

Curriculum Structure – SE Semester-III

Course Code	Course Type	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
			L	T	P	L	T	P	SL	Notional Learning Hour	
15211301	PCC	Discrete Mathematics and Graph Theory	2	1	–	30	15	–	45	90	3
15211302	PCC	Advance Data structure and Algorithm	3	-	--	45	--	--	45	90	3
15211303	PCC	Database Management Systems and Application	3	-	–	45	--	--	45	90	3
15211304	PCC	Automata Theory	3	–	–	45	--	--	45	90	3
15212305	PCCL	Advance Data Structure and Algorithm Lab	–	–	2	--	--	30	--	30	1
15212306	PCCL	SQL lab	–	–	2	--	--	30	--	30	1
9951137WW	OE	Open Elective	2	–	–	30	--	--	30	60	2
98431308	Entrepreneurship	Entrepreneurship Development	2	–	–	30	--	--	30	60	2
98451309	Value Education Course	Environmental Science	2	–	–	30	--	--	30	60	2
15612310	Community Engagement Project	DEA LAB -3 (Innovation Design Engineering and Apply	--	-	1*+2	15	--	30	15	60	2
Total			17	1	7	270	15	90	285	660	22

Note:

1. IDEA Lab: The IDEA Lab fosters individual interdisciplinary projects through theme-based, subject-integrated, experiential learning, assessed via standardized rubrics for innovation, application, and documentation.

2. Notional Learning Hours: In higher education, Notional Learning Hours (NLH) indicates the estimated time that a typical learner, at a specific academic level, is expected to invest in order to achieve the set learning outcomes of a course or module. This time includes a range of structured and independent learning activities, each contributing to the development of knowledge and competencies within a module

3. Self-Learning (SL): Self-learning is integrated into both theory and practical subjects, particularly where practical sessions have only one contact hour per week. It emphasizes student-driven efforts in preparing for assignments, practicals, and examinations. Additionally, self-learning includes topics that go beyond the prescribed syllabus to align with current industry trends and requirements. Assessment of self-learning will follow a formative approach. For theory subjects that include term work, 30% of the assignment questions and student presentations/discussions should be based on self-learning topics. In subjects without term work, the corresponding laboratory sessions will incorporate self-learning, carrying a weightage of 30%. The subject with no term work and practical will have no assessment on self-learning topics. This may involve laboratory work using the latest tools or preparing technical write-ups/research papers on advanced topics.

Examination Scheme – SE Semester-III

Course Code	Course Type	Course Name	Examination Scheme					Term Work	Practical & Oral	Total
			In-Semester Assessment\$			End Sem . Exam (ESE)	Exam Duration for Theory (in Hrs)			
			IAT-1	IAT-2	IAT1 + IAT-2		End-Sem			
15211301	PCC	Discrete Mathematics and Graph Theory	20	20	40	60	2.5	25	–	125
15211302	PCC	Advance Data structure and Algorithm	20	20	40	60	2.5	–	–	100
15211303	PCC	Database Management Systems and application	20	20	40	60	2.5	–	–	100
15211304	PCC	Automate Theory	20	20	40	60	2.5	–	–	100
15212305	PCCL	Advance Data Structure and Algorithm Lab	–	–	–	–	–	25	25	50
15212306	PCCL	SQL lab	–	–	–	–	–	25	25	50
9951137 WW	OE	Open Elective	–	–	–	–	–	25	–	25
98431308	Entrepreneurship	Entrepreneurship Development	–	–	–	–	–	25	–	25
98451309	Value Education Course	Environmental Science	20	20	40	60	2.5	–	–	100
15612310	Community Engagement Project	IDEA LAB -3 (Innovation Design Engineering and Apply	–	–	–	–	–	50	50	100
Total			100	100	200	300	12.5	175	100	775

Teaching Scheme – SY Semester-IV

Course code	Course Type	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
			L	T	P	L	T	P	SL	Notional Learning Hour	
15211401	PCC	Sampling theory and Optimization	2	1		30	15	0	45	90	3
15211402	PCC	Software Engineering and Project Management	3			45		0	45	90	3
15211403	PCC	Operating System	3			45		0	45	90	3
15212404	PCCL	SysOps Lab			2	0		30	0	30	1
15212405	PCCL	IDEA LAB -4(Innovation Design Engineering and Apply)	--	--	1*+2	15		30	15	60	2
15412406	VSEC	Full Stack Development			2	0		30	0	30	1
9931147W	MDM	Multidisciplinary Minor Course	3			45		0	45	90	3
9931248W	MDML	Multidisciplinary Minor Course lab			2	0		30	0	30	1
9951149W	OE	Open Elective	2			30		0	30	60	2
98451410	VEC	Design Thinking	2			30		0	30	60	2
98431411	Entrepreneurship	Business Development Model	2			30		0	30	60	2
98471412	Audit Course	Audit Course	3			45		0		0	
Total			20	1	9	17	4	120	23	690	23

Note:

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3. Self-Learning (SL): Self-learning is integrated into both theory and practical subjects, particularly where practical sessions have only one contact hour per week. It emphasizes student-driven efforts in preparing for assignments, practicals, and examinations. Additionally, self-learning includes topics that go beyond the prescribed syllabus to align with current industry trends and requirements. Assessment of self-learning will follow a formative approach. For theory subjects that include term work, 30% of the assignment questions and student presentations/discussions should be based on self-learning topics. In subjects without term work, the corresponding laboratory sessions will incorporate self-learning, carrying a weightage of 30%. The subject with no term work and practical will have no assessment on self-learning topics. This may involve laboratory work using the latest tools or preparing technical write-ups/research papers on advanced topics.



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R-2025 S.Y B.Tech Information Technology Examination Scheme – SY Semester-IV

Course Code	Course Type	Course Name	Examination Scheme					Ter m Wor k	Prac tical & Oral	Total
			In-Semes ter Assess ment			End Sem Exam (ESE)	Exam Durati on for Theor y (in Hrs)			
			I A T -1	IA T- 2						
15211401	PCC	Sampling theory and Optimization	20	20	40	60	2.5	25	–	125
15211402	PCC	Software Engineering and Project Management	20	20	40	60	2.5	–	–	100
15211403	PCC	Operating System	20	20	40	60	2.5	–	–	100
15212404	PCCL	SysOps Lab	–	–	–	–	–	25	25	50
15212405	PCCL	IDEA LAB -4(Innovation Design Engineering and Apply)	–	–	–	–	–	50	50	100
15412406	VSEC	Full Stack Development	–	–	–	–	–	25	25	50
9931147 WW	MDM	Multidisciplinary Minor Course	20	20	40	60	2.5	–	–	100
9931248 WW	MDML	Multidisciplinary Minor Course lab	–	–	–	–	–	25	25	50
9951149 WW	OE	Open Elective	–	--	–	–	--	25	–	25
98451410	VEC	Design Thinking	20	20	40	60	2.5	–	–	100



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98431411	Entrepreneurship	Business Development Model	—	--	—	—	--	25	—	25
Total			100	100	200	300	12.5	200	125	825



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S.Y. B. Tech

Syllabus

SEM 3



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Semester III

THEME: Sustainable Computational Solutions for Real-World Societal Challenges

Aligned with United Nations Sustainable Development Goals (SDGs)— particularly:

UNSDG 4: Quality Education,

UNSDG 8: Decent Work and Economic Growth,

UNSDG 16: Peace, Justice and Strong Institutions

Keywords: Sustainability, digital literacy, skill development, resource management, accessibility

This theme, "Sustainable Computational Solutions for Real-World Societal Challenges," focuses on the use of computational technologies to address pressing issues in education, employment, environmental sustainability, and public health, particularly in emerging urban and semi-urban regions like Mira Bhayandar. It directly supports several United Nations Sustainable Development Goals (UN SDGs)

UN SDG Alignment:

For Quality Education (SDG 4):

- **Accessible Digital Learning Platforms:**
Providing customized educational content for underprivileged students and those with learning disabilities.
- **Gamified Learning Modules:**
Create engaging educational content for primary and secondary school students.
- **Virtual Labs:**
Develop accessible, low-cost simulation labs for science and computational subjects for students in resource-constrained schools

For Decent Work and Economic Growth (SDG 8):

- **Digital Skill Development Hubs:**
Platforms for skill assessment, training in emerging technologies and real-time job mapping for local industries.
- **Local Artisan Marketplaces:**
Enable small businesses and artisans to reach broader markets with minimal digital barriers.
- **Real-Time Gig Economy Platforms:**
Connect freelancers and gig workers to nearby digital work opportunities with fair pay and accessibility.

Digital Governance and Transparent Institutions (UNSDG 16)

- Strengthen **transparency, inclusion, and justice** using technology,
- Promote **peaceful societies** through data-driven public safety mechanisms,
- Build **responsive and ethical institutions** with sustainable digital infrastructure.

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Local Problem Statements for Mira Road / Mira-Bhayander

1. Mira-Bhayandar possesses rich cultural assets, local heritage sites, and traditional crafts that remain largely under-promoted and disconnected from mainstream tourism circuits. This gap not only hampers opportunities for local artisans, guides, and small businesses but also contributes to the gradual erosion of cultural identity. The city misses a vital opportunity to create decent livelihoods and strengthen community pride.
2. The current public complaint mechanisms in Mira-Bhayander are manual, delayed, and lack transparency. There is a need to track, prioritize, and resolve civic issues like garbage collection, water leaks, and road damage in real-time.
3. Street vendors and small-scale hawkers in Mira Bhayandar are unable to fully participate in the cashless economy due to a lack of digital payment adoption and limited understanding of digital marketplaces. This exclusion limits their customer base, economic potential and growth.”
4. Many residents in Mira Bhayandar, especially elderly people and women in lower-income groups, lack timely access to accurate health information in Marathi, Hindi, or Gujarati. Important updates on vaccination camps, public health advisories, and disease outbreaks are either delayed or communicated in complex medical terms. This restricts access to health resources and improve public health outcomes.”
5. Public libraries and community centers in Mira Bhayandar have low attendance and limited digital outreach. These result in underutilization of valuable community resources affects community engagement and promotion of lifelong learning.”
6. Local farmers near Mira Bhayandar struggle to connect directly with urban consumers due to lack of digital platforms that support farm-to-home deliveries. They rely on intermediaries, reducing their profits. This gives rise to irregular delivery scheduling which hampers the promotion of sustainable agriculture and support for local food systems.”
7. Many residential societies in Mira-Bhayandar have rainwater harvesting infrastructure, but there is no digital mechanism to monitor water collection efficiency, storage levels, and maintenance status, leading to underutilization of valuable water resources.
8. Residents have limited awareness of their collective carbon emissions from electricity, transportation, and waste generation. There is a need for a digital sustainability assessment platform.
9. Many residential buildings have unused rooftop spaces suitable for solar installations. However, there is no platform to facilitate energy sharing, production monitoring, and community participation in renewable energy initiatives.
10. Restaurants, caterers, and housing societies often generate surplus edible food that is not utilized and at the same time, many underprivileged communities face food shortage. There is a need of mechanism for surplus food management



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		L	T	P	L	T	P	SL	Notional Learning Hour	
15211301	Discrete Mathematics and Graph Theory	2	1	--	30	15	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
15211301	Discrete Mathematics and Graph Theory	20	20	40	60	2.5	25	--	125

Rationale:

Elementary Number Theory forms the basis of many cryptographic algorithms used for securing data in IT systems, such as public-key encryption and digital signatures. Functions and Mathematical Relations are fundamental in modeling database relationships, designing algorithms, and structuring software systems. The Fundamental Principle of Counting helps in solving combinatorial problems related to network configurations, password strength calculations, and resource allocation. Algebraic Structures like groups and fields provide the mathematical framework for error correction, hashing, and encryption techniques used in secure communications. Graph Theory is essential for understanding network topologies, optimizing routing protocols, and managing dependencies in software engineering. Finally, Coding Theory equips students with techniques to detect and correct errors in data transmission and storage,



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ensuring reliability in IT infrastructures. Together, these topics prepare students to apply rigorous mathematical reasoning to practical IT engineering challenges..

Course Objectives:

1. To understand the basic principles of number theory and their relevance to secure computing.
2. To Explain the properties and types of functions and relations used in system modeling and database design..
3. To describe counting techniques to solve combinatorial problems in IT systems.
4. To understand algebraic systems such as groups, rings, and fields and their use in computing.
5. To understand graph-based models to represent networks and system dependencies.
6. To explain the need for error detection and correction in digital communication.

Course Outcomes:

1. Students will be able to apply concepts such as modular arithmetic and prime factorization in public key cryptography like RSA.
2. Students will be able analyze functional relationships in the design of normalized relational databases and finite state machines.
3. Students will be able to Solve real-world problems like calculating the number of secure passwords or possible network configurations using permutations and combinations.
4. Students will be able to Apply algebraic structures to implement error detection codes and hashing functions in data storage and retrieval systems.
5. Students will be able to use graph algorithms like shortest path or spanning trees in designing optimized communication networks or task scheduling systems.
6. Students will be able to apply coding techniques like Hamming and cyclic codes to ensure reliable data transmission in IT networks and storage systems..

Prerequisite:

1. Definition of sets, Venn diagrams, complements, cartesian products, power sets.



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2. Propositions and Logical operations, Truth tables, Equivalence, Implications

DETAILED SYLLABUS: Total six module for each subject (15 Weeks)

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Elementary Number Theory	Modular Arithmetic, Divisibility and Euclid Algorithm,	05	CO1
		Primes and Sieve of Eratosthenes.		
		Euler's and Fermat Little Theorem, Congruences, Computing Inverse in Congruences		
		Legendre and Jacobi Symbol, Chinese Remainder Theorem and Well-ordering principle.		
		Self-learning Topics: 1. Wilson's Theorem 2. Applications in modular exponentiation. 3. Quadratic residues 4. Law of Quadratic Reciprocity 5. Continued fractions and Diophantine equations 6. Primitive roots and orders mod n.	08	
II	Functions and Mathematical relations	Types: Injective, Surjective, and Bijective Functions. Composition, Inverse Functions. Real life applications of Functions.	05	CO2
		Partial Order Relations, Poset, Hasse Diagram, Chain and Anti chains, Lattice, Types of Lattices, Sub lattice.		
		Self-learning Topics: 1. Practical applications of function in Neural Network. 2. Determining risk factors for insurance rates, Taxes and tax brackets, Vending machines, etc.	07	



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		3. Practical applications of relations in real life in the field of Database Management, Economics, Social Network, Sports, Medical Diagnosis, Weather, etc. 4. Equivalence Classes.		
III	Fundamental Principle of Counting	Basic Counting Principle-Sum Rule, Product Rule.	05	CO3
		Inclusion-Exclusion Principle and Pigeonhole Principle		
		Recurrence relations, Solving recurrence relations		
		Self-learning Topics: 1. Applications of Recurrence Relations – Analysis of recursive algorithms in computing. 2. Combinatorial Problem Solving – Using counting techniques in probability and decision-making.	08	
IV	Algebraic Structures	Algebraic structures with one binary operation: Semi group, Monoid,	05	CO4
		Groups and Subgroups.		
		Abelian Group, and Cyclic group.		
		Self-learning Topics: 1. Algebraic structures with two binary operations: Ring. 2. Integral domain 3. Finite fields. 4. Error Correcting codes. 5. Isomorphism of groups and rings.	08	
V	Graph Theory	Types of graphs, Graph Representation, Sub graphs.	05	CO5
		Operations on Graphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph, Components of Graph.		
		Homomorphism and Isomorphism of Graphs.		



