DEPARTMENT OF COMPUTER SCIENCE

CHOICE BASED CREDIT SYSTEM (CBCS)
Learning Outcome-based Curriculum Framework (LOCF)
SYLLABUS

2025 - 2026

MADRAS CHRISTIAN COLLEGE
(AUTONOMOUS)

College with Potential for Excellence

Affiliated to University of Madras

Tambaram

Chennai – 600 059

MADRAS CHRISTIAN COLLEGE

VISION

Madras Christian College aspires to be an Institution of excellence transforming lives through education with a commitment to service.

MISSION

Madras Christian College (MCC) with the inspiration of the love of God offers to people of all communities education of the whole person, which is congruous with God's revelation in Christ of the true nature of humanity and is appropriate to the needs of India and of the world. The department of Computer Science strives to provide sound learning in the field of Technical Education, train a sizable group of students to become valuable resources in the IT Industry and develop wholesome personalities, equipped with Christian values

Graduate Attributes

The Madras Christian College defines the philosophy underpinning its academic programmes and student life experience on campus through the Graduate Attributes (GA), that describe the knowledge, competencies, values and skills students imbibe for holistic development and contribution to society. These attributes encompass characteristics that are transferable beyond the domain of study into the national and international realm fostered through curricular, co-curricular and extra-curricular engagements.

GA 1: Intellectual Competencies

- Graduates of MCC have a comprehensive and incisive understanding of their domain of study as well as the capability for cross-disciplinary learning.
- They have the ability to apply the knowledge acquired through the curriculum as well as self-directed learning to a broad spectrum ranging from analytical thinking to synthesise new knowledge through research.
- Forming independent individual opinions regarding academic cores and socially relevant issues

GA 2: Professional Ethics

- Graduates of MCC develop ethical and professional behaviour, which will be demonstrated in their chosen careers and constructive citizenship roles.
- They imbibe intellectual integrity and ethics in scholarly engagement and develop a spirit of inclusiveness through interactions with people of special needs and diversity.

GA3: Leadership Qualities

- Graduates of MCC inculcate leadership qualities & attitudes, and team behaviour along democratic lines through curricular, co-curricular and extra-curricular activities
- They develop managerial and entrepreneurial skills to ideate and create new opportunities along with career readiness and capacity to take up various competitive exams.

GA 4: Holistic Skill Development

- Graduates of MCC develop critical thinking, problem-solving, effective communication, emotional and social skills
- They develop digital competency to live, learn and serve in society.

GA 5: Cross-Cultural Competencies

- Graduates of MCC imbibe cross-cultural competencies through engaging with diverse linguistic, ethnic and religious communities providing scope to understand, accept and appreciate individuals at local, national and international levels.
- They develop a global perspective through contemporary curriculum, culture, language and international exchange programmes

GA 6: Service-Oriented Focus

- Graduates of MCC have sensitivity to social concerns and a conviction toward social justice through a commitment to active social engagement.
- They are endowed with a strong sense of environmental awareness through the curriculum and campus eco-system.

GA 7: Value-Based Spiritual Development

- Graduates of MCC are rooted in the principles of ethical responsibility and integrity permeated with Christian values leading to the building of character.
- They develop virtues such as love, courage, unity, brotherhood, industry and uprightness.

Programme Outcomes

Programme Outcomes (POs) of Madras Christian College define the minimum level that students are expected to do, achieve and/or accomplish in order to graduate from a particular programme. These Outcomes are a framework to assess the nature of learning activity experienced within the programme.

MADRAS CHRISTIAN COLLEGE **POs FOR POSTGRADUATE PROGRAMMES** **Upon completion of a Postgraduate programme, the student will be able to**				
PO1	Domain Knowledge	• Develop intensive and extensive knowledge and expertise in their respective domains • Evaluate and create/construct domain specific knowledge in areas of learning, research and industry • Formulate and extrapolate the knowledge gained to apply in real – life situations and competitive examinations • Develop an aptitude for self-directed learning for excellence in their chosen area within the domain of study	GA1, GA3, GA4	Rigorous
PO2	Applicative knowledge and Lateral Thinking	• Translate theoretical understanding to experimental knowledge and solve complex problems using Systems/Design Thinking • Apply advanced knowledge and approaches to solve concrete and abstract problems in domain-related and multi-disciplinary issues. • Able to solve problems using unconventional and creative approaches	GA1, GA3, GA4	
PO3	Innovation and Research	• Develop aptitude for innovation and entrepreneurship • Identify contemporary research problems, analyze data and propose solutions	GA1, GA4, GA5, GA6	
PO4	Scientific Communication skills	• Document, prepare and present scientific work as reports and research articles in academic forums • Critically assess, review and present theories, principles and concepts	GA1, GA4, GA5, GA6	
PO5	Digital skills	• Use of domain-related advanced software resources, computational skills and digital tools for data analysis, visualization and interpretation • Ethically apply digital skills to creatively communicate a wide range of ideas and issues related to academic experiences	GA1, GA2, GA3, GA4	
PO6	Ethical practices	• Apply domain specific ethical principles and practices in academic, professional and social engagements	GA2, GA6, GA7	
PO7	Career readiness and higher education	• Choose from diverse career options available in local, national and international realms. • Carry out further research or pursue higher education in the country or abroad	GA1, GA2, GA5	

PROGRAMME SPECIFIC OUTCOMES (PSO)

At the time of graduation the graduates would be able to

PSO #	Statement	Mapped with PO #
PSO1	Understand and apply the foundational concepts, techniques and Software Development principles to provide innovative solutions for challenging problems.	PO1, PO2, PO5, PO7
PSO2	Create solutions to real life problems with adequate applicative knowledge of technologies, emerging software trends and tools gained through theory and practice.	PO1, PO2, PO5, PO7
PSO3	Adapt to fast-changing advancements in Software development methods and practices through lifelong learning for a successful career or pursue higher studies / research.	PO1, PO2, PO3, PO5, PO7
PSO4	Apply professional and ethical principles, effective communication skills, multidisciplinary approach, skills to improve existing software systems and abilities to relate computing issues to the social context.	PO1, PO2, PO3, PO4, PO5, PO6, PO7

Curriculum Overview Table		
Part	**Credits**	**Hours per cycle**
I - Core Theory	**34** [(6 * 3) + (4 * 4)]	**38** [(8 * 4) + (2 * 3)]
I - Elective	**20** (5 * 4)	**15** (5 * 3)
I - Core Practical	**18** (9 * 2)	**33** [(6 x 4) + (3 x 3)]
I - Project	**18**	**30**
II - Soft Skill	**8**	**4**
II - Internship	**2**	3-4 weeks during vacation
Total	**100**	**120** 4 semesters * 30 hours

CURRICULUM TEMPLATE FOR M.C.A. (EFFECTIVE FROM 2025 – 26)

Semester	Part	Course Code	Course Title	Instruction hours per Cycle	Duration of Exam	Marks			Credits
						ICA	ESE	Total	
1	I		Data Structures and Algorithms	4	3	50	50	100	3
1	I		Object Oriented Programming using Java	4	3	50	50	100	3
1	I		Advanced Database Technologies	4	3	50	50	100	3
1	I		Cloud Computing and Distributed Systems	3	3	50	50	100	3
1	I		Elective – I	3	3	50	50	100	4
			Advanced Operating Systems						
			Design Thinking and Innovation						
			Universal Human Values						
			User Interface and User Experience Design						
1	I		Data Structures and Algorithms Laboratory	4	3	50	50	100	2
1	I		Object Oriented Programming using Java Laboratory	4	3	50	50	100	2
1	I		Advanced Database Technologies Laboratory	4	3	50	50	100	2
			Total	30					22
2	I		Artificial Intelligence	4	3	50	50	100	4
2	I		Advanced Software Engineering	4	3	50	50	100	3
2	I		Full Stack Web Development	4	3	50	50	100	4
2	I		Elective – II	3	3	50	50	100	4
			Business Intelligence						
			DevOps and Micro Services						
			Digital Image Processing						
			Python Programming						
2	I		Elective – III	3	3	50	50	100	4
			API Development and Integration						
			Mobile Application Development						
			Mobile Commerce Technology						
			Soft Computing						
2	I		Advanced Java Programming Laboratory	3	3	50	50	100	2
2	I		Mobile Application Development Laboratory	4	3	50	50	100	2
2	I		Full Stack Web Development Laboratory	3	3	50	50	100	2
	II		Soft Skill Programme	2	NA	50	NA	50	4

			Total	30					29
3	I		Data Analytics and Visualization	4	3	50	50	100	4
3	I		Internet of Things and Robotics	4	3	50	50	100	3
3	I		Deep Learning	3	3	50	50	100	4
3	I		Elective – IV	3	3	50	50	100	4
			Blockchain and Cryptocurrency						
			Cyber Security and Forensics						
			Ethical Hacking						
			Information Security						
3	I		Elective – V	3	3	50	50	100	4
			Test Automation and Tools						
			Digital Marketing Analytics						
			Generative AI						
			Natural Language Processing						
			Directed Study						
3	I		Virtual and Augmented Reality Laboratory	3	3	50	50	100	2
3	I		Data Analytics and Visualization Laboratory	4	3	50	50	100	2
3	I		Software Development Laboratory	4	3	50	50	100	2
	II		Soft Skill Programme	2	NA	50	NA	50	4
			Total	30					29
4	II		Internship						2
4	I		Project (Duration : 4 months)	30		50	50	100	18
			Total						20
			Total						100

GROUPING OF ELECTIVES

ELECTIVE I	
	Advanced Operating Systems
	Design Thinking and Innovation
	Universal Human Values
	User Interface and User Experience Design

ELECTIVE II	
	Business Intelligence
	DevOps and Micro Services
	Digital Image Processing
	Python Programming

ELECTIVE III	
	API Development and Integration
	Mobile Application Development
	Mobile Commerce Technology
	Soft Computing

ELECTIVE IV	
	Blockchain and Cryptocurrency
	Cyber Security and Forensics
	Ethical Hacking
	Information Security

ELECTIVE V	
	Test Automation and Tools
	Digital Marketing Analytics
	Generative AI
	Natural Language Processing
	Directed Study

COURSE TITLE: DATA STRUCTURES AND ALGORITHMS

Course Code			
Credits	3		
Hours / Cycle	4		
Category	Part I	Core	Theory
Semester	I		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To gain knowledge about the concepts of data structures and algorithms. • To learn techniques for designing algorithms using appropriate data structures, prove correctness and analyze their running times. • To apply suitable data structures and algorithms for solving real-world applications.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the fundamentals in Algorithms as a technology and basic data structures	PSO1, PSO2, PSO3	K1
CO2	Understand the concepts of data structures, algorithms and their usage in applications	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the suitable algorithms and appropriate data structures in problem solving	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the performance of the algorithms when applied to real-time problems	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the prototypes or applications developed with the data structures and algorithms learned, their efficiency and apply improvisation if needed	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Algorithms and their analysis** Role of algorithms in computing - Analysis and efficiency of algorithms - Asymptotic notations - Time complexity of an algorithm, Analyzing Recursive Programs – Analysis of bubble sort and insertion sort algorithms, Order of growth - Divide and Conquer: Quick sort and Merge Sort and their analysis	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Linear Data Structures** Stacks and Queues using arrays, Singly linked lists,: Unsorted and sorted linked lists, Linked representation of stacks and queues - Doubly linked lists	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

III	**Trees** Trees and their terminologies, Binary trees and their traversals, Binary Search Trees – traversing, insertion and deletion, Red Black Trees - properties, rotations, insertions and deletions, B Trees – insertion and deletion of a key, Heap construction and sorting	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Graphs** Graphs and their types, Representation of graphs, Graph Traversal - BFS, DFS, Minimum Spanning tree – Kruskal's and Prim's algorithms, Single source shortest path algorithm - Dijkstra's algorithm, All-Pairs Shortest Path Problem – Floyd-Warshall algorithm.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Design and Analysis of Advanced Algorithms** Dynamic Programming: 0/1 Knapsack Problem. Matrix Chain Multiplication - Greedy Programming: Fractional Knapsack Problem, Huffman Coding – Backtracking: n-queens problem	12	CO1. CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Mark Allen Weiss, *Data Structures and Algorithms in C*, Second Edition, Pearson, 2006
2. A.V.Aho, J.E. Hopcroft and J.D.Ullman, *The Design and Analysis of Computer Algorithms*, Pearson, 2009
3. Kruse R.L, Leung B.P, Tondo C.L, *Data Structures and Program Design in C*, Second Edition, Pearson, 2014
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, *Introduction to Algorithms*, Fourth Edition, Prentice-Hall, 2022.

References

1. Robert Sedgewick and Kevin Wayne, *Algorithms*, Fourth Edition, Pearson Education, 2011
2. Ellis Horowitz, Sartaj Sahni, Sanguthuvar Rajasekaran, *Fundamentals of computer Algorithms*, Second Edition, 2008
3. S. Sridhar, *Design and Analysis of Algorithms*, Oxford University Press, 2014
4. Jean Paul Tremblay and Paul G. Soresson, *An introduction to Data structures with applications*, Second Edition, McGraw Hill, 2017
5. S.K.Basu, *Design Methods and Analysis of Algorithms*, Fourth edition, PHI, 2013
6. Anany Levitin, *Introduction to the Design and Analysis of Algorithm*, Third Edition Pearson Education Asia, 2011

Suggested Readings

1. Narasimha Karumanchi *"Data Structures and Algorithms Made Easy: Data Structure and Algorithmic Puzzles",* CreateSpace Independent Publishing Platform, 2020
2. Allen Sherrod, *Data Structures and Algorithms for Game Developers (Game Development Series)*, Charles River Media, 2007

Web Resources

1. https://www.geeksforgeeks.org/advanced-data-structures/
2. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
3. https://www.studytonight.com/advanced-data-structures/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO 2	PO3	PO4	PO 5	PO 6	PO7	PS O1	PS O2	PS O3	PSO 4	

CO 1	3	3	2	-	2	-	2	3	2	2	-	K1
CO 2	3	3	2	2	3	2	3	3	2	2	2	K2
CO 3	3	3	3	2	3	2	3	3	3	3	3	K3
CO 4	3	3	3	2	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	2.6	2.25	2.8	2.5	2.8	3	2.6	2.6	2.75	
Overall Mapping of the Course with Pos – 2.71								Overall Mapping of the Course with PSOs – 2.74				

COURSE TITLE: OBJECT ORIENTED PROGRAMMING USING JAVA

Course Code			
Credits	3		
Hours / Cycle	4		
Category	Part I	Core	Theory
Semester	I		
Year of Implementation	From the academic year 2025-2026 batch onwards		
Course Objectives	• To understand the object-oriented concepts using Java • To apply the OOP concepts using Java • To write programs to solve problems using the OOP language constructs.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	To learn the concepts of data abstraction, encapsulation, overloading, inheritance and polymorphism.	PSO1, PSO2, PSO3	K1
CO2	To learn the Object-oriented Programming concepts to identify and create classes and objects for a given problem.	PSO1, PSO2, PSO3, PSO4	K2
CO3	To Design and implement Java programs for a given problem.	PSO1, PSO2, PSO3, PSO4	K3
CO4	To get the expertise on how to achieve reusability by using inheritance, polymorphism and generic programming and write programs	PSO1, PSO2, PSO3, PSO4	K4
CO5	To evaluate the output of a Java program and debug a Java program.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**OOP Paradigm:** Key concepts of Object-Oriented Programming - Abstraction, encapsulation, information hiding, class, object, inheritance, polymorphism, interface and implementation. **Java Basics:** Features of Java, Byte Code, JVM, JRE and JDK, Data types, Operators, Control Statements. **Classes and Objects:** Class, object, object reference, constructor, constructor overloading, method overloading, static members, access control modifiers.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Inheritance:** Inheriting data members and methods, constructor in inheritance, method overriding, multilevel inheritance, and multilevel constructors. Stop inheritance of method, stop inheritance of class - final keywords. **Interface:** creation and implementation of an interface, interface reference, instanceof operator, interface inheritance, dynamic method dispatch, interface and abstract class. Wrapper Class. Nested class, inner class, anonymous inner class, abstract class.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Array and Strings:** Single and Multidimensional Array, String class, StringBuffer class, Operations on string, Command line argument. **Package:** use of package, classpath, import statement, static import, access control. **I/O programming:** Introduction to Stream, Byte Stream, Character stream, Readers and Writers, File Class, File InputStream, File Output Stream, InputStreamReader, OutputStreamWriter, FileReader, FileWriter, Buffered Reader.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Exception Handling:** Exception and Error, Use of try, catch, throw, throws and finally, Built in Exception, Custom exception, Throwable Class. **Multithreaded Programming:** Use of Multithread programming, Thread creation, Thread class and Runnable interface, thread priority, thread synchronization, thread communication, deadlock.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Generic Programming:** Parameterized relations, generic methods, generic classes. **Collection Classes:** List, AbstractList, ArrayList, LinkedList, Enumeration, Vector, Properties, introduction to Java.util package. **GUI Programming** – Graphics class, Swing components, forms using Swing, Layout Managers.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Herbert Schildt, Java: The Complete Reference, Twelfth Edition, McGraw Hill Education, 2022.

References

1. Paul Deitel and Harvey Deitel, Java: How to Program, Prentice Hall, Ninth Edition, 2017
2. James Gosling et al., The Java Language Specification, Java SE, Eigth Edition, Addison-Wesley, 2014.
3. Bruce Eckel, Thinking in Java, Prentice Hall, Fourth Edition, 2006
4. Allen B. Downey and Chris Mayfield, Think Java: How to Think Like a Computer Scientist, O'Reilly Media, 2016

Suggested Readings

1. Paul Deitel and Harvey M. Deitel, C++ How to Program, Tenth Edition, Pearson India Education Services Pvt. Ltd, 2017
2. Grady Booch et al., *Object-Oriented Analysis and Design with applications*, Third Edition, Pearson Education, 2008

Web Resources

1. https://docs.oracle.com/javase/specs/jls/se6/jls3.pdf
2. https://chenweixiang.github.io/docs/Thinking_in_Java_4th_Edition.pdf
3. https://dev.java/learn/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO 1	3	2	2	-	1	-	1	2	2	2	-	K1
CO 2	3	2	2	2	2	2	2	2	2	2	2	K2
CO 3	3	3	2	2	3	2	2	3	3	3	2	K3
CO 4	3	3	2	2	3	3	2	3	3	3	3	K4
CO 5	3	3	2	2	3	3	2	3	3	3	1	K5
Wt. Avg.	3	2.6	2	2	2.4	2.5	1.8	2.6	2.6	2.6	2	
Overall mapping of the Course with PO: 2.33								Overall mapping of the Course with PSO: 2.45				

COURSE TITLE: ADVANCED DATABASE TECHNOLOGIES

Course Code			
Credits	3		
Hours / Cycle	4		
Category	Part I	Core	Theory
Semester	I		

Year of Implementation	From the Academic year 2025-26 batch onwards
Course Objectives	● To understand the working principles and query processing of databases. ● To understand the basics of SQL databases and their applications. ● To distinguish the different types of NoSQL databases. ● To understand the basics of XML and create well-formed and valid XML documents.

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the basic concepts various Databases and the Database Design Principles.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand about the ER Diagram, Database design, SQL Queries and Protocols. Compare and Illustrate various Storage Media.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Build ER Diagram, Apply Integrity constraints, and Construct complex SQL Queries.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Understand a simple Transaction of a database application and underlying principles.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Acquire the knowledge about different special purpose databases and to critique how they differ from traditional database systems.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Database System Architecture:** Centralized and Client – Server Architecture – Transaction and Data Servers – Cloud based Databases – Parallel Database Architectures – Distributed Database Systems.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Distributed Databases:** Classification – Distributed Data Storage – Distributed Transactions – Two Phase Commit Protocol: Handling Failures, Recovery and Concurrency control.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**SQL Database:** Introduction to Relational Database - Database Design: Architecture, Integrity Constraints, ER Diagram, Advanced SQL – SQL Server: CRUD Operations - Database Query and Tuning Tools - Indexing – Data Access.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

IV	**NOSQL Databases:** NoSQL – CAP Theorem – Sharding - Document based – MongoDB: Operation: Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**XML Databases:** Structured, Semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "*Database System Concepts*", Seventh Edition, McGraw Hill Education, 2021.
2. Ramez Elmasri, Shamkant B. Navathe, "*Fundamentals of Database Systems*", Seventh Edition, Pearson Education Inc., 2017.
3. C.J.Date, A.Kannan, S.Swamynathan, "*An Introduction to Database Systems*", Eighth
4. Edition, Pearson Education, 2006..

References

1. Guy Harrison, "*Next Generation Databases, NoSQL, NewSQL and Big Data*", First Edition, Apress publishers, 2015
2. Raghu Ramakrishnan, "*Database Management Systems*", Fourth Edition, Tata McGraw Hill, 2014.
3. G.K.Gupta,"*Database Management Systems*", Tata McGraw Hill, 2011.

Suggested Readings

1. C. J. Date, *SQL and Relational Theory: How to Write Accurate SQL Code*, 2nd edition, O'Reilly Media, Inc., 2012.Lip Phang, Chong, XML: A Quick Guide to All Aspects,
2. Dr. Hariram Chavan, Prof. Sana Shaikh, *Introduction to DBMS*, BPB Online, 2022.

Web Resources

1. https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2014/12/CS403-
   a. 1.10-Database-Design-2nd-Edition-CCBY.pdf
2. https://docs.ccsu.edu/curriculumsheets/ChadTest.pdf
3. https://www.mongodb.com/docs/manual/tutorial/getting-started/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	2	2	2	2	2	3	3	3	2	K1
CO 2	3	3	3	2	3	3	2	3	3	3	3	K2
CO 3	3	3	3	2	3	3	2	3	3	3	3	K3
CO 4	3	3	3	2	3	3	2	3	3	3	3	K4
CO 5	3	3	3	2	3	3	3	3	3	2	3	K5
Wt. Avg.	3	2.8	2.8	2	2.8	2.8	2.2	3	3	2.8	2.8	
Overall mapping of the Course with POs: 2.63								Overall mapping of the Course with PSO: 2.9				

COURSE TITLE: CLOUD COMPUTING AND DISTRIBUTED SYSTEMS

Course Code			
Credits	3		
Hours / Cycle	3		
Category	Part I	Core	Theory
Semester	I		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	● To familiarize students with current Cloud Computing practices prevalent in the IT industry. ● To provide a knowledge base on Cloud Technologies and Infrastructures currently used in the Industry. ● To provide insight into the Security Challenges faced in Cloud Computing and the Safeguards in place to counter them.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	List technologies that lead to Cloud Computing, Types of Virtualization, Cloud Challenges, Clouding Programming Models and security challenges.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the Cloud types, convergence of major technologies for Cloud Computing, Cloud Resources and Explain about Programming Models and Cloud Security.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply Resource Provisioning methods and Mapping applications.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Examine Cloud characteristics, SOA, SOAP, Cloud Infrastructure and Cloud Security.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Explain Cloud Architecture, CPU Virtualization and Map Reduce.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level

I	**Introduction and Architecture:** Scalable Computing: HPC, HTC, Degrees of Parallelism - Technologies for Network-Based System: CPU and GPU – Clustering For Massive Parallelism - Cloud Types : IaaS – PaaS - SaaS – Public - Private and Hybrid clouds – Characteristics of Cloud Computing - NIST Cloud Computing Reference Architecture.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Cloud Enabling Technologies:** REpresentational State Transfer (REST) – Basics of Virtualization - Types of Virtualization - Implementation Levels of Virtualization - Virtualization Structures - Tools and Mechanisms - Virtualization of CPU – Memory - I/O Devices - Desktop Virtualization – Server Virtualization.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Cloud Infrastructure:** Architectural Design of Compute and Storage Clouds - Layered Cloud Architecture Development – Design Challenges - Inter Cloud Resource Management – Resource Provisioning and Platform Deployment – Global Exchange of Cloud Resources.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Programming Model:** Parallel and Distributed Programming Paradigms – MapReduce , Twister and Iterative MapReduce – Hadoop Library from Apache – Mapping Applications - Programming Support - Google App Engine, Amazon AWS.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Cloud Security:** Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, *Distributed and Cloud Computing, From Parallel Processing to the Internet of Things*, Morgan Kaufmann Publishers, 2012.
2. John W.Rittinghouse and James F.Ransome, *Cloud Computing: Implementation, Management, and Security*, CRC Press, 2010.

