



Shree Rahul Education Society's (Regd.)

SHREE L. R. TIWARI COLLEGE OF ENGINEERING

An Autonomous Institute Affiliated to University of Mumbai,

Approved by AICTE & DTE, Maharashtra State | NAAC Accredited, NBA Accredited Program | ISO 9001:2015 Certified |
DTE Code No: 3423 | Recognized under Section 2(f) of the UGC Act 1956 | Minority Status (Hindi Linguistic)

Shree Rahul Education Society's (Regd.)

Shree L.R. Tiwari College of Engineering

Shree L.R. Tiwari Educational Campus,

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An Autonomous Institute Affiliated to the University of Mumbai



Department of INFORMATION TECHNOLOGY

Curriculum TY B.Tech A.Y 2026-27

Third Year Syllabus

Revision: R-2025

PREAMBLE

"Think. Design. Innovate. – Learning that Leads the Future."

SLRTCE is proud to be among the youngest institutions to attain academic autonomy—an achievement that strengthens our commitment to becoming a world-class centre for socio-economic development and quality education. It is with great pride and purpose that we introduce the restructured curriculum under academic autonomy at SLRTCE. This initiative marks a significant step toward transforming engineering education by equipping our graduates with strong technical foundations, research acumen, interdisciplinary perspective, and an innovation-driven mindset essential for success in today's evolving professional landscape.

1. Curriculum Design: Theme-Based, Experiential, and Outcome-Oriented The autonomous curriculum adopts a bottom-up, learner-centric approach aligned with all 12 Program Outcomes. Each semester is driven by a central societal or technological theme, with problem statements rooted in local needs, socio-economic priorities, and the UN Sustainable Development Goals (UNSDGs). Students engage with these challenges through individual projects in the IDEA Lab, integrating social science methodologies with engineering solutions to foster innovation, contextual learning, and socially responsible problem-solving.

2. Purpose of Autonomy: Empowering Innovation and Real-World Learning Our pursuit of autonomy is rooted in bridging the gap between academic learning and industry relevance. By integrating undergraduate research through the IDEA Lab—our dedicated innovation and problem-solving hub—students engage with real-world challenges, apply interdisciplinary knowledge, and develop socially impactful solutions. This approach nurtures engineers who are not only technically sound but also responsible and creative thinkers.

3. Alignment with National Education Policy-2020: Aligned with NEP 2020, the curriculum emphasizes multidisciplinary, hands-on learning. Through theme-based projects, electives, value-added courses, and flexible assessments, SLRTCE ensures holistic student development driven by real-world application and academic rigor. SLRTCE, as a part of Rahul Education, benefits from being in a network of HEIs. All Higher Education Institutions under Rahul Education can collectively contribute to curriculum development, promoting multidisciplinary studies.

4. Innovative Pedagogy Initiative by IQAC As part of its transformation strategy, IQAC has introduced an innovative pedagogy model centred on interdisciplinary research and contextual problem-solving. The IDEA Lab enables students to apply subject knowledge through socially relevant projects, supported by design thinking and faculty mentorship. A two-tier assessment framework—covering both project execution and subject-wise application—ensures academic depth, continuous mentoring, and quality assurance.

5. Empowering Faculty as Mentors and Innovators: SLRTCE believes that the success of academic autonomy lies in the hands of its faculty. By empowering educators to think beyond conventional boundaries, we enable them to instil Knowledge, Skills, and Attitudes (KSA) in students while enriching their own professional growth. Faculty serve as research mentors and project guides, supported through structured training in innovation pedagogy and assessment.

Sincerely,

IQAC Chairperson
SLRTCE

COO
Rahul Education

PREFACE

Dear Stakeholders

It is my pleasure to present the newly revised Information Technology curriculum—crafted under our recently granted Autonomous status and in compliance with NEP 2020 Building upon the strong foundational framework of SLRTCE’s legacy—where industry-oriented, tools-based learning complements core computing principles—this syllabus ushers in a truly student-centric, flexible, and future-ready programme.

