dynamically.	Ap	P	Viva Voce Observation of practical skills
CO6	Learners will develop skills in advanced features of spreadsheets such as macros, protecting data sheets and workbooks, utilizing split, freeze, and hide options effectively. They will also learn to incorporate add-ins for extended functionalities and manage printing options for the professional presentation of data.	C	P	Instructor Created -Exams, Assignments
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (30+30)	Marks
I		**Introduction to Spreadsheet**	**7**	**10**
	1	Overview of spreadsheet software (e.g., Microsoft Excel, Google Sheets), Basic spreadsheet navigation and interface	1	
	2	Entering and formatting data, Data types and cell formatting, Sorting and filtering data	2	
	3	Arithmetic operations and basic formulas, Common functions (SUM, AVERAGE, MIN, MAX, COUNT)	2	
	4	Text functions (CONCATENATE, LEFT, RIGHT, MID, TEXT), Date and time functions	2	
II		**Data Cleaning and Visualization**	**8**	**15**

	5	Logical functions (IF, AND, OR, NOT, IFERROR, IFS, SWITCH), Lookup and reference functions (VLOOKUP, HLOOKUP, INDEX, MATCH)	2	
	6	Financial functions (NPV, IRR, PMT), Array formulas (SUMPRODUCT, SUMIF, AVERAGE, TRANSPOSE, Array Multiplication, FILTER, IMPORTRANGE)	2	
	7	Handling missing values and duplicates, Data transformation techniques (text to columns, merging cells)	2	
	8	Using advanced text functions for data cleaning, Data validation rules and error-checking	1	
	9	Creating and customizing charts (bar, line, pie, scatter, Histogram), Conditional formatting for data visualization	1	
III	**Pivot Tables and Pivot Charts**		**8**	**10**
	10	Sparklines and data bars, Advanced chart techniques (combination charts, dual-axis charts)	2	
	11	Creating and configuring pivot tables, Grouping and summarizing data in pivot tables	2	
	12	Creating and customizing pivot charts	2	
	13	Using slicers and timeline for interactive analysis	2	
IV	**Data Analysis Technique**		**7**	**15**
	14	Descriptive statistics (mean, median, mode, standard deviation)	1	
	15	Correlation and regression analysis with example, Data analysis tools (Solver, Analysis ToolPak)	2	
	16	Scenario analysis and what-if analysis (Goal Seek, Data Tables, Scenario Manager)	2	
	17	Introduction to DAX (Data Analysis Expressions) for complex calculations (Concept Only)	2	
V	**Practical Applications**		**30**	
	1	1. Implement filter and sort operations. 2. Perform basic Arithmetic operations (Sum, Difference, Product, Divides) 3. Using a dataset of student grades in different subjects, calculate the average grade, highest grade (MAX), lowest grade (MIN), and the total number of grades recorded (COUNT). 4. Create a spreadsheet with a list of full names in one column. Use text functions to separate the first names and last names into two new columns.	**7**	

		5. Create a spreadsheet with a list of dates of birth and names. Using the appropriate date and time functions, calculate each person's current age. 6. Perform Logical function on a given dataset. 7. Using a dataset of students' information, create a bar chart to visualize the data. Customize the chart with titles, axis labels, and different colours for each bar. 8. A list of 15 students with their hours of study per week and their corresponding exam scores, Use the CORREL function to Calculate the correlation coefficient. 9. Perform a simple linear regression to determine the relationship between advertising spend and sales. 10. Implement any one real life example.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	2	1	-	-						
CO 2	1	-	2	1	-	-						
CO 3	1	-	1	1	-	-						
CO 4	2	-	3	2	-	-						
CO 5	2	-	3	3	1	-						
CO 6	1	-	3	3	1	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Alexander, M., Kusleika, R., & Walkenbach, J. (2018). Excel 2019 Bible. Wiley.
2. Winston, W. (2019). Microsoft Excel Data Analysis and Business Modeling. Microsoft Press.
3. Nigam, M. (2021). Data Analysis with Excel: Tips and Techniques. BPB Publications.
4. Alexander, M., & Kusleika, D. (2018). Excel 2019 Power Programming with VBA. Wiley.
5. McFedries, P. (2019). Excel Pivot Tables and Pivot Charts: Your visual blueprint for creating dynamic spreadsheets. Visual.