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		Euler and Hamiltonian Graphs, Planar Graph, Cut Set, Cut Vertex.		
		Trees and application of trees.		
		Self-learning Topics: 1. Network Flow Problems – Understanding flow in networks and its optimization. 2. Graph Coloring Applications in Scheduling – Use of graph coloring in timetabling and resource allocation. 3. Optimization Techniques – Application of graphs in shortest path problems, spanning trees, and clustering. 4. Spanning trees.	07	
VI	Coding Theory	Introduction to coding	05	CO6
		Group Codes, Decoding and Error Correction		
		Maximum Likelihood Decoding Technique		
		Self-learning Topics: 1. Cyclic and Polynomial Codes 2. Linear Block Codes 3. BCH and Reed–Solomon Codes	07	

Text Books:

1. Susanna S. Epp, “Discrete Mathematics with Applications”, 5th Edition, Cengage Publications.
2. Ralph P. Grimaldi, “Discrete and Combinatorial Mathematics”, 5th Edition, Pearson Publications.
3. Edgar Goodaire and Michael Parmenter, “Discrete Mathematics and Graph Theory”, 3rd Edition, Pearson Publications.

Reference Books:

1. Kenneth A. Ross, “Discrete Mathematics”, 5th Edition, Pearson Publications.



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2. Swapan Kumar Sarkar, "Textbook of Discrete Mathematics", 9th Edition, S. Chand Publications.
3. Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, "Discrete Mathematical Structures", 6th Edition, Pearson Education.
4. T. Veera Rajan, "Discrete mathematics with Graph Theory and Combinatorics", McGraw Hill Publications.
5. C. L. Liu "Elements of Discrete Mathematics", second edition 1985, McGraw-Hill Book Company.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/106106094
2.	https://nptel.ac.in/courses/106108227
3.	https://nptel.ac.in/courses/106106183
4.	https://nptel.ac.in/courses/106103205
5.	https://nptel.ac.in/courses/111107058
6.	https://nptel.ac.in/courses/106103015

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

Term work (TW) for 25 marks:

General Instructions:



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1. Batch wise tutorials are to be conducted. The number of students per batch should be as per the university pattern for practical.
2. Students must be encouraged to write **at least 10** class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project.

This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1. Regularity and active involvement (Theory and Tutorial) 05 marks.
2. Class Tutorials on entire syllabus 10 marks.
3. Mini Project 10 marks.

➤ Question paper format

- Question Paper will comprise of a total of **six questions each carrying 15 marks**. Q.1 will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Four questions** needs to be answered



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		L	T	P	L	T	P	SL	Notional Learning Hour	
15211302	Advance Data structure and Algorithm	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
15211302	Advance Data structure and Algorithm	20	20	40	60	2.5	--		100

Rationale :

Advanced Data Structures and Algorithms (ADSA) are crucial in engineering as they enable efficient data organization, retrieval, and problem-solving using optimized computational techniques. Mastering ADSA helps students design high-performance software solutions and



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forms the basis for advanced fields like artificial intelligence, data science, and system design.

Course Objectives:

- 1 To understand the mathematical foundations essential for algorithm analysis.
- 2 To explore and study advanced data structures.
- 3 To apply the greedy strategy for problem-solving.
- 4 To gain knowledge of backtracking techniques and maximum flow in networks.
- 5 To learn and implement dynamic programming approaches.
- 6 To comprehend the fundamentals of pattern matching.

Course Outcomes:

On successful completion, of course, learner/student will be able to:

1. Learn techniques to analyze algorithms and solve recurrence relations. (L2, L4)
2. Identify and apply suitable advanced data structures for specific problems, along with analyzing their time and space complexities. (L3, L4)
3. Examine the greedy approach for problem-solving and assess its effectiveness. (L4, L5)
4. Explore and assess backtracking algorithms and gain insight into solving problems involving maximum flow in networks. (L2, L5)
5. Apply dynamic programming strategies to efficiently solve complex problems. (L3)
6. Choose and implement the most appropriate pattern matching algorithm based on the problem context. (L5, L3)

Prerequisite: Overview of Data Structures: Revision of basic data structures (arrays, stacks, queues, linked lists, trees).



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DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Overview of Data Structures: Revision of basic data structures (arrays, stacks, queues, linked lists, trees).	1	
I	Introduction to Analysis of Algorithms	Fundamentals of the analysis of algorithms: Time and Space complexity, Asymptotic notation, Recurrence Relations: Methods to solve recurrence relations in algorithms (Substitution, Recursion tree, Master theorem).	4	CO1
		Self-learning Topics: Solve problems on analysis of algorithms.	5	
II	Advanced Data Structures	Introduction. AVL trees, B tree, B tree operations, B+ tree, Red-Black Trees, tries data structures, time complexity analysis of all problems. Graphs, Representation, Graph Traversals: Breadth First Search, Depth First Search.	9	CO2
		Self-learning Topics: Solve problems on AVL trees, B tree, B+ tree etc.	6	
III	Greedy algorithms and Applications	Introduction and properties of greedy algorithms, Fractional Knapsack problem, Minimum Spanning Trees (Prim's and Kruskal's algorithms), Job	7	CO3

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		sequencing with deadlines, Optimal storage on tapes, Analysis of All problems.		
		Self-learning Topics: Solve problems on Spanning Trees, Knapsack etc.	9	
IV	Backtracking and Maximum flow Networks	Backtracking Techniques: Introduction, N-Queens problem, sum of subsets problem, graph coloring, Hamiltonian cycles. Introduction to flow networks, Augmenting Paths Residual Network, Ford Fulkerson method, Applications of Flow Networks in real-world problems.	9	CO4
		Self-learning Topics: Solve problems N-Queens, Hamiltonian cycles, Augmenting Paths Residual Network etc.	7	
V	Dynamic Algorithms	Introduction Dynamic algorithms, Greedy vs. Dynamic algorithms, Single source shortest path- Dijkstra's Algorithm, Bellman Ford Algorithm, All pair shortest path- Floyd Warshall Algorithm, 0/1 knapsack problem, Travelling salesman problem, Analysis of All problems.	10	CO5
		Self-learning Topics: Solve problems on shortest path- Dijkstra's Algorithm etc. Solve problems on DNA	7	

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		equencing, and data compression.		
VI	String Matching Algorithms and Application on Advance Data Structure & Analysis	Introduction String Matching Algorithms, Naïve string matching algorithm, Rabin-Karp algorithm, Knuth-Morris-Pratt(KMP) algorithm, Longest common subsequence(LCS).	05	CO6
		Self-learning Topics: Case Study 1: Optimizing Water Distribution using Graph Algorithms and Network Flow Analysis. Case Study 2: Waste Management Route Optimization using Greedy and Dynamic Programming Approaches Case Study 3: Real-Time Disaster Relief Logistics using Advanced Priority Queues and Backtracking. Case Study 4: Efficient Digital Land Record Management using B+ Trees Case Study 5: Green Library Management System for Smart Campuses Case Study 6: Dynamic Algorithms in Disaster Response and Relief Management	11	

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Text Books

1. Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein, PHI 3rd Edition, 2011
2. Algorithm Design, Jon Kleinberg, Éva Tardos, Pearson, 1st Edition 2006
3. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss
4. Data Structures, Algorithms and Applications in C++ by Sartaj Sahni

References:

1. Introduction to the Design and Analysis of Algorithms, Anany Levitin, Pearson, 3rd Edition, 2011
2. Algorithms Robert, Sedgewick, Kevin Wayne, Addison- Wesley, 4th Edition 2011

Online Resources:

S. No.	Website Name	URL
1	NPTEL	https://archive.nptel.ac.in/courses/106/106/106106200/
2	NPTEL	https://archive.nptel.ac.in/courses/106/105/106105085/
3	NPTEL	https://archive.nptel.ac.in/courses/106/104/106104120/
4	Coursera	https://www.coursera.org/learn/algorithms-part1
5	MIT OpenCourseWare	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/

Assessment:

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- A total of **four questions** need to be answered



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15211303	Database Management System & Application	3		--	45		--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
15211303	Database Management System & Application	20	20	40	60	2.5	--	--	100

Rational:

Database Management Systems (DBMS) play a crucial role in engineering by teaching students how to efficiently store, retrieve, and manage large volumes of data. They provide foundational knowledge essential for building reliable and scalable software systems across



various domains.

Course Objectives

1. To learn the basics and understand the need for database management systems and To Build a Relational Model from ER/EER.
2. To construct a conceptual data model and Relational algebra.
3. To introduce the concept of SQL to store and retrieve data efficiently.
4. To demonstrate notions of normalization for database design.
5. Understand the concepts of transaction processing- concurrency control and recovery procedures.
6. To understand Advance DBMS and the applications of concepts learnt in this subject.

Course Outcomes:

1. Identify the need of a Database Management System. (L1, L2)
2. Design conceptual model for real life applications. (L6)
3. Formulate query using SQL commands. (L3)
4. Apply the concept of normalization to relational database design.(L3)
5. Demonstrate the concept of transaction, concurrency and recovery.(L2)
6. Apply the concept of DBMS, ADBMS and SQL to solve the case study.(L3)

Prerequisite: C, Python Programming.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	C, Python Programming.	02	--
I	Database System Concepts, Architecture, and ER Models.	Introduction, Characteristics of Databases, File system v/s Database system, Data abstraction and Data Independence, DBMS system architecture, Database Administrator (DBA), Role of DBA. Conceptual Modeling of a database, The Entity-Relationship (ER) Model, Entity Type, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Weak entity Types. Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model.	08	CO1



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		Self-learning Topics: Identify the types of Databases. Design a ER diagram based on any of the application such as banking system, Healthcare System etc.	07	
II	Relational Model & Relational Algebra	Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Key, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model, Introduction to Relational Algebra, Relational Algebra expressions for Unary Relational Operations : Set Theory Operations, Binary Relational Operations.	07	CO2
		Self-learning Topics: Map the ER model designed in module I to relational schema. Explore tools that are used to represent relational algebra. Practice relational algebra queries using real life rural datasets, Compare join operations using examples.	08	
III	Structured Query Language (SQL)	Overview of SQL, Data Definition Commands, Set Operations, Aggregate Function, null values, Data Manipulation commands, Data Control commands, Complex Retrieval Queries using Group By, Recursive Queries, nested Queries, Integrity constraints in SQL. Database Programming with JDBC, Security and authorization: Grant & Revoke in SQL Functions and Procedures in SQL and cursors. Indexing: Basic Concepts, Ordered Indices, Index Definition in SQL.	06	CO3
		Self-learning Topics: Physical design of database for the relational model designed in module III and fire various queries. Practice and perform all the queries of DDL and DML in a rural dataset.	08	



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IV	Relational Database Design:	Design guidelines for relational Schema, Functional Dependencies, Database tables and normalization, The need for normalization, The normalization process, Improving the design, Definition of Normal Forms- 1NF, 2NF, 3NF & The Boyce-Codd Normal Form (BCNF).	07	CO4
		Self-learning Topics: Design a database and perform normalization, compare all the normal forms based on database you've created.	08	
V	Transaction	Transaction: Transaction concept, State Diagram, ACID Properties, Transaction Control Commands, Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based-protocols, Deadlock handling Timestamp-based protocols, Recovery System: Recovery Concepts, Log based recovery.	07	CO5
		Self-learning Topics: Study the various deadlock situations which may occur for a database designed in module V.	07	
VI	Advanced DBMS Applications & Real World Problem Solving	Introduction to bigdata and hadoop ecosystem, Role of datasets in AI/ML integration, NoSQL databases overview. Advanced bigdata tools and trends. Bigdata Security and privacy. Limitations of traditional RDBMS for big data.	08	CO6
		Self-learning Topics: Case study : 1) To design a scalable data management solution using traditional DBMS and bigdata technologies to store, process and analyze healthcare records . 2) To design and implement a database system that captures and analyzes key indicators of	07	



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		education quality across schools/colleges such as teacher-student ratio, infrastructure, learning outcome, and dropout rates to support evidence based educational policy and planning.	
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Text Books:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

References:

1. Peter Rob and Carlos Coronel, — Database Systems Design, Implementation and Management, Thomson Learning, 9th Edition.
2. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
3. G. K. Gupta : “Database Management Systems”, McGraw – Hill

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.oreilly.com
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

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- Question Paper will comprise of a total of **six questions each carrying 15 marks**. Q.1 will be **compulsory** and should **cover maximum contents of the syllabus**



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- A total of **Four questions** need to be answered



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15211304	Automata Theory	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
15211304	Automata Theory	20	20	40	60	2.5	--	--	100

Rationale : " It provides a foundational understanding of computation and equips students with the tools to design efficient systems, validate software, and solve complex engineering problems."

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Course Objectives:

1. To understand the relation between Regular Language and Finite Automata and machines.
2. To learn fundamentals of Regular and Context Free Grammars and Languages.
3. To learn how to design Automata's as Acceptors, Verifiers and Translators.
4. To understand the relation between Regular Languages, Contexts free Languages, PDA and TM.
5. To learn how to design PDA as acceptor and TM as Calculators.
6. To learn applications of Automata Theory.

Course Outcomes:

1. Design different types of Finite Automata and Machines as Acceptor, Verifier and Translator. (L6)
2. Explain, analyze and design Regular languages, Expression and Grammars. (L2, L4, L6)
3. Analyze and design Context Free languages and Grammars. (L4, L6)
4. Design different types of Push down Automata as Simple Parser.(L6)
5. Design different types of Turing Machines as Acceptor, Verifier, Translator and Basic computing machine. (L6)
6. Develop understanding of applications of various Automata. (L6)

Prerequisite:

Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions

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DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.	02	
I	Basic Concepts and Finite Automata	Languages: Alphabets and Strings. Closure properties, Finite Automata (FA) and Finite State machine (FSM). Finite Automata as a language acceptor or verifier Finite Automata - Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA) : Definitions, transition diagrams and Language recognizers, NFA (with and without ϵ), DFA, RE to NFA, NFA to DFA Conversion , Reduced DFA , NFA-DFA equivalence, FA to RE. Finite State Machines with output : Moore and Mealy machines. Applications and limitations of FA.	10	CO1
		Self-learning Topics: Practice exercise on FA and NFA	09	
II	Introduction and Regular Languages	Regular Languages: Regular Expressions, Regular Languages, Regular Grammars, RL and LL grammars, Closure properties , Arden's Theorem	07	CO2

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		Self-learning Topics: Practice exercise on Regular Expressions. Identify the tools also.	06	
III	Context Free Grammars	Context Free Languages: CFG, Leftmost and Rightmost derivations, Ambiguity, Simplification of Context Free Grammar, Chomsky Normal Form ,Greibach Normal Form (CNF & GNF) and Chomsky Hierarchy (Types 0 to 3)	09	CO3
		Self-learning Topics: Practice numerical or exercise on CFG	09	
IV	Push Down Automata	Push Down Automata: Deterministic (single stack) PDA, Equivalence between PDA and CFG. Power and Limitations of PDA.	07	CO4
		Self-learning Topics: List the examples of PDA.	06	
V	Turing Machine	Turing Machine: Deterministic TM, Variants of TM, Halting problem, Power of TM.	06	CO5
		Self-learning Topics: Practice numerical of TM.	07	
VI	Applications of Automata	Applications of FA, CFG, PDA & TM. Introduction to Compiler & Its phases.	04	CO2,CO 3, CO4,CO 5, CO6
		Self-learning Topics: Case study on 1. Automating Skill Development in E-Learning Platforms with Finite Automata (FA) 2.Context-Free Grammar (CFG) for Creating Sustainable Business Models	08	

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		3.Sustainable Water Distribution in Agriculture Using Pushdown Automata (PDA)		
		4. Turing Machines for Simulating Climate Change Models		

Text Books:

1. J.C.Martin, "Introduction to languages and the Theory of Computation", TMH.
2. Kavi Mahesh, "Theory of Computation A Problem Solving Approach", Wiley India
3. A. V. Aho, R. Shethi, Monica Lam , J.D. Ulman , "Compilers Principles, Techniques and Tools ",Pearson Education.

References:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education.
2. Daniel I.A. Cohen, "Introduction to Computer Theory", John Wiley & Sons.
3. Vivek Kulkarni," Theory of Computation", Oxford University.
- 4.N.Chandrashekhar, K.L.P. Mishra, "Theory of Computer Science, Automata Languages & Computations", PHI publications.
5. J. J. Donovan, " Systems Programming", TMH.

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		L	T	P	L	T	P	SL	Notional Learning Hour	
15212305	ADSA Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Total of 2 Tests				
15212305	ADSA Lab	--	--	--	--	25	25	50

Lab Objectives: The course aims to

1. To analyze and evaluate the mathematical foundations and complexities of various algorithms.
2. To implement and apply diverse advanced data structures to efficiently solve complex computational problems.
3. To design and develop solutions utilizing greedy algorithms, assessing their applicability and limitations.
4. To construct and optimize solutions using backtracking algorithms and model problems with maximum flow networks.
5. To formulate and implement solutions using dynamic programming techniques, evaluating their performance trade-offs.



6. To select and integrate appropriate pattern matching algorithms for efficient string and sequence analysis in real-world applications.

Lab Outcomes: Upon completion of the course students will be able to:

1. Calculate and interpret the space and time complexities of algorithms, justifying their efficiency for various problem sizes.(L3, L4, L5)
2. Implement and critique advanced data structures such as balanced trees, heaps, and hash tables to optimize data storage and retrieval.(L3, L4, L5)
3. Apply greedy programming techniques to solve optimization problems, evaluating the optimality and feasibility of their solutions.(L3, L5)
4. Develop backtracking algorithms to explore solution spaces for combinatorial problems and model network flow problems using relevant algorithms. (L3, L6)
5. Design and construct dynamic programming solutions for complex problems, comparing their performance with other algorithmic paradigms. (L6, L5)
6. Choose and adapt appropriate string matching algorithms for text processing and bioinformatics applications, justifying their selection based on performance requirements. (L3, L5)

List of Experiments.

Sr No	List of Experiments	Hrs
01	Implement and compare the performance of Merge Sort and Quick Sort for large datasets, analyzing their space and time complexities.	1
02	Design and implement a randomized quicksort algorithm, evaluating its average-case performance.	1
03	Explore and implement various hash functions and collision resolution techniques (e.g., separate chaining, open addressing), assessing their efficiency.	1

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04	Construct and traverse Binary Search Trees (BSTs) for given data sequences. Analyze and visualize the tree structure and traversal complexities.	2
05	Implement robust insert, delete, search, and display operations on BSTs, handling edge cases and evaluating their complexities.	2
06	Develop and demonstrate operations (insert, delete, search) on B-Trees or B+-Trees, discussing their applications in databases.	2
07	Implement and evaluate the performance of AVL or Red-Black trees to maintain balanced search trees.	1
08	8. Implement a solution for the fractional knapsack problem using a greedy approach and compare it with the 0-1 knapsack problem (dynamic programming).	1
09	Implement Prim's and Kruskal's algorithms to find Minimum Spanning Trees (MSTs) and visualize the construction process.	2
10	Develop a solution for the job sequencing with deadlines problem, optimizing total profit.	1
11	Implement the N-Queens problem using backtracking, visualizing the solution space exploration.	2
12	Develop a solution for the Sum of Subsets problem using backtracking, identifying all possible subsets that sum to a target.	2
13	Implement Hamiltonian cycles for a given graph, determining if a cycle exists that visits each vertex exactly once.	2
14	Implement the Bellman-Ford algorithm to find shortest paths in graphs with negative edge weights, handling negative cycles.	2
15	Implement the Floyd Warshall Algorithm to compute all-pairs shortest paths in a graph.	2

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16	Develop a dynamic programming solution for the Traveling Salesperson Problem (TSP) for small instances, analyzing its complexity.	2
17	Implement and compare the Naïve string matching algorithm with the Rabin-Karp algorithm.	2
18	Implement the Knuth-Morris-Pratt (KMP) algorithm for efficient string matching.	2

Sr No	List of Assignments / Tutorials	Hrs
01	Performance Analysis and Optimization Challenge	1
02	Real-world Application of Advanced Data Structures	1
03	Ethical Considerations in Algorithmic Design	1
04	Greedy vs. Dynamic Programming: A Comparative Study	1
05	Network Flow Applications and Optimization	1
06	Algorithmic Efficiency for Sustainable Development	1

Text Books

1. Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein, PHI, 3rd Edition, 2011
2. Algorithm Design, Jon Kleinberg, Éva Tardos, Pearson 1st Edition, 2006
3. Data Structures and Algorithm Analysis in C++ Mark Allen Weiss, Pearson 4th Edition, 2013

References:

1. Introduction to the Design and Analysis of Algorithms, Anany Levitin, Pearson, 3rd Edition, 2011



2. Introduction to Algorithms, Robert Sedgewick, Kevin Wayne, Addison- Wesley, 4th Edition, 2011
3. The Algorithm Design Manual, Steven S. Skiena,

Online Resources:

Sr. No.	Website Name
1	NPTEL : https://archive.nptel.ac.in/courses/106/106/106106200/
2	NPTEL : https://archive.nptel.ac.in/courses/106/105/106105085/
3	NPTEL : https://archive.nptel.ac.in/courses/106/104/106104120/
4	Coursera : https://www.coursera.org/learn/algorithms-part1
5	OpenCourseWare : https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15212306	SQL Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Total of 2 Tests				
15212306	SQL Lab	--	--	--	--	25	25	50

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Rational:

The SQL Lab in engineering education provides hands-on experience in querying, managing, and manipulating data using structured query language. It reinforces theoretical DBMS concepts by allowing students to design schemas, write queries, and implement real-time database solutions.

Lab Objectives:

1. 2 .To construct a conceptual data model for real life applications.
3. To Build a Relational Model from ER/EER and demonstrate usage of relational algebra.
4. To Apply SQL to store and retrieve data efficiently.
5. To implement database connectivity using JDBC.
6. To understand the concepts of transaction processing- concurrency control also learn basics of No-SQL and hadoop functionalities.

Lab Outcomes:

1. Define problem statements and Construct the conceptual model for real life application. (L1, L2, L3)
2. Create and populate a RDBMS using SQL.(L1, L6)
3. Formulate and write SQL queries for efficient information retrieval.(L1, L6)
4. Apply view, triggers and procedures to demonstrate specific event handling.(L2, L3)
5. Demonstrate database connectivity using JDBC.(L2)
6. Demonstrate the concept of concurrent transactions and basics of NoSQL.(L2)

*R-2025- S.Y. B.Tech Information Technology***List of Experiments.**

Sr No	List of Experiments	Hrs
01	Experiment1: Title: Database and Table Creation Aim: Understand how to create a database, tables, and define constraints.	02
02	Experiment2: Title: Basic Data Insertion and Viewing Aim: Insert records into tables and view them.	02
03	Experiment3: Title: Filtering and Conditional Retrieval. Aim: Use filtering conditions to retrieve specific data.	02
04	Experiment4: Title: Data Update and Deletion Aim: Modify and remove records in the database.	02
05	Experiment5: Title: Built-in Functions and Expressions Aim: Use SQL functions for calculations and data manipulation.	02
06	Experiment6: Title: Data Grouping and Aggregation Aim: Analyze data by grouping it.	02
07	Experiment7: Title: Joins – Combining Tables Aim: Retrieve data from multiple related tables.	02
08	Experiment8: Title: Types of joins. Aim: Performing different joining over data sets.	02
09	Experiment9: Title: Views and Indexes Aim: Understand abstraction and performance tuning.	02
10	Experiment10: Title: Nested Queries and Subqueries Aim: To Understand and execute nested queries and subqueries in SQL to retrieve data based on complex conditions using inner SELECT statements.	02



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11	Experiment11: Title: Set Operators Aim: To use UNION, INTERSECTION and EXCEPT to combine results etc.	02
12	Experiment12: Title: Transactions and TCL Aim: Work with transaction control and consistency.	02
13	Experiment13: Title: Introduction to NoSQL Aim: NoSQL databases overview(Document, Column, Key-Value stores).	02
14	Experiment14: Title : Capstone Project using bigdata and hadoop concepts Aim: Design and implement a small relational schema for a real-world application that can be used to improve quality education in our society (make it more interactive with the help of AIML and big data concept).	02
15	Experiment 15 : Mini Project	02

Sr No	List of Assignments / Tutorials	Hrs
01	Student Information System Create, insert, update, and delete student records.	02
02	Employee Salary Report Generate salary-based summaries using aggregation and filtering.	02
03	Product Inventory Management Implement inventory tables and manage stock using joins and updates.	02
04	Library Database Use joins to fetch book-author details, and subqueries to filter books.	02
05	Sales Dashboard View Create views for monthly sales and apply indexes on region or category.	02
06	Course Enrollment System Manage enrollments with foreign key relations and advanced queries.	02



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Text Books:

1. Scott M L, Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers, 2009
2. Harold Abelson and Gerald Jay Sussman with Julie Sussman foreword by Alan J. Perlis, Structure and Interpretation of Computer Programs (2nd Edition)
3. Graham Hutton, Programming in Haskell, 2nd Edition, Cambridge University Press, 2016

References:

1. Sethi R, Programming Languages Concepts and Constructs , 2nd Ed, Pearson Education
2. Yogesh Sajnikar, Haskell Cookbook, Packt Publishing, 2017

Online Resources:

Sr. No.	Website Name
1.	FreeCodeCamp – Free hands-on courses with certification.
2.	W3Schools – Comprehensive tutorials with live editors for HTML, CSS, JS.
3.	JSON.org – Official page with structure and use-cases.
4.	XML Validation Tool – Online tool for validating XML and DTD/XSD.

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.



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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
9951137WW	Open Elective	2	-	-	2	-	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total .					
9951137WW	Open Elective	--	--	--	--	--	25	--	25

Students must select a course for Open Elective from a bucket provided by the Rahul Education Group.

Term Work Assessment: 25 Marks (Total marks) = 15 Marks (Case Study/Activity) + 5 Marks (Assignments) + 5 Marks (Attendance)



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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C)
		L	T	P	L	T	P	SL	Notional Learning Hour	(Notional Learning Hour/30)
98431308	Entrepreneurship Development	2	-	-	30	-	-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total.					
98431308	Entrepreneurship Development	--	--	--	--	--	25	--	25

Rationale :

Entrepreneurship is a crucial skill in the 21st century, fostering innovation, self-employment, and economic development. This course is designed to equip students with practical entrepreneurial competencies such as ideation, business model development, financial planning, legal frameworks, and pitching.

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Course Objectives:

1. Understand and explain the fundamentals of entrepreneurship and startup ecosystems.
2. Generate, validate, and refine business ideas using structured techniques.
3. Develop comprehensive business plans and financial strategies.
4. Explore legal and funding options for startups in India.
5. Apply marketing, digital tools, and CRM for business growth.
6. Design prototypes and present business pitches to stakeholders.

Course Outcomes:

On successful completion of the course learner will be able to:

- 1) Explain entrepreneurial concepts and analyze types and traits of entrepreneurs.
- 2) Apply ideation techniques and validate business ideas using customer discovery tools.
- 3) Create business plans with financial projections and risk analysis.
- 4) Evaluate funding sources and legal requirements for a startup.
- 5) Implement digital marketing and branding strategies effectively.
- 6) Prepare and deliver compelling business pitches with basic prototyping.

Prerequisite: Fundamentals of communication and leadership skills.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of communication and leadership skills.		
I	Introduction to Entrepreneurship	Definition, Characteristics, and Types of Entrepreneurs. Entrepreneurial Motivation and Traits. Start-up Ecosystem in India. Challenges in Entrepreneurship	4	CO1



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		Self-learning Topics: Evolution of Indian startup ecosystem post-2010 Case Study: Nirma – A middle-class entrepreneur revolutionizing detergents.	4	
II	Business Idea Generation & Validation	Ideation Techniques: Design Thinking, Brainstorming, Mind Mapping. Business Model Canvas (BMC). Market Research & Customer Validation. Minimum Viable Product (MVP) Concept.	5	CO2
		Self-learning Topics: Lean Canvas, Persona Creation Case Study: Airbnb – Validating the concept with MVP	5	
III	Business Planning & Strategy	Writing a Business Plan. SWOT Analysis and Competitive Analysis. Financial Planning and Budgeting. Risk Assessment and Management.	5	CO3
		Self-learning Topics: Financial forecasting using Excel/Google Sheets. Case Study: Zomato – Expansion through mergers & strategic pivots	5	
IV	Funding and Legal Framework	Sources of Funding: Bootstrapping, Angel Investors, Venture Capital Government Schemes & Start-up India Initiatives. Business Registration & Legal Formalities.	6	CO4



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		Intellectual Property Rights (IPR) & Patents		
		Self-learning Topics: DPIIT recognition process and types of funding Case Study: Paytm – From Wallet to IPO: Funding journey	6	
V	Marketing & Digital Presence	Branding and Digital Marketing. Social Media Marketing & SEO. Customer Relationship Management (CRM). E-commerce & Online Business Models.	5	CO5
		Self-learning Topics: Use of Canva, Google Analytics Case Study: Lenskart – Omnichannel e-commerce marketing	5	
VI	Business Pitching & Prototype Development	Pitch Deck Preparation & Presentation Techniques. Prototyping with Open-source Tools. Elevator Pitch & Investor Pitch.	5	CO6
		Self-learning Topics: Canva for pitch deck or Successful Start-ups Case Study: Dunzo – MVP to final app evolution	5	

Text Books:

1. "Entrepreneurship Development and Small Business Enterprises" – Poornima M. Charantimath, Pearson, 3rd Edition, 2021.
2. "Innovation and Entrepreneurship" – Peter F. Drucker, Harper Business, Reprint Edition, 2019.
3. "Startup and Entrepreneurship: A Practical Guide" – Rajeev Roy, Oxford

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University Press, 2022.