References

1. Barrie Sosinsky, *Cloud Computing Bible*, Wiley India Pvt. Ltd, 2013.
2. Roger Jennings, *Cloud Computing with Windows Azure Platform*, Wiley India Pvt. Ltd, 2009.
3. Buyya R., Broberg J., Goscinski A., *Cloud Computing: Principles and Paradigm*, John Wiley, 2011.

Suggested Readings

1. James E. Smith, Ravi Nair, *Virtual Machines: Versatile Platforms for Systems and Processes*, Elsevier/Morgan Kaufmann, 2005.
2. Katarina Stanoevska-Slabeva, Thomas Wozniak, Santi Ristol, *Grid and Cloud Computing – A Business Perspective on Technology and Applications*, Springer.

Web Resources

1. https://aws.amazon.com/what-is-cloud-computing/
2. https://www.salesforce.com/products/platform/best-practices/cloud-computing/
3. https://www.simplilearn.com/tutorials/cloud-computing-tutorial

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO 5	PO 6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	3	2	2	3	2	3	2	2	2	K1
CO 2	3	3	3	2	2	3	2	3	2	3	2	K2
CO 3	3	3	3	2	2	3	2	3	2	3	3	K3
CO 4	3	3	3	2	2	3	2	3	2	3	3	K4
CO 5	3	3	3	2	2	3	2	3	2	3	3	K5
Wt. Avg.	3	3	3	2	2	3	2	3	2	2.8	2.6	
Overall mapping of the Course with POs: 2.57								Overall mapping of the Course with PSO: 2.6				

COURSE TITLE: DATA STRUCTURES AND ALGORITHMS LABORATORY

Course Code			
Credits	2		
Hours / Cycle	4		
Category	Part I	Core	Practical
Semester	I		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To impart and apply the knowledge gained about the concepts of data structures and algorithms. • To design, solve problems and analyze the data structures and algorithms learned. • To apply suitable data structures and algorithms for solving real-world applications.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember different types of data structures and algorithms	PSO1, PSO2, PSO3	K1
CO2	Understand the concepts of using data structures and algorithms for problem solving	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the appropriate data structures and algorithms for the given problems	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the various algorithms and choose the best with the appropriate data structures	PSO1, PSO2, PSO3. PSO4	K4

CO5	Evaluate the efficiency of the algorithms used and justify the chosen algorithm for the given problem	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Sorting** Bubble Sort and Insertion Sort Merge sort and Quick sort using Divide and Conquer Algorithm	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Stacks, Queues, Linked Lists** Stacks and Queues using arrays Unsorted and sorted Singly Linked List Doubly Linked List	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Trees** Binary Tree Traversal Binary Search Tree with traversing, insertion and deletion Red Black Tree with rotation, insertion and deletion B Trees with insertion and deletion of a key Heap construction and sorting	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Graphs** Graphs Traversal using BFS and DFS Minimum spanning tree using Kruskal's and Prim's algorithms Single source shortest path using Djkstra's algorithm All pair shortest path using Floyd-Warshall algorithm	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Dynamic programming:** 0/1 Knapsack problem Matrix Chain Multiplication **Greedy Technique** Factorial Knapsack problem Huffman Coding **Backtracking** n-queens problem	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Mark Allen Weiss, *Data Structures and Algorithms in C*, Second Edition, Pearson, 2006
2. A.V.Aho, J.E. Hopcroft and J.D.Ullman, *The Design and Analysis of Computer Algorithms*, Pearson, 2009
3. Kruse R.L, Leung B.P, Tondo C.L, *Data Structures and Program Design in C*, Second Edition, Pearson, 2014
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, *Introduction to Algorithms*, Fourth Edition, Prentice-Hall, 2022.

References

1. Robert Sedgewick and Kevin Wayne, *Algorithms*, Fourth Edition, Pearson Education, 2011

2. Ellis Horowitz, Sartaj Sahni, Sanguthuvar Rajasekaran, *Fundamentals of computer Algorithms*, Second Edition, 2008
3. S. Sridhar, *Design and Analysis of Algorithms*, Oxford University Press, 2014
4. Jean Paul Tremblay and Paul G. Soresson, *An introduction to Data structures with applications*, Second Edition, McGraw Hill, 2017
5. S.K.Basu, *Design Methods and Analysis of Algorithms*, Fourth edition, PHI, 2013
6. Anany Levitin, *Introduction to the Design and Analysis of Algorithm*, Third Edition Pearson Education Asia, 2011

Suggested Readings

1. Narasimha Karumanchi *"Data Structures and Algorithms Made Easy: Data Structure and Algorithmic Puzzles"*, CreateSpace Independent Publishing Platform, 2020
2. Allen Sherrod, *Data Structures and Algorithms for Game Developers (Game Development Series)*, Charles River Media, 2007

Web Resources

1. https://www.geeksforgeeks.org/advanced-data-structures/
2. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
3. https://www.studytonight.com/advanced-data-structures/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	2	-	3	-	2	3	2	2	-	K1
CO 2	3	3	3	2	3	2	3	3	2	2	2	K2
CO 3	3	3	3	2	3	2	3	3	3	2	2	K3
CO 4	3	3	3	2	3	2	3	3	3	3	3	K4
CO 5	3	3	3	2	3	2	3	3	3	3	3	K5
Wt. Avg.	3	3	2.8	2	3	2	2.8	3	2.6	2.4	2.5	
Overall Mapping of the Course with Pos – 2.66								Overall Mapping of the Course with PSOs – 2.63				

COURSE TITLE: OBJECT ORIENTED PROGRAMMING USING JAVA LABORATORY

Course Code			
Credits	2		
Hours / Cycle	4		
Category	Part I	Core	Practical
Semester	I		
Year of Implementation	From the academic year 2025-2026 batch onwards		
Course Objectives	• To learn the features in Java • To learn Object-based features in Java • To learn compile time and runtime polymorphism in Java • To use inheritance for reusability of code • To learn generic programming		

On completing the course successfully, the student will be able to			
CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
CO1	To remember the Java programming logic and syntax.	PSO1, PSO2, PSO3	K1
CO2	To understand Object-oriented Programming concepts to identify and create classes and objects for a given problem	PSO1, PSO2, PSO3, PSO4	K2
CO3	To Design and implement Java programs for a given problem	PSO1, PSO2, PSO3, PSO4	K3
CO4	To get the expertise on how to achieve reusability by using inheritance, polymorphism and generic programming and write programs	PSO1, PSO2, PSO3, PSO4	K4
CO5	To evaluate the output of a Java program and debug a Java program	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Java Control Statements :** if, else, nested if, if-else ladders, Switch, while, do-while, for, for-each, break, continue. Wrapper Class. **Classes and Objects:** constructor, constructor overloading, method overloading,	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Inheritance:** constructor in inheritance, method overriding, multilevel inheritance, multilevel constructors. Stop inheritance of method, stop inheritance of class. **Interface:** creation and implementation of an interface, interface reference, interface inheritance, interface and abstract class.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Array:** Single and Multidimensional Array **Strings:** String class, StringBuffer class, Operations on string, Command line argument. **Package:** use of package, classpath, import statement, static import, access control **I/O programming:** Byte Stream, Character stream, Readers and Writers, InputStreamReader, OutputStreamWriter, Buffered Reader.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

IV	**Exception Handling:** Built in Exception, Custom exception, Throwable Class. **Multithreaded Programming:** Thread class and Runnable interface, thread priority, thread synchronization, thread communication, deadlock.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Generic Programming:** Generic methods, generic classes. **Collection Classes:** List, AbstractList, ArrayList, LinkedList. **GUI Programming** – Graphics class, Swing components, forms using Swing, Layout Managers.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Herbert Schildt, Java: The Complete Reference, Twelfth Edition, McGraw Hill Education, 2022.

References

1. Paul Deitel and Harvey Deitel, Java: How to Program, Prentice Hall, Ninth Edition, 2017
2. James Gosling et al., The Java Language Specification, Java SE, Eigth Edition, Addison-Wesley, 2014.
3. Bruce Eckel, Thinking in Java, Prentice Hall, Fourth Edition, 2006
4. Allen B. Downey and Chris Mayfield, Think Java: How to Think Like a Computer Scientist, O'Reilly Media, 2016

Suggested Readings

1. Paul Deitel and Harvey M. Deitel, C++ How to Program, Tenth Edition, Pearson India Education Services Pvt. Ltd, 2017
2. Grady Booch et al., *Object-Oriented Analysis and Design with applications*, Third Edition, Pearson Education, 2008

Web Resources

1. https://docs.oracle.com/javase/specs/jls/se6/jls3.pdf
2. https://chenweixiang.github.io/docs/Thinking_in_Java_4th_Edition.pdf
3. https://dev.java/learn/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	2	2	3	2	2	3	2	1	1	K1
CO 2	3	3	2	2	3	2	3	3	2	2	1	K2
CO 3	3	3	2	2	3	2	3	3	3	2	1	K3
CO 4	3	3	2	2	3	2	3	3	3	2	3	K4
CO 5	3	3	2	2	3	2	3	3	3	3	3	K5
Wt. Avg.	3	3	2	2	3	2	2.8	3	2.6	2	1.8	
Overall mapping of the Course with PO: 2.54								Overall mapping of the Course with PSO: 2.35				

COURSE TITLE: ADVANCED DATABASE TECHNOLOGIES LABORATORY

Course Code			
Credits	2		
Hours / Cycle	4		
Category	Part I	Core	Practical
Semester	I		
Year of Implementation	From the Academic year 2025-26 batch onwards.		
Course Objectives	▪ To understand the concepts of DBMS. ▪ To familiarize with SQL queries. ▪ To write stored procedures in DBMS. ▪ To understand the concepts of NOSQL Database. • To learn front end tools to integrate with databases.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember basic SQL commands to create and Implement Databases and Table structure.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand CRUD operations and formulate simple queries using SQL.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Analyze SQL transactions and work with advanced programmatic SQL.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Design a NOSQL database, and perform CRUD operations	PSO1, PSO2, PSO3, PSO4	K4
CO5	Create and Implement applications that have GUI and access databases for backend connectivity.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**SQL Database:** Database Design and Integrity Constraints - SQL commands: Data Definition Language (DDL), Data Manipulation Language (DML), Transaction Control Language (TCL)	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**SQL Database:** SQL commands: Data Query Language (DQL) - Clauses and SQL operators – Aggregate Function - Data Control Language (DCL)	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

III	**SQL Database:** Join statements – Sub Queries – SQL Injection – Triggers – Case Study	14	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**NOSQL Database** MongoDB: Mongo: CRUD operations, Indexing, Sharding.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**XML Databases:** XML table creation, XQuery	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Petkovic, *Microsoft SQL Server 2008 A Beginner's Guide*, Tata McGraw Hill Edition,2008
2. Ying Bai, *SQL Server Database Programming with Visual Basic.NET: Concepts, Designs and Implementations*, First edition, Wiley IEEE Press, 2020
3. Guy Harrison, "Next Generation Databases, NoSQL, NewSQL and Big Data", First Edition, Apress publishers, 2015.

References

1. Itzik Ben-Gan, *Microsoft SQL Server 2008 T-Sql Fundamentals*, Microsoft Press, Indian Reprint 2009
2. Paul Nielsen, *Microsoft SQL Server 2008 Bible*, Wiley India, Reprint 2010.
3. Bill Sheldon, *Professional Visual Basic 2010 and .NET 4*, Wrox, Reprint 2010.

Suggested Readings

1. Bill Sheldon, Billy Hollis, Rob Windsor, David Mccarter, Gastón C. Hillar And Todd Herman, *Professional Visual Basic® 2012 And .Net 4.5 Programming*, Wiley, 2013.
2. Rod Stephens, *Visual Basic® 2012 Programmer's Reference*, Wiley, 2012.

Web Resources

1. https://learn.microsoft.com/en-us/troubleshoot/developer/dotnet/framework/general/open-database-by-sql-server-dotnet-data-provider
2. https://xn--webducation-dbb.com/wp-content/uploads/2020/06/Ying-Bai-SQL-Server-Database-Programming-With-Visual-Basic.NET_-Concepts-Designs-and-Implementations-IEEE-2020.pdf
3. https://www.mongodb.com/docs/manual/tutorial/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO 1	3	3	3	2	3	2	2	3	3	3	3	K1
CO 2	3	3	3	2	3	2	2	3	3	3	3	K2
CO 3	3	3	3	3	3	2	2	3	3	3	3	K3
CO4	3	3	3	3	3	2	2	3	3	3	3	K4
CO5	3	3	3	3	3	2	2	3	3	3	3	K5
Wt. Avg.	3	3	3	2.6	3	2	2	3	3	3	3	
Overall mapping of the Course with POs: 2.66								Overall mapping of the Course with PSO: 3.0				

COURSE TITLE: ARTIFICIAL INTELLIGENCE

Course Code			
Credits	4		
Hours / Cycle	4		
Category	Part 1	Core	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To understand the fundamentals of computational intelligence • To understand the various characteristics of Intelligent agents • To learn about the different search strategies in AI • To know about the various knowledge representation methods in solving AI problems • To understand the features of neural network and its implementation To know about the various applications of AI.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	To learn about AI basics, agents, search algorithms, knowledge representation, learning and AI Applications	PSO1, PSO2, PSO3, PSO4	K1
CO2	To understand about agents, search algorithms, knowledge representation, learning and AI Applications	PSO1, PSO2, PSO3, PSO4	K2
CO3	To apply different search algorithms for AI problems, apply appropriate representation of knowledge and to apply approximate reasoning	PSO1, PSO2, PSO3, PSO4	K3
CO4	To analyze the selection of appropriate search algorithm for any AI problem, to identify a representation of AI knowledge, to identify correct learning methods	PSO1, PSO2, PSO3, PSO4	K4
CO5	To evaluate the different search algorithms, knowledge representation and learning techniques for finding a solution to a problem	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Artificial Intelligence and Intelligent Agents** Introduction: Approaches to AI - Foundations of AI – Applications of AI. Intelligent agents: Agents and	12	CO1, CO2, CO3, CO4,	K1, K2, K3, K4, K5

	environments – Nature of environments: Specifying the PEAS description of the task environment, Properties of task environment. Structure of agents – Agent programs – Basic types of Agent programs: Simple reflex agents, Model-based reflex agents, Goal-based agents, Utility-based agents.		CO5	
II	**Problem-solving by Searching** Problem-solving agents: Well-defined problems and solutions, Formulating problems. Searching for solutions - Uninformed search strategies: Breadth-first search, Depth-first search, Iterative deepening depth-first search, Bidirectional search. Informed search strategies: Greedy best-first search, A* Algorithm. Adversarial search: Games - Optimal Decisions in Games – MiniMax algorithm - Alpha-Beta Pruning.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Knowledge and Reasoning** Knowledge-based agents - Propositional logic - Agents based on propositional logic - propositional inference. First order (Predicate) logic – Unification and Lifting - Inference in First order logic - Forward Chaining - Backward Chaining - Resolution. Expert System. Knowledge representation: Categories and objects – Reasoning systems for categories - Reasoning with default information	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Machine Learning** Learning - Learning Agents - Forms of Learning – Unsupervised learning – Clustering using K-Means. Supervised Learning – Learning Decision Trees – Artificial Neural Networks. Knowledge in Learning: A Logical Formulation of Learning – Explanation-Based Learning – Inductive Logic Programming. Learning with hidden variables –Reinforcement learning – Passive Reinforcement Learning – Active Reinforcement Learning.	14	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**AI Applications** Text Classification – AI Chatbots – ChatGPT - Machine Translation – Speech Recognition – Object Recognition – Robotics - GenerativeAI	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Stuart J. Russell and Peter Norvig, *Artificial Intelligence A Modern Approach*, Fourth Edition, Pearson Education, Inc., 2020

References

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair, *Artificial Intelligence*, Third Edition, Tata McGraw-Hill Publishing Company Limited, 2009.
2. David Pool, Alan Mackworth, *Artificial Intelligence: Foundations of Computational agents*, Cambridge University, 2011.
3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2013.
4. Nils J.Nilsson, *The Quest for Artificial Intelligence: A History of Ideas and achievements*, Cambridge University Press, 2010.

Suggested Readings

1. https://openai.com/
2. https://openai.com/blog/chatgpt

Web Resources

1. https://nptel.ac.in/courses/106105077
2. https://openai.com/blog/chatgpt
3. https://in.coursera.org/learn/practical-python-for-ai-coding-2
4. https://in.coursera.org/learn/python-machine-learning

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO 1	3	3	3	3	3	3	3	3	3	3	2	K1
CO 2	3	3	3	3	3	3	3	3	3	3	2	K2
CO 3	3	3	3	3	3	3	3	3	3	3	2	K3
CO 4	3	3	3	3	3	3	3	3	3	3	2	K4
CO 5	3	3	3	3	3	3	3	3	3	3	2	K5
Wt. Avg.	3	3	3	3	3	3	3	3	3	3	2	
Overall mapping of the Course with PO: 3								Overall mapping of the Course with PSO: 2.75				

COURSE TITLE: ADVANCED SOFTWARE ENGINEERING

Course Code			
Credits	3		
Hours / Cycle	4		
Category	Part I	Core	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		

Course Objectives	• To understand the advanced methods and models of software development and its application to real world context • To understand software requirements modeling and designing complex software solutions • To acquire sound knowledge on system dependability and security • To understand advanced SE concepts like Software Reuse, Component-based SE, Distributed SE and Service Engineering • To gain knowledge on advanced software testing techniques

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the basic concepts of SE, Modeling, and Design.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the advanced concepts of SE, Agile development and advanced testing methods	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the advanced methods, models. designs and testing of software development to real time problems	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the various advanced methods and designs of SE	PSO1, PSO2, PSO3, PSO4	K4
CO5	Develop a coordinated series of activities and tasks to create a software product or solution.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Software Process, Requirements Engineering and Modeling** Prescriptive Process Models – Agility and Process: Agile methods, Agile development, XP, Scrum – Requirement Elicitation and Specification – Modeling: Context, Interaction and Structure models, Scenario-based Modeling – Class-based Modeling – Functional Modeling – Behavioral Modeling	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Software Design** Design Concepts, Software Architecture: Styles, Design and Patterns – Component-Level Design – User Experience Design – Design for Mobility – Pattern Based Design: Singleton, Factory, Strategy, Observer, Builder, Adapter and State	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

III	**System Dependability and Security** Dependable and complex Systems – Dependability Properties – Availability and Reliability – Dependability and Security Specification: Risk-driven requirements specification, Safety, Reliability, and Formal specification - Sociotechnical Systems – Dependability Engineering: Redundancy and diversity, Dependable processes, Dependable system architectures, Dependable programming – Security Engineering: Security risk management - Design for security - System survivability Formal Methods and Dependability – Fault-tolerant Architectures	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Software Reuse, Component-based Software Engineering and Distributed Software Engineering** Software reuse: Reuse landscape, Application frameworks, Software product lines, COTS product reuse - Component-based Software Engineering: Components and component models - CBSE processes - Component composition - Distributed Software Engineering: Distributed systems issues - Client–server computing - Architectural patterns for distributed systems	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Service Engineering and Software Testing** Service Engineering: service candidate identification, service interface design, service implementation and deployment, legacy system service - Software development with services Software Testing: Software Review, Testing Strategies - Testing Conventional Applications, Testing Object- Oriented Applications, Reliability and Security testing,- Testing Web Applications, Formal Modeling and verification, Metrics: Product, process, project, testing and quality metrics, Software Test Automation	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Software Engineering: A Practitioner's Approach, 9th Edition. Roger Pressman and Bruce Maxim, McGraw-Hill 2019.
2. Software Engineering, 10th Edition, Ian Somerville, Pearson Education Asia 2016.

References

1. Software Architecture In Practice, 3rd Edition, Len Bass, Paul Clements and Rick Kazman, Pearson India 2018
2. An integrated approach to Software Engineering, 3rd Edition, Pankaj Jalote, Narosa Publishing House, 2018
3. Fundamentals of Software Engineering, 5th Edition, Rajib Mall, PHI Learning Private Ltd, 2018

Suggested Readings

1. Thomas B. Hilburn, Massood Towhidnejad, *Software Engineering Practice: A Case Study Approach*, Chapman & Hall, Crc, 2020
2. Kshirasagar Naik and Priyadarshi Tripathy, *Software Testing and Quality Assurance Theory and Practice*, 2nd Edition, John Wiley & Sons Publication, 2011

Web Resources

1. https://www.tpointtech.com/advanced-software-engineering-books
2. https://www.cse.msu.edu/~cse870/IEEEXplore-SRS-template.pdf
3. https://www.cse.msu.edu/~cse870/Materials/GoalModeling/KaosTutorial-2007.pdf
4. https://www.cse.msu.edu/~cse870/Materials/main-tech-report-security-patterns.pdf
5. http://agilemanifesto.org/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO 1	3	2	2	3	2	2	2	3	2	2	1	K1
CO 2	3	2	3	3	3	2	3	3	2	2	2	K2
CO 3	3	3	3	2	3	3	3	3	3	3	3	K3
CO 4	3	3	3	2	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.6	2.8	2.6	2.8	2.6	2.8	3	2.6	2.6	2.4	
Overall mapping of the Course with POs: 2.74								Overall mapping of the Course with PSOs: 2.65				

COURSE TITLE: FULL STACK WEB DEVELOPMENT

Course Code			
Credits	4		
Hours / Cycle	4		
Category	Part I	Core	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	▪ To understand and practice markup languages ▪ To learn and practice embedded dynamic scripting on client side Internet Programming • To understand and practice web development techniques on Server and client-side.		