Programme	BCA				
Course Title	Website Designing using Content Management System				
Type of Course	SEC				
Semester	III				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	2	-	2	60
Pre-requisites	1. Familiarity with web content management systems (CMS). 2. Basic knowledge of internet technologies provides a foundation for learning web design.				
Course Summary	The course covers fundamental web design concepts including HTML and CMS principles, focusing on Drupal as a robust Content Management System. Students will learn to create and customize websites using Drupal, exploring its features such as content types, themes, and modules				

	to build dynamic and interactive web pages.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Cultivate a robust understanding of web design fundamentals, laying a strong foundation for their journey into the dynamic world of digital design and development.	U	C	Assignment / Instructor-created exams / Quiz
CO2	Attain comprehensive knowledge and practical proficiency in Content Management Systems (CMS), empowering to navigate and excel in the ever-evolving landscape of digital content creation and management.	U	C	Assignment / Instructor-created exams / Quiz
CO3	Develop expertise in Drupal, a widely used CMS platform, gaining comprehensive understanding of its features, configuration, and installation processes, thus preparing them for proficient and innovative web development endeavors.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO4	Impart a comprehensive understanding of website development using Drupal and facilitate the acquisition of expertise across various options within the Drupal ecosystem.	Ap	P	Practical Assignment / Instructor-created exams / Quiz
CO5	Gain an understanding of how to apply web design concepts to real-world scenarios, effectively designing and developing functional and aesthetically pleasing websites utilizing the Drupal CMS.	C	P	Practical Assignment / Instructor-created exams / Quiz
CO6	Develop proficiency in advanced website management skills, including installing and configuring modules, managing menus, and more, to effectively navigate and optimize the functionality of websites built on the Drupal platform.	C	P	Practical Assignment / Instructor-created exams / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Unit	Content	Hrs (30+30)	Marks
I	**Introduction to Web Designing**		**6**	**10**
	1	Basics of Web Designing -World Wide Web (WWW), W3C, Web Browser	1	
	2	Web Server, Web Hosting, Web Pages, DNS, URL	2	

	3	Overview of HTML (Concept only) and its role in Web Development	1	
	4	Open-Source S/W, Open-Source vs Closed Source Software, Open Source Licenses (Concept only)	2	
II	**Introduction to CMS**		**6**	**10**
	5	Introduction to Content Management Systems (CMS) - Features of CMS	2	
	6	Web Content Management System	2	
	7	Components of Content Management System	2	
III	**Introduction to Drupal**		**8**	**15**
	8	Drupal - Features, Advantages and Disadvantages, Installation and Configuration	2	
	9	Content types and Field Drupal Architecture	2	
	10	User Management, Managing Comments	2	
	11	Creating and Customizing Themes	2	
IV	**Building Website**		**10**	**15**
	12	Website Development - Working with Templates and Template files	2	
	13	Articles, Creating Web Forms	1	
	14	Managing blocks, Add Links to Blocks, Moving Elements within Block	2	
	15	Blocks and Regions	1	
	16	Creating and Customizing Views, Installing and Configuring Modules	2	
	17	Static Pages, Creating Pages, Menu Management.	2	
V	**Practical**		**30**	
		1. Install and configure Drupal on your computer. 2. Design a website of your college using Drupal and modify the basic site settings. 3. Add different menus to your website. The menus should contain: home, news, gallery, about us and contact us. 4. Create user roles for your site and assign permissions. 5. Install and activate a new theme from the Drupal theme repository. 6. Add different blocks in to your website. 7. Create a new content type and add some fields to it. 8. Add new article to your site. 9. Install and configure the 'pathauto' module. 10. Create the mobile view of your website.	30	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	1	1	3	1						
CO 2	1	3	2	1	3	1						
CO 3	1	3	1	1	3	2						

CO 4	1	3	3	1	3	2						
CO 5	3	3	3	1	3	2						
CO 6	1	3	3	1	3	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References:

1. Jennifer Campbell, Jennifer T Campbell, Web Design: Introductory, Course Technology.

2. Jason Beaird and Alex Walker, The Principles of Beautiful Web Design, SitePoint.

3. Bob Boiko, Content Management Bible, Wiley.

4. Daniel Sipos, Drupal 9 Module Development, Packt Publishing Limited.

Programme	BCA
Course Title	Professional Skill Development for IT Career Excellence
Type of Course	SEC