4. "Essentials of Entrepreneurship and Small Business Management" – Norman Scarborough, Pearson, 9th Edition, 2021.
5. "The Lean Startup" – Eric Ries, Crown Publishing, 2018.

References:

1. "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" – Bill Aulet, MIT Press, 2017.
2. "Zero to One: Notes on Startups, or How to Build the Future" – Peter Thiel, 2014.
3. "The \$100 Startup" – Chris Guillebeau, Crown Business, 2019.
4. "Business Model Generation" – Alexander Osterwalder & Yves Pigneur, Wiley, 2020.
5. "Blue Ocean Strategy" – W. Chan Kim & Renée Mauborgne, Harvard Business Review Press, 2019.

Online References:

Sr. No.	Website Name
1.	Startup India Portal – https://www.startupindia.gov.in
2.	MIT OpenCourseWare – Entrepreneurship – https://ocw.mit.edu/courses/sloan-school-of-management/
3.	Coursera – Entrepreneurship Specialization – https://www.coursera.org/specializations/entrepreneurship

Assessment:

Term Work: Term Work shall consist of at least 4 to 5 **Case Study Analysis , Presentation** based on the above list. Also, Term work Journal must include at least 2 to 3 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Case Study report)+ 5 Marks (Assignments) + 5 Marks (Attendance)



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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
98451309	Environmental Science	2	-	-	30	-	-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total.					
98451309	Environmental Science	20	20	40	60	2.5	--	--	100

Rationale

Environmental Science provides a multidisciplinary perspective to understand, analyze, and solve ecological challenges. With growing global concern over climate change, pollution, and sustainable development, it is essential to equip students with the knowledge, skills, and values needed to contribute to sustainable solutions.

Course Objectives:

1. To understand the interrelationship between human activities and the environment.

2. To explore natural ecosystems and biodiversity conservation techniques.
3. To identify causes, effects, and mitigation strategies for various types of environmental pollution.
4. To analyze key environmental policies, laws, and sustainability practices.
5. To develop awareness, ethics, and responsibility towards environmental protection.
6. To promote sustainable development through informed decision-making and community participation.

Course Outcomes:

On successful completion of the course learner will be able to:

- 1) Explain core concepts of environmental science and ecological balance.
- 2) Identify sources and impacts of pollution on ecosystems and human health
- 3) Evaluate biodiversity importance and conservation strategies.
- 4) Analyze climate change, global warming, and their mitigation approaches.
- 5) Interpret government policies and sustainable practices for environment management.
- 6) Propose solutions for environmental issues at local and global levels.

Prerequisite: Basic Science Knowledge, General Awareness – About environmental issues, public policies, and civic responsibilities.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Science Knowledge, General Awareness – About environmental issues, public policies, and civic responsibilities.	1	
I	The Multidisciplinary	Definition, scope and importance. Need for public awareness. Role of information technology in	5	CO1



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	Nature of Environmental Studies	environment and human health. Human population and the Environment. Population growth, variation among nations. Population Explosion- family welfare program. Environment and human health Women and child welfare.		
		Self-learning Topics: Environmental ethics Case Study: Chipko Movement (India) – Grassroot conservation.	4	
II	Natural Resources	Renewable and non-renewable resources. Natural resources & associated problems: a. Forest resources: b. Water resources: Natural resources & associated problems c. Mineral resources: d. Food resources: e. Energy resources: Role of an c. Mineral resources: d. Food resources: e. Energy resources: Role of an individual in conservation of natural resources: f. Equitable use of resources for sustainable lifestyles.	5	CO2
		Self-learning Topics: Carbon footprint calculators Case Study: Rainwater Harvesting	5	



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III	Ecosystems	Concepts of an ecosystem. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, Oceans, estuaries). Case study on various ecosystems in India.	5	CO3
		Self-learning Topics: Biodiversity in Indian context Case Study: various ecosystems in India.	5	
IV	Biodiversity and its Conservation	Introduction-Definition: genetic species and ecosystem diversity. Bio-geographical classification of India Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, national, local levels India as a mega diversity nation Case study on Bio diversity in India.	5	CO4
		Self-learning Topics: Indoor pollution sources	4	
V	Environmental Pollution Definition	Causes of Pollution , effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution. Solid waste management: Causes,	5	CO5



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		effect and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.		
		Self-learning Topics: Greenhouse gases Case study: Pollution Disaster management: floods, earthquake, cyclone and landslides. Carbon Credits for pollution prevention	5	
VI	Social Issues and Environment	From unsustainable to sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Consumerism and waste products. Environment protection act. Public awareness.	5	CO6
		Self-learning Topics: Environmental audit methods. Case Study: Environmental Ethics.	5	

Text Books:

1. Environmental Science: Towards a Sustainable Future, G. Tyler Miller and Scott Spoolman, 13th Edition, Cengage Learning 2021
2. Environmental Management: Text and Cases, Bala Krishnamoorthy, 3rd

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Edition, PHI Learning, Publication Year: 2016

3. Green IT: Concepts, Technologies, and Best Practices, Markus Allemann 1. Springer 2008
4. Sustainable IT: Slimming Down and Greening Up Your IT Infrastructure, David F. Linthicum, IBM Press 2009
5. Environmental Modelling: Finding Solutions to Environmental Problems, David L. Murray, Cambridge University Press 2016
6. Remote Sensing and Image Interpretation, Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 9th Edition, John Wiley & Sons 2020
7. Business Ethics: Concepts and Cases, Manuel Velasquez, Pearson 2012

References:

1. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, 2nd Edition, Oxford University Press 2018.
2. The International Handbook of Environmental Laws, David Freestone and Jonathon L. Rubin, Edward Elgar Publishing 2000.
3. E-Waste Management: Challenges and Opportunities in Developing Countries, Ruediger Kuehr and Ram K. Jain, Springer 2008.
4. The E-Waste Handbook: Managing Electronic Waste, Klaus Hieronymi, Ruediger Kuehr, and Ram K. Jain, Earth 2009.
5. Environmental Ethics: An Introduction, J. Baird Callicott, University of Georgia Press, 1999.

Online References:

Sr. No.	Website Name
1.	Centre for Science and Environment (CSE), Website: cseindia.org
2.	Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India
3.	CSIR-National Environmental Engineering Research Institute (NEERI)

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Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

Question paper format

- Question Paper will comprise of a total of six questions each carrying 15 marks
- Q.1 will be compulsory and should cover maximum contents of the syllabus
- Remaining questions will be mixed in nature (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the module
- A total of Four questions need to be answered



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15612310	IDEA LAB -3 (Innovation Design Engineering and Apply)	--	--	1*+2	15	--	30	15	60	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of 2 Tests				
15612310	IDEA LAB - 3 (Innovation Design Engineering and Apply)	--	--	--	--	25	25	50

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Rationale :

Aligned with the National Education Policy (NEP) 2020, the institution emphasizes experiential, interdisciplinary, and project-based learning through the IDEA Lab—a central hub for hands-on innovation.

To strengthen the undergraduate research ecosystem, the institution has adopted a theme-based academic model aligned with UN SGD. Each semester features six curated problem statements based on local need and aligned with core subjects in the same semester, enabling students to apply classroom knowledge to real-world challenges. Every student selects one problem and develops an individual, subject-integrated solution—enhancing both academic understanding and research skills.

The IDEA Lab supports this initiative with facilities for design thinking, prototyping, and product development. Students maintain a project logbook throughout the semester to track their progress and reflections.

To ensure academic accountability, a two-tier assessment framework is implemented:

- Project Assessment based on standardized IDEA Lab rubrics.
- Subject-Based Term Work Assessment focused on the application of same-semester subject knowledge in the project.

Lab Objectives:

1. To promote experiential and project-based learning that bridges theoretical knowledge with real-world problem-solving.
2. To encourage interdisciplinary integration by enabling students to apply concepts from multiple subjects within a single cohesive project.
3. To develop innovation and design thinking skills through hands-on activities and iterative solution development.
4. To foster critical thinking and creativity by engaging students in open-ended problems with multiple solution pathways.



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5. To enhance communication, collaboration, and documentation skills essential for professional engineering practice.
6. To build an entrepreneurial and research mindset by guiding students to develop scalable, socially-relevant, and technically viable prototype

Lab Outcomes: Student will be able to

1. Recall and articulate key concepts from core and allied subjects relevant to the assigned project.
2. Explain the interdisciplinary nature of the problem and the role of each subject in addressing it.
3. Apply appropriate tools, techniques, and theoretical knowledge to develop project components.
4. Analyze problem constraints and user requirements to structure a feasible and efficient solution.
5. Evaluate multiple design options and justify the chosen solution based on technical and practical considerations.
6. Create a functional prototype or solution that demonstrates innovation, utility, and integration of interdisciplinary knowledge

1) Guidelines for IDEA Project

a) Project Guidelines (Interdisciplinary Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- Faculty in-charges for the IDEA Lab are assigned according to the complexity of the project and the capacity of the respective departments.
- Faculty in-charges mentor both the academic and technical aspects, and track weekly



progress.

- Project assessment will be rubric-based, ensuring depth, innovation, documentation, and ownership.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- Faculty in-charges must attend relevant FDPs to ensure uniformity in mentoring and evaluation.

b) Guidelines for same semester Subject Concepts Applied within the Project

- Termwork for each subject will partially reflect how well a student applies subject-specific concepts in their interdisciplinary project.
- Internal assessment panel will collaborate to align project components with subject learning outcomes.

c) Role of Faculty In-Charges in IDEA Lab Projects

Faculty in-charges play a pivotal role in the success of interdisciplinary, theme-based projects under the IDEA Lab. Their responsibilities extend beyond technical supervision to include academic alignment, innovation facilitation, and active student engagement. Their key roles include:

- 1. Motivating and Inspiring Students**
 - Encourage students to take ownership of their learning and projects.
 - Cultivate a mindset of curiosity, exploration, and social relevance.
 - Foster an environment where students feel empowered to take creative risks.
- 2. Conducting Brainstorming and Ideation Sessions**
 - Organize structured brainstorming sessions at the start of the semester to help students define their problem statements and solution pathways.



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- Promote collaborative thinking, design exploration, and interdisciplinary integration.
- 3. **Arranging Guest Lectures and Expert Talks**
 - Identify and invite industry experts, researchers, and innovators for guest lectures aligned with the semester's theme or subject areas.
 - Facilitate exposure to real-world challenges, current trends, and future opportunities.
- 4. **Ensuring Uniqueness and Originality of Projects**
 - Actively review proposed ideas to ensure **no duplication of solutions** across students.
 - Encourage students to explore novel approaches, technologies, and perspectives.
- 5. **Promoting Discussion and Collaborative Learning**
 - Create platforms for students to present, discuss, and receive peer and mentor feedback.
 - Facilitate idea refinement through regular discussions and group engagement.
- 6. **Aligning Subject Content Beyond Syllabus**
 - Faculty in-charges must **align subject content beyond the syllabus of the same semester** with the **IDEA Lab theme and assigned problem statements**.
 - This ensures relevance, depth, and meaningful interdisciplinary integration.
- 7. **Same Semester Faculty Requirement**
 - Faculty in-charges must be teaching subjects in the **same semester** as the students' project to ensure seamless academic integration and contextual understanding.
- 8. **Monitoring and Documentation**
 - Oversee project logbook maintenance, milestone tracking, and submission of progress reports.
 - Provide ongoing feedback and ensure project alignment with learning outcomes.
- 9. **Coordination with Subject Faculty**
 - Work in collaboration with other subject faculty to help students embed theoretical and practical aspects of their coursework into the project.
 - Facilitate subject-term mapping and contribute to termwork assessment based on evidence.

2) Implementation Strategy

a) Project Implementation in IDEA Lab



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Aspect	Implementation Strategy
Faculty in-charges	Faculty in-charges assigned based on project nature and department capacity.
Mentoring Role	Faculty in-charges oversee academic/technical development, interdisciplinary integration, and timely documentation.
Capacity Building	Faculty in-charges undergo workshops on design thinking, innovation, assessment rubrics, and outcome-based mentoring.
Assessment Contribution	Faculty in-charges contribute to 25 marks allocated for the IDEA Lab project termwork. The remaining assessments are conducted by the external examiner.
Recognition Incentives	& Faculty in-charges receive workload credits or are formally acknowledged in performance reviews.

b) Implementation of Subject-Term Work Mapping within Projects

Aspect	Implementation Strategy
Mapping Subject Outcomes	Faculty in-charges align their content beyond syllabus with the student's project by coordinating with the assigned project guide.
Independent Evaluation	Internal assessment panel evaluate students based on their application of subject-specific concepts within the project. This contributes to a separate 25 marks allocated for termwork based on subject application.
Evidence Sources	Evaluation is supported by project logbooks, subject-specific deliverables (e.g., tools, simulations, models), and review presentation inputs.
Outcome Assurance	Ensures practical demonstration of subject understanding and its integration into the interdisciplinary solution.



Implementation Notes:

- Guide faculty assess their course's contribution using specific evidence such as:
 - Logbooks
 - Subject-specific outputs (e.g., simulations, designs)
 - Paper publications or review presentations

2) Guidelines for Assessment

Two-tier rubrics are applied independently to evaluate subject concept application and innovation within the project.

a) Assessment of IDEA Lab Projects (Individual Interdisciplinary Projects) (25 Marks)

Presentation-Based Assessment Structure (Total: 25 Marks)

Assessment Month	Weightage	Marks
Month 1 (Formative 1)	20%	5 marks
Month 2 (Formative 2)	40%	10 marks
Month 3 (Formative 3)	40%	10 marks



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Rubric-Based Evaluation Criteria

Criteria	Month 1 (5)	Month 2 (10)	Month 3 (10)
Problem Understanding	Connects problem to subjects	Defines interdisciplinary scope	Demonstrates deep conceptual grasp
Subject Knowledge Application	Identifies relevant concepts	Applies principles in design	Integrates multiple subject areas correctly
Innovation & Design Thinking	Proposes creative idea	Develops and tests feasible solution	Final solution shows originality and utility
Documentation & Presentation	Logbook initiated, plan presented	Mid-design log and visuals	Final report and demo completed
Progress & Ownership	Meets deadlines, shows planning	Demonstrates self-motivation	Completes project independently with reflection

b) Term Work Assessment of Subject Concepts Applied in Projects (25 Marks)

Applicable to All Subjects Integrated with Interdisciplinary Projects

To reflect meaningful application of subject knowledge, each subject will be assessed through the following rubric:



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Criteria	Marks	Description
Subject Knowledge Application	8	Depth and accuracy of concept integration into the project
Practical Design or Tool Usage	5	Use of subject-specific hardware/software/simulation/tools
Documentation	4	Quality and clarity of subject-related logs and reports
Viva/Presentation	4	Ability to explain subject's relevance and role in the project
Continuous Engagement	4	Evidence of consistent participation via logbooks and feedback

c) Total Assessment Structure

Component	Marks	Assessed By
Termwork – Project Execution	25 Marks	Project Guide
Termwork – Application of Subject Concepts	25 Marks	IDEA Lab Panel
Viva Voce (Final Evaluation)	50 Marks	External Examiner

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Syllabus

SEM 4

Semester IV

Theme: Sustainable Digital Supply Chains and Smart Logistics

Aligned with United Nations Sustainable Development Goals (SDGs)— particularly:

UNSDG 9 : Industry, Innovation, and Infrastructure

UNSDG 11: Sustainable Cities and Communities,

UNSDG 12: Responsible Consumption and Production,

UNSDG 13: Climate Action

UNSDG 17: Partnerships for the Goals

Keywords: Smart logistics, green transportation, digital supply chain, real-time tracking, sustainable packaging, last-mile delivery, carbon reduction, accessible logistics.