Under NEP 2020’s emphasis on experiential, interdisciplinary, and outcome-based education, we have adopted a theme-based model where each semester focuses on real-world problem statements, drawn from local and global challenges mapped to relevant and the United Nations Sustainable Development Goals (UN SDGs) and supported by IDEA Lab for hands-on innovation and research — from design thinking to prototyping and product development. This approach not only fosters technical proficiency but also nurtures ethical leadership, social responsibility, and the entrepreneurial mindset required to become change-makers.

Moreover, in line with the National Credit Framework (NCRF) and the latest NBA accreditation guidelines, we have restructured the Third year Btech (Sem V and VI) to ensure credit uniformity. Our curriculum’s flexibility allows us to swiftly incorporate emerging technologies and stakeholder feedback, minimizing the traditional four-year revision cycle.

I appreciate and thank our Mr Utsav Tiwari, COO Rahul Education and Principal, Prof. Dr. Umesh S. Bhadade of Shree L R Tiwari College of Engineering for their valuable inputs. I extend my sincere gratitude to the contributors from academia, industry, and our Board for their invaluable insights—your guidance has been instrumental in shaping a programme that we trust will exceed the expectations of all our stakeholders.

I look forward to your constructive feedback and approval, as we collectively uphold SLRTCE’s vision of nurturing technically competent, ethically grounded, and socially conscious IT professionals prepared for the challenges of the 21st century.

Dr. Vikas Kaul
Chairperson, Board of Studies (IT), SLRTCE

A. Abbreviations

AEC	Ability Enhancement Course
AECL	Ability Enhancement Course Laboratory
AU	Audit Course
BSC	Basic Science Course
BSCL	Basic Science Course Laboratory
CC	Co-Curricular Courses
CEP	Community Engagement Project
ELC	Experiential Learning Course
ESC	Engineering Science Course
ESCL	Engineering Science Course Laboratory
EMC	Entrepreneurship/economics/management courses
HSSM	Humanities Social Sciences and Management
IKS	Indian Knowledge System
INTR	Internship
L	Lecture
LC	Laboratory Course
LLC	Liberal Learning Course
MDM	Multidisciplinary Minor
MDML	Multidisciplinary Minor Laboratory
OE	Open Elective
OJT	On Job Training
P	Practical
PROJ	Project
PCC	Program Core Course
PCCL	Program Core Course Lab
PEC	Program Elective Course
RM	Research Methodology
SL	Self-Learning
T	Tutorial
VEC	Value Education Course
VSEC	Vocational and Skill Enhancement Course

**Curriculum Structure and Examination Scheme for B.Tech. in Information Technology
(TY with Effect from AY 2026-2027) Curriculum Structure – TY Semester-V**

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)	Examination Scheme				Exam Duration for Theory (in Hrs.)	Term Work	Practical / Oral	Total
			L	T	P	L	T	P	SL	Notional Learning		In-Semester Assessment			End Semester Exam (ESE)				
												IAT-I	IAT-II	Total					
15211501	PCC	Web Technology	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
15211502	PCC	Data Mining and Business Intelligence	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
15211503	PCC	Computer Networks	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
15212504	PCC LAB	Web Analytics and Mining Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
15212505	PCC LAB	Network Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
15212506	PCC LAB	IDEA LAB - 5	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
1522157XX	PEC-I	Program Elective Course -I	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
9931158WW	MDM-II	Multidisciplin ary Minor Course -II	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
15412509	VSEC	MAD& PWA Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	--	25
99512510XX	OE-III*	Open Elective-III	2	--	--	30	--	--	30	60	2	--	--	--	--	--	25	--	25
Total			17	–	8	285	–	90	285	630	21	100	100	200	300	12.5	125	2.5	700

Program Elective Course-I	
Course Code	Name of the Course
152215701	Computer Graphics and Multimedia System
152215702	Distributed Computing
152215703	Advance Database Management Technology
152215704	Principles of Analog and Digital Communication
152215705	Green IT

Open Elective-III		
SR NO.	Course Code	Name of the Course
1	9951251001	International Financial Management
2	9951251002	Marketing Management - I
3	9951251003	HR Analytics
4	9951251004	Operations and Supply Chain Management
5	9951251005	Quantitative Investment Management
6	9951251006	Economics of Banking and Finance Markets
7	9951251007	Corporate Finance
8	9951251008	Principles of Behavioral Economics

Students who achieve a CGPI of 7.5 or higher by the end of the semester VI are eligible to pursue an additional 18 credits from the semesters V to VIII to qualify for a B. Tech degree with Honors.