On completing the course successfully, the student will be able to			
CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
CO1	Remember the basic syntax and write the HTML tags and Cascading Style Sheets.	PSO1, PSO2, PSO3, PSO4	K1, K2, K3, K4, K5
CO2	To extend the web page capabilities by embedding JavaScript and validating the web form.	PSO1, PSO2, PSO3, PSO4	K1, K2, K3, K4, K5
CO3	To build and practice server side Programming skills using NODE.JS and the Express framework.	PSO1, PSO2, PSO3, PSO4	K1, K2, K3, K4, K5
CO4	To examine the SQL and NOSQL database operations from NODE.JS .	PSO1, PSO2, PSO3, PSO4	K1, K2, K3, K4, K5
CO5	Build Advanced Client Side Programming forms with React JS.	PSO1, PSO2, PSO3, PSO4	K1, K2, K3, K4, K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**HTML5 & CSS:** Advanced HTML5 tags - HTML Form Controls – HTML Form Validation - Basic syntax and structure Inline Styles – Embedding Style Sheets - Linking External Style Sheets - Introduction to CSS3 – Backgrounds - Manipulating text - Margins and Padding - Positioning using CSS.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**JavaScript**: Embedding JavaScript in HTML - JavaScript Variables, Operators and Statements – Working with Strings and Arrays - JavaScript Dialog boxes – JavaScript Event handling - Form processing using JavaScript: Form Validation – JavaScript's RegExp object.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Server Side Programming with NODE JS:** Node.js Overview: Node.js - Basics and Setup – Node.js Console -Node.js Command Utilities – Node.js Modules -Node.js Concepts – Node.js Events - Node.js with Express.js - Node.js Database Access	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Advanced Client Side Programming**: React JS - ReactDOM - JSX – React Components – State and Lifecycle - Props – Events - Conditionals - React forms	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

V	**Working with NoSQL database**: MongoDB system overview - Basic querying with MongoDB shell – Request body parsing in Express – NodeJS MongoDB connection – Adding and retrieving data to MongoDB from NodeJS – Handling SQL databases from NodeJS	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. James Jaworski, *Mastering JavaScript*, First Edition, BPB Publications, 1999.
2. Steven Holzner, *PHP: The Complete Reference*, Tata McGraw Hill, 2017.
3. Marc Wandschneider, "*Learning Node*", Addison-Wesley Professional, 2nd Edition, 2016.

References

1. David Flanagan, "*Java Script: The Definitive Guide*", O'Reilly Media, Inc, 7th Edition, 2020.
2. Matt Frisbie, "*Professional JavaScript for Web Developers*", Wiley Publishing, Inc, 4th Edition, ISBN: 978-1-119-36656-0, 2019.
3. Alex Banks, Eve Porcello, "*Learning React*", O'Reilly Media, Inc, 2nd Edition, 2020.

Suggested Readings

1. Thomas A. Powell, *HTML & CSS: The Complete Reference*, 5th Edition, McGraw Hill, 2010.
2. David Sawyer McFarland, *JavaScript & jQuery: The Missing Manual*, Second Edition, O'Reilly, 2012.

Web Resources

1. https://condor.depaul.edu/sjost/hci430/web-examples.htm
2. https://www.cloudways.com/blog/connect-mysql-with-php/
3. https://nodejs.org/en/learn/getting-started/introduction-to-nodejs

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO 1	3	3	2	2	3	2	2	3	3	2	2	K1
CO 2	3	3	2	2	3	2	2	3	3	2	2	K2
CO 3	3	3	3	2	3	2	2	3	3	2	2	K3
CO 4	3	3	2	2	3	2	2	2	2	2	2	K4
CO 5	3	3	2	2	3	3	2	3	3	2	2	, K5
Wt. Avg.	3	3	2.2	2	3	2.2	2	2.8	2.8	2	2	
Overall mapping of the Course with POs: 2.49								Overall mapping of the Course with PSO: 2.4				

COURSE TITLE: ADVANCED JAVA PROGRAMMING LABORATORY

Course Code			
Credits	2		
Hours / Cycle	3		
Category	Part I	Core	Practical
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To install and configure Eclipse IDE and Tomcat Server • To develop dynamic web applications using Servlet and JSP. • Learn to access the MYSQL database using JDBC. • Understand and learn to map Java classes and object associations with relational database tables using Hibernate. • To create MVC web applications using Spring frameworks		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember and learn the fundamentals of server-side programming servlet, JSP, Hibernate and Spring.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the fundamentals to develop dynamic web applications using Servlet and JSP and learn MYSQL database connections, Hibernate and Spring.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply fundamentals of web programming concepts to develop web applications using Servlet, JSP and Spring and implement the Hibernate framework by mapping Java applications with the database.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the major components of web development for solving real-time problems using Java frameworks.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the significance of web development and build a MVC-based web application.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Runtime Environment** ● Setting up the Runtime Environment for creating and deploying Servlet and JSP using Eclipse IDE and Tomcat Server. ● Spring Environment Setup	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Servlet** ● Basic Servlet Programming ● HTML to Servlet Applications ● Session Management and Implementation of Cookies using Servlet ● Developing a web application with MySQL Database using Servlet	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**JSP** ● Basic JSP Programming- JSP Scripting elements, Directives and Actions. ● Designing web applications with JSP – Form Processing and database access.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**JDBC with Servlet and JSP:** Implementation of any Information System using JDBC and MySQL **Spring:** Develop Spring MVC application - form validation, file upload, and session tracking.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Spring Boot:** Implement a RESTful Spring Boot application using Spring REST	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Herbert Schildt , *Java The Complete Reference*, Eleventh Edition, McGraw Hill, 2018.
2. Budi Kurniawan, *Servlet & JSP: A Tutorial*, Second Edition, Brainy Software, 2015.
3. Gary Gregory, Christian Bauer, *Java Persistence with Hibernate*, Manning, 2015.

References

1. LulianaCosmina, Rob Harrop, Chris Schaefer, Clarence Ho, *Pro Spring 5: An In-Depth Guide to the Spring Framework and Its Tools*, Apress, Fifth edition 2017.
2. Paul Deitel and Harvey Deitel, *Java How to Program*, Ninth Edition, Prentice Hal, 2012.
3. Byyan Basham, Kathy Sierra, Bert Bates, *Head First Servlets and JSP*, Second Edition, O'Reilly Media Incorporated, 2008.

Suggested Readings

1. Larne Pekowsky, *JavaServer Pages*, Second Edition, Pearson Education, 2008.
2. David R. Heffelfinger, *Java EE 8 Application Development*, Packt Publishing, First edition, 2017.

Web Resources

1. www.javatpoint.com/jsp-tutorial
2. www.javatpoint.com/servlet-tutorial
3. www.tutorialspoint.com/hibernate/hibernate_query_language.htm
4. www.javatpoint.com/spring-tutorial
5. www.tutorialspoint.com/spring/index.htm

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	2	2	3	2	1	2	2	2	2	K1
CO 2	3	3	2	2	3	2	3	3	3	3	3	K2
CO 3	3	3	2	2	3	3	3	3	3	3	3	K3
CO 4	3	3	2	2	3	3	3	3	3	3	3	K4
CO 5	3	3	2	2	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	2	2	3	2.6	2.6	2.8	2.8	2.8	2.8	
Overall Mapping of the Course with POs – 2.6								Overall Mapping of the Course with PSOs – 2.8				

COURSE TITLE: MOBILE APPLICATION DEVELOPMENT LABORATORY

Course Code			
Credits	2		
Hours / Cycle	4		
Category	Part I	Core	Practical
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To install and configure an Android application runtime environment using Eclipse IDE. • Learn how to develop Android applications using Android Widgets. • To develop a Multimedia, SMS, Phone Call and Location Based Android application. • To develop Android database applications using SQLite. • To develop and deploy applications for mobile cross-platforms using Flutter		

On completing the course successfully, the students will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember fundamental syntax and semantics required to write an android and flutter program. Learn to install and	PSO1, PSO2, PSO3, PSO4	K1

	configure Android and Flutter development environment.		
CO2	Demonstrate Android and Flutter development environment and understand how to write programs using widgets and layouts.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Build mobile UI design by using various Android and Flutter widgets, Event Handling, and SQLite database connection.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the major components of mobile APIs for solving real-time problems using Android UI toolkits and frameworks and Flutter.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the significance of Android and Flutter applications.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Runtime Environment** ● Android Development Environment-Eclipse IDE and Emulator ● Building a simple Android application using Eclipse ● Flutter Development Environment **User Interface Design** ● Applications using GUI components-Activities ● Styles and Themes	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**UI and Layout** ● Intents:Linking Activities using Intents ● Layout Managers ● Views- ListView, Spinner View, ImageView and GridView	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Event Handling and Database Applications** ● Event Handling ● Data retrieval applications using SQLite	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Application Development** ● Multimedia application ● Service ● JSON Communication	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

V	**Application Development** ● Telephony - SMS, Phone Call ● Notification ● Location based applications ● Case Study: To develop and deploy applications for mobile cross-platforms using Flutter	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Reto Meier, Ian Lake, *Professional Android*, 4th Edition, Wrox, 2018.
2. John Horton, *Android Programming for Beginners*, Second Edition, Packt, 2018.
3. Marco L. Napoli, *Beginning Flutter A Hands On Guide to App Development*,Wiley,2019

References

1. Wei-Meng Lee, *Beginning Android 4 Application Development*, Wiley, 2012.
2. Onur Cinar, *Android Apps with Eclipse*, Apress, Springer, 2012.
3. Zigurd Mednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura, *Programming Android*, O'Reilly, 2nd Edition, 2012.

Suggested Readings

1. Bill Phillips, Chris Stewart, Brian Hardy, and Kristin Marsicano, A*ndroid Programming: The Big Nerd Ranch Guide*, 4th edition, 2019.
2. Rap Payne, *Beginning App Development with Flutter: Create Cross-Platform Mobile Apps*, APress, 2019.

Web Resources

1. developer.android.com/training/basics/firstapp/index.html
2. www.tutorialspoint.com/android/index.htm
3. www.javatpoint.com/android-tutorial
4. www.vogella.com/articles/Android/article.html

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO 1	3	3	2	2	3	3	3	2	2	2	2	K1
CO 2	3	3	2	2	3	3	3	2	3	2	2	K2
CO 3	3	3	2	2	3	3	3	3	3	2	3	K3
CO 4	3	3	2	2	3	3	3	3	3	3	3	K4
CO 5	3	3	2	2	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	2	2	3	3	3	2.6	2.8	2.4	2.6	
Overall mapping of the Course with POs - 2.7								Overall mapping of the Course with PSOs - 2.6				

COURSE TITLE: FULL STACK WEB DEVELOPMENT LABORATORY

Course Code	
Credits	2
Hours / Cycle	3

Category	Part I	Core	Practical
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• Try and develop the most important technologies that are being used today by web • developers to build a wide variety of web applications. • To build web applications using proven developer tools and message formats. • To understand and practice web development techniques on both Server and client-side. • Web applications using technologies such as HTML, Javascript, NODE.JS, React.js and MySQL		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember HTML5 form tags, CSS3 syntax and SQL syntax.	PSO1, PSO2, PSO3	K1
CO2	Understand about web forms using HTML and CSS, Form Validation, working with NODE.JS	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply HTML and CSS techniques in web forms, HTML and JavaScript validation for form data and store data using NODE.JS.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Test the input data for numeric, string etc., Add data into a MongoDB database from NODE.JS.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Construct applications using React.js. The information is stored in MongoDB.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**HTML5** 1. Create a basic web form using HTML and Cascading Style Sheets. 2. Use HTML Form controls. **CSS3** 3. Add Styles using CSS 3 Properties. 4. Add External, Internal and Inline CSS styles to know the priority. 5. Add CSS3 Animation to your profile.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

II	**Form Validation** 1. HTML Validation **JavaScript** 2. Embedding JavaScript in HTML 3. JavaScript Validations	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**NodeJS Basics** 1. Create a NodeJS server that serves static HTML and CSS files to the user without using Express. 2. Create a NodeJS server using Express that stores data from a form as a file and displays it in another page.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Implement a SPA using React	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Develop a web application using NodeJS and Express	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. James Jaworski, *Mastering JavaScript*, First Edition, BPB Publications, 1999
2. Steceb Holzner, *PHP*: *The Complete Reference*, Tata McGraw Hill, 2007
3. Robin Nixon, *Learning PHP, MySQL, JavaScript, and CSS*, Second Edition, O'Reilly Media, Inc., 2012.

References

1. Peter Lubbers, Brian Albers, Frank Salim, *Pro HTML5 Programming*, APRESS, 2010.
2. Thomas A.Powell and Fritz Schneider, *JavaScript: The Complete Reference*, Tata McGraw Hill, 2002.
3. Marc Wandschneider, "*Learning Node*", Addison-Wesley Professional, 2nd Edition, 2016.

Suggested Readings

1. Thomas A. Powell, *HTML & CSS: The Complete Reference*, Fifth Edition, McGraw Hill, 2010.
2. David Sawyer McFarland, *JavaScript & jQuery: The Missing Manual*, Second Edition, O'Reilly, 2012

Web Resources

1. https://condor.depaul.edu/sjost/hci430/web-examples.htm
2. https://www.tutorialrepublic.com/html-tutorial/
3. https://nodejs.org/en/learn/getting-started/introduction-to-nodejs

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	2	2	3	3	2	3	3	3	-	K1

CO 2	3	3	2	2	3	3	2	3	3	3	2	K2
CO 3	3	3	2	2	3	3	2	3	3	3	2	K3
CO 4	3	3	2	2	3	3	2	3	3	3	2	K4
CO 5	3	3	2	2	3	3	2	3	3	3	2	K5
Wt. Avg.	3	3	2	2	3	3	2	3	3	3	1.6	
Overall mapping of the Course with POs: 2.57							Overall mapping of the Course with PSO: 2.65					

COURSE TITLE: DATA ANALYTICS AND VISUALIZATION

Course Code			
Credits	4		
Hours / Cycle	4		
Category	Part I	Core	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To apply statistical analysis and technologies to data to find trends and solve problems. • To extract information from data, the process of data analysis employs analytical and logical reasoning. • To enable students to have skills that will help them to solve complex real-world problems		

On completing the course successfully, the students will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the fundamental concepts of data analytics and visualization.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the basics of data, data analytics types and tools, data wrangling, data analysis techniques, and data visualization tools.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply analytical techniques, mathematical and statistical models, machine learning algorithms, the principles of optimization and visualization tools to solve real-time data analytics problems more sensibly and effectively.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the need for data processing, visualization techniques and propose solutions.	PSO1, PSO2, PSO3, PSO4	K4

CO5	Build and evaluate machine learning models and use them for prediction and decision to have a complete business data analytics solution. Evaluate information visualization systems and other forms of visual presentation for their effectiveness	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Data Definitions and Analysis Techniques:** Elements, Variables, Data categorization, Data Types, Measure of central tendency, Measures of Dispersion, Data analytics overview, Process of Data Analytics, Types of Data Analytics: Descriptive Analytics, Diagnostics Analytics, Predictive Analytics, and Prescriptive Analytics, Benefits of Data Analytics, Data Visualization for Decision Making.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Data Wrangling:** Handling Missing Data- Data Transformation- String Manipulation, Join, Combine, and Reshape: Hierarchical Indexing Combining and Merging Datasets Reshaping and Pivoting.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Basics of Data Analytics** Introduction to statistical learning and Python Programming, Descriptive Statistics – Mean, Standard Deviation, Skewness, and Kurtosis, BoxPlot – Data reduction techniques - Hypothesis testing – Statistical Tests: Chi-Square test, t-Test, Analysis of variance	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Data analysis techniques** Correlation analysis,Regression analysis-**Evaluation:** Normalization - Cross-validation techniques - Overfitting – Underfitting and Model Selection Prediction and Decision Making- Accuracy metrics for evaluation of models –ROC curve, Precision-recall curves - A/B testing	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Data Visualization** Charts and Graphs, Maps, Dashboard- Inbuilt visuals, Custom visuals, Various visualization techniques, data structures used in data visualization-Visualization Tools: POWER BI ,TABLEAU and Excel AI	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Paul Kinley, *Data Analytics for Beginners: Basic Guide to Master Data Analytics*, CreateSpace Independent Publishing Platform, 2016
2. Dr. Anil Maheshwari, *Data Analytics Made Accessible*, McGraw Hill Education, Kindle Edition, 2023
3. Ward, Grinstein, Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick, 2nd edition,A K Peters, Ltd 2015.
4. Claus Wilke, *Fundamentals of Data Visualization A Primer on Making Informative and Compelling Figures*, O'Reilly Media, 2019

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1. Chirag Shah, *A Hands-on Introduction to Data Science*, Cambridge University Press, UK, 2020
2. Rafael A. Irizarry, *Introduction to Data Science*, Chapman & Hall, 2022
3. Grus, Joel, *Data science from scratch: first principles with python*, O'Reilly Media,2019.
4. Scott Murray,Interactive Data Visualization for the Web ,2nd Edition, 2017

Suggested Readings

1. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly, 2015.
2. Al-Sakib Khan Pathan, Mohiuddin Ahmed, *Data Analytics Concepts, Techniques, and Applications*,CRC Press,2018

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1. www.tutorialspoint.com/excel_data_analysis/data_analysis_overview.htm
2. www.datacamp.com/tutorial/data-visualisation-powerbi
3. https://help.tableau.com/current/pro/desktop/en-us/getstarted_buildmanual_ex1basic.htm
4. www.geeksforgeeks.org/tableau-tutorial/
5. https://www.datacamp.com/tutorial/visualizing-data-in-excel

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	2	2	2	2	2	2	2	2	2	K1
CO 2	3	3	2	2	2	2	2	2	2	2	2	K2
CO 3	3	3	3	2	3	3	3	3	3	3	3	K3
CO4	3	3	3	3	3	3	3	3	3	3	3	K4
CO5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.8	2.6	2.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	
Overall mapping of the Course with POs - 2.65								Overall mapping of the Course with PSOs- 2.6				

COURSE TITLE: INTERNET OF THINGS AND ROBOTICS

Course Code			
Credits	3		
Hours / Cycle	4		
Category	Part I	Core	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	● To familiarize students with the various protocols and standardization of IoT. ● To provide a knowledge about the need of IoT, CoT and WoT. ● To understand the role of IoT in user defined applications		

On completing the course successfully, the student will be able to			
CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
CO1	To remember the importance of Internet of Things and its need	PSO1, PSO2, PSO3, PSO4	K1
CO2	To understand the impact of IoT in smart devices.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Build knowledge in IoT devices, Sensors and adapt to IoT environment.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the key technologies that help in the development of cloud operations.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Develop applications using Arduino and Raspberry Pi	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Introduction:** Architecture – Four Pillars of IoT – DNA of IoT - Middleware for IoT: Overview – M2M and WSN Protocols – SCADA and RFID Protocols	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**IOT Protocols:**– BACNet Protocol – Modbus – KNX – Zigbee Architecture **Web of Things:** Web of Things versus Internet of Things – Two Pillars of the Web – WoT Portals and Business Intelligence	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Applications:** Technologies for IOT: RFID, Sensor Networks, GPS, Arduino Uno and Raspberry PI – Smart Grid	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Robot Basics:** Definition – Need – Laws of Robotics - Components - Robotic Joints – Classifications of Robots: cartesian, cylinder, polar and articulate - Robot wrist mechanism - Precision and accuracy of robot – Robot Accidents and Safety.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Robot Sensors:** Sensors in robot – Touch sensors - Proximity Sensor - range sensors - Force sensor – Light Sensors - Pressure sensors - Introduction to Machine Vision and Artificial Intelligence.	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Honbo Zhou, *The Internet of Things in the Cloud: A Middleware Perspective*, CRC Press, 2012
2. Dieter Uckelmann; Mark Harrison; Florian Michahelles-(Eds.), *Architecting the Internet of Things*, Springer, 2011
3. Olivier Hersent, Omar Elloumi and David Boswarthick *The Internet of Things: Applications to the Smart Grid and Building Automation*, Wiley, 2012
4. Jean-Philippe, *Interconnecting Smart Objects with IP: The Next Internet*, Vasseur, Adam Dunkels, Morgan Kuffmann, 2010.

References

1. Vijay Madisetti , Arshdeep, *Internet of Things (A Hands-on-Approach)*, Bahga-2014.
2. Adrian McEwen , *Designing the Internet of Things*, Hakim Cassimally-2013.
3. Jeeva Jose, *Internet of Things*, First Edition, Khanna publisher, 2018.