This theme, "Sustainable Digital Supply Chains and Smart Logistics", is a forward-thinking framework to use emerging technologies for optimizing supply chain efficiency, reducing environmental impacts, and fostering resilient urban logistics.

It is highly relevant for rapidly growing urban areas like Mira Bhayandar, where smart city initiatives, increasing consumer demands, and sustainability pressures require the adoption of intelligent, tech-enabled logistics solutions. This theme aligns with key United Nations Sustainable Development Goals (UNSDGs) by promoting responsible consumption, industrial innovation, and climate-conscious operations.

Alignment with UNSDGs:

For Industry, Innovation, and Infrastructure (UNSDG 9):

- **Digitalization of Supply Chains:** Improving transparency and efficiency in supply chain networks.
- **Smart Warehousing:** Optimizing storage and distribution.
- **Predictive Analytics:** Employing data-driven forecasting for demand management, reducing stockouts and overproduction.
- **Green Transport Solutions:** Promoting electric vehicles, drones, and optimized routing to reduce carbon emissions in logistics.

For Sustainable Cities and Communities (UNSDG 11):

- **Last-Mile Delivery Optimization:** Designing sustainable last-mile solutions to reduce urban congestion.
- **Urban Freight Management:** Smart scheduling to minimize traffic disruptions caused by goods transportation.
- **Smart Infrastructure Integration:** Linking supply chain operations with smart city platforms to ensure seamless logistics, especially around growing transit nodes like the Mumbai Metro Line 9.

For Responsible Consumption and Production (UNSDG 12):

- **Sustainable Packaging:** Adoption of biodegradable and minimalistic packaging solutions to reduce waste.
- **Reverse Logistics:** Implementing efficient return and recycling mechanisms to promote circular economy practices.
- **Supplier Collaboration:** Encouraging eco-conscious sourcing and partnerships with sustainable vendors.

For Climate Action (UNSDG 13):

- **Carbon Footprint Reduction:** Leveraging route optimization, energy-efficient transport, and smart warehousing to minimize greenhouse gas emissions.
- **Data-Driven Sustainability:** Using real-time data to monitor emissions and continuously improve eco-efficiency across the supply chain.
- **Decarbonized Logistics:** Shifting towards renewable energy-powered logistics operations.

For Partnerships for the Goals (UNSDG 17):

- **Public-Private Collaboration:** Engaging local authorities, businesses, and technology providers to co-create smart logistics solutions.
- **Global-Local Supply Chain Partnerships:** Building inclusive supply networks that benefit local businesses while meeting international standards.
- **Community-Centric Logistics:** Developing partnerships with local transport services, SMEs, and digital platforms to foster inclusive growth.

Local Problem Statements for Mira Road / Mira-Bhayander

1. In Mira Bhayandar's logistics landscape, there is often limited collaboration between suppliers, transporters, retailers, and local authorities, leading to fragmented operations, duplicated trips, and inefficient resource utilization. The absence of shared logistics platforms and cooperative delivery models results in increased congestion, higher emissions, and reduced profitability. There is a critical need to create more efficient, sustainable, and resilient supply chains.
2. In high-density residential complexes like the increasing number of e-commerce deliveries has resulted in a noticeable surge in packaging waste, especially single-use plastics and non-biodegradable materials. Currently, Mira Bhayandar Municipal Corporation (MBMC) has no dedicated system to manage reverse logistics for packaging recycling or promote sustainable delivery practices. There is a growing gap between consumption and responsible waste management.
3. Local truck drivers, tempo operators, and delivery riders in Mira Bhayandar, especially those serving the markets in Bhayandar East and Dahisar Check Naka, often lack awareness and training in using digital logistics platforms, GPS tracking, and fuel-optimization apps. As a result, manual paperwork, inefficient fuel use, and non-optimal route selection are common, increasing operational costs and emissions.
4. Many school transportation systems in Mira Bhayandar operate without real-time vehicle tracking or route optimization. Parents have no live updates on bus locations, and inefficient bus routing increases fuel consumption, commute time, and traffic congestion near schools. There is a need to improve safety, reduce carbon footprint, and streamline school logistics
5. During summer months or pipeline maintenance, water tanker services in Mira Bhayandar are in high demand, but the allocation process is manual, unstructured, and prone to delays. Residents often have to call multiple vendors and cannot track arrival times or tanker availability in real-time. This leads to unnecessary waiting, water hoarding, and unfair distribution. There is a need to improve tracking and automated scheduling to improve service efficiency and ensure equitable distribution.

- 6. With rapid construction in various areas of Mira Bhayandar, material deliveries like cement, bricks, and sand are often unscheduled and untracked, leading to road blockages, dust pollution, and inefficient loading/unloading times. There is need for a smart scheduling and logistics tracking platform for construction materials that can improve urban mobility, minimize environmental impact, and ensure timely project execution.**
- 7. Traffic Congestion Due to Uncoordinated Delivery Timings Multiple logistics vehicles, courier vans, and supplier trucks enter narrow roads and market areas at the same peak hours, causing heavy congestion and fuel wastage. There is no centralized system to schedule delivery slots or manage urban freight timing. A smart digital scheduling and congestion-aware delivery system is required to reduce emissions and traffic load.**
- 8. Lack of Digital Inventory Visibility for Small Retailers Small shop owners and kirana stores in Mira Bhayandar still rely on manual inventory tracking, leading to overstocking, stock-outs, and inefficient supply ordering. Without real-time digital inventory integration with suppliers, supply chain efficiency remains low. There is a need for an affordable digital inventory and demand-forecasting system for small businesses.**
- 9. Lack of Smart Cold-Chain Monitoring for Perishable Goods Small vendors and local markets in Mira Bhayandar dealing with milk, fish, fruits, and vegetables often lack affordable cold-chain logistics and temperature monitoring. This leads to food spoilage, wastage, and financial loss. The absence of IoT-based cold-storage tracking reduces food quality and increases environmental waste. There is a need for a lowcost smart cold-chain system for small suppliers.**
- 10. Absence of Electric Vehicle (EV) Integration in Local Logistics Most delivery and transport operations in Mira Bhayandar rely on fuel-based vehicles, increasing carbon emissions and pollution. There is limited EV infrastructure, charging coordination, and route planning for electric logistics fleets. A sustainable transition requires digital EV fleet management and charging-aware logistics optimization.**



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Course Code	Course Name	Teaching Scheme (Contact Hours Per week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
BSC101	Sampling Theory and Optimization	2	1	--	30	15	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
BSC101	Sampling Theory and Optimization	20	20	40	60	2.5	25	--	125

Rationale:

In a second-year Information Engineering course, understanding statistical and optimization techniques is essential for analyzing data and improving system efficiency. Large and small sample tests help students make inferences from data—large sample tests apply to big datasets like internet usage logs, while small sample tests are used for limited data, such as evaluating a new data compression method. Chi-square and F-tests are valuable for comparing distributions and variances—for instance, verifying symbol frequencies in encoded messages or comparing network performance under different conditions. The Simplex method enables optimal resource allocation, such as distributing bandwidth among users, while Duality provides deeper insight into constraints and trade-offs. Nonlinear problems, common in signal processing or wireless networks, can be addressed using Kuhn-Tucker conditions to optimize performance within practical limits. Markov Chains model systems with probabilistic transitions, such as user navigation patterns or communication errors. Queuing Theory is vital for analyzing delays and



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optimizing performance in routers and server systems. These tools equip students with a practical foundation for building efficient and reliable information systems.

Course Objectives:

1. To explain statistical hypothesis testing methods to analyze large and small datasets in IT systems.
2. To describe the use of Chi-square and F-tests for validating relationships and comparing variances in IT data.
3. To understand linear programming to optimize resource allocation in IT project management and network design.
4. To explain the Kuhn-Tucker conditions to solve constrained non-linear optimization problems in IT system design.
5. To describe Markov chain models for stochastic process analysis in IT applications.
6. To understand queuing theory to analyze and improve IT system performance.

Course Outcomes:

1. Students will be able to apply large and small sample tests to assess network traffic data and system reliability metrics.
2. Students will be able to perform chi-square tests to verify user behavior patterns and conduct f-tests to compare performance variance across different software versions.
3. Students will be able to solve optimization problems like bandwidth allocation or cloud resource scheduling using simplex method and interpret dual solutions.
4. Students will be able to formulate and analyze non-linear problems such as optimizing database query performance under resource constraints.
5. Students will be able to model user session behaviors in web applications and predict state transitions in network protocols using Markov chains.
6. Students will be able to analyze server request handling and optimize load balancing in cloud computing environments using queuing models like M/M/1.

Prerequisite:

1. Basic Probability Theory, Matrix Algebra.



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DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Sampling theory-I	Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two tailed test, Degree of freedom.	05	CO1
		Test significance for large samples. Test the significance of mean.		
		Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test)		
		Self-learning Topics: 1. Estimate parameters of a population. 2. Test of significance of large samples, Proportion test. 3. Difference between the means of two large samples.	08	
II	Sampling theory-II	Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction.	05	CO2
		Analysis of variance: F-test (significant difference between variances of two samples).		
		Self-learning Topics: 1. ANOVA: One way classification, 2. ANOVA: Two-way classification (short-cut method).	08	
III	Linear Programming Problems	Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables.	05	CO3



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		Simplex method.		
		Duality, Dual of LPP.		
		Dual Simplex Method.		
		Self-learning Topics: 1. Artificial variable method, Big M method. 2. Sensitivity Analysis, Two-Phase Simplex Method, Revised Simplex Method.	08	
IV	Nonlinear Programming Problems	NLPP with one equality constraint (two variables) using the method of Lagrange's multipliers	05	CO4
		NLPP with one inequality constraint (two variables): Kuhn-Tucker conditions.		
		Self-learning Topics: 1. NLPP with one inequality constraint (three variables): Kuhn-Tucker conditions. 2. NLPP with one equality constraint (three variables) using the method of Lagrange's multipliers	07	
V	Markov Chains	Introduction to Markov Chains	05	CO5
		Transition Probability matrix, Transition Diagram		
		Homogeneous Markov Chains		
		Chapman-Kolmogorov Equations for discrete Markov chains.		
		Self-learning Topics: 1. Initial Conditions 2. Classification of states 3. Semi-Markov Chains	07	



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		4. Markov Processes State Space and Continuous time.		
VI	Queuing Theory	Introduction to Queuing Systems	05	CO6
		Birth-Death Processes & M/M/1 Queues		
		M/M/c and Finite Queue Models		
		M/G/1 and G/G/1 Queues		
		Queuing Networks	07	
		Self-learning Topics: 1. Priority Queues. 2. Queueing Disciplines. 3. Retrial Queues & Balking/Reneging 4. Queueing with Server Vacations		

Text Books:

1. Operations Research, Hira and Gupta, S. Chand Publication.
2. Fundamentals of Statistics, S. C. Gupta.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa.
4. Murray Spiegel, "Schaum's Outline of Probability and Statistics", 4th Edition, Tata McGraw-Hill.

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Operations Research: An Introduction, Hamdy A Taha, Pearson.



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4. Engineering Optimization: Theory and Practice, S.S Rao, Wiley-Blackwell.
5. S. D. Sharma, "Operations Research", Kedarnath Ramnath Publishing, Meerut, 8th Edition, 2015.

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/117/103/117103017/
2.	https://archive.nptel.ac.in/courses/111/102/111102111/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

Term work (TW) for 25 marks:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per the university pattern for practical.
2. Students must be encouraged to write **at least 10** class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project.

This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1. Regularity and active involvement (Theory and Tutorial) 05 marks.



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2. Class Tutorials on entire syllabus 10 marks.

3. Mini Project 10 marks.

1 Question paper format

- Question Paper will comprise of a total of **six questions each carrying 15 marks**. Q.1 will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Four questions** needs to be answered



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		L	T	P	L	T	P	SL	Notional Learning Hour	
15211402	Software Engineering & Project Management	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
15211402	Software Engineering & Project Management	20	20	40	60	2.5	--	--	100

Rationale :

This course equips students with essential software engineering and project management skills. It strategically focuses on Sustainable Digital Supply Chains and Smart Logistics, addressing a critical industry demand. The curriculum aligns with NEP 2020 by offering holistic, multidisciplinary education. It fosters skill-based learning, critical thinking, and problem-solving through practical

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applications. Emphasis on experiential learning is achieved via real-world case studies and a dedicated project module. Crucially, the course directly contributes to UN Sustainable Development Goals like Responsible Consumption (SDG 12) and Sustainable Cities (SDG 11). It also promotes Climate Action (SDG 13) and Innovation (SDG 9) within logistics. The pedagogical approach, guided by Bloom's Taxonomy, ensures comprehensive cognitive development. Graduates will be competent, responsible, and future-ready professionals for a sustainable global economy.