Semester	V				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	1. Basic Mathematics 2. Basic English reading and Writing Skills				
Course Summary	The course provides a comprehensive overview of essential skills and knowledge relevant to success in information technology. It covers various topics, including personal development, communication, quantitative reasoning, programming, software development, and web technologies.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will demonstrate effective communication skills, including verbal and written communication, and adhere to professional etiquette standards in various contexts, including digital communication.	Ap	C	Assignment / Instructor-created exams / Quiz
CO2	Students will develop job readiness skills, including resume writing, job application preparation, and interview techniques, to enhance their employability and succeed in job interviews.	E	C	Assignment / Instructor-created exams / Quiz
CO3	Students will collaborate effectively in group discussions and presentations, demonstrating teamwork, leadership, and critical thinking skills in diverse group settings.	Ap	C	Assignment / Instructor-created exams / Quiz
CO4	Students will apply quantitative and logical reasoning skills to solve mathematical problems, analyse data, and make informed decisions in various contexts, including financial and analytical reasoning.	Ap	C	Assignment / Instructor-created exams / Quiz
CO5	Students will understand fundamental programming concepts, data structures, and database principles, and apply them to solve computational problems and develop software applications.	Ap	C	Assignment / Instructor-created exams / Quiz
CO6	The student will be able to learn areas and skills essential for success in the IT industry, including communication, problem-solving, programming, and technology integration.	Ap	C	Assignment / Instructor-created exams / Quiz

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (36+9)	Marks
I	**Introduction to Soft Skills and Academic Skills**		**10**	**15**
	1	Personality Development: Knowing Yourself, Positive Thinking, Communication Skills, Professional Etiquette	2	
	2	Employment Communication: Introduction, Resume, Curriculum Vitae, Developing an Impressive Resume, Job Application or Cover Letter	2	
	3	Job Interviews: Definition of Interview, Types of Interviews, Preparatory Steps for Job Interviews, Interview Skill Tips	2	
	4	Group Discussion: Importance of Group Discussions, Difference between Group Discussion, Panel Discussion and Debate, Preparing the Presentation, Delivering the Presentation	2	
	5	HR round: Self Introduction, Strength and Weakness Analysis, Scenario-Based Tasks, Body Language, Positive Attitude	2	
II	**Basic Aptitude Skills**		**9**	**15**
	6	Number System: HCF and LCM, Decimal Fraction, Problems on Age	2	
	7	Square Root, Cube Root, Problems on Numbers,	1	
	8	Problems on Speed, Time and Distance, Percentage, Problems on Trains	2	
	9	Profit and Loss, Ratio and Proportion, Partnership	2	
	10	Simple Interest, Compound Interest, Chain Rule, Problems on Callender and Clock	2	
III	**Reasoning Skills Development**		**9**	**10**
	11	Verbal Reasoning: Antonym and Synonym, Verbal Analogies, Spotting Errors, Ordering Words, Sentence correction, Fill in blanks, Replace the word, Idioms and Phrases	3	
	12	Logical Reasoning Aptitude: Series: Missing Numbers, Odd One Out, Assumptions and Conclusions, Alpha-Numeric Sequence Puzzle, Number, Ranking & Time Sequence Test	3	
	13	Non-Verbal Reasoning: Choosing the Missing Figure in a Series, Choosing the Set of Similarly Related Figures, Dot Situation, Basic Analytical Reasoning	3	
IV	**Technical Skills and Programming Skills**		**8**	**10**
	14	Concept of Procedure-Oriented Programming and Object-Oriented Programming, Basic structure of C Programming	2	

	15	Data Structures: Array, Linked list, Stack, Queue, Tree and Graphs (Concept Only)	2	
	16	Database Concept: ER Model, Normalisation, ACID Property, DML and DDL	2	
	17	Basic Concept of SDLC, Agile Model(Concept Only), Blackbox and Whitebox Testing(Concept)	2	
V	**Open Ended Module- Application Level**		**9**	
		Assign the tasks from the following • Writing an impressive resume • Active listening and feedback mechanisms • Conduct Ice breaking Session • Assign students to participate in a group discussion on a given topic and write a reflective analysis of their experience, including observations on communication dynamics, collaboration, and leadership. • Pair students and assign roles (interviewer and interviewee) to conduct mock interviews based on various scenarios, such as behavioural questions, technical challenges, or situational inquiries. • Task students with designing and delivering a professional presentation on a topic related to their field of study or interest, incorporating effective visual aids, storytelling techniques, and audience engagement strategies. • Conduct low-level Aptitude tests, including Verbal and Non-Verbal Reasoning. • Conduct high-level Aptitude tests, including Verbal and Non-Verbal Reasoning. • Writing Simple programming in any language. • Assign students to research and analyse a real-world software development project, applying concepts of the Software Development Life Cycle (SDLC)		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	2	1	-	-						
CO 2	1	1	2	1	-	-						
CO 3	-	3	1	1	-	-						
CO 4	-	3	3	2	-	-						
CO 5	-	1	3	3	1	-						
CO 6	-	1	3	3	1	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Reference:

1. Chauhan, G. S., & Sharma, S. (2016). Soft Skills: An Integrated Approach to Maximise Personality. Wiley India.
2. Sonmez, J. (2015). Soft Skills: The Software Developer's Life Manual. Manning Publications.
3. Mitra, B. K. (2011). Personality Development and Soft Skills. Oxford University Press.
4. Aggarwal, R. S. (2017). Quantitative Aptitude for Competitive Examinations. S. Chand Publishing.
5. Verma, R. (2018). Fast Track Objective Arithmetic. Arihant Publications.
6. Aggarwal, R. S. (2018). A Modern Approach to Verbal and Non-Verbal Reasoning. S. Chand Publishing.
7. Rizvi, M. A. (2005). Effective Technical Communication. Tata McGraw-Hill Publishing.