Suggested Readings

1. Olivier Hersent, David Boswarthick, Omar Elloumi , *The Internet of Things – Key applications and Protocols*, Wiley, 2012
2. An Introduction to Programming the Internet of Things (IOT) | Coursera

Web Resources

1. What is the Internet of Things, and how does it work? (ibm.com)
2. IoT Tutorial | Internet of Things Tutorial - Javatpoint
3. https://standardbots.com/blog/every-type-of-sensors-in-robotics---explained?srsltid=AfmBOopJCLiLNPJWn-Zj3zolvq5bt6t1dwxbXyC09vnzB0CC9m-qU-bR

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	2	2	2	2	2	3	3	3	2	K1
CO 2	3	3	3	2	3	3	2	3	3	3	3	K2
CO 3	3	3	3	2	3	3	2	3	3	3	3	K3
CO 4	3	3	3	2	3	3	3	3	3	3	3	K4
CO 5	3	2	3	2	3	3	3	3	3	2	2	K5
Wt. Avg.	3	2.6	2.8	2	2.8	2.8	2.4	3	3	2.8	2.8	
Overall mapping of the Course with POs: 2.63								Overall mapping of the Course with PSO: 2.9				

COURSE TITLE: DEEP LEARNING

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Core	Theory
Semester	III		

Year of Implementation	From the academic year 2025-2026 batch onwards
Course Objectives	• To understand the basics of deep learning fundamentals from scratch • To learn the deep learning networks such as CNN and RNN • To understand deep reinforcement learning and create models • To be capable of developing applications with TensorFlow for real-world data

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO 1	Remember the fundamental concepts of Deep Learning and learning networks	PSO1, PSO2, PSO3, PSO4	K1
CO 2	Understand the basic concepts of CNN, RNN, Reinforcement Learning and libraries used for Deep Learning in Python	PSO1, PSO2, PSO3, PSO4	K2
CO 3	Apply CNN to create models for object detection, RNN for text analysis and auto encoder/decoder for Deep RL models	PSO1, PSO2, PSO3, PSO4	K3
CO 4	Analyse the various learning networks for the real-time problems and choose the best one	PSO1, PSO2, PSO3, PSO4	K4
CO 5	Develop research-based applications using deep learning techniques and TensorFlow	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Fundamentals of Deep Learning:** McCulloch Pitts Neuron: OR and AND Gate implementation, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent (GD):, Momentum Based GD, Optimizers: Adagrad, AdaDelta,, Adam - learning rate schedulers - Batch Normalization	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

II	**Convolutional Neural Networks (CNN)**: Architecture - Convolutions - Pooling Layers – Transfer Learning - Feature Selection and Feature Maps - Leveraging Convolutional Filters to Replicate Artistic Styles - Learning Convolutional Filters for Other Problem Domains - Architecture and application of LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Recurrent Neural Network:** RNN - Sequence modelling - RNN as graphical models - Modeling Sequence - Bidirectional RNN - LSTM, GRU, Encoder/Decoder Architectures – Autoencoders: Standard - Sparse – Denoising – Contractive	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Deep Reinforcement Learning** Reinforcement Learning - Explore Versus Exploit - Policy versus Value Learning - Pole-Cart with Policy Gradients-Q-Learning and Deep Q-Networks - DQN - Deep Boltzmann Machine - Deep belief networks - Capsule Networks	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**TensorFlow:** TensorFlow - tf variables and model checkpoints - Tensor Flow Operations - Placeholders - Tensors - Sessions - -Logging and Training the Logistic Regression. **Case studies** Developing CNN, other transfer learning models and Autoencoder/decoder model for object detection in images - Text analysis – Creating Logistic Regression Model using Tensor Flow	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Textbooks

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville,. *Deep Learning*, MIT Press. 2016.
2. Charu C. Aggarwal, *Neural Networks and Deep Learning: A Textbook*, Springer, 2019

References

1. Nikhil Buduma, Nicholas Locascio, *Fundamentals of Deep Learning: Designing Next Generation Machine Intelligence Algorithms*, O'Reilly Media, 2017
2. Andrew Glassner, *Deep Learning: A Visual Approach*, No Starch Press, San Francisco, 2021.
3. Jon Krohn, *Deep Learning Illustrated, A Visual and Interactive Guide to Artificial Intelligence*, Pearson Education, 2020.
4. Eugene Charniak, *Introduction to Deep Learning*, MIT Press, 2018
5. Francois Chollet, *Deep Learning with Python*, Manning Publications, 2018.
6. Mohamed Elgendy, *Deep learning for Vision Systems*, Manning Publications, O' Reilly, 2020

Suggested Reading

1. Silaparasetty, *Deep Learning Projects Using Tensorflow 2*, APress, 2020
2. Josh Patterson, Adam Gibson, *Deep Learning A Practitioner's Approach*, O'Reilly, 2017

Web Resource

1. http://www.deeplearningbook.org/
2. https://machinelearningmastery.com/what-is-deep-learning/
3. http://neuralnetworksanddeeplearning.com/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	3	1	3	1	3	3	3	2	2	K1
CO 2	3	3	3	2	3	2	3	3	3	2	2	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	3	2.4	3	2.4	3	3	3	2.6	2.6	
Overall mapping of the Course with POs: 2.83								Overall mapping of the Course with PSO: 2.8				

COURSE TITLE: VIRTUAL AND AUGMENTED REALITY LABORATORY

Course Code			
Credits	2		
Hours / Cycle	3		
Category	Part I	Core	Practical
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To understand the concepts of Virtual and Augmented Reality • To have a hands-on experience in transformations of objects in the virtual world, visual perception and rendering and motion tracking • To set up a virtual environment using Unity • To create interactive VR and AR applications with dynamically changing scenes		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the basic concepts of a VR system and creating an AR experience	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the concepts in VR such as transformations of objects in the virtual world, visual perception and rendering and motion tracking and AR concepts such as	PSO1, PSO2, PSO3, PSO4	K2

	marker-based approach in AR and AR components		
CO3	Apply all the VR concepts in a virtual environment set up by Unity and AR concepts in creating an AR experience	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyse the scenes created by VR and AR and improvise the design and development	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the VR and AR applications developed to get highly immersive experiences.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Representing the Virtual World** Understanding the key elements of a Virtual Reality Experience - VR System - Interface to the virtual world - Aural and haptic displays and their representation in VR – Hardware: sensors, displays – Software: virtual world generator, game engines **Geometry of Virtual Worlds and Physiology of Human Vision** Changing position and orientation of objects - Axis-angle representations of rotation - Viewing transformations - Chaining the transformations - Human eye movements and implications for VR. ***Exercise 1:*** Set up Unity for VR development and demonstrate the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR. ***Exercise 2:*** Develop a scene in Unity that includes. a cube, plane and sphere. ***Exercise 3:*** Apply transformations on the three game objects and sweep the coverage of eye movements	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Visual Perception & Rendering** Virtual Perception: Perception of Depth, Motion and Color - Visual Rendering: Ray tracing and shading, Creating realistic and immersive experience with lighting, shadows and textures. **Motion Tracking** Velocities and accelerations - Vestibular system - Mismatched Motion and Vection Tracking - Tracking 2D and 3D orientation, position and orientation of the attached bodies. ***Exercise 4:*** Create a new material and texture separately for the three game objects. Change the colour, material and texture of each game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click. ***Exercise 5:*** Apply rigid body component, material and Box collider to the game objects. Write a C# program to grab and throw the sphere using VR controller.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

III	**Interaction and Audio** Interaction: Motor programs and remapping, Locomotion, Manipulation, Social Interaction - Audio: Auditory Perception, Auditory Rendering. ***Exercise 5:*** Add an audio source to the scene. ***Exercise 6:*** Develop a simple UI(User interface) menu with images, canvas, sprites and button. Write a C# program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene. ***Exercise 7:*** Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. Create 3D game objects using Blender or any available 3D models. Include animation and interaction in the immersive environment. ***Case Study:*** Create a VR application to visit a zoo with at least 4 scenes, which can be changed dynamically, a good UI, animation and interaction with game objects.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Augmented Reality Experience** Ingredients - Augmented Reality Displays: Audio, Haptic, Visual and other sensory displays - Tracking and Sensors: Stationary tracking systems, Mobile sensors, Optical tracking sensor fusion. **Computer Vision for Augmented Reality** Marker-based approach: Markers, multiple cameras, feature, visual, outdoor and hybrid tracking, Tracking methods, Types of markers - Creating content using AR Software. ***Exercise 8:*** Create the planets and other celestial bodies in a 3D environment for an AR solar system. ***Exercise 9:*** Create a view of the solar system in their surroundings and interact with the objects by zooming, rotating, or tapping on them.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**AR Components** Scene Generator - Monitoring system – Display - Game scene - AR Devices: Optical see-through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, Video see-through systems ***Case Study:*** Develop an AR book with a fusion of traditional printed books and cutting-edge digital enhancements. Make the paperback turn into a live and moving story. With a simple scan of the book's pages using your device's camera, unlock a world of animations, videos, audio, and interactive elements on your screen.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Steven M. LaValle, *Virtual Reality*, Cambridge University Press, 2016
2. William R Sherman and Alan B Craig, *Understanding Virtual Reality: Interface, Application and Design*, Morgan Kaufmann Publishers, 2002
3. Alan B Craig, William R Sherman and Jeffrey D Will, *Developing Virtual Reality Applications: Foundations of Effective Design*, Morgan Kaufmann Publishers, 2009
4. Schmalstieg D, and Hollerer T., *Augmented Reality: Principles & Practice*, Pearson Education India, 2016
5. Chetankumar G Shetty, *Augmented Reality*, 1st Edition, McGraw Hill, 2020

References

1. Gerard Jounghyun Kim, *Designing Virtual Systems: The Structured Approach*, 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J Laviola, Jr and Ivan Poupyrev, *3D User Interfaces, Theory and Practice*, Addison Wesley, 2005.
3. Oliver Bimber and Ramesh Raskar, *Spatial Augmented Reality: Merging Real and Virtual Worlds*, 2005.
4. Burdea, Grigore C and Philippe Coiffet, *Virtual Reality Technology*, Wiley Interscience, India, 2003.
5. Allan Fowler*, AR Game Development‖,* 1st Edition, A press Publications, 2018
6. Bowman,D.A., Kruijff,E., LaViola,J.J. and Poupyrev,I., (2014), 3D User Interfaces: Theory and Practice, 2nd Edition, Addison Wesley Professional

Suggested Readings

1. Mather,G., *Foundations of Sensation and Perception*, 2nd Edition, Psychology Press, 2009
2. Jerald,J., *The VR Book: Human-Centered Design for Virtual Reality*, Morgan & Claypool, 2015
3. M. Nebling, Developing AR/VR/MR/XR Apps with WebXR, Unity & Unreal, University of Michigan
4. Ralf Doerner, *Virtual and Augmented Reality (Vr/Ar): Foundations and Methods of Extended Realities (Xr),* Springer, 2022

Web Resources

1. http://lavalle.pl/vr/book.html
2. https://www.youtube.com/playlist?list=PLbMVogVj5nJSyt80VRXYC-YrAvQuUb6dh
3. https://www.blender.org/support/tutorials/
4. https://unity.com/learn

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	3	2	3	2	3	3	3	3	2	K1
CO 2	3	3	3	2	3	2	3	3	3	3	2	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	3	2.6	3	2.6	3	3	3	3	2.6	
Overall Mapping of the Course with Pos – 2.89								Overall Mapping of the Course with PSOs – 2.9				

COURSE TITLE: DATA ANALYTICS AND VISUALIZATION LABORATORY

Course Code			
Credits	2		
Hours / Cycle	4		
Category	Part I	Core	Practical
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To learn different visualization tools POWER BI , TABLEAU and Excel AI. • To understand the importance of data, analyze data and data visualization techniques to help make more effective business decisions. • To perform simple statistical analysis and build machine learning models. • To solve analytical problems in real-world scenarios.		

On completing the course successfully, the students will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the syntax and packages needed for data analytics concepts and learn different visualization tools.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand data preprocessing, manipulation, visualization and machine learning algorithms.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the knowledge of data processing and perform data analysis using statistical methods and visualization tools.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the data and achieve effective solutions to solve real-time business problems.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate machine learning models and use them for prediction and decision to have a complete business data analytics solution. Evaluate information visualization systems and other forms of visual presentation for their effectiveness	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	1.**Visualization Tools:** POWER BI, TABLEAU and Excel AI	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Data Processing** • Data Operations • Data Cleansing-Identify and Handle Missing Values • Data Formatting • Data Normalization Sets • Binning • Indicator variables	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Data Frame Manipulation using Pandas** • Descriptive Statistics • Basic of Grouping • ANOVA • Correlation • Regression: Linear and Multiple and Logistic Regression	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Data Visualization** • Charts and Graphs • Maps • Dashboard • Inbuilt visuals • Custom visuals • Visualization techniques	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Building Machine Learning models using Scikit-Learn** 1. Building Data Pipelines • Prediction and Decision Making 2. Model Evaluation • Model Evaluation • Over-fitting,Under-fitting, and Model Selection • Model Refinement	12	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Paul Kinley, *Data Analytics for Beginners: Basic Guide to Master Data Analytics*, CreateSpace Independent Publishing Platform, 2016
2. Dr. Anil Maheshwari, *Data Analytics Made Accessible*, McGraw Hill Education, Kindle Edition, 2023
3. Ward, Grinstein, Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick, 2nd edition,A K Peters, Ltd 2015.
4. Claus Wilke, *Fundamentals of Data Visualization A Primer on Making Informative and Compelling Figures*, O'Reilly Media, 2019

References

1. Chirag Shah, *A Hands-on Introduction to Data Science*, Cambridge University Press, UK, 2020
2. Rafael A. Irizarry, *Introduction to Data Science*, Chapman & Hall, 2022
3. Grus, Joel, *Data science from scratch: first principles with python*, O'Reilly Media,2019.
4. Scott Murray, *Interactive Data Visualization for the Web* ,2nd Edition, 2017.

Suggested Readings

1. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly, 2015.
2. Al-Sakib Khan Pathan, Mohiuddin Ahmed, *Data Analytics Concepts, Techniques, and Applications*,CRC Press,2018

Web Resources

1. www.tutorialspoint.com/excel_data_analysis/data_analysis_overview.htm
2. www.datacamp.com/tutorial/data-visualisation-powerbi
3. https://help.tableau.com/current/pro/desktop/en-us/getstarted_buildmanual_ex1basic.htm
4. www.geeksforgeeks.org/tableau-tutorial
5. www.datacamp.com/tutorial/visualizing-data-in-excel

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	2	2	3	2	2	3	3	2	2	K1
CO 2	3	3	2	2	3	2	3	3	3	2	2	K2
CO 3	3	3	3	2	3	3	3	3	3	3	2	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	2.6	2.4	3	2.6	2.8	3	3	2.6	2.4	
Overall mapping of the Course with POs - 2.77								Overall mapping of the Course with PSOs 2.75				

COURSE TITLE: SOFTWARE DEVELOPMENT LABORATORY

Course Code			
Credits	2		
Hours / Cycle	4		
Category	Part I	Core	Practical
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	● Develop a mini-project by students working in a team ● Each student develops few modules in the mini-project ● Integrate all the modules into a single project. ● Follow the project life cycle with requirement analysis, specification, design, coding, implementation, testing and documentation		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
CO1	Remember the software development lifecycle	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the various stages of the project such as gathering requirements, preparing a proposal and the requirement specification for the problem chosen on using any notations.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the software development lifecycle and the various stages of the development and do the coding using the coding standards	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the efficiency of the development in every stage of the project	PSO1, PSO2, PSO3, PSO4	K4
CO5	Carry out the testing by preparing test cases	PSO1, PSO2, PSO3, PSO4	K5
CO6	Deploy the application, make a presentation and document the work	PSO1, PSO2, PSO3, PSO4	K6

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Domain knowledge acquisition, choose the problem (research, innovative or complex) in one of the following areas, Requirement analysis, Prepare the proposal ● Cryptography using C# or Java ● Data Analytics using Python	10	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5. K6

	• Digital Image Processing using Java or Python • Natural Language Processing using Python or Java • Networking using Java • Web applications using PHP in MVC Framework like Laravel or CodeIgniter • Web applications using Python in Django Framework • Web applications using Angular, Node JS/ React JS and C# or Java • Web applications using the Java Framework Spring • Web applications using MVC, C# and .NET • Android with Web Application using Java and Flutter • Machine Learning and Deep Learning using Python • Game Development AI and Robotics			
II	Design the application – ER/Use case/Class diagram, Table design, Module Design, Page Design	12	CO1, CO2, CO3, CO4, CO5 CO6	K1, K2, K3, K4, K5, K6
III	Software Development life cycle, Coding standards, coding, debugging	13	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6
IV	Testing – test cases, unit testing, integration testing	10	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6
V	Presentation, documentation, deployment of the application	15	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6

Text Books

1. Arthur M. Langer, *Guide to Software Development: Designing and Managing the Life Cycle*, Springer, 2016
2. Software Engineering Practice: A Case Study Approach (Chapman & Hall/Crc Innovations in Software Engineering and Software Development) Hardcover – Import, 16 December 2020
3. Richard Murch, *The Software Development Lifecycle - A Complete Guide*, Publisher: Richard Murch, 2012

References

7. William Stallings, *Cryptography and Network Security : Principles and Practices*, Seventh Edition, Prentice Hall, 2017
8. William McKinney, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython*, Second Edition, O'Reilly, 2017.
9. Fabio Nelli, *Python Data Analytics with Pandas, Numpy, and Matplotlib*, Second Edition, Apress, 2018.
10. Rafael C Gonzalez, Richard E Woods, *Digital Image Processing*, Fourth Edition, Pearson Education, 2018
11. Steven Bird, S., Klein, E., Loper, E, *Natural Language Processing with Python - Analyzing Text with the Natural Language Toolkit*, O'Reilly Media, 2009.
12. Herbert Schildt, *Java The Complete Reference*, Eleventh Edition, McGraw Hill, 2018.
7. Elliotte Rusty Harold, *Java Network Programming: Developing Networked Applications*, Fourth edition, O'Reilly Media, 2013
8. James Jaworski, *Mastering JavaScript*, First Edition, BPB Publications, 1999
9. Steven Holzner, *PHP: The Complete Reference*, Tata McGraw Hill, 2017
10. Budi Kurniawan, *Servlet & JSP: A Tutorial*, Second Edition, Brainy Software, 2015.
11. Robin Nixon, *Learning PHP, MySQL, JavaScript, and CSS*, Second Edition, O'Reilly Media, Inc., 2012
12. Frank Wells, *Web Development Mastery with Django 5.1.x: A Complete Guide to Building Powerful Website Applications, Leveraging Advanced Features & Integrating Front end Frameworks for Beginners and Professional*, First Edition, 2024
13. Nirbhay Chauhan, *The Complete Front-End Interview Guide: Angular, Node.js, React, Next.js, Vue.js, & TypeScript: Master the Fundamentals and Advanced Concepts, Become a Front-End Expert with Comprehensive Interview*
14. LulianaCosmina, Rob Harrop, Chris Schaefer, Clarence Ho, P*ro Spring 5: An In-Depth Guide to the Spring Framework and Its Tools*, Apress, Fifth edition 2017.
15. Thuan Thai, *.NET Framework*, Third Edition, O'Reily publications, 2009
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17. Herbert Schildt, *C# 4.0 The Complete Reference*, Third Edition Tata McGraw Hill, 2010
18. Deitel & Deitel, *C# 2012 for Programmers*, Fifth Edition, Pearson, 2010
19. Wei-Meng Lee, *Beginning Android 4 Application Development*, Wiley India Edition, 2012.
20. Onur Cinar, *Android Apps with Eclipse*, Apress, Springer(India) Private Limited, 2012.
21. Kevin Moore, *Mastering Flutter: Learn to develop Flutter apps for iOS, Android, desktop and web*, bpb, 2025
22. EthemAlpaydin, *Machine Learning: The New AI*, MIT Press, 2016.
23. Shai Shalev-Shwartz, Shai Ben-David, *Understanding Machine Learning: From Theory to Algorithms*, Cambridge University Press, 2014.
24. Ian Goodfellow, Yoshua Bengio and Aaron Courville,. *Deep Learning*, MIT Press. 2016.
25. Charu C. Aggarwal, *Neural Networks and Deep Learning: A Textbook*, Springer, 2019
26. Andrew Rollings, Dave Morris, Game Architecture and Design: New Riders, 2003
27. Francis X. Govers,Artificial Intelligence for Robotics, Packt Publishing, 2018

Suggested Readings

1. McConnell, Steve. *Code Complete*, Microsoft Press, 2004

Michael Feathers, *Working Effectively with Legacy Code*, 1st Edition, Pearson, 2004

Web Resources

1. https://docs.python.org/3/tutorial/
2. https://www.w3schools.com/python/
3. https://www.javatpoint.com/java-tutorial
4. https://www.tutorialspoint.com/php/index.htm
5. https://developer.mozilla.org/en-US/docs/Games/Tutorials
6. https://machinelearningmastery.com/start-here/
7. http://www.deeplearningbook.org/
8. https://machinelearningmastery.com/what-is-deep-learning/
9. http://neuralnetworksanddeeplearning.com/
10. http://developer.android.com/training/basics/firstapp/index.html
11. www.vogella.com/articles/Android/article.html
12. www.coreservelets.com/android-tutorial/
13. www.edumobile.org/android/category/android-beginner-tutorial/
14. http://www.tutorialspoint.com/java/java_generics.htm

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	3	2	3	2	3	3	2	2	2	K1
CO 2	3	3	3	3	3	3	3	3	3	3	3	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
CO6	3	3	3	3	3	3	3	3	3	3	3	K6
Wt. Avg.	3	3	3	2.83	3	2.83	3	3	2.83	2.83	2.83	
Overall Mapping of the Course with Pos – 2.95								Overall Mapping of the Course with PSOs – 2.87				

COURSE TITLE: PROJECT

Course Code			
Credits	18		
Hours / Cycle	30		
Category	Part I	Core	Practical
Semester	IV		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To develop an application in a company/institution/department/college • To follow the software development life cycle in developing the application • To present the work at the end of the project work.		
On completing the course successfully, the student will be able to			

C#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
CO1	Recollect and remember the various concepts and techniques in developing an application	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand every stage of the software development life cycle	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the proper coding standards and the concepts in the domain of the work in the software development	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyse all the modules of the application developed for efficiency	PSO1. PSO2, PSO3, PSO4	K4
CO5	Verify, validate the application and carry out the testing with test cases	PSO1. PSO2, PSO3, PSO4	K5
CO6	Integrate all the modules created and deploy the application	PSO1. PSO2, PSO3, PSO4	K6

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Domain knowledge acquisition, Choosing the problem (research, innovative or complex), Requirement analysis, Study of the existing system, Determine the proposed system and prepare the proposal.	90	CO1, CO2, CO3 CO4 CO5 CO6	K1, K2, K3, K4, K5 K6
II	Design the application – ER/Use case/Class diagram, Table design, Module Design, Page Design	90	CO1, CO2, CO3, CO4 CO5 CO6	K1, K2, K3, K4, K5 K6
III	Coding and implementation	100	CO1, CO2, CO3, CO4, CO5 CO6	K1, K2, K3, K4, K5 K6
IV	Testing – test cases, unit testing, integration testing, system testing, acceptance testing	80	CO1, CO2, CO3, CO4, CO5 CO6	K1, K2, K3, K4, K5 K6

V	Documentation Presentation, Deployment of the application	90	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6

Text Books

1. Arthur M. Langer, *Guide to Software Development: Designing and Managing the Life Cycle*, Springer, 2016
2. Chapman & Hall, *Software Engineering Practice: A Case Study Approach (Innovations in Software Engineering and Software Development)*, 2020
3. Ian Somerville, *Software Engineering*, 10th Edition, Pearson Education Asia 2016.

References

1. Richard Murch, *The Software Development Lifecycle - A Complete Guide*, Publisher: Richard Murch, 2012
2. Roger Pressman and Bruce Maxim, *Software Engineering: A Practitioner's Approach*, 9th Edition. McGraw-Hill 2019.
3. Len Bass, Paul Clements and Rick Kazman, *Software Architecture In Practice*, 3 rd Edition, Pearson India 2018

Suggested Readings

1. McConnell, Steve. *Code Complete*, Microsoft Press, 2004
2. Michael Feathers, *Working Effectively with Legacy Code*, 1st Edition, Pearson, 2004

Web Resources

1. **https://www.tpointtech.com/advanced-software-engineering-books**
2. **https://www.cse.msu.edu/~cse870/IEEEXplore-SRS-template.pdf**
3. **https://www.cse.msu.edu/~cse870/Materials/GoalModeling/KaosTutorial-2007.pdf**
4. **https://www.cse.msu.edu/~cse870/Materials/main-tech-report-security-patterns.pdf**

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	3	3	3	3	3	3	3	3	3	K1
CO 2	3	3	3	3	3	3	3	3	3	3	3	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
CO6	3	3	3	3	3	3	3	3	3	3	3	K6
Wt. Avg.	3	3	3	3	3	3	3	3	3	3	3	
Overall Mapping of the Course with POs – 3								Overall Mapping of the Course with PSOs – 3				

Rubrics for Evaluation of Project Work

Internal Continuous Assessment Marks

Weekly Reports	Review 1	Review 2	Review 3	Manuscript	Total	Internal Marks
10 Marks	10 Marks	20 Marks	30 Marks	25 Marks	100 Marks	50 Marks

External Marks

Dissertation						Viva-voce		Total	Total
Work Done	Documentation (Content, grammar & format)	Complexity of work &Technology Used	Implementation (Coding)	Results	PPT Slides	Presentation	Ques & Ans		
20 Marks	20 Marks	10 Marks	10 Marks	10 Marks	10 Marks	10 Marks	10 Marks	100 Marks	50 Marks

COURSE TITLE: ADVANCED OPERATING SYSTEMS

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	I		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To get a comprehensive knowledge of the architecture of distributed systems. • To understand the deadlock and shared memory issues and their solutions in distributed environments. • To know the security issues and protection mechanisms for distributed environments. • To get a knowledge of multiprocessor operating systems and database operating systems		
On completing the course successfully, the student will be able to			
CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**

CO1	Remember and explore the working of Theoretical Foundations of OS.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the working principles of Distributed Deadlock Detection and resource management, distributed shared memory and scheduling mechanisms, Data security, Multiprocessor database operating system.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the learning of Distributed Deadlock Detection, Resource Management, distributed shared memory and scheduling mechanisms, Data security and multiprocessor systems in real-time problems.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the various algorithms used in Distributed Deadlock Detection, Resource Management, distributed shared memory and scheduling mechanisms, Data security and multiprocessing systems.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the various algorithms used in each topic and analyze their efficiency.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Introduction Overview – Synchronization Mechanisms – Processes and Threads - Process Scheduling Models of Resources - Deadlocks: Detection, Prevention and Recovery.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	DISTRIBUTED OPERATING SYSTEMS in Distributed Operating System – Communication – Lamport's Logical clocks – Causal Ordering of Messages – Distributed Mutual Exclusion Algorithms – Centralized and Distributed Deadlock Detection Algorithms Primitives.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	DISTRIBUTEDRESOURCE MANAGEMENT Distributed File Systems – Design Issues – Distributed Shared Memory – Algorithms for Implementing Distributed Shared Memory – Distributed Scheduling – Issues in Load Distributing – Load Distributing Algorithms.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	REAL TIME AND MOBILE OPERATING SYSTEMS CASE STUDIES Basic Model of Real Time Systems - Characteristics- Applications of Real Time Systems Real Time Task Scheduling - Handling Resource Sharing - Mobile Operating Systems – Microkernel Design - Client Server	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

	Resource Access – Processes and Threads - Memory Management - File system.			
V	Multiprocessor operating systems - basic multiprocessor system architectures – interconnection networks for multiprocessor systems – caching – hypercube architecture. Database Operating systems	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Mukesh Singhal, Niranjan G.Shivaratri, *Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems*, TMH, 2001
2. Andrew S.Tanenbaum, *Modern operating system*, PHI, 2003
3. Pradeep K.Sinha, *Distributed operating system-Concepts and design*, PHI, 2003.
4. Andrew S.Tanenbaum, *Distributed operating system*, Pearson education, 2003.