Course Objective:

1. Comprehend the foundational principles of software development, including various software life cycle process models, agile methodologies, SCRUM, and other contemporary agile practices.
2. Apply methods for eliciting, specifying, visualizing, and analyzing software requirements, ensuring comprehensive understanding of stakeholder needs.
3. Design and implement software solutions utilizing core concepts and principles of software design, emphasizing user-centric approaches and principles of effective user interfaces.
4. Evaluate and select appropriate software testing strategies and tactics, implement quality assurance processes, and manage software configurations effectively.
5. Articulate the critical role of project management within the software development life cycle (SDLC) and assess the significance of Software Engineering in the overall Product Life Cycle (PLC).
6. Develop and optimize project schedules, construct network diagrams (AON, AOA), utilize CPM and PERT techniques, and mitigate project risks by organizing activities based on risk impact factors

Course Outcomes:

1. Categorize various software application domains and differentiate between diverse process models employed in software development (L2, L4)
2. Formulate precise software specifications, classify distinct types of software requirements, and employ effective requirement gathering techniques. (L3, L4)
3. Translate requirements models into robust design models and demonstrate the application of sound software and user-interface design principles. (L3, L6)



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4. Differentiate between Software Configuration Management (SCM) and Software Quality Assurance (SQA), evaluate various testing strategies and tactics, and compare their effectiveness. (L4, L5)
5. Justify the integral role of SDLC in Software Project Development and evaluate the paramount importance of Software Engineering within the overall Product Life Cycle.(L5)
6. Construct and optimize project schedules, design and develop network diagrams for diverse project types, and prioritize different project activities based on their risk impact factor. (L3, L5, L6)

Prerequisite: Nature of Software, Software Definition, Software Characteristics, Software Application Domains

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Nature of Software, Software Definition, Software Characteristics, Software Application Domains	-	-
I	Introduction to Software Engineering	Evolution and scope of software engineering. Software process models: Waterfall, Spiral, V-Model, Agile, DevOps. Characteristics of good software (reliability, maintainability, efficiency, etc.) Software engineering ethics and professional conduct. Overview of SDLC and software process activities.	8	CO1
		Self-learning Topics: History and Milestones of Software Engineering. In-depth Study of Agile & DevOps Practices. DevOps for Agile Software Delivery. Explore the principles and practices of DevOps, and how they enhance agile methodologies (Scrum, XP) for continuous integration, delivery, and deployment in modern supply chain software	6	



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II	Requirements Engineering and Feasibility Analysis	Functional vs Non-functional requirements. Elicitation techniques: Interviews, questionnaires, use cases. Writing Software Requirements Specification (SRS) using IEEE standards. Feasibility analysis: Technical, economic, operational. Requirements validation and change management.	7	CO1, CO2
		Self-learning Topics: AI-Powered Requirements Analysis and Automation: Investigate tools and techniques that use AI/ML to assist in requirements gathering (e.g., sentiment analysis of user feedback) and automated test case generation for complex logistics systems.	6	
III	Software Design and Architecture with Implementation	Design principles: Modularity, cohesion, coupling, abstraction. UML diagrams: Class, Use Case, Sequence, Activity. Design patterns: Singleton, Factory, MVC. Software architecture styles: Layered, Client-Server, Microservices. Formulate Architecture Design, Component Level Design, System Level Design. Create User Interface Designs focusing on usability and accessibility. Coding standards (PEP8, MISRA), naming conventions, comments. Procedural vs Object-Oriented Programming (OOP) design.	8	CO1, CO2, CO3, CO4
		Self-learning Topics: Compare Procedural vs. Object-Oriented Programming. Hands-on with Code Reusability Techniques. Study Microservices Architecture in Large-Scale Logistics Systems: Research the benefits and challenges of designing large-scale, distributed logistics applications	8	



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IV	Software Testing & Quality Assurance	Software Testing Life Cycle (STLC). Testing types: Unit, Integration, System, Acceptance. White-box & Black-box techniques. Evaluating quality metrics like defect density and test coverage and testing tools such as JUnit (Java), PyTest (Python), and Selenium for automation. Examine the role of reviews, inspections, and audits in ensuring software quality	8	CO5
		Self-learning Topics: Practice Black-box and White-box Testing Techniques. Study Cybersecurity in IoT-Enabled Supply Chains	7	
V	Software Project Management & Maintenance	Introduction to software project management principles. Software project lifecycle: Initiation → Closure. Estimation techniques: COCOMO, Function Point. Gantt Charts, PERT, CPM for scheduling. Risk management and stakeholder communication strategies. Building a Project Charter and Work Breakdown Structure (WBS). Types of maintenance: Corrective, Adaptive, Preventive. Configuration and change management tools.	7	CO1, CO2, CO3, CO4, CO6
		Self-learning Topics: Create a project plan with WBS, estimation & risk register. Risk Management with Artificial Intelligence: Explore how AI and predictive analytics can be used to identify, assess, and mitigate project risks more effectively	6	
VI	Practical Application - Theme Based Case Studies Theme: Sustainable Digital Supply Chains &	AI / ML Integration DevOps, CI/CD & Microservices Cloud-Native & IoT Systems Blockchain & Security in Software Engineering	7	CO1, CO2, CO3, CO4, CO5, CO6



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Smart Logistics Project	Case Study 1: Optimizing Last-Mile Delivery for Urban Sustainability Scenario: A large e-commerce company faces challenges with inefficient last-mile delivery in dense urban areas, leading to high fuel consumption, increased carbon emissions, traffic congestion, and customer dissatisfaction due to delayed deliveries. They decide to invest in a "Smart Logistics" software solution. Case Study 2: Implementing a Digital Twin for Green Manufacturing & Supply Chain Transparency Scenario: A manufacturing company producing electronic components aims to achieve greater sustainability by reducing waste, optimizing energy consumption, and ensuring ethical sourcing throughout its supply chain. They decide to develop and implement a "Digital Twin" of their manufacturing process and supply chain. Case Study 3: Blockchain for Ethical Sourcing and Supply Chain Traceability Scenario: A fashion brand commits to ensuring ethical sourcing of raw materials (e.g., cotton, dyes) and transparent supply chain practices to prevent child labor and environmental damage. They decide to implement a blockchain-based traceability system for their supply chain. Case Study 4: AI-Powered Demand Forecasting for Waste Reduction in Food Supply Chain Scenario: A large supermarket chain struggles	12	
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		with significant food waste due to inaccurate demand forecasting, leading to overstocking and expired products. They aim to implement an AI/Machine Learning-driven demand forecasting system to optimize inventory and reduce waste. Case Study 5: IoT-Enabled Cold Chain Monitoring for Pharmaceutical Logistics Scenario: A global pharmaceutical company needs to ensure that sensitive vaccines and medicines are maintained within precise temperature ranges throughout their journey from manufacturing plants to hospitals and clinics worldwide. Any deviation can render Case Study 6: AI-Driven Warehouse Automation for Circular Economy Initiatives Scenario: A company specializing in electronics recycling and refurbishment aims to increase its processing efficiency and material recovery rates. They want to implement an "AI-driven warehouse automation" system to sort incoming electronic waste, identify Case Study 7: Predictive Maintenance for Fleet Management in Green Logistics Scenario: A large logistics company with a fleet of delivery vehicles wants to reduce operational costs, minimize vehicle downtime, and lower carbon emissions by proactively identifying and addressing potential mechanical failures. They aim to implement a "Predictive Maintenance" system using IoT and AI.		
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Text Books:

1. Roger S Pressman, "Software Engineering: A Practitioner's Approach," 7th Edition, McGraw-Hill. ISBN: 0073375977.
2. Jack T. Marchewka, "Information Technology Project Management," 4th Edition, Wiley India.
3. Ian Sommerville "Software Engineering" 9th edition Pearson Education SBN-13: 978-0-13-703515-1, ISBN-10: 0-13-703515-2

References:

1. Pankaj Jalote, "Software Engineering: A Precise Approach," Wiley India.
2. Ian Sommerville, "Software Engineering," 9th Edition, Pearson Education. ISBN-13: 978-0-13-703515-1, ISBN-10: 0-13-703515-2.
3. John M. Nicholas, "Project Management for Business and Technology," 3rd Edition, Pearson Education.
4. Bob Hughes, Mike Cotterell, Rajib Mall, "Software Project Management."

Online References:

Sr. No.	Website Name
1.	https://www.ireb.org/en/ (International Requirements Engineering Board (IREB) - CPRE Syllabus)
2.	https://martinfowler.com/ (Martin Fowler's website)
3.	https://www.pmi.org/ (Project Management Institute (PMI))

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test
- Question paper format
 - o Question Paper will comprise of a total of six questions each carrying 15 marks Q.1 will be compulsory and should cover maximum contents of the syllabus
 - o Remaining questions will be mixed in nature (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
 - o A total of Four questions need to be answered



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15211403	Operating System	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
15211403	Operating System	20	20	40	60	2.5	--		100

Rationale :

Operating Systems form the backbone of computer systems by managing hardware and software resources, enabling efficient and secure application execution. Understanding OS concepts equips engineering students with the skills to design system-level software, handle concurrency, memory, and process management. This foundational knowledge is essential for advanced areas like cloud computing, cybersecurity, embedded systems, and performance optimization.

Course Objectives:

1. Analyze the fundamental components and operational paradigms of modern Operating Systems.



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- 2.Design and implement process management solutions, including process lifecycle, thread management, and diverse scheduling algorithms.
- 3.Evaluate inter-process communication mechanisms, mitigate race conditions, and formulate strategies for deadlock prevention and recovery in concurrent systems.
- 4.Optimize memory allocation and virtual memory techniques to enhance system performance and resource utilization.
- 5.Secure and manage storage systems, implementing efficient file handling and I/O operations in diverse computing environments.
- 6.Assess the design principles and operational challenges of special-purpose Operating Systems for emerging technologies, considering their societal and environmental impact.

Course Outcomes:

On successful completion, of course, learner/student will be able to:

- 1.Explain and classify the core concepts and structures of Operating Systems. (L2, L4)
2. Implement process management policies and analyze the performance of various CPU scheduling algorithms. (L3, L4)
- 3.Apply synchronization primitives to resolve concurrency issues and propose solutions for deadlock scenarios in multi-threaded applications. (L3, L5)
- 4.Configure and evaluate memory allocation strategies, and troubleshoot virtual memory issues to improve system efficiency. (L3, L5)
- 5.Design secure and efficient storage management solutions, and assess the reliability of file systems and I/O operations. (L6, L5)
- 6.Compare and critique the architecture and functionalities of specialized Operating Systems, considering their application in sustainable development. (L4, L5)

Prerequisite: Programming Language C (with emphasis on pointers and memory management); Basic of Hardware (ALU, RAM, ROM, HDD, CPU Architecture); Computer System Organization.

DETAILED SYLLABUS:



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Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Programming Language C (with emphasis on pointers and memory management); Basic of Hardware (ALU, RAM, ROM, HDD, CPU Architecture); Computer System Organization.	02	-
I	Fundamentals of Operating System	Introduction to Operating Systems; Goals of OS: Efficiency, Reliability, Security, Adaptability; Operating System Structures (Monolithic, Layered, Microkernel, Modules); System Calls and APIs; OS Services and User Interface; System Programs; Virtualization Concepts (Hypervisors); Boot Process.	4	CO1
		Self-learning Topics: Comparative study of OS architectures (e.g., Linux vs. Windows Kernel); Basics of Containerization (Docker Architecture); Evolution of OS and its impact on digital infrastructure.	5	
II	Process Management	Process Definition and Attributes; Process State Model and Transitions; Process Control Block (PCB); Context Switching; Threads (User vs. Kernel, Threading Models); Concurrency vs. Parallelism; CPU Scheduling Criteria and Algorithms (FCFS, SJF, Priority, Round Robin, Multilevel Queue, Multilevel Feedback Queue); Real-Time	7	CO2



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		Scheduling (Rate Monotonic, Earliest Deadline First).		
		Self-learning Topics: Performance analysis and benchmarking of scheduling algorithms in different scenarios; Introduction to Container Orchestration (e.g., Kubernetes Pods and Processes); Process isolation for secure applications	6	
III	Process Coordination	Process Coordination and Synchronization Inter-process Communication (IPC) Mechanisms (Shared Memory, Message Passing); Race Conditions and Critical Section Problem; Solutions to Critical Section (Peterson's, Mutex Locks, Semaphores); Classic Synchronization Problems (Producer-Consumer, Dining Philosophers, Readers-Writers); Deadlock: Characterization, Prevention, Avoidance (Banker's Algorithm), Detection, and Recovery.	9	CO3
		Self-learning Topics: Case studies of concurrency issues in real-world distributed systems; Exploring distributed locking mechanisms; Designing fault-tolerant communication systems.	9	
IV	Memory Management	Logical vs. Physical Address Space; Swapping; Contiguous Memory Allocation (Fixed and Variable Partitioning); Fragmentation (Internal and External); Paging (Basic,	9	CO4



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		Hierarchical, Hashed Page Tables); Segmentation; Virtual Memory Concepts; Demand Paging; Copy-on-Write (CoW); Page Replacement Algorithms (FIFO, LRU, Optimal, LFU, MFU); Thrashing and its Prevention.		
		Self-learning Topics: Memory management in Cloud VMs; Memory profiling and optimization tools; Impact of efficient memory use on energy consumption	7	
V	Storage Management	File System Concepts; File Access Methods (Sequential, Direct, Indexed); Directory Structures (Single-level, Two-level, Tree-structured); File-System Implementation (Allocation Methods: Contiguous, Linked, Indexed; Free-Space Management); Mass-Storage Structure (Disk Structure, Disk Attachment); Disk Scheduling Algorithms (FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK); RAID Structure; Introduction to I/O Systems (Polling, Interrupts, DMA).	8	CO5
		Self-learning Topics: Distributed File Systems (HDFS, Ceph); Object Storage (e.g., AWS S3 principles); Data durability and resilience in cloud storage.	7	
VI	Special-purpose Operating Systems and Application	Fundamentals of Distributed Operating System; Network Operating System; Embedded	6	CO6



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	on Operating System	Operating Systems; Real-Time Operating System; Mobile Operating System; Multimedia Operating System; Comparison between Functions of various Special-purpose Operating Systems		
		Case Study 1: Flipkart – Android-Based Delivery Tracking Context: E-commerce logistics across India OS Role: Android provides GPS, camera access, and real-time sync with cloud systems. Case Study 2: Indian Railways – Smart Parcel Management via Android App Context: Parcel logistics optimization OS Role: Android enables mobile-based access to backend systems for real-time data entry and updates. Case Study 3: Microsoft Hyper-V for Sustainable E-Commerce Fulfillment Context: A fast-growing e-commerce startup wanted to expand sustainably while ensuring fast delivery and accurate inventory tracking. Application of Virtualization OS: Using Microsoft Hyper-V, the company virtualized its warehouse management systems and integrated smart logistics solutions in the cloud.	11	



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		Case Study 4: Deadlock Recovery in Port Logistics Management System Context: A major seaport logistics system handling container tracking and cargo routing experienced deadlocks in its centralized control system during peak cargo movements. Deadlock Problem: • OS-level deadlocks occurred in the process queues managing multiple cranes, trucks, and storage slots. • Processes were stuck waiting for each other's I/O buffers and semaphores. Case Study 5: Memory Management in Warehouse Automation – Flipkart Fulfillment Centers OS Concept: Virtual Memory and Paging Context: Flipkart's automated warehouse systems handle massive logistics data in real-time, including order picking, stock levels, and shipping. OS-Driven Challenge: Real-time processes overwhelmed available physical memory, causing paging delays and system slowdowns during peak shopping seasons.		
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		Case Study 6: Distributed File System in Global Supply Chain – Walmart Logistics OS Concept: Distributed File Systems (DFS), Replication, Consistency Context: Walmart needed a real-time, resilient logistics network to handle deliveries across thousands of stores and warehouses, with minimal environmental impact.		
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Text Books:

1. A. Silberschatz, P. Galvin, G. Gagne, Operating System Concepts, 10th ed., Wiley, 2018.
2. W. Stallings, Operating Systems: Internal and Design Principles, 9th ed., Pearson, 2018.
3. A. Tanenbaum, Modern Operating Systems, Pearson, 4th ed., 2015.