Curriculum Structure and Examination Scheme for B.Tech. in Information Technology
(TY with Effect from AY 2026-2027) Curriculum Structure – TY Semester-VI

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)	Examination Scheme				Exam Duration for Theory (in Hrs.)	Term Work	Practical & Oral	Total
			L	T	P	L	T	P	SL	Notional Learning		In-Semester Assessment			End Semester Exam (ESE)				
												IAT-I	IAT-II	Total					
15211601	PCC	AIDS I	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
15211602	PCC	Cryptography and Network Security	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
15211603	PCC	Microcontroller and Embedded Programming	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
15212604	PCC LAB	Data Science Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
15212605	PCC LAB	Security Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
15812606	PROJ CT	Dissertation- I	--	--	2 ^s	--	--	30	--	30	1	--	--	--	--	--	50	50	100
1522167XX	PEC-II	Program Elective Course-II	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
9931168W W	MDM-III	Multidisciplinary Minor Course -III	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
98451609	VEC	Professional Communication and Ethics	2	--	--	30	--	--	30	60	2	–	–	–	–	–	25	–	25
99512610X X	OE-IV*	Open Elective-IV	2	--	--	30	--	--	30	60	2	–	–	–	–	–	25	--	25
Total			19	--	6	285	--	90	285	660	22	100	100	200	300	12.5	150	100	750

Program Elective Course -II	
Course Code	Name of the Course
152216701	Image Processing
152216702	High Performance Computing
152216703	Information Retrieval Systems
152216704	Wireless Technology
152216705	Disaster Management and Mitigation

Open Elective-IV		
SR NO.	Course Code	Name of the Course
1	9951261001	Moral Thinking: Introduction to Values and Ethics,
2	9951261002	Ethics in Engineering Practice,
3	9951261003	Introduction to Psychology,
4	9951261004	Direct foreign language courses (like German, French),
5	9951261005	Financial Institutions and Markets,
6	9951261006	Investment Management
7	9951261007	Introduction to Sociology
8	9951261008	Cultural Studies Language for Competitive Exams

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.
- 4.** \$ indicates work load of learner (not faculty), for Dissertation- I.
student group and load of faculty per week.
Dissertation- I
Student can form groups with minimum 2 (Two) and not more than 4 (four)
Faculty Load:
In semester VI – $\frac{1}{2}$ hour per week per project group
- 5.** * Recommended that OE to be offered in the form of MOOCs (NPTEL /Swayam).

Indicative list of Multidisciplinary Minors:

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)
Communication Engineering	Introduction to Telecommunication Systems	Mobile & Wireless Technology for Defence Communication	Telecommunication for Defense Sector
	Introduction to Telecommunication Systems Lab		
Internet of Technology	IOT Sensor Technology	IOT System Design	Dynamic Paradigm in IOT Project
	IOT Sensor Technology Lab		
Electronics Engineering	Basic Electronics Circuits	Analog & Digital IC	VLSI and Embedded systems
	Basic Electronics Circuits Lab		
Mechanical Engineering	Smart Manufacturing in Assembly Line	Industrial Automation	Cyber Physical System
	Smart Manufacturing Lab		
Sustainability & Environment	Renewable and Non Renewable Energy System	Sustainable urban planning development	Geo Informatics
	Renewable and Non Renewable Energy System Lab		
Information Technology	Agentic AI	Data Engineering	Web Engineering
	Intelligent Agents Lab		
Cyber Security	Information Security	Cyber Security	Open Source Intelligence
	Information Security Lab		
Computer Engineering	Computational Thinking.	Applied Cryptography	Decentralized technology
	Data Structure Lab		
Artificial Intelligence	Foundations of Artificial Intelligence	Machine Learning for Engineers	Applied Deep Learning
	Artificial Intelligence Lab		