References

1. Achyut Godbole, *Operating Systems*, McGraw Hill, third Edition, 2017
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, *Operating System Concepts*, Ninth Edition, Wiley, 2013.
3. Deitel H.M., *Operating Systems*, Second Edition, Addison Wesley Publishing Company, 2000.

Suggested Readings

1. Milan Milenkovic, *Operating System Concepts and Design*, Eighth Reprint, Tata McGraw-Hill, 2000.
2. 10 Best Operating Systems for Laptops and Computers [2023 LIST] (softwaretestinghelp.com)

Web Resources

1. Operating System Structure - Scaler TopicsSystem software - Wikipedia
2. Distributed Operating System: Definition, Types and Characteristics (toppr.com)

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	3	3	2	2	2	3	3	2	2	K1
CO 2	3	3	3	3	2	2	2	3	3	2	2	K2
CO 3	3	3	3	3	2	2	2	3	3	2	2	K3
CO 4	3	3	3	3	2	2	2	3	3	2	2	K4
CO 5	3	3	3	3	2	2	2	3	3	2	2	K5
Wt. Avg.	3	3	3	3	2	2	2	3	3	2	2	
Overall Mapping of the Course with POs – 2.57								Overall Mapping of the Course with PSOs – 2.5				

COURSE TITLE: DESIGN THINKING AND INNOVATION

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	I		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To recognize the importance of design thinking and its various phases • To apply design thinking phases to create successful prototypes • To understand that both agile and design thinking process complement each other. • To have knowledge of Innovation and its impact and benefit to software development • To apply design thinking and innovation to a real-life scenario and develop a prototype (software process / product)		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
CO1	Remember the importance of design thinking, its different phases, role of design thinking in building innovative software with patenting, empathize with user situations and be able to state clear problem statements	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the stages of design thinking - empathizing, defining, ideating, prototyping and testing and the basic concepts of IPR	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the different ideation methods and come out with feasible and viable ideas for solving the problem statements.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the efficiency and ideation behind the problem statements and optimize the problem	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the prototypes created and iterate if t design does not meet the customer requiremer	PSO1, PSO2, PSO3, PSO4	K5
CO6	Create an innovative solution for a problem with proper documentation and attempt for patenting	PSO1, PSO2, PSO3, PSO4	K6

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level

I	**Introduction to Design Thinking**: Importance of Design Thinking – The 3 E's for design thinking: Empathy, expansive thinking/brainstorming, experimentation- **Five stage model**: Empathize, define, ideate, prototype, test – Non-linearity of the five-stage model – **Empathize Phase**: Empathy – Developing empathy towards people — Ask What? And Why? – Immersion Activity –Steps in immersion activity.	9	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6
II	**Define Phase**: Define the problem– Analysis and synthesis – Personas – Four different perspectives on Personas – Steps to creating personas – Problem statement – Affinity diagrams – Empathy mapping – **Ideate:** What is ideation – Need for and uses of ideation –Ideation Methods – Brainstorming – Rules for brainstorming – Mind maps – Guidelines to create mind maps – Ideation games - Doodling – Use of doodling in expressing creative ideas.	9	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6
III	**Prototype**: Prototyping and its importance – Types of prototyping – Guidelines for prototyping – Story telling – Value proposition **Test**: Need to test – User feedback - Conducting a user test – How to test - Desirable, feasible and viable solutions – **Iterate phase**	9	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6
IV	**Role of Design Thinking**: Design thinking and Agile Methodology – Differences between agile and design thinking – Overview of Design Thinking in Software and AI Projects - **Innovation** – Definition – Innovation Life cycle - Eight essentials of Innovation – Benefits of Innovation – Innovation process - Innovation software - Important innovations in the IT sector – **Inclusive Design Thinking** – Need for Inclusive design – Inclusive design principles - Inclusivity vs. Accessibility	9	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6
V	**IPR**: IP concepts and nature of IP, Need for IP - Patents, Copyrights, Trademarks, Geographical Indications, Trade secrets - Important examples of IPR in Computer Science. - **Case study** applying design thinking 5 stage model to develop a prototype of an innovative product / service – Case study documentation.	9	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6

Text Books

1. Eli Woolery, *Design Thinking Handbook*, Invision, 2019.
2. Christian Müller-Roterberg, *Handbook of Design Thinking*, Kindle Direct Publishing ISBN: 978-1790435371, November 2018
3. Regine M. Gilbert, *Inclusive Design for a Digital World: Designing with Accessibility in Mind (Design Thinking)*, Apress, 2019
4. Robert Stackowiak, Tracey Kelly, *Design Thinking in Software and AI Projects: Proving Ideas Through Rapid Prototyping*, 2020
5. Johnny Schneider, *Understanding Design Thinking, Lean and Agile*, O'Reilly Media, 2017
6. Gavin Ambrose, Paul Harris, *Basics Design - 8: Design Thinking*, Illustrated Reprint, AVA Publishing, 2010
7. V. Scople Vinod, *Managing Intellectual Property*, Prentice Hall of India pvt Ltd, 2012
8. Deborah E. Bouchoux, *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, *Cengage Learning*, Third Edition, 2012.

References

1. Nir Eyal, *Hooked: How to build habit-forming*, 2014
2. Rod Judkins, *The Art of Creative Thinking*, Sceptre; 1st edition, 2015

Suggested Readings

1. Jennifer Hehn, Daniel Mendez, Walter Brenner, Manfred Broy, *Design Thinking for Software Engineering Creating Human-oriented Software-intensive Products and Services*, 2022.
2. Michael Lewrick, Patrick Link, Larry Leifer, *The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods*, 1st Edition, April 2020

Web Resources

1. https://www.tutorialspoint.com/design_thinking/design_thinking_introduction.htm
2. https://dmexco.com/stories/5-tips-to-successfully-implement-the-design-thinking-process/
3. 4204-Article%20Text-22169-1-10-20220206.pdf
4. https://cac.annauniv.edu/aidetails/afug_2017_fu/09.B.Tech.CSBS.pdf
5. https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/the-eight-essentials-of-innovation
6. https://ezassi.com/innovation-software/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO2	PSO 3	PSO 4	
CO1	3	2	3	1	1	2	2	3	2	2	2	K1
CO2	3	2	3	2	2	2	2	3	2	2	2	K2
CO3	3	3	3	2	2	2	3	3	3	3	3	K3
CO4	3	3	3	2	2	2	3	3	3	3	3	K4
CO5	3	3	3	3	3	2	3	3	3	3	3	K5
CO6	3	3	3	3	3	3	3	3	3	3	3	K6
Wt. Avg.	3	2.67	3	2.17	2.17	2.17	2.67	3	2.67	2.67	2.67	
Overall Mapping of the Course with POs – 2.55								Overall Mapping of the Course with PSOs – 2.75				

COURSE TITLE: UNIVERSAL HUMAN VALUES

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	I		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS'. • To facilitate the development of a Holistic perspective among students towards life and profession. • To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct. • Trustful and mutual human behavior and mutual enriching interaction with Nature.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Students understand the importance of human values in technical education and their role in sustainable solutions.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Students realize that right understanding and relationships are more important than material wealth for a fulfilling life.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Students understand the distinction between 'I' and the body, recognizing that most of their desires relate to 'I' while their efforts are often focused on the body.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Students realize that physical needs are limited, while feelings should be continuous, and they become aware of their inner activities and external influences on their desires.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Students realize that living in harmony is everyone's natural intention, and that many societal issues arise from misjudging others based on competence rather than intention, which can be resolved through right evaluation and respect.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Introduction to Value Education – Understanding Value Education – Self-exploration as the Process for Value Education – Sharing about Oneself – Continuous Happiness and Prosperity – The Basic Human Aspirations – Right Understanding, Relationship, and Physical Facility – Exploring Human Consciousness – Happiness and Prosperity – Current Scenario – Method to Fulfill the Basic Human Aspirations – Exploring Natural	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Harmony in the Human Being Understanding Human Being as the Co-existence of the Self and the Body – Distinguishing between the Needs of the Self and the Body – Exploring the Difference of Needs of Self and Body – The Body as an Instrument of the Self – Understanding Harmony in the Self – Exploring Sources of Imagination in the Self – Harmony of the Self with the Body – Programme to Ensure Self-regulation and Health – Exploring Harmony of Self with the Body	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	Harmony in the Family and Society Harmony in the Family – The Basic Unit of Human Interaction – Values in Human-to-Human Relationship – 'Trust' as the Foundational Value in Relationship – Exploring the Feeling of Trust – 'Respect' as the Right Evaluation – Exploring the Feeling of Respect – Understanding Harmony in the Society – Vision for the Universal Human Order – Exploring Systems to Fulfill the Human Goal	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Harmony in Nature/Existence Understanding Harmony in Nature – Interconnectedness, Self-regulation, and Mutual Fulfillment among the Four Orders of Nature – Exploring the Four Orders of Nature – Realizing Existence as Co-existence at All Levels – The Holistic Perception of Harmony in Existence – Exploring Co-existence in	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Implications of the Holistic Understanding – A Look at Professional Ethics– Natural Acceptance of Human Values – Definitiveness of (Ethical) Human Conduct – Exploring Ethical Human Conduct – A Basis for Humanistic Education, Humanistic Constitution, and Universal Human Order – Competence in Professional Ethics – Exploring Humanistic Models in Education – Holistic Technologies, Production Systems, and Management Models – Typical Case Studies – Strategies for Transition towards Value-based Life and Profession – Exploring Steps of Transition towards Universal Human Order	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. R R Gaur, R Asthana, G P Bagaria, . *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

References

1. M. Govindrajran and S. Natrajan – *Engineering Ethics (Including Human Values)*, Eastern Economy Edition, Prentice Hall, 2005.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *A Foundation Course in Human Values and Professional Ethics*, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Suggested Readings

1. https://www.goodreads.com/shelf/show/college-uhv
2. Teaching Materials (aicte-india.org)

Web Resources

1. https://uhv.org.in/
2. https://library.uhv.edu/az/databases

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PSO 1	PSO2	PSO 3	PSO 4	
CO 1	3	3	3	3	2	2	2	3	3	2	2	K1
CO 2	3	3	3	3	2	2	2	3	3	2	2	K2
CO 3	3	3	3	3	2	2	2	3	3	2	2	K3
CO 4	3	3	3	3	2	2	2	3	3	2	2	K4
CO 5	3	3	3	3	2	2	2	3	3	2	2	K5
Wt. Avg.	3	3	3	3	2	2	2	3	3	2	2	
Overall Mapping of the Course with POs – 2.57								Overall Mapping of the Course with PSOs – 2.5				

COURSE TITLE: USER INTERFACE AND USER EXPERIENCE DESIGN

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part 1	Elective	Theory
Semester	I		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To impart knowledge on UI Design in order to design with intention. • To impart knowledge on the principles of UX Design • To enable understanding of UI and UX design processes • To Learn the aspects of good UIUX design		

	• To be aware of industry-standard tools and specific project deliverables in UI/UX.

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)		Bloom's Taxonomy Levels (K1 to K5)	
CO1	Summarize all stages of the UI/UX development process and tools	PSO1, PSO2, PSO3, PSO4	K1	
CO2	Experiment with various visual design aspects to understand design of graphical user interfaces	PSO1, PSO2, PSO3, PSO4	K2	
CO3	Theme the visual look and feel based on user experiences and apply the user Interfaces to different devices and requirements	PSO1, PSO2, PSO3, PSO4	K3	
CO4	Analyze the UI and UX design process and have applicative knowledge	PSO1, PSO2, PSO3, PSO4	K4	
CO5	Create high quality professional documents and artifacts related to the design process	PSO1, PSO2, PSO3, PSO4	K5	

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**UI:** Definition, Types of UI: Command line (CLI), graphical user interface (GUI). Menu driven interface (MDI), Form based interface (FBI), Natural language interface (NLI) –Human Computer Interaction: Human Characteristics In Design – Human Consideration In Screen Design - usability, accessibility, and user-centered design. Fundamentals of Design: Design principles and elements - Color theory and its application in UI/UX - Typography and its role in user interfaces. Introduction to User Research: Basics of user research methods - User personas and scenarios - Conducting usability studies and gathering feedback.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**UI Design:** Interface Components and Navigation: Common UI components (buttons, forms, etc.) - Navigation patterns and information architecture - Introduction to Gestalt principles in UI design. Visual Hierarchy and Layout Design: Establishing visual hierarchy in interfaces - Layout design principles - Grid systems and their application. Responsive Design: Designing for different screen sizes - Mobile-first design approach - Introduction	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

	to responsive frameworks. Prototyping and Wire framing: Creating low-fidelity prototypes - Iterative design and feedback - Introduction to prototyping tools			
III	**UX Design:** Interaction Design: Basics of interaction design - Micro interactions and animations - Designing for user engagement. Information Architecture and Content Strategy: Organizing information effectively - Content-first design approach - Basics of SEO in UX. Usability Testing: Methods for usability testing - A/B testing and user feedback - Incorporating testing into the design process. Introduction to UX Metrics and Analytics: Key performance indicators (KPIs) in UX - Basics of user behavior analytics - Tools for UX metrics.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Advanced Topics:** Design Systems and Collaboration: Importance of design systems - Collaboration between designers and developers - Tools for collaborative design. Emerging Technologies in UI/UX: Introduction to AR and VR in design - Voice and conversational UI - Basics of AI in UX. Ethical Design and Inclusive Design: Ethical considerations in UI/UX - Inclusive design principles - Addressing bias in design. Industry Trends and Case Studies: Current trends in UI/UX - Analysis of successful UX/UI projects - Guest lectures from industry professionals	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**UIUX Tools**: wireframing and Prototyping applications: A/B testing software, Content inventory software, User testing and Feedback software, Analytics software – Mobile UI UX Design - Case study	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Steve Krug, *Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability*, New Riders, Revisited Edition (2014)
2. Don Norman, *The Design of Everyday Things*, *Basic Books*,2nd edition, 2013.
3. Russ Unger, Carolyn Chandler, *A Project Guide to UX Design: For User Experience Designers in the Field Or in the Making*, New Riders. 2nd edition, 2012
4. Everett N. McKay, *UI is Communication: How to Design Intuitive, User Centered Interfaces by Focusing on Effective Communication, Morgan Kaufman*n,Illustrated edition, 2013.

References

1. Jesse James Garrett, *The Elements of User Experience: User-centered Design for the Web, New Riders*,2nd edition, 2010.
2. https://nulab.com/learn/design-and-ux/what-is-a-ux-sitemap-and-why-is-it-important/
3. https://www.smashingmagazine.com/2010/10/what-is-user-experience-design-overview-tools-and-resources/

Suggested Readings

1. https://www.uxbeginner.com/ultimate-list-of-ux-topics-all-beginners-should-know/
2. https://blog.tubikstudio.com/mobile-ui-design-15-basic-types-of-screens/

Web Resources

1. https://www.nngroup.com/articles/ten-usability-heuristics/
2. https://www.uxdesigninstitute.com/blog/what-is-ui-design/
3. https://www.coursera.org/specializations/ui-ux-design
4. https://learnux.io/
5. https://www.smashingmagazine.com/2018/02/comprehensive-guide-ui-design/
6. https://hackernoon.com/6-bad-ui-design-examples-common-errors-of-ui-designers-

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	3	3	3	3	3	3	3	3	3	K1
CO 2	3	3	3	3	3	3	3	3	3	3	3	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	3	3	3	3	3	3	3	3	3	
Overall mapping of the Course with PO: 3								Overall mapping of the Course with PSO: 3				

COURSE TITLE: BUSINESS INTELLIGENCE

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To expose the basic rudiments of business intelligence systems. • To understand the modeling aspects behind business intelligence. • To understand the business intelligence life cycle and its techniques. • To be exposed to different data analysis tools and techniques.		
On completing the course successfully, the students will be able to			
CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
CO1	**Remember** the core concepts, system architectures,development lifecycle, efficiency measurement models, and various tools and technologies used in Business Intelligence (BI) within IT environments.	PSO1, PSO2, PSO3, PSO4	K1

CO2	**Understand** the fundamental concepts, architectures, and development lifecycle of Business Intelligence (BI) systems in IT environments.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply efficiency measurement models, and machine learning techniques, to evaluate and optimize the performance of IT-enabled BI systems.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze different knowledge delivery methods, reporting techniques, and user interaction models in BI systems, including data visualization and real-time analytics.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the application of BI tools and technologies in IT-driven business functions such as marketing, and logistics with a focus on real-world case studies.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Introduction to Business Intelligence for IT** Importance of Effective and Timely Decision Making in IT systems-Data, Information, and Knowledge in the IT Environment-Role of Mathematical Models and Algorithms in BI-Business Intelligence System Architectures and Frameworks-BI Development Lifecycle: Cycle of BI Analysis in IT projects-Introduction of Enabling Technologies: Databases, Data Warehousing, Cloud Computing-Software Development of BI Systems: Tools, Platforms, and Methodologies	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K2, K3, K4, K5
II	**Knowledge Delivery and BI System Interaction** BI User Roles in IT: Developers, Analysts, Managers, and End Users-Generating Reports: Standard, Interactive, and Ad-hoc Querying-Parameterized Reports and Self-Service BI Platforms-Dimensional Data Modeling and Analysis in IT systems -Advanced Data Visualization Techniques: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Information Systems (GIS) in BI- Embedded and Integrated Analytics in IT Applications-User Interface (UI) and UX Considerations for Optimized BI Presentation	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K2, K3, K4, K5

III	**Efficiency Models and Analytical Techniques in BI** Efficiency Measurement in IT-enabled BI systems-CCR Model: Defining Target Objectives and Performance Benchmarks, Peer Groups and Best Practice Identification, Cross Efficiency Analysis-Machine Learning Techniques in BI: Pattern Matching Algorithms, Cluster Analysis for IT Data Sets, Outlier Detection in Large-Scale IT Systems.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K2, K3, K4, K5
IV	**Business Intelligence Applications in IT** BI Applications in IT-driven Business Functions: Marketing Analytics and Customer Insights, Logistic Models-Real-world IT Case Studies on BI Implementation	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K2, K3, K4, K5
V	**Emerging Trends and Future of Business Intelligence in IT** Future of BI: AI-driven analytics and Machine Learning Integration, Predictive Analytics and Forecasting in IT Operations, BI Search Engines and Text Mining for Unstructured IT Data	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Ramesh Sharda, Dursun Delen, Efraim Turban, *Business Intelligence: A Managerial Approach,4th Edition, Pearson Education, 2017.*
2. Ramesh Sharda, Dursun Delen, Efraim Turban, *Business Intelligence, Analytics, and Data Science :A Managerial Perspective, Pearson Education ,2018*
3. Cindi Howson , *Business Intelligence: Unlock the Value of BI & Big Data*, 2nd Edition, McGraw-Hill Education, 2013

References

1. Rick Sherman, *Business Intelligence Guidebook: From Data Integration to Analytics*, First Edition, Morgan Kaufmann, 2014
2. David Loshin Morgan, Kaufman, *Business Intelligence: The Savvy Manager's Guide*, Second Edition, 2012.
3. Larissa T.Moses,S.Atre, *Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making*,Addison Wesley, 2003.