Reference Books:

1. N. Chauhan, Principles of Operating Systems, 1st ed., Oxford University Press, 2014.
2. A. Tanenbaum and A. Woodhull, Operating System Design and Implementation, 3rd ed., Pearson.
3. R. Arpaci-Dusseau and A. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, CreateSpace Independent Publishing Platform, 1st ed., 2018.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in (Look for Operating Systems courses)
2.	https://swayam.gov.in (Search for Operating Systems and related topics)
3.	https://www.coursera.org/ (Courses on OS, Cloud Computing, DevOps)
4.	https://developer.android.com/ (For Mobile OS insights)



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5.	https://docs.docker.com/ (For Containerization concepts)
6.	https://kubernetes.io/docs/ (For Orchestration concepts)

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test
- **Question paper format**
 - Question Paper will comprise of a total of **six questions each carrying 15 marks** Q.1 will be **compulsory** and should **cover maximum contents of the syllabus**
 - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15212404	SysOps Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test	Test 2	Avg. of 2 Tests				
15212404	SysOps Lab	--	--	--	--	25	25	50

Lab Objectives:

1. To develop foundational skills in Linux system administration, including user management, file operations, and process handling
2. To introduce core DevOps principles and practices including DevSecOps, SRE, and NoOps.



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3. To enable effective use of Git and GitHub/GitLab for version control and collaborative software development.
4. To equip students with the ability to write and use shell scripts for automating system and administrative tasks.
5. To train students in configuration management, containerization, and building CI/CD pipelines using tools like Ansible, Docker, and Jenkins.
6. To provide knowledge of secure DevOps practices, monitoring systems, and logging tools aligned with modern observability and SRE frameworks.

Lab Outcomes:

1. Identify basic Linux commands, file structures, user permissions, and process management features. (L1)
2. Explain core concepts of DevOps, DevSecOps, SRE, and NoOps, and differentiate them from traditional IT operations.(L2)
3. Demonstrate the use of Git commands for version control and collaborate using GitHub/GitLab.(L3)
4. Analyze system performance using monitoring tools like Prometheus, Grafana, and ELK Stack to identify bottlenecks and reliability issues.(L4)
5. Evaluate the effectiveness of CI/CD pipelines and DevSecOps practices in improving deployment frequency, security, and system uptime.(L5)
6. Design and develop automated infrastructure solutions using Ansible, Docker, and Jenkins to implement end-to-end DevOps workflows.(L6)

List of Experiments.

Sr No	List of Experiments	Hrs
01	Install and Configure Linux OS (Ubuntu/CentOS) on a virtual machine or bare metal	1
02	Create and manage user accounts, permissions, and directories using Linux commands (useradd, chmod, chown, etc.).	1
03	Write a basic shell script to automate backup of user home directories.	2
04	Initialize a local Git repository, perform commits, create branches, and merge changes.	1
05	Collaborate on GitHub/GitLab by pushing code, creating pull requests (PRs), and resolving merge conflicts.	2



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Sr No	List of Experiments	Hrs
01	Install and Configure Linux OS (Ubuntu/CentOS) on a virtual machine or bare metal	1
06	Develop a shell script to monitor CPU, memory, and disk usage, and send alerts if thresholds are exceeded.	1
07	Write a script to automate user creation, group assignment, and password setup.	2
08	Use grep, awk, and sed in scripts for text processing and log file filtering.	1
09	Write and execute an Ansible playbook to install and configure an Apache or NGINX web server on multiple virtual machines.	2
10	Dockerize a simple Linux-based script or C application, build a Docker image, and run it as a container.	2
11	Create a basic CI pipeline using GitHub Actions or Jenkins to compile and test a C/Linux program.	1
12	Perform static and dynamic code analysis using SonarQube (SAST) and Trivy/OWASP ZAP (DAST) on a sample application.	2
13	Use netstat and nmap to scan running services and ports, and automate the results in a report with a shell script.	2
14	Manage secrets securely in a CI/CD pipeline using GitHub Secrets or Vault.	1
15	Set up Prometheus and Grafana for real-time system monitoring and create a basic dashboard to visualize metrics.	1

Sr No	List of Assignments / Tutorials	Hrs
01	Install a Linux distribution (Ubuntu or CentOS) on a VM. Create users, set permissions, and demonstrate 5 essential file operations.	1
02	Write a Bash script to automate daily backup of user home directories and schedule it using cron.	1
03	Initialize a Git repository, create a feature branch, commit changes, and push to GitHub. Create and merge a Pull Request.	1



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04	Write an Ansible playbook to install and configure Apache/NGINX on multiple virtual machines.	1
05	Containerize a shell script that monitors CPU and memory usage. Build and run the Docker container.	1
06	Create a simple CI pipeline using GitHub Actions or Jenkins to build and test a C/Linux program.	1
07	Perform static and dynamic code analysis using SonarQube and Trivy on a sample codebase.	1
08	Install and configure Prometheus and Grafana. Monitor CPU/memory and create a dashboard with at least two metrics.	1

Text Books:

1. The Linux DevOps Handbook by Damian Wojsław & Grzegorz Adamowicz
2. The Linux Command Line by William E. Shotts
3. How Linux Works: What Every Superuser Should Know (3rd Edition) by Brian Ward
4. Accelerate: The Science of Lean Software and DevOps by Nicole Forsgren, Jez Humble & Gene Kim
5. The DevOps Handbook by Gene Kim, Jez Humble, Patrick Debois & John Willis

References:

- The Linux Documentation Project. (n.d.). Linux System Administrator's Guide. Retrieved from <https://www.tldp.org/LDP/sag/html/index.html>
- Medium. (2021). *DevOps: Complete CI/CD Pipeline Setup*. Retrieved from <https://medium.com/@abhishekjain.wisdom/devops-complete-ci-cd-pipeline-setup-d64b410f3240>
- Docker Inc. (n.d.). *Get Started with Docker*. Retrieved from <https://docs.docker.com/get-started/>



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- Kubernetes. (n.d.). *Kubernetes Basics*. Retrieved from <https://kubernetes.io/docs/tutorials/kubernetes-basics/>
- Red Hat. (n.d.). *Viewing Logs with Journalctl*. Retrieved from https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/7/html/system_administrators_guide/sec-viewing_logs_with_journalctl

Online Resources:

Sr. No.	Website Name
1.	Linux From Scratch (linuxfromscratch.org)
2.	Awesome DevOps Books on GitHub
3.	Google SRE Book (O'Reilly)

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15212405	IDEA LAB -4 (Innovation Design Engineering and Apply)	--	--	1*+2	15	--	30	15	60	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Tot. of 2 Tests				
15212405	IDEA LAB -4 (Innovation Design Engineering and Apply)	--	--	--	--	50	50	100

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Rationale :

Aligned with the National Education Policy (NEP) 2020, the institution emphasizes experiential, interdisciplinary, and project-based learning through the IDEA Lab—a central hub for hands-on innovation.

To strengthen the undergraduate research ecosystem, the institution has adopted a theme-based academic model aligned with UN SGD. Each semester features six curated problem statements based on local need and aligned with core subjects in the same semester, enabling students to apply classroom knowledge to real-world challenges. Every student selects one problem and develops an individual, subject-integrated solution—enhancing both academic understanding and research skills.

The IDEA Lab supports this initiative with facilities for design thinking, prototyping, and product development. Students maintain a project logbook throughout the semester to track their progress and reflections.

To ensure academic accountability, a two-tier assessment framework is implemented:

- Project Assessment based on standardized IDEA Lab rubrics.
- Subject-Based Term Work Assessment focused on the application of same-semester subject knowledge in the project.

Lab Objectives:

1. To promote experiential and project-based learning that bridges theoretical knowledge with real-world problem-solving.
2. To encourage interdisciplinary integration by enabling students to apply concepts from multiple subjects within a single cohesive project.
3. To develop innovation and design thinking skills through hands-on activities and iterative solution development.
4. To foster critical thinking and creativity by engaging students in open-ended problems with multiple solution pathways.
5. To enhance communication, collaboration, and documentation skills essential for professional engineering practice.
6. To build an entrepreneurial and research mindset by guiding students to develop scalable,



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socially-relevant, and technically viable prototype

Lab Outcomes: Student will be able to

1. Recall and articulate key concepts from core and allied subjects relevant to the assigned project.
2. Explain the interdisciplinary nature of the problem and the role of each subject in addressing it.
3. Apply appropriate tools, techniques, and theoretical knowledge to develop project components.
4. Analyze problem constraints and user requirements to structure a feasible and efficient solution.
5. Evaluate multiple design options and justify the chosen solution based on technical and practical considerations.
6. Create a functional prototype or solution that demonstrates innovation, utility, and integration of interdisciplinary knowledge

1) Guidelines for IDEA Project

a) Project Guidelines (Interdisciplinary Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- Faculty in-charges for the IDEA Lab are assigned according to the complexity of the project and the capacity of the respective departments.
- Faculty in-charges mentor both the academic and technical aspects, and track weekly progress.
- Project assessment will be rubric-based, ensuring depth, innovation, documentation, and ownership.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.



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- Faculty in-charges must attend relevant FDPs to ensure uniformity in mentoring and evaluation.

b) Guidelines for same semester Subject Concepts Applied within the Project

- Termwork for each subject will partially reflect how well a student applies subject-specific concepts in their interdisciplinary project.
- Internal assessment panel will collaborate to align project components with subject learning outcomes.

c) Role of Faculty In-Charges in IDEA Lab Projects

Faculty in-charges play a pivotal role in the success of interdisciplinary, theme-based projects under the IDEA Lab. Their responsibilities extend beyond technical supervision to include academic alignment, innovation facilitation, and active student engagement. Their key roles include:

- 1. Motivating and Inspiring Students**
 - Encourage students to take ownership of their learning and projects.
 - Cultivate a mindset of curiosity, exploration, and social relevance.
 - Foster an environment where students feel empowered to take creative risks.
- 2. Conducting Brainstorming and Ideation Sessions**
 - Organize structured brainstorming sessions at the start of the semester to help students define their problem statements and solution pathways.
 - Promote collaborative thinking, design exploration, and interdisciplinary integration.
- 3. Arranging Guest Lectures and Expert Talks**
 - Identify and invite industry experts, researchers, and innovators for guest lectures aligned with the semester's theme or subject areas.
 - Facilitate exposure to real-world challenges, current trends, and future opportunities.
- 4. Ensuring Uniqueness and Originality of Projects**
 - Actively review proposed ideas to ensure **no duplication of solutions** across students.
 - Encourage students to explore novel approaches, technologies, and perspectives.
- 5. Promoting Discussion and Collaborative Learning**



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- o Create platforms for students to present, discuss, and receive peer and mentor feedback.
- o Facilitate idea refinement through regular discussions and group engagement.
- 6. **Aligning Subject Content Beyond Syllabus**
 - o Faculty in-charges must **align subject content beyond the syllabus of the same semester** with the **IDEA Lab theme and assigned problem statements**.
 - o This ensures relevance, depth, and meaningful interdisciplinary integration.
- 7. **Same Semester Faculty Requirement**
 - o Faculty in-charges must be teaching subjects in the **same semester** as the students' project to ensure seamless academic integration and contextual understanding.
- 8. **Monitoring and Documentation**
 - o Oversee project logbook maintenance, milestone tracking, and submission of progress reports.
 - o Provide ongoing feedback and ensure project alignment with learning outcomes.
- 9. **Coordination with Subject Faculty**
 - o Work in collaboration with other subject faculty to help students embed theoretical and practical aspects of their coursework into the project.
 - o Facilitate subject-term mapping and contribute to termwork assessment based on evidence.

2) Implementation Strategy

a) Project Implementation in IDEA Lab

Aspect	Implementation Strategy
Faculty in-charges	Faculty in-charges assigned based on project nature and department capacity.
Mentoring Role	Faculty in-charges oversee academic/technical development, interdisciplinary integration, and timely documentation.
Capacity Building	Faculty in-charges undergo workshops on design thinking, innovation, assessment rubrics, and outcome-based mentoring.
Assessment Contribution	Faculty in-charges contribute to 25 marks allocated for the IDEA Lab project termwork. The remaining assessments are conducted by the external examiner.



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Aspect

Implementation Strategy

Recognition & Incentives

Faculty in-charges receive workload credits or are formally acknowledged in performance reviews.

b) Implementation of Subject-Term Work Mapping within Projects

Aspect

Implementation Strategy

Mapping Subject Outcomes

Faculty in-charges align their content beyond syllabus with the student's project by coordinating with the assigned project guide.

Independent Evaluation

Internal assessment panel evaluate students based on their application of subject-specific concepts within the project. This contributes to a separate 25 marks allocated for termwork based on subject application.

Evidence Sources

Evaluation is supported by project logbooks, subject-specific deliverables (e.g., tools, simulations, models), and review presentation inputs.

Outcome Assurance

Ensures practical demonstration of subject understanding and its integration into the interdisciplinary solution.

Implementation Notes:

- Guide faculty assess their course's contribution using specific evidence such as:
 - Logbooks
 - Subject-specific outputs (e.g., simulations, designs)
 - Paper publications or review presentations

2) Guidelines for Assessment

Two-tier rubrics are applied independently to evaluate subject concept application and innovation within the project.



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a) Assessment of IDEA Lab Projects (Individual Interdisciplinary Projects) (25 Marks)

Presentation-Based Assessment Structure (Total: 25 Marks)

Assessment Month	Weightage	Marks
Month 1 (Formative 1)	20%	5 marks
Month 2 (Formative 2)	40%	10 marks
Month 3 (Formative 3)	40%	10 marks

Rubric-Based Evaluation Criteria

Criteria	Month 1 (5)	Month 2 (10)	Month 3 (10)
Problem Understanding	Connects problem to subjects	Defines interdisciplinary scope	Demonstrates deep conceptual grasp
Subject Knowledge Application	Identifies relevant concepts	Applies principles in design	Integrates multiple subject areas correctly
Innovation & Design Thinking	Proposes creative idea	Develops and tests feasible solution	Final solution shows originality and utility
Documentation & Presentation	Logbook initiated, plan presented	Mid-design log and visuals	Final report and demo completed
Progress & Ownership	Meets deadlines, shows planning	Demonstrates self-motivation	Completes project independently with reflection

b) Term Work Assessment of Subject Concepts Applied in Projects (25 Marks)

Applicable to All Subjects Integrated with Interdisciplinary Projects

To reflect meaningful application of subject knowledge, each subject will be assessed through the following rubric:



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Criteria	Marks	Description
Subject Knowledge Application	8	Depth and accuracy of concept integration into the project
Practical Design or Tool Usage	5	Use of subject-specific hardware/software/simulation/tools
Documentation	4	Quality and clarity of subject-related logs and reports
Viva/Presentation	4	Ability to explain subject's relevance and role in the project
Continuous Engagement	4	Evidence of consistent participation via logbooks and feedback

c) Total Assessment Structure

Component	Marks	Assessed By
Termwork – Project Execution	25 Marks	Project Guide
Termwork – Application of Subject Concepts	25 Marks	IDEA Lab Panel
Viva Voce (Final Evaluation)	50 Marks	External Examiner



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15412406	Full Stack Development	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total.					
15412406	Full Stack Development	--	--	--	--	--	25	25	50

Lab Objectives:

1. To learn the fundamentals of Java and OOP principles.
2. To build backend applications using Spring Boot and REST APIs.
3. To develop frontend interfaces using HTML, CSS, and JavaScript.
4. To connect and perform CRUD operations with databases.
5. To deploy full stack apps and practice DevOps basics.
6. To promote self-learning using Git, Docker, and modern tools.