MDM Sequels for EXTC:

- Internet of Technology
- Electronics Engineering
- Mechanical Engineering
- Sustainability & Environment
- Information Technology
- Cyber Security
- Computer Engineering
- Artificial Intelligence

MDM Sequels for ECS:

- Communication Engineering
- Internet of Technology
- Mechanical Engineering
- Sustainability & Environment
- Information Technology
- Cyber Security

- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for Mechanical:

- **Communication Engineering**
- **Internet of Technology**
- **Electronics Engineering**
- **Sustainability & Environment**
- **Information Technology**
- **Cyber Security**
- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for Civil:

- **Communication Engineering**
- **Internet of Technology**
- **Electronics Engineering**
- **Mechanical Engineering**
- **Information Technology**
- **Cyber Security**
- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for IT:

- **Communication Engineering**
- **Internet of Technology**
- **Electronics Engineering**
- **Mechanical Engineering**
- **Sustainability & Environment**
- **Cyber Security**
- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for CS:

- **Communication Engineering**
- **Internet of Technology**
- **Electronics Engineering**
- **Mechanical Engineering**
- **Sustainability & Environment**
- **Information Technology**
- **Cyber Security**
- **Artificial Intelligence**

T.Y. B.Tech Syllabus

SEM V

Intelligent, scalable and inclusive platforms for Digital Empowerment and Sustainable Futures

(Harnessing Intelligent, Ubiquitous, and Sustainable Technologies to Build an Inclusive Digital Ecosystem for Mira Bhayandar and Beyond)

This theme blends intelligence (CN,BI, Web), and sustainability (Green IT) to focus on urban challenges (traffic, waste, e-health, cyber safety, energy use). It ensures that technology growth = sustainable + ethical + inclusive growth.

UN SDGs Alignment

- SDG 3: Good Health & Well-Being
- SDG 7: Affordable & Clean Energy
- SDG 9: Industry, Innovation & Infrastructure
- SDG 11: Sustainable Cities & Communities
- SDG 12: Responsible Consumption & Production
- SDG 13: Climate Action
- SDG 16: Peace, Justice & Strong Institutions

Theme : Urban System

- 1. To study challenges in urban systems and demonstrate a very basic system for improved service efficiency.**
- 2. To observe urban resource usage and demonstrate a very basic system for better coordination.**
- 3. To study urban service practices and demonstrate a very basic system supporting sustainability.**
- 4. To observe operational patterns in urban environments and demonstrate a very basic system for improvement.**
- 5. To study urban infrastructure needs and demonstrate a very basic system for better management.**
- 6. To study mobility-related challenges in urban environments and explore approaches that improve movement and accessibility.**
- 7. To investigate the interaction between urban services and citizens and identify opportunities for improved service delivery.**
- 8. To observe public service usage and demonstrate a very basic system for efficient operation.**
- 9. To study urban system behavior and demonstrate a very basic system supporting organized functioning.**
- 10. To observe service-related challenges in urban areas and demonstrate a very basic system for enhancement.**

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	
15211501	Web Technology	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
15211501	Web Technology	20	20	40	60	2.5	--	--	100

Rationale:

Web technologies play a vital role in developing modern interactive and data-driven applications. This course introduces students to the fundamental concepts of web protocols, web analytics and semantic web technologies used in modern web systems. It provides knowledge of scripting languages such as JavaScript and TypeScript for developing dynamic web applications. The course also covers modern frontend frameworks like React and Angular for building responsive user interfaces. Backend development using Node.js along with database integration using MongoDB is also introduced. In addition, students learn to develop RESTful APIs and web services using Express and Flask frameworks. Overall, the course prepares students to design and develop full-stack web applications using modern web technologies

Course Objectives:

1. To understand the fundamentals of web technologies, including web protocols, web analytics, and semantic web concepts used in modern applications.
2. To learn and apply modern JavaScript and TypeScript for building dynamic, scalable, and maintainable web applications.
3. To design and develop interactive single-page applications using modern frontend frameworks such as React and Angular.
4. To develop server-side applications using Node.js and integrate them with databases like MongoDB.
5. To build RESTful APIs and web services using frameworks such as Express.js and Flask.