Suggested Readings

1. Efraim Turban et al , *Decision Support and Business Intelligence Systems*, Nineth Edition, Pearson 2013
2. Jiawei Han, Micheline Kamber, *Data Mining: Concepts and Techniques*, Third Edition,Elsevier,2012

Web Resources

1. https://www.tutorialspoint.com/business-intelligence/index.htm
2. https://www.tableau.com/business-intelligence/what-is-business-intelligence
3. https://data-flair.training/blogs/business-intelligence/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO 1	3	3	3	2	2	2	2	2	2	2	2	K1

CO 2	3	3	3	3	3	3	3	3	3	3	2	K2
CO 3	3	3	3	2	3	3	3	3	3	3	3	K3
CO4	3	3	3	3	3	3	3	3	3	3	3	K4
CO5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	3	2.6	2.8	2.8	2.8	2.8	2.8	2.8	2.6	
Overall mapping of the Course with PO's - 2.85								Overall mapping of the Course with PSO's- 2.75				

COURSE TITLE: DEVOPS AND MICROSERVICES

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To learn the basic concepts of Microservices and DevOps. • To understand microservices architecture and how it is applied in the real world. • To become familiar with DevOps automation tools. • To work with DevOps and build, test and deploy code.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the basic concepts of Microservices and DevOps	PSO1, PSO2, PSO3	K1
CO2	Understand the microservices architecture, Microservices in DevOps Environment and the concept of Velocity and Continuous Memory	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply microservices in DevOps	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the various DevOps automation tools based on maximum efficiency in building, testing and deploying code	PSO1, PSO2, PSO3, PSO4	K4
CO5	Develop, integrate and deploy projects using DevOps	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level

I	**Introduction to Microservices** Definition of Microservices – Working of Microservices - Characteristics – components - Microservices and Containers – Interacting with Other Services – Monitoring and Securing the Services – Containerized Services – Deploying on Cloud.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Microservices Architecture** Microservice architectural style - Benefits - Design patterns for Microservices architecture - Monolithic v, Microservices architecture – Service Oriented Architecture vs. Microservices architecture - Drawbacks of Microservice architectural style - decomposing monolithic applications into Microservices – Real world examples of microservices	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Basics of DevOps and DevOps Automation Tools** DevOps practices - Why DevOps? – DevOps perspective - DevOps and software development life cycle – DevOps and agile – DevOps automation tools: infrastructure automation, configuration management, deployment automation, performance management, log management, monitoring	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Microservices in DevOps Environment** Evolution of Microservices and DevOps – Implementing DevOps with Microservices Benefits of combining DevOps and Microservices - Working of DevOps and Microservices in Cloud environment - DevOps Pipeline representation for a NodeJS based Microservices	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Velocity and Continuous Memory** Velocity - Delivery Pipeline- test stack - Small/Unit Test – medium /integration testing – system testing- Job of Development and DevOps - Job of Test and DevOps – Job of Op and Devops Infrastructure and the job of Ops.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Eberhard Wolff, *Microservices: Flexible Software Architecture*, 1st Edition, Pearson Education, 2017
2. Sam Newman, *Building Microservices Designing Fine-Grained Systems*, O'Reilly Media, 2015
3. Len Bass, Ingo Weber and Liming Zhu, *DevOps: A Software Architect's Perspective*, Pearson Education, 2016
4. Joakim Verona, *Practical DevOps*, Packt Publishing, 2016

References

1. Sam Newman, *Monolith to Microservices Evolutionary Patterns to Transform your Monolith*, O'Reilly Media, 2019
2. Viktor Farcic, *The DevOps 2.1 Toolkit: Docker Swarm*, Packt Publishing, 2017

3. Joyner Joseph, Devops for Beginners, First Edition, Mihails Konoplovs publisher, 2015
Suggested Readings 1. Namit Tanasseri, RahulRai, *Microservices with Azure*, 1st Edition, Packt Publishing, UK, 2017 2. Gene Kim, Kevin Behr, George Spafford, *The Phoenix Project, A Novel about IT, DevOps*, 5th Edition, IT Revolution Press, 2018. 3. Gaurav Agarwal, *Modern DevOps Practices*, Packt Publishing, 2021
Web Resources 1. https://www.geeksforgeeks.org/microservices/ 2. https://www.tutorialspoint.com/microservice_architecture/index.htm 3. https://www.geeksforgeeks.org/devops-and-microservices/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	2	-	2	-	2	3	2	2	-	K1
CO 2	3	3	2	2	3	2	3	3	2	2	2	K2
CO 3	3	3	3	2	3	2	3	3	3	3	3	K3
CO 4	3	3	3	2	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.8	2.6	2.25	2.8	2.5	2.8	3	2.6	2.6	2.75	
Overall Mapping of the Course with POs – 2.68								Overall Mapping of the Course with PSOs – 2.74				

COURSE TITLE: DIGITAL IMAGE PROCESSING

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To provide the basic knowledge on image processing techniques like image acquisition, enhancement, transform. Restoration, segmentation, compression and object recognition in images and their applications. • To impart the mathematical logic behind the various image processing algorithms • To facilitate the students, apprehend and implement various image processing algorithms.		
On completing the course successfully, the student will be able to			

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Ascertain and describe the basics of image processing concepts through mathematical interpretation.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the concepts of Image processing such as Image Enhancement, transforms, compressions, segmentation and object recognition	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the Image Analysis algorithms using Python and OpenCV in various images	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the image processing algorithms used in images for their efficiency.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the created prototypes or applications using Image Analysis and ML techniques	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Digital Image Fundamentals and Image Acquisition** Digital Image Fundamentals: Digital Images and their Structure, Fields that use Digital Image Processing, Steps in Digital Image Processing, Components of an Image Processing System. Image Acquisition: Image Sensors and Scanners, Image Digitization - Sampling and Quantization, Image Types and Formats, Color Images, Color Models.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Image Enhancement and Morphological Image Processing** Image Enhancement: Spatial Filtering – histogram processing and equalization, color image histogram, point, mask and neighborhood operations. Frequency Domain Filtering – low-pass and high-pass filters, Gamma Correction, Image Arithmetic Morphological Image Processing: Morphological Operations – dilation, erosion, open and close, hole-filling	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Image Transforms and Compression** Image Transforms: Need for Transforms, Fourier Transform, Discrete Fourier Transform, Discrete Cosine Transform, Discrete Wavelet Transforms, Basic Geometric Transformations. Image Compression: Redundancy in Images, Run-length Coding, Huffman Coding – binary and non-binary, Lossless and Lossy Compression, Image Compression Standards.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

IV	**Image Segmentation** Thresholding, Point, Line and Edge Detection, Region Based Segmentation,	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Object Recognition in Images** Pattern Matching – minimum distance classifier, Feature Extraction and Machine Learning for Object Recognition, Recognition Strategies - classification (Nearest Neighbor, Bayes, Neural Networks), Brief Introduction to Object Recognition using Deep Learning and Convolution Neural Networks. Case Study – Performing image preprocessing using enhancement methods, morphology-based segmentation to detect objects in the images and recognizing them using Python, ML/DL libraries and predefined models.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Rafael C Gonzalez, Richard E Woods, *Digital Image Processing*, Fourth Edition, Pearson Education, 2018
2. S. Jayaraman, S. Esakkirajan, T. Veerakumar, *Digital Image Processing*, Mc-Graw Hill, 2012

References

1. A.K. Jain, *Fundamentals of Digital Image Processing*, PHI, 2011
2. Mark Nixon, Alberto Aguado, *Feature Extraction and Image Processing*, Second Edition, Elsevier, 2008
3. Scott E Umbaugh, *Computer-Imaging: Digital Image Analysis and Processing*, CRC Press, 2000
4. Himanshu Singh, *Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python*, Apress, 2019
5. Xiaoyue Jiang, Abdenour Hadid, Yanwei Pang, Eric Granger, Xiaoyi Feng (Eds.), *Deep Learning in Object Detection and Recognition*, Springer, 2019

Suggested Readings

1. Joseph Howse, Joe Minichino, *Learning OpenCV 4 Computer Vision with Python 3: Get to grips with tools, techniques, and algorithms for computer vision and machine learning*, 3rd Edition, Packt Publishing, 2020

Web Resources

1. https://docs.opencv.org/master/d2/d96/tutorial_py_table_of_contents_imgproc.html
2. https://www.pyimagesearch.com/
3. https://www.projectpro.io/article/image-processing-projects-ideas/460
4. https://www.v7labs.com/blog/computer-vision-project-ideas

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	

CO 1	3	2	2	1	2	1	2	3	2	2	2	K1
CO 2	3	3	2	2	2	1	3	3	3	2	2	K2
CO 3	3	3	2	2	3	3	3	3	3	3	3	K3
CO 4	3	3	3	2	3	3	3	3	3	3	3	K4
CO 5	3	3	3	2	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.8	2.4	1.8	2.6	2.2	2.8	3	2.8	2.6	2.6	
Overall Mapping of the Course with POs – 2.51								Overall Mapping of the Course with PSOs – 2.75				

COURSE TITLE: PYTHON PROGRAMMING

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To acquire programming skills in Python. • To learn Python basics - conditionals, loops, functions and Strings. • To use Modules, and Packages in Python • To learn Python data structures –Lists, Sets, Tuples, and Dictionaries. • To read and write data from/to files in Python. • To learn exception handling in Python • To develop GUI Application using in Python		

On completing the course successfully, the students will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the concepts of basic python syntax.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the basics of Python, Functions, Strings, Lists, Sets, Tuples, Dictionaries, File and Exception handling ,Modules,Visualization in Python Programming.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the concepts of Python programming to develop solutions to simple computational problems.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the major components of Python for solving real-time problems.	PSO1, PSO2, PSO3, PSO4	K4
CO5	To evaluate and solve real-time problems using Python.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Python Basics**: Python, features of Python, variables, expression, statements, operators. Data Types – Control Flow Statements – Function-Strings:Slicing Strings, Modify, Concatenation, Formatting, String Methods. Files: Introduction – File Path – Opening and Closing Files – Reading and Writing Files Exception: Errors and Exceptions, Exception Handling.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Python Data Structures** **Lists:** Access, Change, Add and Remove List, Loop, Sort, Copy, Join, List Methods- **Tuples**: Access, Update, Unpack Tuples, Tuple Methods- **Sets:** Access, Add, Remove Set Items, Loop, Join Sets, Set Operators, Set Methods- **Dictionary:** Access, Add, Remove Dictionary Items, Operators. Dictionary Methods, Dictionary Keys.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Functional Programming:** Lambda, Iterators, Generators, List Comprehensions. **Modules**: Module Introduction, Built-in modules: OpenCV, NumPy, Pandas,Scikit-learn, NLTK, spaCy, TensorFlow- Module Loading and Execution.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Data Visualization using Matplotlib and Seaborn Basic Plots with Matplotlib:**Line plots, Area plots, Histograms, Bar charts, Box plots,Pie charts, , Lag Plots, Autocorrelation Plots, Bootstrap Plots, **Statistical graphics using Seaborn:** Stripplot, Swarmplot, Heatmap, Pairplot, Regression Plot – Formatting – Customizing Visualizations.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Python GUI Development:** Building Python GUI Application using Tkinter, Working With Widgets, Case Study.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Meenu Kohli, *Advance Core Python Programming Begin your Journey to Master the World of Python*, Bpb Publications, 2021.
2. Allen B. Downey, *Think Python: How to Think Like a Computer Scientist*, Second Edition, Shroff, O'Reilly Publishers, 2016.
3. Sedgewick and Wayne, Dondero, *Introduction to Programming in Python*, Third Edition Pearson Education, 2016.

References

1. Joakim Sundnes, *Introduction to Scientific Programming with Python (Simula Springer Briefs on Computing)*, Springer, 2020
2. Reema Thareja, *Python Programming using Problem Solving Approach*, Oxford University Press, First edition, 2017.
3. Charles Dierbach, *Introduction to Computer Science using Python*, Wiley India Edition, First Edition, 2016.
4. Guido van Rossum, Fred L. Drake Jr., *An Introduction to Python – Revised and Updated for Python 3.2*, Network Theory Ltd., First edition, 2011
5. Mark Lutz, *Learning Python: Powerful Object Oriented Programming*, Fourth Edition, O,Reilly Media, 2013

Suggested Readings

1. Zed Shaw, *Learn more python 3 hard way: The next step for new python programmers*, Addison Wesley, 2017
2. John V Guttag, *Introduction to Computation and Programming Using Python*, Revised and Expanded Edition, MIT Press, 2013

Web Resources

1.www.tutorialspoint.com/python/python_object_classes.htm
2.www.geeksforgeeks.org/python-programming-languagee/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	2	2	3	2	1	2	2	2	2	K1
CO 2	3	3	2	2	3	2	3	3	3	3	3	K2
CO 3	3	3	2	2	3	3	3	3	3	3	3	K3
CO 4	3	3	2	2	3	3	3	3	3	3	3	K4
CO 5	3	3	2	2	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	2	2	3	2.6	2.6	2.8	2.8	2.8	2.8	
Overall mapping of the Course with POs -2.6								Overall mapping of the Course with PSOs - 2.8				

COURSE TITLE: API DEVELOPMENT AND INTEGRATION

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		

Course Objectives	• To introduce students to the fundamentals of API development • To enable students to design, develop, and integrate RESTful APIs • To provide hands-on experience with API authentication, security, and documentation and explore third-party API integration and real-world use cases

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
CO1	Remember the fundamentals of APIs	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the concepts of REST APIs, API Design, integration and security	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the concepts to design a fully functional API	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the API performance, error handling mechanisms, and best practices for API design	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate and integrate the existing and user defined APIs using appropriate tools and frameworks	PSO1, PSO2, PSO3, PSO4	K5
CO6	Develop a fully functional API including documentation and deployment	PSO1, PSO2, PSO3, PSO4	K6

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Introduction to APIs and Fundamentals of REST APIs** Definition - API vs. Web Services - API Request and Response Lifecycle- Types of APIs: REST, SOAP, GraphQL- Benefits and Use Cases of APIs - Understanding REST Architecture - REST API Principles - JSON and XML Formats - RESTful API	9	CO1, CO2, CO3, CO4 CO5, CO6	K1, K2, K3, K4, K5, K6
II	**API Design and Integration** Consuming External APIs - Handling API Responses and Errors - Principles of Good API Design - Structuring Endpoints and Resources - Using Query Parameters and Path Variables	9	CO1, CO2, CO3, CO4 CO5, CO6	K1, K2, K3, K4, K5, K6
III	**API Development** Setting Up the Development Environment - API Endpoints and	9	CO1, CO2, CO3, CO4 CO5, CO6	K1, K2, K3, K4, K5, K6

	Resource Naming - Creating First API Endpoint - API Development Tools - Postman, Curl - Setting up a REST API - Building a REST API - CRUD Operations with Database Integration - Implementing Middleware for Logging and Validation			
IV	**API Security** Overview of API Security- Rate limiting - DDoS mitigation – Throttling - Authentication and Authorization: Implementing API Keys, Username and Password, OAuth token, mTLS - JWT-Securing Endpoints – Securing Rest APIs	9	CO1, CO2, CO3, CO4 CO5, CO6	K1, K2, K3, K4, K5, K6
V	**Testing, Deployment, and Maintenance** Unit Testing and Integration Testing- Tools for Testing -Mocking APIs for Testing – Deploying APIs - Logging and Monitoring - Importance of API Documentation-Creating API Documentation - Proper Error Handling and Status Codes – Pagination in APIs	9	CO1, CO2, CO3, CO4 CO5, CO6	K1, K2, K3, K4, K5, K6

Text Books

1. Doglio, Fernando. *REST API Development with Node.js*. Packt Publishing, 2018.
2. Geewax, JJ. *API Design Patterns*. Manning Publications, 2021.
3. Jin, Brenda, Saurabh Sahni, and Amir Shevat. *Designing Web APIs*. O'Reilly Media, 2018.
4. Sturgeon, Phil. *Build APIs You Won't Hate*. Leanpub, 2016.

Reference Books

1. Knight, Andrew. *The API Tester's Handbook*. Self-Published, 2022.
2. Madden, Neil. *API Security in Action*. Manning Publications, 2020.
3. Masse, Mark. *REST API Design Rulebook*. O'Reilly Media, 2011.

Suggested Reading

1. Wolff, Eberhard. *Microservices: Flexible Software Architecture*. Addison-Wesley, 2016
2. Leonard Richardson, Amundsen Mike, Sam Ruby, *Restful Web APIs: Services for a Changing World*, O'Reily, 2013

Web Resources

1. https://developer.mozilla.org/en-US/docs/Learn/Server-side/RESTful_web_services
2. https://expressjs.com/en/guide/routing.html
3. https://flask.palletsprojects.com/en/latest/
4. https://learning.postman.com/
5. https://swagger.io/docs/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO 1	3	3	3	2	3	2	3	3	2	2	2	K1
CO 2	3	3	3	2	3	2	3	3	2	2	2	K2
CO 3	3	3	3	2	3	2	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
CO 6	3	3	3	3	3	3	3	3	3	3	3	K6
Wt. Avg.	3	3	3	2.5	3	2.5	3	3	2.67	2.67	2.67	
Overall Mapping of the Course with POs – 2.86								Overall Mapping of the Course with PSOs – 2.75				

COURSE TITLE: MOBILE APPLICATION DEVELOPMENT

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To understand the needs and characteristics of mobile applications. • To design the right user interface for mobile applications. • To understand the design issues in the development of mobile applications. • To understand the development procedure for mobile applications. • To develop mobile applications using various Android tools and platforms. • To develop and deploy applications for mobile cross-platforms using Flutter		

On completing the course successfully, the students will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the essential Android programming syntax and Android development environment.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the concepts of Android widgets, layouts, Event Handling, SQLite database connection and Content Provider.	PSO1, PSO2, PSO3, PSO4	K1

CO3	Develop Android GUI applications using built-in widgets and work with the database.	PSO1, PSO2, PSO3, PSO4	K1
CO4	Analyze the components of Android APIs for solving real-time problems and designing an app using Android UI toolkits and frameworks and Flutter.	PSO1, PSO2, PSO3, PSO4	K1
CO5	Evaluate the significance of Android and Flutter applications.	PSO1, PSO2, PSO3, PSO4	K1

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Introduction:** Mobile Applications – Characteristics and Benefits, **Android Introduction & Building Blocks:** Android Features, Architecture, Application Components-DVM, Android Manifest file, **Development Environment:** Using Eclipse IDE for Mobile Development, Android Sdk, AVD and Emulator.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**User Interface:** Activity, Activity Life Cycle, UI Controls, Menu- Styles and Themes- I**ntents**: Linking Activities with Intent-**View Groups**: Linear Layout, Relative Layout, Table Layout, Frame Layout-Views: List View, Spinner View, Image View, GridView.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	Event Handling, **Dealing with Data**: SQLite Database Connectivity, Creating database applications. Content Providers basics.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Multimedia & Service Introduction:** Multimedia: Working with Audio and Video- **Service:** Services, Service Lifecycle, Fundamentals of Android Services, Communication Methods (JSON Parsing).	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Application Development: Telephony**SMS, Phone call, Notification, Location-based Application, Sensor, **Case Study:** Development of simple mobile applications for mobile cross platforms using Flutter.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Reto Meier, Ian Lake, *Professional Android*, 4th Edition, Wrox, 2018.
2. John Horton, *Android Programming for Beginners*, Second Edition, Packt, 2018.
3. Rap Payne, *Beginning App Development with Flutter: Create Cross-Platform Mobile Apps* , APress, 2019.

References

1. Wei-Meng Lee, *Beginning Android 4 Application Development*, Wiley, 2012.
2. Onur Cinar, *Android Apps with Eclipse*, Apress, Springer, 2012.
3. Zigurd Mednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura, *Programming Android*, O'Reilly, 2nd Edition, 2012.

Suggested Readings

1. Bill Phillips, Chris Stewart, Brian Hardy, and Kristin Marsicano, *Android Programming: The Big Nerd Ranch Guide*, 4th edition, 2019.
2. Marco L. Napoli, *Beginning Flutter A Hands On Guide to App Development*,Wiley,2019

Web Resources

1. developer.android.com/training/basics/firstapp/index.html
2. www.tutorialspoint.com/android/index.htm
3. www.javatpoint.com/android-tutorial
4. www.vogella.com/articles/Android/article.html

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO1	3	3	2	2	3	2	1	2	2	2	2	K1
CO2	3	3	2	2	3	2	3	3	3	3	3	K2
CO3	3	3	2	2	3	3	3	3	3	3	3	K3
CO4	3	3	2	2	3	3	3	3	3	3	3	K4
CO5	3	3	2	2	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	2	2	3	2.6	2.6	2.8	2.8	2.8	2.8	
Overall mapping of the Course with PO's - 2.6								Overall mapping of the Course with PSO's - 2.8				

COURSE TITLE: MOBILE COMMERCE TECHNOLOGY

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	II		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To understand M-commerce services. • To understand M -commerce infrastructure, applications and Mobile Marketing. • To know the availability of the latest technology and applications of M-commerce in various domains. • Learn how to deal with business-to-business applications. • Understand online business activities through mobile devices such as smartphones or tablet computers - across a wireless internet connection.		

On completing the course successfully, the students will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)

CO1	Learn M–commerce services, and principles to various business domains.	PSO1, PSO2, PSO3,PSO4	K1
CO2	Understand the basics of M-commerce, current and emerging business models.	PSO1, PSO2, PSO3,PSO4	K2
CO3	Apply the knowledge of mobile marketing, current technological advancements in M-commerce, and mobile applications.	PSO1, PSO2, PSO3,PSO4	K3
CO4	Classify and compare M-commerce business models.	PSO1, PSO2, PSO3,PSO4	K4
CO5	Evaluate the need of mobile commerce.	PSO1, PSO2, PSO3,PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Introduction:M–Commerce–M-Commerce Applications- Types of Mobile Commerce Services – Technologies of Wireless Business – Benefits and Limitations,M-Commerce Framework- M-Commerce Business Models .	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Wireless and Mobile Communications: Communication Systems-Analog and Digital, Wireless Communication Systems- Wireless Services, Spectrum Allocation, Wireless Systems, WLAN, Mobile Communication Systems- Broadband Technology, Wireless Broadband Internet, Wireless Application Protocol (WAP).	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	Mobile Access Technologies : 3G, 4G and 5G ,Mobile Devices : Types of Mobile Devices , Mobile Internet Device (MID) , Mobile Service Providers: Mobile Network Operators– Mobile Commerce Service Providers (Mcsp).	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Mobile Applications: Location-Based Marketing-Mobile Banking: Mobile Banking Business Models and Technologies, Mobile Ticketing: Mobile Ticketing Process, Applications of Mobile Tickets-Case Studies.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Mobile Application Development: Mobile Payments – Mobile Payment Models, Types of Mobile Payments-Mobile Payment Systems: IMPS, UPI Payment, QR Code Payment - Mobile Myment Service Providers: NIT DoCoMo, PayPal, MobilePay.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Karabi Bandyopadhyay, *Mobile Commerce*, First Edition, PHI, 2022.

References

1. U S Pandey, Saurabh Shukla, *E-Commerce and Mobile Commerce Technologies*, First Edition, Edtech , 2018.
2. Kristian Bass, E-Paul May, Tom Jell, *Mobile Commerce, Opportunities, Applications and Technologies of Wireless Business*, First Edition, Cambridge University Press, 2001.
3. Paul Skeldon, *M- Commerce*, Second Edition, Crimson Publishing, 2012.

Suggested Readings

1. Jeanne Hopkins, Jamie Turner, *Go Mobile: Location-Based Marketing, Apps, Mobile Optimized Ad Campaigns, 2D codes and other Mobile Strategies to Grow your Business*, First Edition, Wiley, 2012.
2. Brian E. Mennecke, Troy J. Strader, *Mobile Commerce: Technology, Theory and Applications*, First Edition, Idea Group Inc., IRM press, 2003.