Model Question Paper - Major

FIRST SEMESTER (CUFYUGP) DEGREE EXAMINATIONS

BCA

BCA1CJ101 - Fundamentals of Computers and Computational Thinking

(2024 Admissions)

Time: Two Hours **Maximum: 70 Marks**

Section A

[Answer All. Each question carries 3 marks] (Ceiling 24 Marks)

1. Briefly describe the historical development of computers mentioning two key figures and their contributions.
2. Explain the concept of the Von Neumann architecture.
3. Convert the following numbers from decimal to binary: (a) 25, (b) 100.
4. Differentiate between active and passive electronic components. Provide an example of each.
5. What is the function of a motherboard? List four key components on a motherboard.
6. Distinguish between application software and system software. Give an example of each.
7. Briefly explain the role of an operating system in a computer system.
8. Define the term "computational thinking."
9. What are the steps involved in problem decomposition?
10. Explain the difference between inductive and deductive reasoning.

Section B

[Answer All. Each question carries 6 marks] (Ceiling 36 Marks)

11. Describe the evolution of computers from first generation to present day, highlighting the key features of each generation.
12. Explain the concept of digital codes with reference to Gray code and BCD.
13. Briefly explain the working principle of a transistor.
14. Differentiate between RAM and ROM. Explain the different types of RAM.
15. Discuss the different types of operating systems and their characteristics.
16. Explain the concept of booting with reference to POST and UEFI/Legacy BIOS.
17. Describe the four key pillars of computational thinking.
18. Explain the importance of algorithms in solving problems. Discuss the qualities of a good algorithm.

Section C

[Answer any one. Each question carries 10 marks] (1 x 1 = 10 Marks)

20. a) Discuss the contributions of John von Neumann to the field of computing.

    b) Briefly explain the concept of Quantum Processing Units (QPU) and their potential applications.

21. a) Describe the various components of a computer system and their functionalities.

    b) Explain the need for device drivers in a computer system.

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Model Question Paper - General Foundation Courses

SECOND SEMESTER (CUFYUGP) DEGREE EXAMINATIONS

BCA

BCA2FS112 - Data Analysis using Spread Sheet

(2024 Admissions)

Time: One and Half Hours **Maximum: 50 Marks**

Section A

[Answer All. Each question carries 2 marks] (Ceiling 16 Marks)

1. Define the terms "worksheet" and "workbook" in the context of Excel.
2. Explain three formatting options available for cells in Excel and briefly describe their applications.
3. How can you insert a new row and a new column within an Excel sheet?
4. Write a formula to calculate the average of a range of cells (A1:A10) in Excel.
5. Explain the purpose and benefits of data validation in Excel.
6. Differentiate between absolute and relative cell referencing with an example for each.
7. Describe the concept of Autofill and give an example of how it can be used in Excel.
8. Explain the steps involved in filtering data based on a specific criterion in Excel.
9. Describe the process of importing data from a text file into an Excel spreadsheet.
10. List two commonly used functions for applying conditional formatting in Excel.

Section B

[Answer All. Each question carries 6 marks] (Ceiling 24 Marks)

11. A dataset contains duplicate entries. Describe the steps involved in removing these duplicate rows in Excel.
12. You are given a dataset with sales figures for different regions. Explain how you

would create a pivot table to analyse trends in sales across these regions.

13. Explain the concept of "What-If Analysis" in Excel and provide an example of how it can be used to support decision-making.
14. Write a formula using the VLOOKUP function to find the product price based on a product code in another table.
15. Describe three different chart types suitable for visualizing data in Excel and explain when you might use each type.

Section C

[Answer any one. Each question carries 10 marks] (1 x 1 = 10 Marks)

16. You are provided with a large dataset containing customer information and sales data.
    a. Describe how you would utilize advanced features like data filtering, sorting, and pivot tables to identify the top 5 customers by sales in a specific region for the past year.
    b. Create a visually appealing dashboard in Excel that summarizes key customer and sales data, including a chart to represent the top-selling products.

17. Explain the concept of macros in Excel and discuss their potential benefits and drawbacks. Briefly describe the steps involved in creating a simple macro to automate a repetitive task.