6. To understand modern web application architecture, including MERN stack, API integration, and implement secure web applications using authentication and web security practices.

Course Outcomes: Student will able to

1. Explain web protocols, web analytics concepts, and semantic web technologies used in modern web applications. (L1, L2)
2. Apply modern JavaScript (ES6+) and TypeScript to develop interactive and scalable web applications. (L2, L3)
3. Design and develop responsive single-page applications using modern frontend frameworks like React and Angular. (L3, L4, L5)
4. Develop backend applications using Node.js and integrate them with MongoDB. (L3, L4)
5. Implement RESTful APIs and web services using Express.js and Flask. (L3, L4)
6. Design and build full-stack web applications using MERN architecture, apply API integration, and implement authentication and security mechanisms. (L4, L5, L6)

Prerequisite: Object Oriented Programming, HTML and CSS

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Introduction to Web Technology	Domain Name System (DNS), HTTP and HTTPS Protocol, Transport Layer Security (TLS) Web Analytics and Semantic: Evolution of Web 1.0, Web 2.0 and Web 3.0, Introduction to Web Analytics, Web Analytics 2.0 & 3.0, Clickstream analysis, Strategy for choosing web analytics tools overview, Characteristics and components of Semantic Web, Semantic Web stack, Ontology, RDF and SPARQL	7	CO1
		Self-Learning: Semantic Web vs Artificial Intelligence, SPARQL vs SQL, Nginx, Web server performance optimization techniques, Applications of Semantic Web in search engines, Web analytics tools (Google Analytics overview), Case Study: Study how a search engine like Google uses DNS, HTTP/HTTPS, TLS, web analytics, and semantic web technologies to improve search results and user experience.	7	
II	JavaScript ES6 and TypeScript Programming	JavaScript Fundamentals: Introduction to ES6, Difference between ES5 and ES6, Variables and data types, Conditional statements and loops, Functions and events, Arrow functions, Classes and inheritance, Iterators and Generators, Promises & Async/Await (Modern Asynchronous Programming), Client-server	8	CO2

		communication TypeScript: Overview of TypeScript and architecture, Environment setup, Data types and variables, Operators and control structures, Functions and classes, Modules in TypeScript		
		Self-Learning: JavaScript vs TypeScript, Fetch API and working with external APIs, Debugging JavaScript applications, Case Study: Develop a dynamic web application using JavaScript ES6 and enhance it using TypeScript for type safety and better code management.	8	
III	Frontend Frameworks – React and AngularJS	React Fundamentals: Installation and environment setup, Components and lifecycle, Hooks (use State, use Effect, use Context, custom hooks), Refs, State and Props, React Router (SPA), Forms and event handling, MVC Architecture, Flux Angular Framework Overview: Introduction to Angular, Angular modules, Directives and expressions, Data binding, Filters, Scope, Controllers and services, Dependency injection, Form validation and routing, Using Angular with TypeScript, Routing using ng-Route, ng-Repeat, ng-style, Built-in Helper Functions	7	CO3
		Self-Learning: UI design, Forms, Events, Animations, React vs Angular vs Vue.js, React Native, React Native for mobile application development, Progressive Web Applications (PWA), Case Study: Design a single-page web application using React or Angular with routing, components, and form handling.	7	
IV	Node.js Backend Development and Database Integration	Node.js Backend Development: Introduction and Environmental setup to Node.js, Creating first Node.js application, Callback concept and event loop, REPL environment, Event emitter, Buffers, Streams, File system and networking modules Database Integration: Introduction to MongoDB, SQL vs NoSQL databases, MongoDB data types Adding the MongoDB Driver to Node.js, Connecting Node.js with MongoDB, Manipulating MongoDB Documents from Node.js, Accessing MongoDB from Node.js, Schema design and validation using Mongoose, CRUD operations,	8	CO4
		Self-Learning: Database indexing and performance optimization, Logging and debugging in Node.js applications, Mongoose vs native MongoDB driver, Data validation techniques in MongoDB, Case Study: Build a Node.js backend application integrated with MongoDB	8	