Web Resources

1. www.tutorialspoint.com/mobile_marketing/m_commerce.htm
2. https://www.hostinger.in/tutorials/mobile-commerce
3. https://www.mobiloud.com/blog/the-basics-of-mobile-commerce

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	2	2	2	2	3	2	2	2	2	2	2	K1
CO 2	2	2	2	2	3	2	2	2	2	2	2	K2
CO 3	2	2	2	2	3	2	2	2	2	3	3	K3
CO 4	3	3	2	2	3	2	2	3	3	3	3	K4
CO5	3	3	2	2	3	2	2	3	3	3	3	K5
Wt. Avg.	2.4	2.4	2	2	3	2	2	2.4	2.4	2.6	2.6	
Overall mapping of the Course with POs - 2.25								Overall mapping of the Course with PSOs - 2.5				

COURSE TITLE: SOFT COMPUTING

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	II		
Year of Implementation	From Academic year 2025-2026 batch onwards		
Course Objectives	• To acquire knowledge on Soft systems. • To gain an understanding of Artificial neural networks and its applications. • To understand Perceptron networks. • To understand Fuzzy logic, Genetic Algorithms, Hybrid Systems and their applications • To understand the applications of Soft computing to solve problems in any application domain.		
On completing the course successfully, the student will be able to			
CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**

CO1	Remember soft computing techniques and their applications.	PSO1, PSO2, PSO3	K1
CO2	Understand the various Neural Network architectures, fuzzy systems. Genetic algorithms concepts, hybrid systems and their applications	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the ANN, fuzzy, Genetic and hybrid algorithms to create models for various dataset	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the models with the testing set against the training set.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate and select a suitable Soft Computing technology to solve a problem and construct a solution and implement a Soft Computing solution.	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Introduction to Soft Computing and Artificial Neural Networks:** Concept of computing systems - Soft versus Hard computing - Characteristics of Soft computing - Applications of Soft computing techniques - Biological neurons - Basic models of Artificial Neural Networks – Different ANN architectures - Training techniques for ANNs - Applications of ANNs to solve some real-life problems.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Perceptron Networks:** Learning rule – Training and testing algorithm, Adaptive Linear Neuron, Back Propagation Networks – Architecture, Back Propagation Learning, Training algorithm, Effect of Tuning Parameters of the BPN, Selection of various parameters in BPN, Applications.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Fuzzy logic**: Introduction to Fuzzy logic – Fuzzy vs Crisp - Fuzzy sets and membership functions – Crisp sets and member functions – Predicate Logic – Fuzzy Logic - Operations on Fuzzy sets - Fuzzy relations, rules, propositions, implications and inferences - Defuzzification techniques – Fuzzy BP networks - Applications of Fuzzy logic.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Genetic Algorithms (GAs)**: Concept of Genetics and Evolution and its application to probabilistic search techniques - Basic GA framework and different GA architectures - GA operators: Encoding, Crossover, Selection, Mutation, etc. - Solving single-objective optimization problems using GAs - A simple program / case study on ANN/Fuzzy algorithm / Genetic algorithms	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Hybrid Systems** Integration of Neural Networks, Fuzzy Logic and Genetic Algorithms - Fuzzy Associative	9	CO1, CO2, CO3,	K1, K2, K3, K4, K5

	Memories - FAM, An introduction - Single Association FAM - Fuzzy Hebb FAMs - FAM involving a Rule Base - FAM Rules with Multiple Antecedents/Consequents – Applications - Fuzzy Logic Controlled Genetic Algorithms - Soft Computing Tools - Problem Description of Optimum Design - Fuzzy Constraints - GA in Fuzzy Logic Controller Design - Fuzzy Logic Controller - Applications		CO4, CO5	

Text Books

1. Sivanandam S.N., Deepa S.N., *Principles of Soft Computing*, Wiley India Pvt. Ltd., Reprint 2012
2. S. Rajasekaran, and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis, and Applications*, Prentice Hall of India, 2007.
3. Samir Roy, Udit Chakraborty, *Introduction to Soft Computing Paperback*, Pearson, 2013

References

1. Jang J.S.R., Sun C.T., and Mizutani E., *Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence*, Pearson India, 2015.
2. David E. Goldberg, *Genetic Algorithms In Search, Optimization And Machine Learning*, Addison Wesley, 2007.
3. D. K. Pratihar, *Soft Computing*, Narosa publn., 2008.K. Sundareswaran, "*A Learner's Guide to Fuzzy Logic Systems*", Jaico Publishing House, 2006.

Suggested Readings

1. Simon Haykin, *Neural Networks and Learning Machines*, (3rd Edn.), PHI Learning, 2011.
2. Timothy J. Ross, *Fuzzy Logic with Engineering Applications* (3rd Edn.), Willey, 2010.

Web Resources

1. https://www.javatpoint.com/what-is-soft-computing
2. https://www.elprocus.com/soft-computing/
3. https://onlinecourses.nptel.ac.in/noc23_cs40/preview

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	2	-	2	-	2	3	2	2	-	K1
CO 2	3	2	2	2	2	2	3	3	2	2	2	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	2	3	3	3	3	3	K4
CO 5	3	3	3	3	3	2	3	3	3	3	3	K5
Wt. Avg.	3	2.6	2.6	2.75	2.6	2.25	2.8	3	2.6	2.6	2.75	
Overall Mapping of the Course with POs – 2.66								Overall Mapping of the Course with PSOs – 2.74				

COURSE TITLE: BLOCKCHAIN AND CRYPTOCURRENCY

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To understand the need of Block chain applications. • To understand the usage of Bitcoins as decentralized cryptocurrency. • To know about the emerging trends of Cryptocurrency as a Digital Asset.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	To know and learn about cryptography and Digital Signature tools.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand Blockchain and its role in the society	PSO1, PSO2, PSO3, PSO4	K2
CO3	Build and compare the role of Distributed Consensus in Blockchain applications	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the impact of Global Market due to cryptocurrencies.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the global market and global economy through blockchain applications	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Blockchain: Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

III	Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate. Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Joseph Bonneau and Arvind Narayanan, *Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction*, First Edition, Princeton University Press, 2016.
2. Roger Wattenhofer, *The Science of the Blockchain*, First Edition, CreateSpace 2017
3. Andreas S. Antonopoulos, *Mastering Bitcoin: Unlocking Digital Cryptocurrencies*., First Edition, O'Reilly, 2014

References

1. Arvind Narayanan and Joseph Bonneau, *Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction*, First Edition, Princeton University Press, 2016
2. Saifedean Ammous *The Bitcoin standard: The Decentralized Alternative to Central Baning* First Edition, Wiley, 2018
3. Kumar Saurabh, *"Blockchain Technology: Concepts and Applications"*, Wiley, 2020

Suggested Readings

1. Ambadas, Arshad *"Blockchain for Enterprise Application Developers"*, Wiley, 2020
2. GitHub - frankiefab100/Blockchain-Development-Resources: The contents of this repository will help you launch a career in Blockchain development. How to deploy Smart contracts on Ethereum, build DApps, DeFi, DAO, NFT and Token protocol.

Web Resources

1. IBM DeveloperIoT Tutorial | Internet of Things Tutorial - Javatpoint
2. Cyber Security Tutorial: A Step-by-Step Tutorial [Updated 2021] (simplilearn.com)
3. https://www.dappuniversity.com/articles/blockchain-tutorial

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO1	3	2	1	1	2	1	2	3	2	2	2	K1
CO2	3	3	2	2	2	2	3	3	2	2	2	K2
CO3	3	3	3	3	3	3	3	3	3	3	3	K3
CO4	3	3	3	3	3	3	3	3	3	3	3	K4
CO5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.8	2.4	2.4	2.6	2.4	2.8	3	2.6	2.6	2.6	
Overall mapping of the Course: POs - 2.6								Overall mapping of the Course: PSOs-2.5				

COURSE TITLE: CYBER SECURITY AND FORENSICS

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	● To bring awareness to students on the numerous possible computer-related crimes ● To present the existing laws and methods of countering the crimes ● To ignite the creative thinking of students to analyze an existing Cybercrime case and present a solution alternative, if any through a Case study		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the awareness on Cybercrimes and its impact	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the threats related to mobile applications	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the cyber tools to identify the threats	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze and influence the student to take up a career in cyber forensics and / or Cyber security	PSO1, PSO2, PSO3, PSO4	K4
CO5	Create concepts of cyber security and forensics through a project and provide innovative solutions	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Cyber Crime - Internet: Introduction, Categories and Classifications of Cybercrimes: E-Mail Spoofing, Spamming, Cyber defamation, Hacking, Software Piracy, Password Sniffing, Credit Card Frauds and Identity Theft.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Cybercrime- Cyber offenses: Passive Attack, Active Attacks Cyberstalking, Cybercafe and Cybercrimes, Botnets: The Fuel for Cybercrime Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

	Mobile and Wireless Computing Era, Mobile security			
III	Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, SQL Injection.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Computer Forensics: Introduction, Digital Forensics -Digital Evidence, Network forensics, Computer Forensics Investigation, Digital Forensics life cycle, Forensics and Social Networking Sites: The Security/Privacy Threats, Challenges	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Forensics of Hand-Held Devices: Hand-Held Devices and Digital Forensics, Toolkits for Hand-Held Device Forensics: EnCase, Device Seizure and PDA Seizure, Palm DD, Forensics Card Reader, Cell Seizure	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Nina Godbole, Sunit Belapur, *Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*, Wiley India Publications, 2011
2. James Graham, Richar Howard,Ryan Olson, *Cyber Security Essentials*, CRC Press, Tailor and Francis Group, 2011
3. Robert E. Davis, *"Auditing Information and Cyber Security Governance"*, CRC Press, 2021

References

1. Robert Jones, *Internet Forensics: Using Digital Evidence to Solve Computer Crime*,
2. O'Reilly Media, 2005
3. Chad Steel, *Windows Forensics: The field guide for conducting corporate computer investigations*, Wiley India Publications, 2006
4. 3. Liam Smith *Cyber Security for Beginners*, 2022

Suggested Readings

1. https://govcyberhub.com/2020/02/19/six-cybersecurity-trends-to-watch-in-2020/.ZBhn7cJBy3C
2. Aamer Khan, *Ethical Hacking : The Beginning (Digital Hacking Tools Free)* Hack Book works, 2021

Web Resources

1. What is Cyber Security? | Definition, Types, and User Protection (kaspersky.co.in)
2. What is Cybersecurity? | IBM
3. https://www.udemy.com/course/learn-ethical-hacking-from-a-z-beginner-to-expert-course/?couponCode=IND21PM

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO4	PO5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	1	1	2	1	2	3	2	2	2	K1
CO 2	3	3	2	2	2	2	3	3	2	2	2	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4

CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.8	2.4	2.4	2.6	2.4	2.8	3	2.6	2.6	2.6	
Overall mapping of the Course: PO's - 2.63,							Overall mapping of the Course: PSO's - 2.5					

COURSE TITLE: ETHICAL HACKING

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To learn various hacking techniques and attacks. • To know how to protect Windows and Networks • To know how to protect data assets against attacks from the Internet. • To assess and measure threats to information assets. • To evaluate where information networks are most vulnerable.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Recall and remember hacking attacks, security systems and remember the various ways of hacking	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand different types of security and their attacks.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the safe techniques of hacking on the World Wide Web, network infrastructure vulnerabilities, web applications and cracking passcodes.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyse the various attacks in order to take countermeasures	PSO1,PSO2, PSO3, PSO4	K4
CO5	Assess and evaluate the vulnerabilities and evaluate the windows, network and web security testing tools	PSO1,PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Introduction to Ethical Hacking and Methodology Introduction to Ethical Hacking: Planning and performing attacks - Five stages of Ethical Hacking – Ways to conduct Ethical Hacking - Types of hacking – Hacker types	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

	Hacking Methodology: Setting the stage for testing - Seeing what others see - Scanning systems - Determining what's running on open ports - Assessing vulnerabilities - Penetrating the system			
II	Reconnaissance and Social Engineering *Reconnaissance:* HTTrack - Google Directives – Harvester - Whois – Netcraft – Host - Fierce and other tools to extract information from DNS - Extracting Information From E-mail Servers – MetaGooFil – ThreatAgent	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	Windows Hacking and Security Security architecture of Windows – Windows User Account Architecture and Attack – Windows vulnerabilities – Detecting null sessions - Cracking BIOS and Windows Password – Changing Windows Visuals – Editing the OS – Registry - Other system files – Checking share permissions	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Network Hacking Network infrastructure vulnerabilities - Scanning, poking and prodding the network - IP address – DNS – NslookUp – Port scanning and surfing - Sockets – PING – Netstat – Getting information about a domain – FTP Port and using FTP Client – FTP Commands –Detecting common Router, Switch and Firewall weaknesses – Discovering wireless network attacks and taking countermeasures -	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Web Hacking and Cracking Passwords *Web Hacking:* Get, Post and Head methods – Hacking from Web Browser – Post Dial Up Screen hacking – Web security testing tools – Web Vulnerabilities – Minimizing Web security risks *Cracking Passwords:* Password vulnerabilities – Cracking passwords – Password cracking countermeasures	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Ankit Fadia, *Ethical Hacking*, Second Edition, Macmillan India Ltd, 2006

References

1. Kevin Beaver, *Hacking for Dummies*, Fifth Edition, Wiley, 2016
2. CEH *official Certfied Ethical Hacking Review Guide*, Wiley India Edition, 2015.
3. Kenneth C.Brancik, *Insider Computer Fraud*, Auerbach Publications Taylor & Francis Group, 2008.

Suggested Readings

1. Patrick Engebretson, *The Basics of Hacking and Penetration Testing*, Second Edition, Syngress, 2013
2. 13 Best Ethical Hacking Courses Online in 2025 [Free + Paid] (hackr.io)

3. Free Ethical Hacking Tutorials for Beginners [Learn How to Hack] (guru99.com)
Web Resources 1. https://ethicalhackingblog.com/ 2. https://pentestblog.in/ 3. https://www.udemy.com/course/learn-ethical-hacking-from-a-z-beginner-to-expert-course/?couponCode=IND21PM

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	1	1	2	1	2	3	2	2	2	K1
CO 2	3	3	2	2	2	2	3	3	2	2	2	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.8	2.4	2.4	2.6	2.4	2.8	3	2.6	2.6	2.6	
Overall mapping of the Course: PO's - 2.63								Overall mapping of the Course: PSO's - 2.5,				

COURSE TITLE: INFORMATION SECURITY

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To understand Encryption and Decryption techniques in cryptography. • To understand the importance of Security in Networks and Databases. • To strengthen knowledge on Security Standards and Models.		
On completing the course successfully, the student will be able to			
CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
CO1	Remember the importance of security in the digital world.	PSO1, PSO2, PSO3, PSO4	K1
CO2	To understand and gain knowledge on Cryptography and its need.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the security features to obtain secured database connection	PSO1, PSO2, PSO3, PSO4	K3

CO4	To analyze about Firewalls and various malicious Software in networks and databases.	PSO1, PSO2, PSO3, PSO4	K4
CO5	To evaluate and create the security models and standards	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Elementary Cryptography Terminology and Background – Substitution Ciphers – Transpositions Technique – Encryption algorithm-DES–Digital Signatures – Certificates	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Program Security Secure programs – Non-malicious Program Errors – Malicious code – Countermeasures for Users and Developers – User Authentication: Tokens and Biometrics – Good Coding Practices – Security in Operating Systems: Layered Design and Kernelized Design	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	Security In Networks Threats in networks – Encryption – Virtual Private Networks –IPSec – Content Integrity – Access Controls – Wireless Security – Honeypots – Traffic Flow Security – Firewalls – Intrusion Detection Systems – E-mail attacks.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Security In Databases Security requirements of database systems – Reliability and Integrity in databases – Redundancy – Recovery – Concurrency/ Consistency – Monitors – Sensitive Data – Types of disclosures –Inference-Finding and Confirming SQL injection	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Security Models And Standards Secure SDLC – Secure Application Testing – Security architecture models – Trusted Computing Base – Bell-LaPadula Confidentiality Model – Biba Integrity Model– Security Standards - ISO 27000 family of standards – NIST.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Charles P. Pfleeger and Shari Lawrence Pfleeger, *Analyzing Computer security Computing-A threat*, Fourth Edition, Prentice hall, 2012.
2. Michael Whitman and Herbert J. Mattord, *Management of Information Security*, Third Edition, Cengage Learning, 2010.
3. William Stallings, *Cryptography and Network Security : Principles and Practices*, Fifth Edition, Prentice Hall, 2012.
4. JAson Andress, " Foundation of Information Security", No starch press, 2019

References

1. Michael Howard, David LeBlanc and John Viega, *24 Deadly Sins of Software Security: Programming Flaws and How to Fix Them*, First Edition, Mc GrawHill Osborne Media, 2009.
2. Robert E. Davis, *"Auditing Information and Cyber Security Governance"*, CRC Press, 2021
3. Neil Daswani *"Big Breaches: Cybersecurity Lessons for Everyone",* 2021

Suggested Readings

1. Matt Bishop, *Computer Security: Art and Science*, First Edition, Addison-Wesley, 2002.
2. W3C Security Resources

Web Resources

1. Firewall Security Management - ManageEngine Firewall Analyzer
2. What is Database ecurity | Threats & Best Practices | Imperva
3. https://tryhackme.com/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO3	PO 4	PO5	PO6	PO 7	PSO 1	PSO 2	PSO 3	PSO4	
CO 1	3	3	3	3	3	2	3	3	3	2	2	K1
CO 2	3	3	3	3	3	2	3	3	3	2	2	K2
CO 3	3	3	3	3	3	2	3	3	3	2	2	K3
CO4	3	3	3	3	3	2	3	3	3	2	2	K4
CO5	3	3	3	2	3	2	3	3	3	2	2	K5
Wt. Avg.	3	3	3	2.8	3	2	3	3	3	2	2	
Overall mapping of the Course: POs-2.82						Overall mapping of the Course: PSOs-2.5						

COURSE TITLE: TEST AUTOMATION AND TOOLS

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To gain knowledge about the fundamental concepts test automation. • To learn techniques and tools for web applications testing, mobile application testing, API testing, performance testing of a web application and cross-browser testing. • To apply the concepts learned in testing a web application, mobile app and an API.		
On completing the course successfully, the student will be able to			

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the fundamental concepts of test automation	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the concepts of web applications testing, mobile application testing, API testing, performance testing of a web application and cross-browser testing.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the tools in testing a website, mobile application, API and performance of a web application	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze the various automated testing that are carried out	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the automated test results and generate reports	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Fundamentals of Test Automation** Types of Automated Tests: Unit Tests, Integration Tests, Functional Tests, Regression Tests, Performance Tests, Security Tests – Test Automation Life Cycle – When and how to do automation testing - Test Automation Frameworks: linear automation, modular-based testing, library architecture testing, data-driven, keyword-driven, hybrid testing and behavior-driven - Components of a test automation framework: Test Data Management, Object Repository, Utilities and Reusable Functions, Configuration Files, Test Scripts, Test Results and Reporting	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Web Application Testing** Process of Web Application Testing – Functionality, usability, interface, compatibility, performance and security testing of web applications - Crowd testing – Database testing – Testing tools: Selenium, Cypress, Puppeteer, Playwright – Selenium Testing: Importance, History, Components of Selenium: Selenium IDE, Selenium RC, Selenium Web Driver and Selenium Grid, Selenium Grid 4 Architecture, Understanding Selenium Web Driver, Usage of Selenium: Prerequisites for automation testing in Selenium, Performing automation testing in Selenium - Case Study: Test three websites using Selenium and present an analysis report	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

III	**Mobile Application Testing** Types of Mobile Applications – Importance of Mobile Application testing – Approaches to testing Mobile Applications – Advantages – Types of Mobile and Mobile Applications Mobile application testing strategies -Testing Tools: Appium, Espresso (Android), XCTest (iOS), Detox – Appium: History of Appium, Architecture of the Appium Framework, Appium for IOS and Android, Appium Doctor and Inspector, Testing a Mobile App with Appium, Cloud Based Mobile App, Testing using Appium, Case study: Test a Mobile App using Appium	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**API Testing** Key Aspects of API Testing, Types of APIs: REST, SOAP, GraphQL - Relationship between API testing and API monitoring - Types of API testing - - API Testing using Postman: design API specifications in Postman, Create mock servers in Postman to simulate API end points - Build and run tests directly in Postman Mock Servers – Case Study: Test any healthcare app to check if it works well with healthcare providers' scheduling and security (opening of an appointment slot, appointment confirmation, secured transmission of medical data) using Postman.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Performance Testing, Cross-browser Testing and Continuous Integration Tools** Types of Performance Tests: Load Testing, Stress Testing, Endurance Testing, Spike Testing - Key Performance Metrics – Tools for Performance Testing: JMeter, Gatling, LoadRunner, K6 - Tools Cross-browser testing: Importance - Features that are analyzed - Selecting browsers for testing - Process of testing - Tools: BrowserStack, Sauce Labs, LambdaTest - Continuous Integration: Creating the test build process, Changing the development processes and culture, Decreasing the test run duration, Tools: Jenkins, GitLab CI, CircleCI, Travis CI - Case Study: Perform Performance Testing & Load Testing of a web application with JMeter by creating a Test Plan, adding a Thread Group, Sampler (HTTP Request) and Listeners, Configure Load Scenarios, run the test and analyze the results	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Boby Jose, *Test Automation A Manager's Guide,* BCS, 2021
2. Yogashiva Mathivanan, *Selenium and Appium with Python: Build robust and scalable test automation frameworks using Selenium, Appium and Python* bpb, 2023
3. Syeda Javaria, Imtiaz, *Automated Testing for Web Applications*, Blurb, 2022
4. Nishant Verma, *Mobile Test Automation with Appium*, Packt, 2017
5. Arnon Axelrod, *Complete Guide to Test Automation Techniques, Practices and Patterns for Building and Maintaining Effective Software Projects,* Apress, 2018
6. Dave Westerveld, *API Testing and Development with Postman API creation, testing, debugging, and management made easy,* Second Edition, packt, 2024
7. Bayo Erinle, *Performance Testing with JMeter 3, Third Edition, Packt, 2017*

References

1. Navneesh Garg, *Test Automation using Selenium WebDriver with Java: Step by Step Guide*, 2014
2. Daniel Knott, *Hands-On Mobile App Testing: A Guide for Mobile Testers and Anyone Involved in the Mobile App Business*, 2015
3. Emily H. Halili, *Apache JMeter A Practical Beginner's Guide to Automated Testing and Performance Measurement for Your Websites*, Packt, 2008
4. 4. Mark Winteringham, *Testing Web APIs*, 2022

Suggested Readings

1. Dorothy Graham, Mark Fewster, *Experiences of Test Automation: Case Studies of Software Test Automation*, Lee Copeland, 2011
2. Elfriede Dustin, Thom Garrett, Bernie Gauf, *Implementing Automated Software Testing How to Save Time and Lower Costs While Raising Quality*, Pearson Education, 2009

Web Resources

1. https://usersnap.com/blog/web-application-testing/
2. https://www.browserstack.com/selenium
3. https://www.geeksforgeeks.org/what-is-mobile-application-testing/
4. https://www.lambdatest.com/appium
5. https://jmeter.apache.org/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	3	3	3	2	3	3	3	3	2	K1
CO 2	3	3	3	3	3	3	3	3	3	3	3	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	3	3	2.8	3	2.8	3	3	3	3	2.8	
Overall Mapping of the Course with POs – 2.94								Overall Mapping of the Course with PSOs – 2.95				

COURSE TITLE: DIGITAL MARKETING ANALYTICS

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To learn how to take a systematic approach to develop a Digital Marketing strategy • To know the various Digital Analytic tools with overall marketing objectives • To learn global strategy in digital marketing. • To learn all the essentials of mobile analysis.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Relate to digital media marketing and remember its needs and analytics.	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand digital marketing principles, needs, types, metrics, influence, research plans and analytics and choose the tools used for digital marketing analytics.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the necessary tools to measure the various metrics in Digital Media	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyze and appraise the outcomes of digital influence and listening, formulate a research plan and perform search analytics, ROI and Mobile analytics on the digital marketing data.	PSO1, PSO2, PSO3, PSO4	K4
CO5	Evaluate the various analytics and improvise the marketing strategies	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Digital Marketing and Digital Media:** Digital marketing principles - Digital media types: Paid, Owned and Earned – Social media metrics: Owned (Facebook, Twitter, SlideShare, Pinterest, Google+, flickr, LinkedIn), Earned metrics – Paid searches and Organic Searches	9	CO1, CO2, CO3 CO4, CO5	K1, K2, K3, K4, K5

II	**Digital Analytics – Social Media Listening and Engagement** Social Media Listening tools: Identification and selection of social media listening tools, Sysomos and Radian6 Social media engagement – Need and usage, Understanding social media engagement software – Social media engagement tools.	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4. K5
III	**Digital Analytics – Search Analytics, Audience and Content Analysis** Search Analytics – Use cases, Free tools for collecting insights through search data, Google trends, YouTube trends, Google Adwords, Yahoo clues, Paid tools for collecting insights through search data. Audience Analysis – Use Cases, Audience analysis tool types – Audience analysis Techniques, Conversation typing, Event Triggers. Content Analysis – Content auditing, Page Trawler	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Digital Influence and Listening** Core elements of digital influence - Tipping Point Phenomenon - Community Rules Phenomenon - Developing a modern-day media list - Tools: Klout, PeerIndex - Online versus Offline Influence - Conversation online - Online influencers - Use of Online data for crisis anticipation – Managing issues - Corrections after crisis	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4. K5
V	**ROI and Mobile Analytics:** Return on Investment (ROI) – Return on Engagement - Return on Influence, Return on Experience – Tracking ROI - Mobile Analytics – Mobile market landscape – Mobile marketing measurement – Marketing activities – Audience/visitor metric – Mobile app performance - Social CRM– Social CRM Initiative - Future of Digital Data	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4. K5

Text Books

1. Chuck Hemann and Ken Burbary, Digital Marketing Analytics: Making Sense of Consumer Data in a Digital World, Second Edition, Pearson, 2017
2. Wayne L.Winston, *Marketing Analytics: Data driven techniques and Microsoft Excel*.