Lab Outcomes:

1. Understand and apply Java programming fundamentals including OOPs concepts. (LO1)
2. Build a responsive frontend using HTML, CSS, and JavaScript. (LO1)
3. Develop backend services and REST APIs using Spring Boot. (LO2)
4. Integrate frontend and backend and perform data operations using databases. (LO3, LO4)
5. Demonstrate skills in deploying full stack apps using Docker and cloud platforms.(LO4)

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6. Utilize GitHub, Postman, and modern tools for full stack development workflow. (LO5,LO6)

List of Experiments:

Sr No	List of Experiments	Hrs.
01	Write a Java program to demonstrate class, object, and constructors	1
02	Implement method overloading and overriding using inheritance	2
03	Demonstrate file handling (read/write to file) and exception handling in Java	1
04	Use Java Collections (List, Set, Map) to perform basic data storage operations	2
05	Create and manage threads in Java using Thread class and Runnable interface	1
06	Design a responsive web page using HTML5 and CSS3 with Bootstrap	2
07	Build an interactive form and validate inputs using JavaScript and DOM manipulation	1
08	Set up a Spring Boot project and expose a simple REST API using @RestController	1
09	Test the REST API using Postman (GET, POST, PUT, DELETE) and analyze HTTP responses	2
10	Connect Spring Boot to MySQL/PostgreSQL using Spring Data JPA and perform CRUD operations	1
11	Implement entity relationships (OneToMany, ManyToOne) using JPA annotations	2
12	Integrate frontend HTML/JS form with Spring Boot backend using fetch/axios	2
13	Dockerize a Spring Boot application and run it as a container	1
14	Deploy the backend app to Heroku and frontend (static) to Netlify/Vercel	1
15	Capstone Project: Build and present a complete full stack app (e.g., To-Do List, Student Portal, Inventory System)	2

Sr No	List of Assignments / Tutorials	Hrs
01	Describe primitive data types in Java and explain the use of if, switch, for, while, and do-while with examples.	1

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02	Define and explain the four pillars of OOP: Encapsulation, Inheritance, Polymorphism, and Abstraction with real-life analogies.	1
03	Write a comparative analysis of ArrayList, HashSet, and HashMap in terms of structure, use cases, and performance.	1
04	Discuss types of exceptions, try-catch-finally structure, and basic file reading/writing using FileReader and BufferedWriter.	1
05	Explain how each technology contributes to building modern, interactive, and responsive websites.	1
06	Define REST APIs and describe how Controllers, Services, and Dependency Injection work together in a Spring Boot application.	1
07	Explain how CRUD operations are performed using JpaRepository and annotate entity classes for one-to-one/many relationships.	1
08	Write an overview of CI/CD pipelines, environment variables, Docker containers, and version control using GitHub.	1

Text Books:

1. "Java: The Complete Reference" by Herbert Schildt
2. "Head First Java" by Kathy Sierra and Bert Bates
3. "HTML and CSS: Design and Build Websites" by Jon Duckett
4. "Pro Spring Boot 3" by Felipe Gutierrez
5. "Docker Deep Dive" by Nigel Poulton

References:

1. Herbert Schildt – *Java: The Complete Reference*
2. Craig Walls – *Spring in Action*
3. Kirupa Chinnathambi – *Learning React*
4. Josh Long – *Spring Boot: Up and Running*

Online References:

Sr. No.	Website Name
1.	https://docs.oracle.com/javase
2.	https://spring.io – Official Spring Boot Docs

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3.	https://reactjs.org – React Documentation
4.	https://getbootstrap.com – Bootstrap Docs
5.	https://www.w3schools.com – HTML/JS/CSS

Assessment:

- **Term Work Marks:** 25 Marks (Total marks) = 10 Marks (Experiment) + 10 Marks (Capstone Project) + 5 Marks (Attendance)
- **Practical & Oral Exam:** An Oral & Practical exam will be held based on the above syllabus.



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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
9951149WW	Open Elective	2	-	-	2	-	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duratio n (in Hrs)			
		Test 1	Test 2	Total .					
9951149WW	Open Elective	--	--	--	--	--	25	--	25

Students must select a course for Open Elective from a bucket provided by the Rahul Education Group.

Term Work Assesment: 25 Marks (Total marks) = 15 Marks (Case Study/Activity) + 5 Marks (Assignments) + 5 Marks (Attendance)



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		L	T	P	L	T	P	SL	Notional Learning Hour	
98451410	Design Thinking	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
98451410	Design Thinking	20	20	40	60	2.5	--	--	100

Rationale :

Design Thinking is a human-centered approach that fosters creativity, empathy, and problem-solving. This course equips students with tools to understand user needs, generate innovative ideas, and develop practical solutions for real-world challenges.

Course Objectives:

1. Introduce the core principles and stages of the Design Thinking process.
2. Develop an empathetic mindset to understand user needs.
3. Frame clear problem statements using user-centered tools.



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4. Apply ideation techniques to generate creative solutions.
5. Understand various types of prototypes and their role in product development.
6. Learn the process of testing and refining ideas based on feedback.

Course Outcomes:

On successful completion of the course learner will be able to:

1. Compare traditional and design thinking-based approaches to problem solving.
2. Define user personas using empathy and mapping techniques.
3. Frame actionable problem statements using POV and problem definition tools.
4. Apply ideation techniques to develop diverse solution sets.
5. Differentiate between low and high-fidelity prototypes and understand their usage.
6. Explain how to test prototypes based on desirability, feasibility, and usability..

Prerequisite: Fundamentals of communication and leadership skills.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of communication and leadership skills		
I	Introduction to Design Thinking	Introduction to Design Thinking: Definition, Comparison of Design Thinking and traditional problem-solving approach, Need for Design Thinking approach, Key tenets of Design Thinking, 5 stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test)	4	CO1
		Self-learning Topics: Design thinking case studies from various domains. Link: https://www.design-thinking-association.org/explore-design-thinking-to	4	



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		pics/external-links/design-thinking-case-study-index		
II	Empathy	Foundation of empathy, Purpose of empathy, Observation for empathy, User observation technique, Creation of empathy map.	5	CO2
		Self-learning Topics: Creation of empathy maps Link: https://www.interaction-design.org/literature/topics/empathy-mapping Case Study: Designing MRI for Children – GE Healthcare	5	
III	Define	Significance of defining a problem, Rules of prioritizing problem solving, Conditions for robust problem framing, Problem statement and POV	5	CO3
		Self-learning Topics: Creating a Persona – A step-by-step guide with tips and examples Link: https://uxpressia.com/blog/how-to-create-persona-guide-examples	5	
IV	Ideate	What is ideation? Need for ideation, Ideation techniques, Guidelines for ideation: Multi-disciplinary approach, Imitating with grace, Breaking patterns, Challenging assumptions, Looking across value chain, Looking beyond recommendation, Techniques for ideation: Brainstorming, Mind mapping	6	CO4
		Self-learning Topics: How To Run an Effective Ideation Workshop: A Step-By-Step Guide Link:	6	



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		https://uxplanet.org/how-to-run-an-effective-ideation-workshop-a-step-by-step-guide- d520e41b1b96		
V	Prototype	Low and high-fidelity prototypes, Paper prototype, Story board prototype, Scenario Prototype.	4	CO5
		Self-learning Topics: IDEO Prototyping Toolkit	4	
VI	Test	5 guidelines of conducting test, The end goals of test: Desirability, Feasibility and Viability, Usability testing	6	CO6
		Self-learning Topics: Real-world Testing Examples from Stanford d.school or IDEO Case Study: IDEO's Shopping Cart Redesign – A classic innovation sprint (All stages)	6	

Textbooks:

1. Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Pavan Soni, Penguin, Random House India Private Limited
2. Design Thinking: Methodology Book, Emrah Yayichi, 2016
3. Handbook of Design Thinking: Christian Mueller-Roterberg, 2018

Reference books:

1. Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, Idris Mootee, Wiley, 2013
2. Change by Design, Tim Brown, Harper Business, 2009

Online References:

Sr. No.	Website Name
1.	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
2.	Introduction to Design Thinking by Dr. Rajeshwari Patil, Dr. Manisha Shukla,



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	Dr Deepali Raheja, Dr. Mansi Kapoor https://onlinecourses.swayam2.ac.in/imb24_mg37/preview
3.	Usability Testing https://www.interaction-design.org/literature/topics/usability-testing

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

Question paper format

- Question Paper will comprise of a total of **six questions each carrying 15 marks** Q.1 will be **compulsory** and should **cover maximum contents of the syllabus**
- Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Four questions** need to be answered



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		L	T	P	L	T	P	SL	Notional Learning Hour	
98431411	Business Model Development	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
98431411	Business Model Development	--	--	--	--	--	25	--	25

Rationale :

Entrepreneurship is the backbone of innovation and economic growth. In the 21st-century knowledge economy, students must be equipped not just with employment-ready skills but with a problem-solving and innovation mindset to become job creators. This course blends core entrepreneurship principles with business model design, startup financing, and digital business strategies.

Course Objectives:

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1. To introduce students to entrepreneurship and its socio-economic relevance.
2. To enable understanding of different business structures and MSME significance.
3. To familiarize learners with funding mechanisms for startups.
4. To introduce the basics of IPR and ethical innovation practices.
5. To equip students with tools for building business models and MVPs.
6. To explore digital marketing and disruption in online business ecosystems.

Course Outcomes:

On successful completion of the course learner will be able to:

1. Define and explain entrepreneurship and its key types.
2. Analyze the legal and operational structure of business ownership.
3. Identify and compare startup funding models and sources.
4. Apply the fundamentals of IPR to protect entrepreneurial innovations.
5. Create comprehensive business models using BMC tools.
6. Evaluate and apply digital marketing techniques for online business models.

Prerequisite: Basic Design Thinking principles.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Design Thinking principles	1	
I	Introduction to Entrepreneurship	Definition, the role of entrepreneurship in the economic development, The entrepreneurial process, Women entrepreneurs, Corporate entrepreneurship, Entrepreneurial mindset.	5	CO1
		Self-learning Topics: Case studies: Henry Ford https://www.thehenryford.org/docs/default-source/default-document-library/	5	



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		default-document-library/henryfordandinnovation.pdf?sfvrsn=0 The Tatas: How a Family Built a Business and a Nation by Girish Kuber, April 2019, Harper Business		
II	Entrepreneurship Development	Types of business ownerships: Proprietorship, Public and Private Companies, Co-operative businesses, Micro, Small and Medium Enterprises (MSME): Definition and role of MSMEs in economic development.	4	CO2
		Self-learning Topics: MSME Act and Udyam Registration portal Case Study: Amul – Co-operative innovation in dairy sector	4	
III	Start-up financing	Start-up financing: Cost and revenue models, Sources of start-up fundings: Angel investors, Venture capitalists, Crowd funding, Government schemes funding(e.g., SIDBI, Startup India).	4	CO3
		Self-learning Topics: Successful business pitching. Case Study: Shark Tank pitch breakdown.	4	
IV	Intellectual Property Rights (IPR)	Types of IPR: Patents, trademarks and copyrights, Patent search and analysis, Strategies for IPR protection, Ethics in technology and innovation.	4	CO4
		Self-learning Topics: Case Study: WIPO Patent Search Exercise	4	
V	Business Model	Types of business models, Value proposition, Customer	4	CO5



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	Development	segments, Customer relationships, Channels, Key partners, Key activities, Key resources, Prototyping and MVP.		
		Self-learning Topics: The Art of the Start 2.0: The Time-Tested, Battle- Hardened Guide for Anyone Starting Anything by Guy Kawasaki Case Study: The Rise of Zomato – A Disruptive Food Delivery Platform	4	
VI	Digital Business Management	Digital Business models (Subscription, Freemium <i>etc</i>), Digital marketing: Search Engine Optimization (SEO), Search Engine Marketing (SEM), Social media and influencer marketing, Disruption and innovation in digital business.	4	CO6
		Self-learning Topics: Case study: Airbnb https://www.prismetric.com/airbnb-business-m	4	

Sr No	List of Assignments	Hrs
01	Presentation on case study of a failed business model	2
02	Presentation on case study of a woman entrepreneur	2

Textbooks:

1. Entrepreneurship: David A. Kirby, McGraw Hill, 2002
2. Harvard Business Review: Entrepreneurs Handbook, HBR Press, 2018
3. Business Model Generation; Alexander Ostlewalder and Yves Pigneur, Strategyzer, 2010
4. E- Business & E– Commerce Management: Strategy, Implementation,

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Practice – Dave Chaffey, Pearson Education

Reference books:

1. Entrepreneurship: New venture creation by David Holt, Prentice Hall of India Pvt. Ltd.
2. E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Online References:

Sr. No.	Website Name
1.	Startup India Portal – https://www.startupindia.gov.in
2.	Entrepreneurship by Prof. C Bhaktavatsala Rao https://onlinecourses.nptel.ac.in/noc20_mg35/preview
3.	Innovation, Business Models and Entrepreneurship by Prof. Rajat Agrawal, Prof. Vinay Sharma https://onlinecourses.nptel.ac.in/noc21_mg63/preview
4.	Sarasvathy's principles for effectuation https://innovationenglish.sites.ku.dk/model/sarasvathy-effectuation/
5.	WIPO Patent Search https://www.wipo.int/portal/en/index.html
6.	Airbnb Business Model Case https://www.prismatic.com/airbnb-business-model/
7.	BMC Tool https://www.strategyzer.com/canvas/business-model-canvas

Assessment:

Term Work: Term Work shall consist of at least 4 to 5 **Case Study Analysis , Presentation** based on the above list. Also, Term work Journal must include at least 2 to 3 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Case Study report)+ 5 Marks (Assignments) + 5 Marks (Attendance).



Teaching Scheme								
Course Code	Course Name	(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
	R-2025-S.Y.	B.Tech	Information	Technology				
98471412	Audit Course (non-graded)	3	-	-	3	-	-	-

Audit Course: Career Readiness for Students

This audit course is a strategic offering designed to significantly enhance students' preparedness for the professional world, extending their educational experience beyond the confines of their core curriculum. Students who opt to audit this course will actively participate in class discussions and complete assigned work, gaining invaluable skills and insights without the pressure of formal examinations or academic credit.

Course Objectives:

The primary aim of this course is to equip students with the essential tools and confidence needed to navigate the contemporary job market successfully. By the end of this course, students will be able to:

- Master key concepts and problem-solving techniques for aptitude tests.
- Develop critical soft skills necessary for professional interactions and interviews.
- Construct impactful resumes that effectively highlight their strengths and experiences.
- Optimize their LinkedIn profiles for professional networking and job search opportunities.

Course Structure:

The course shall be delivered in Semester 4 and 5 and is structured around three weekly lectures, each dedicated to a vital aspect of career readiness. The emphasis will be on interactive sessions, practical exercises, and real-world application to foster deep learning and skill development. To ensure relevance and specialized learning, each department is empowered to customize the course content based on their unique discipline.