		for managing and storing application data.		
V	Express Framework, REST APIs and Flask	Express Framework: Introduction to Express.js, Express router, Express generator, Authentication mechanism, Session management, Integrating Express with React Web APIs: REST API concept and architecture, Principles of REST APIs, API design patterns, CRUD operations FLASK: Introduction to Flask, Routing and URL building, HTTP methods, Request & Response Handling Cookies and file uploading	7	CO5
		Self-Learning: Flask vs Django, Middleware in Express.js, Case Study: Develop a RESTful API using Express.js and implement a small web service using Flask.	7	
VI	AJAX, Modern Web Application Architecture and Web Security	AJAX: Introduction and Working Developing RIA using AJAX Techniques: CSS, HTML, DOM, XML HTTP Request, JavaScript, PHP, AJAX as REST Client Introduction to Open-Source Frameworks and CMS for RIA: WordPress (Traditional + Headless CMS), Django, Strapi, Sanity Modern Web Application Architecture • Introduction to MERN Stack • State management techniques • API integration in frontend Web Security JWT (JSON Web Token) Authentication, OAuth Basics, Session vs Token Authentication	8	CO6
		Self-Learning: Introduction to GraphQL AND Next.js, Commercial deployment of web applications, Applications of AJAX in Blogs, Wikis and RSS feeds, GraphQL vs REST APIs, CI/CD for web application deployment, Case Study: Develop a full-stack web application using MERN architecture with AJAX-based API communication.	8	

Text Books:

1. Rediscovering JavaScript, Master ES6, ES7, and ES8, By Venkat Subramaniam · 2018
2. Learning React Functional Web Development with React and Redux, Alex Banks and Eve Porcello, O'Reilly.
3. Learning Node.js Development, Andrew Mead, Packt Publishing
4. RESTful Web API Design with Node.js 10, Valentin Bojinov, Packt Publication
5. Boris Cherny, "Programming TypeScript- Making Your Javascript Application Scale", O'Reilly Media Inc.

6. Simon Holmes Clive Harber, “Getting MEAN with Mongo, Express, Angular, and Node”, Manning Publications.
7. Miguel Grinberg, “Flask Web Development: Developing Web Applications with Python”, O’Reilly.
8. Dr. Deven Shah, “Advanced Internet Programming”, StarEdu Solutions.
9. Vasan Subramanian, Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Apress, 2019.

References:

1. Web Development with Node and Express, Ethan Brown, O’Reilly
2. Yakov Fain and Anton Moiseev, “TypeScript Quickly”, Manning Publications.
3. Steve Fenton, “Pro TypeScript: Application - Scale Javascript Development”, Apress
4. Brad Dayley, Brendan Dayley, Caleb Dayley, “Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications”, 2nd Edition, Addison- Wesley Professional
5. Roy Derks, React Projects (2nd Edition), Packt Publishing – includes projects using Next.js and GraphQL for full-stack application

Online References:

Sr. No.	Website Name
1.	https://www.mongodb.com/mern-stack
2.	https://www.apollographql.com/docs
3.	https://nextjs.org/docs
4.	https://nodejs.org/en/docs
5.	https://react.dev/learn

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO’s and **IAT-II** will cover the remaining three CO’s (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: 2 Hours 30 Minutes
- Question paper consists of six compulsory questions, 10 marks each.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have two alternatives (Option A / Option B) from the same module.
- Both options should be of similar difficulty level and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the entire syllabus, all Course Outcomes, and different levels of learning as per Bloom’s Taxonomy.