Reference Books

1. Simon Kingsnorth, Digital Marketing Strategy: An Integrated Approach to Online Marketing, Fourth edition, Kogan Page Publisher, ISBN-13: 978-1398622078, 2025.
2. Dave Chaffey, Fiona Ellis-Chadwick, *Digital Marketing – Strategy, Implementation and Practice*, Sixth edition, Pearson Education, ISBN-13: 978-1292077611, 2016.
3. Calvin Jones, *The best digital marketing campaigns in the world*, Mastering The Art of Customer Engagement

Suggested Reading

1. Eric Enge, Andy Crestodina, Larry Kim, Steve Rayson and Chad White, *How the Pros Turn Marketing Analytics Into Effective Marketing Strategies*, Alexa, An Amazon Company.

Web Resources

1. blog.alexa.com/wp-content/uploads/2016/12/How-to-Pros-Turn-Marketing-Analytics-into Effective-Marketing-Strategies-ebook.pdf
2. https://piwik.pro/blog/digital-marketing-analytics-beginners-guide/
3. https://careerfoundry.com/en/blog/digital-marketing/digital-marketing-analytics/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	1	1	1	1	2	3	2	2	1	K1
CO 2	3	2	2	2	2	2	3	3	2	2	1	K2
CO 3	3	3	2	2	3	2	3	3	3	2	3	K3
CO 4	3	2	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.4	2.2	2.2	2.4	2.2	2.8	3	2.6	2.4	2.2	
Overall Mapping of the Course with Pos – 2.46								Overall Mapping of the Course with PSOs – 2.55				

COURSE TITLE: GENERATIVE AI

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	III		
Year of Implementation	From the Academic year 2025 – 2026 batch onwards		
Course Objectives	• Understand and apply the fundamentals of Generative AI and large language models. • Implement GPT architecture for text generation and dialogue systems. • Implement and optimize GANs and VAEs for image generation, including training, fine-tuning, and advanced techniques. • Understand ethical implications of Generative AI in science.		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Understand the fundamental concepts and technologies involved in Generative AI development	PSO1,PSO2, PSO3, PSO4	K1

CO2	To understand the impact of generative AI in various fields.	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the GPT model for natural language processing tasks.	PSO1, PSO2, PSO3, PSO4	K3
CO4	Generate text using neural network models by understanding its concepts, methods and techniques	PSO1, PSO2, PSO3, PSO4	K4
CO5	Implement Generative Adversarial Networks (GANs) for image generation tasks using TensorFlow	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Introduction:** The Impact of Generative AI on Business and Society, Emerging Trends and Technologies in Generative AI, Ethical Challenges and Regulatory Frameworks, Real-World Applications of Large Language Models. **Generative AI Applications:** Applications in Various Fields : Art and Creativity, Image and Video Generation, Text Generation, Music Composition, Healthcare, Finance. Real-world use cases and challenges in deploying generative AI models	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Large Language Models:** Overview of Generative AI and Large Language Models. Basics of attention mechanisms and Transformer architecture. Pre-training techniques and transfer learning strategies. **GPT Models and Applications:** Study of GPT architecture and variants. Applications of GPT models in text generation and dialogue systems	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Text Generation with Generative AI:** Introduction to Text Generation, LSTM-based Text Generation, Transformer-based Text Generation, Fine-Tuning Language Models, and Text Generation Applications	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Image Generation with Generative AI:** Introduction to Image Generation, Implementing GANs for Image Generation. Training and Fine-Tuning GANs, Generating Images with VAEs, Advanced Techniques in Image Generation, and Image and Video Generation Applications.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Responsible AI:** Importance of ethical and unbiased algorithms in AI systems, Ethical frameworks and principles for AI development, Techniques for Implementing Unbiased Algorithms, Roles and responsibilities of stakeholders in the AI ecosystem. **Prompt Engineering**: Messages and roles, Strategies for getting better results, Tactics to be	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

	used for the strategies, Optimising model outputs, Prompt caching **Future Directions:** Emerging trends and future directions in Generative AI.			

Text Books

1. Altaf Rehmani , *Generative AI for Everyone: Understanding the Essentials and Applications of This Breakthrough Technology*.
2. Joseph Babcock and Raghav Bali, *Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs*, LSTMs,Transformer models", Packt Publishing, 2021

References

1. Josh Kalin, *Generative Adversarial Networks Cookbook: Over 100 recipes to build generative models using Python, TensorFlow, and Keras*.
2. Jesse Sprinter, *Generative AI in Software Development: Beyond the Limitations of Traditional Coding*, 2024.
3. urafsky, D. and J. H. Martin. *Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*, Third Edition, Prentice-Hall, 2019
4. Steven Bird, S., Klein, E., Loper, E, *Natural Language Processing with Python - Analyzing Text with the Natural Language Toolkit*, O'Reilly Media, 2010.
5. Ehud Reiter and Robert Dale (2000) *Building Natural Language Generation Systems*, Cambridge University Press, 2000
6. https://www.analyticssteps.com/blogs/natural-language-generation-nlg-types-working-and-applications

Suggested Readings

1. https://devopedia.org/natural-language-generation#qst-ans-7
2. https://medium.com/nerd-for-tech/create-ai-application-in-minutes-with-openai-api-5e84bd3ec5d0
3. Nitin Indurkhya and Fred J. Damerau, Handbook of Natural Language Processing, 2nd Edition, Chapman & Hall Crc, 2010

Web Resources

1. https://elearn.nptel.ac.in/shop/iit-workshops/completed/leveraging-generative-ai-for-teaching-programming-courses/?v=c86ee0d9d7ed
2. https://elearn.nptel.ac.in/shop/iit-workshops/completed/introduction-to-language-models/?v=c86ee0d9d7ed
3. https://platform.openai.com/docs/guides/prompt-engineering
4. https://platform.openai.com/docs/guides/prompt-caching
5. https://cookbook.openai.com/articles/related_resources

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Cognitive Level				Cognitive level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	1	1	2	1	2	3	2	2	2	K1
CO 2	3	3	2	2	2	2	3	3	2	2	2	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5

Wt. Avg.	3	2.8	2.4	2.4	2.6	2.4	2.8	3	2.6	2.6	2.6	
Overall mapping of the Course with PO: 2.63							Overall mapping of the Course with PSO: 2.7					

COURSE TITLE: NATURAL LANGUAGE PROCESSING

Course Code			
Credits	4		
Hours / Cycle	3		
Category	Part I	Elective	Theory
Semester	III		
Year of Implementation	From the Academic year 2025 - 2026 onwards		
Course Objectives	• To enable the students to understand the basics of language structure and how it is represented and processed by the computer • To learn the concepts and how natural language text is generated by the computer. • To have the knowledge of programming and skill to use software tools for NLP and NLG • To understand the concepts and developments in large language models. • To enable application of concepts learnt on NLP and NLG to real-life problems		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO1	Remember the basics of Human language and the concepts, algorithms, programming language and tools to process and generate natural language text	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand and gain adequate applicative and computing knowledge on text pre-processing and generation	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply NLP and NLG concepts to development of applications to real-life problems	PSO1, PSO2, PSO3, PSO4	K3
CO4	Generate text using neural network models by understanding its concepts, methods and techniques	PSO1, PSO2, PSO3, PSO4	K4
CO5	Generate text using GPT models	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**NLP**: Phases and challenges– Language and Grammar - Syntax, Semantics, and Pragmatics, Morphology and Lexicons - Language Models - **Lexical Analysis:** Text Preprocessing with NLTK programs -Tokenization, Part of Speech (POS) Tagging, Word frequency count, Stop words removal, Simple N-gram model – Stemming – Lemmatization - **Feature extraction -** Bag-of-Words model, TF-IDF model	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Syntactic Analysis/Parsing:** Top-down and Bottom-up parsing **–** Constituency-Parsing, Dependency parsing, CFG - Morphological Parsing - **Semantic Analysis:** Building blocks of a Semantic system - Meaning Representation – Lexical semantics - Word-Sense Disambiguation **IE**: NER, Relation Extraction, Template Filling - **IR** - **Semantic Parsing**. Discourse Processing, Coreference Resolution – Applications of NLP	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**NLG**: Definition, 6 Steps to NLG – Requirements of a good NLG system - Pipeline in an NLG application - Components or tasks in NLG - Technical approaches to building NLG systems ***Application of NLG:*** Analytics reporting, Content automation, Virtual assistants and chatbots	9	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Neural networks to build NLG models:** Markov model, RNN, LSTM, Transformer – Transformer model: Generative pretrained Transformer (GPT) - Bidirectional Encoder Representations from Transformers (BERT) - Evaluation of NLG models - ***Case Study***: NLP / NLG application using Python NLTK	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

V	**Large Language Models:** Overview of Generative AI and Large Language Models. **GPT Models and Applications:** Applications of GPT models in text generation and dialogue systems **Text Generation with Generative AI:** Introduction to Text Generation, LSTM-based Text Generation, Transformer-based Text Generation. Text Generation Applications.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Jurafsky, D. and J. H. Martin. *Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*, Third Edition, Prentice-Hall, 2019
2. Steven Bird, S., Klein, E., Loper, E, *Natural Language Processing with Python - Analyzing Text with the Natural Language Toolkit*, O'Reilly Media, 2010.
3. Nitin Indurkhya and Fred J. Damerau, Handbook of Natural Language Processing, 2nd Edition, Chapman & Hall Crc, 2010
4. Ehud Reiter and Robert Dale (2000) Building Natural Language Generation Systems, Cambridge University Press, 2000
5. https://www.analyticssteps.com/blogs/natural-language-generation-nlg-types-working-and-applications

References

1. https://analyzingalpha.com/openai-api-python-tutorial
2. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, *Practical Natural Language Processing, A comprehensive Guide to building real-world NLP systems*, O'Reilly Publn., 2020
3. Sohom Ghosh, Dwight Gunning, "Natural Language Processing Fundamentals", Packt Publishing Limited, 2019.

Suggested Readings

1. https://devopedia.org/natural-language-generation#qst-ans-7
2. nerd-for-tech/create-ai-application-in-minutes-with-openai-api-5e84bd3ec5d0

Web Resources

1. Application of NLP: QAS: https://www.iosrjournals.org/iosr-jce/papers/Vol19-issue6/Version-4/D1906041923.pdf
2. Application of NLP: QAS: https://www.riverpublishers.com/journal_read_html_article.php?j=JWE/17/8/5#sec17

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Cognitive Level				Cognitive level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	2	1	1	2	1	2	3	2	2	2	K1

CO 2	3	3	2	2	2	2	3	3	2	2	2	K2
CO 3	3	3	3	3	3	3	3	3	3	3	3	K3
CO 4	3	3	3	3	3	3	3	3	3	3	3	K4
CO 5	3	3	3	3	3	3	3	3	3	3	3	K5
Wt. Avg.	3	2.8	2.4	2.4	2.6	2.4	2.8	3	2.6	2.6	2.6	
Overall mapping of the Course with PO: 2.63							Overall mapping of the Course with PSO: 2.7					

DIRECTED STUDY

COURSE TITLE: ALLIED COMPUTER SCIENCE I

Course Code			
Credits	5		
Hours / Cycle	6		
Category	Part III	Allied	Theory
Semester	III		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	● To teach OO concepts like abstraction, encapsulation, information hiding, inheritance and polymorphism with examples ● To help the students to develop programming skills and to solve problems using the various OOP Concepts.		
On completing the course successfully, the student will be able to			
CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
CO1	Remember the concepts of basic python syntax	PSO1, SO2, PSO3, PSO4	K1
CO2	Understand the Basics of conditional and looping statements in Python Programming.	PSO1, SO2, PSO3, PSO4	K2
CO3	Apply and understand the concepts of strings, list and tuples	PSO1, SO2, PSO3, PSO4	K3
CO4	Analyze file operations and exceptions for strings, list, tuples and dictionary	PSO1, SO2, PSO3, PSO4	K4
CO5	To evaluate and solve problems using python	PSO1, SO2, PSO3, PSO4	K5

SYLLABUS

Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**

I	Introduction: Python, features of Python, documentation, program output, print statement, input, comment, variable, expression, statement, assignment. Function - calling functions, creating functions, formal arguments, and local variables	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Conditionals: Logical operators, conditional execution, alternative execution, chained conditionals and nested conditionals. Code blocks, indentation Iterators: Multiple assignment, while statement, for statement. Fruitful Functions and Recursion.	20	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	Strings, Lists and Tuples: Accessing elements, operators, built-in functions.	20	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Dictionaries. Introduction to Dictionaries. Operators. Built-in Functions. Built-in Methods. Dictionary Keys. NumPy package. Mathematical operations and methods.	20	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Exceptions in Python. Detecting and Handling Exceptions. Matplotlib: Data Visualizations and Graphs.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Allen Downey, Jeffrey Elkner and Chris Meyers, *How to think like a Computer Scientist Learning with Python*, Second Edition, Soho Books, 2009
2. Sedgewick and Wayne,Dondero, *Introduction to Programming in Python*, Third Edition Pearson Education, 2016

References

1. Mark Lutz, *Learning Python : Powerful Object Oriented Programming,* Fourth Edition, O,Reilly Media, 2013
2. Zed Shaw, Learn more python 3 hard way: The next step for new python programmers, Addison Wesley, 2017
3. Joakim Sundnes, *"Introduction to Scientific Programming with Python (Simula SpringerBriefs on Computing"*, Springer, 2020

Suggested Readings

1. Vedaang Gulhane, "The easiest Book on Python", Notion Press, 2020
2. Python For Beginners | Python.org

Web resources

1. Welcome to Python.org
2. Python Tutorial (w3schools.com)
3. https://www.geeksforgeeks.org/python-programming-language-tutorial/

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes						Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	
CO 1	3	3	1	1	2	2	1	3	2	2	2	K1
CO 2	3	3	1	1	2	2	2	3	2	2	2	K2
CO 3	3	3	2	2	3	2	3	3	3	3	1	K3
CO 4	3	3	2	2	3	2	3	3	3	3	2	K4
CO 5	3	3	2	2	3	2	3	3	3	3	3	K5
Wt. Avg.	3	3	1.6	1.6	2.6	2	2.4	3	2.6	2.6	2	
Overall mapping of the Course: PO's-2.32							Overall mapping of the Course: PSO's:2.55					

COURSE TITLE: ALLIED COMPUTER SCIENCE II

Course Code			
Credits	5		
Hours / Cycle	6		
Category	Part III	Allied	Theory
Semester	IV		
Year of Implementation	From the Academic year 2025-26 batch onwards		
Course Objectives	• To teach OO concepts like abstraction, encapsulation, information hiding, inheritance and polymorphism with examples • To help the students to develop programming skills and to solve problems using the various OOP Concepts. • To help the students to apply the concepts to real time situations		

On completing the course successfully, the student will be able to

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 and K5)
CO1	Remember the various concepts of programming and the basics of writing C++ programs .	PSO1, PSO2, PSO3, PSO4	K1
CO2	Understand the concepts of Object Oriented Principles	PSO1, PSO2, PSO3, PSO4	K2
CO3	Apply the OO concepts and write and execute programs in C++	PSO1, PSO2, PSO3, PSO4	K3
CO4	Analyse and choose effective algorithms in problem solving	PSO1, PSO2. PSO3, PSO4	K4
CO5	Evaluate all the programs using test cases	PSO1, PSO2, PSO3, PSO4	K5

SYLLABUS

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Fundamentals of Object Oriented Programming: abstraction, encapsulation, information hiding, inheritance and polymorphism. object-oriented programming languages. Basics of C++: variables, constants, operators and expressions; Control statements – if statements, for loop, while loop, using continue, using break;	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Arrays: one-dimensional and two-dimensional arrays; Functions in C++: call by value and call by reference, arguments, return types, scope, default arguments.	20	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	Object-oriented features of C++: classes and objects; member functions, messages, constructors, destructors, copy constructors, access control specifiers	20	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Overloading: overloading member function, overloading constructor; operator overloading - unary and binary operators Inheritance: simple - multilevel - multiple	20	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Virtual base classes, Abstract classes; overriding member functions, virtual functions and Polymorphism. Exception handling.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Bjarne Stroustrup, *The C++ Programming Language*, Fourth Edition, Addison Wesley, 2013

References

1. Horton, Ivor, *Beginning C++*, Aprèss, 2014
2. Herbert Schildt, *C++: The Complete Reference*, Fifth Edition, McGraw Hill, 2012
3. E.Balagurusamy, *Object-oriented programming with C++*, Tata McGraw Hill, Seventh Edition, 2017

Suggested Readings

1. John Horton, *Beginning C++ Game Programming*, Second edition, Packt Publishing, 2016
2. John Sestak, *C++ Programming Projects Activities Workbook*, South Western Educational Pub, 2000

Web Resources

1. w3schools.com/cpp/
2. https://www.geeksforgeeks.org/c-plus-plus/
3. tutorialspoint.com/cplusplus/index.htm

Correlation of POs/PSOs to each CO

Course Articulation Matrix												
Course Outcomes	Programme Outcomes							Programme Specific Outcomes				Cognitive Level
	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PS O4	
CO 1	3	2	1	1	2	1	1	3	2	2	2	K1
CO 2	3	2	1	1	2	1	2	3	2	2	2	K2
CO 3	3	3	2	2	3	2	3	3	3	3	1	K3
CO 4	3	3	2	2	3	2	3	3	3	3	2	K4
CO 5	3	3	2	2	3	2	3	3	3	3	3	K5
Wt. Avg.	3	2.6	1.6	1.6	2.6	1.6	2.4	3	2.6	2.6	2	
Overall mapping of the Course: POs- 2.2								Overall mapping of the Course: PSOs- 2.45				

Percentage of Syllabus Revision

Course title in the old syllabus	Course title in new syllabus	Content Modified / removed / added (Enter number less than 1 for each unit)					Quantity of units modified / removed / added	% revision
		Unit I	Unit II	Unit III	Unit IV	Unit V	Total (Unit 1 to Unit 5)	
	CORE							
Data Structures and Algorithms	Data Structures and Algorithms	0.5	0.4	0.4	1	0.6	2.9	58
Object-Oriented Programming	Object Oriented Programming using Java	1	1	1	1	1	5	100
Principles of Database Management Systems	Advanced Database Technologies	1	1	1	1	1	5	100
Cloud Computing (Elective I)	Cloud Computing and Distributed Systems	1	1	1	1	1	5	100
Data Structures and Algorithms Laboratory	Data Structures and Algorithms Laboratory	0.6	0.4	1	1	0.8	3.8	76
Programming Laboratory in C++	Object Oriented Programming using Java Laboratory	1	1	1	1	1	5	100
RDBMS Laboratory	Advanced Database Technologies Laboratory	1	1	1	1	1	5	100
Artificial Intelligence	Artificial Intelligence	0	0.1	0.5	0.1	0.5	1.2	24
Software Engineering	Advanced Software Engineering	1	1	1	1	1	5	100
Web Programming	Full Stack Web Development	1	1	1	1	1	5	100
Java Programming Laboratory	Advanced Java Programming Laboratory	1	1	1	1	1	5	100
Mobile Application Development Laboratory	Mobile Application Development Laboratory	0	0.4	0.4	0.4	0.6	1.8	36
Web Programming Laboratory	Full Stack Web Development Laboratory	1	1	1	1	1	5	100

Course title in the old syllabus	Course title in new syllabus	Content Modified / removed / added (Enter number less than 1 for each unit)					Quantity of units modified / removed / added	% revision
		Unit I	Unit II	Unit III	Unit IV	Unit V	Total (Unit 1 to Unit 5)	
Data Analytics	Data Analytics and Visualization	1	1	1	1	1	5	100
Internet of Things and Cloud (Elective V)	Internet of Things and Robotics	1	1	1	1	1	5	100
-	Deep Learning	1	1	1	1	1	5	100
-	Virtual and Augmented Reality Laboratory	1	1	1	1	1	5	100
Data Analytics with Python Programming Laboratory	Data Analytics and Visualization Laboratory	1	1	1	1	1	5	100
Software Development Laboratory	Software Development Laboratory	0.1	0	0	0	0	0.1	2
Project	Project	0	0	0	0	0	0	0
	ELECTIVES							
	ELECTIVE I							
Principles of Operating Systems	Advanced Operating Systems	1	1	1	1	1	5	100
Design Thinking and Innovation	Design Thinking and Innovation	0	0	0	0.2	0	0.2	4
-	Universal Human Values	1	1	1	1	1	5	100
User Interface and User Experience Design	User Interface and User Experience Design	0.5	0.8	1	1	0	3.3	66
	ELECTIVE II							
-	Business Intelligence	1	1	1	1	1	5	100
-	DevOps and Micro Services	1	1	1	1	1	5	100
Digital Image Processing	Digital Image Processing	0	0	0	0	0	0	0
-	Python Programming	1	1	1	1	1	5	100

Course title in the old syllabus	Course title in new syllabus	Content Modified / removed / added (Enter number less than 1 for each unit)					Quantity of units modified / removed / added	% revision
		Unit I	Unit II	Unit III	Unit IV	Unit V	Total (Unit 1 to Unit 5)	
	ELECTIVE III							
-	API Development and Integration	1	1	1	1	1	5	100
Mobile Application Development	Mobile Application Development	0	0.4	0.4	0.4	0.8	2	40
Mobile Commerce Technology	Mobile Commerce Technology	0.7	0.8	0.9	1	1	4.4	88
Soft Computing	Soft Computing	0.7	1	1	1	1	4.7	94
	ELECTIVE IV							
BlockChain and Cryptocurrency	Blockchain and Cryptocurrency	0	0	0	0	0	0	0
Cyber Security and Forensics	Cyber Security and Forensics	0	0	0	0	0	0	0
Ethical Hacking	Ethical Hacking	0	0	0	0	0	0	0
Information Security	Information Security	0	0	0	0	0	0	0
	ELECTIVE V							
-	Test Automation and Tools	1	1	1	1	1	5	100
Digital Marketing	Digital Marketing Analytics	1	1	1	1	1	5	100
-	Generative AI	1	1	1	1	1	5	100
Natural Language Processing and OPENAI	Natural Language Processing	1	1	1	1	1	5	100
Directed Study	Directed Study							
Allied Computer Science I	Allied Computer Science I	0	0	0	0.8	0.8	1.6	32
Allied Computer Science II	Allied Computer Science II	0	0	0	0.3	0	0.3	6

Percentage of revision for MCA = (22/25) * 100 = 88%

Percentage of revision for UG Allied Computer Science = (1/2) * 100 = 50%