Note: -

- 1. Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
- 2. No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

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	
15211502	Data Mining & Business Intelligence	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
15211502	Data Mining & Business Intelligence	20	20	40	60	2.5	--	--	100

Rationale:

Data Mining and Business Intelligence play a vital role in extracting meaningful insights from large volumes of data to support effective decision-making. This course introduces students to the fundamental concepts of data warehousing, data preprocessing, and knowledge discovery techniques used in modern data-driven systems. It provides knowledge of data mining methods such as classification, clustering, association rule mining, and predictive analysis. The course also covers statistical techniques, data similarity measures, and model evaluation methods for accurate analysis. In addition, students learn to use business intelligence tools to create reports and visualizations for decision support. Overall, the course prepares students to analyze complex datasets and develop intelligent solutions for real-world business applications.

Course Objectives:

- 1 To introduce the concept of data warehouse & data Mining as an important tool for enterprise data management and as a cutting-edge technology for building competitive advantage.
- 2 To enable students to effectively identify sources of data and process it for data mining.
- 3 To impart knowledge of classification, regression, validation techniques, and ensemble methods to build and evaluate accurate predictive models.
- 4 To provide knowledge on clustering techniques and outlier detection methods to analyze data patterns.
- 5 To introduce the concept of association rule mining and frequent itemset techniques for effective data analysis.
- 6 To impart knowledge on advanced pattern mining and business intelligence concepts, and the development of data-driven decision support systems for real-world applications.

Course Outcomes: Student will able to

- 1 Demonstrate an understanding of the importance of data warehousing and data mining and statistical techniques for data analysis. (L1, L2)
- 2 Organize and prepare the data needed for data mining using pre-preprocessing techniques. (L1, L2, L3)
- 3 Apply and evaluate predictive models using classification, regression, and ensemble techniques to improve accuracy and support effective data-driven decision-making. (L1, L2, L3, L4, L5)
- 4 Apply clustering techniques and outlier detection methods to analyze data patterns and identify anomalies. (L1, L2, L3)
- 5 Apply association rule mining and frequent itemset techniques to discover data patterns. (L1, L2, L3)
- 6 Develop analytical interfaces and apply advanced pattern mining techniques for data driven decision support systems. (L1, L2, L3, L4, L5, L6)

Prerequisite: Database Management System

DETAILED SYLLABUS:

Sr. No	Name of Module	Detailed Content	Hours	CO Mapping
I	Introduction to Data Warehouse With Fundamentals of Data Mining And Data	DWH characteristics, Dimensional modelling: Star, Snowflakes, OLAP operation, OLTP vs OLAP Data Mining as a step in KDD, Kind of patterns to be mined, Technologies used, Data Mining applications. Types of Attributes, Statistical Description of Data, Measuring Data Similarity and Dissimilarity.	8	CO1

	Exploration	Self-Learning: Data Marts, Major issues in Data Mining. Case Study: Real-world case studies of Data Warehousing implementation in industries, Study of real-life applications of Data Mining in healthcare, finance, and e-commerce, Research on emerging trends in Data Warehousing and Data Mining (Big Data, Cloud-based DW)	8	
II	Data Preprocessing	Why pre-processing? Data Cleaning, Data Integration, Data Reduction: Attribute Subset Selection, Histograms, Clustering, Sampling, Data Cube aggregation, Data transformation and Data Discretization: Normalization, Binning, Histogram Analysis.	7	CO2
		Self-Learning: Data Visualization, Concept hierarchy generation. Case Study: Data cleaning in real-world datasets, Study of data pre-processing in big data environments (Hadoop, Spark)	7	
III	Classification and Prediction	Basic Concepts; Classification methods: 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naive Bayes Classifier. Prediction: Structure of regression models; Simple linear regression, Accuracy and Error measures, Precision, Recall, Holdout, Random Sampling, Cross Validation, Bootstrap, Introduction of Ensemble methods, Bagging, Boosting, AdaBoost and Random Forest.	8	CO3
		Self-Learning: Multiple linear regression, logistic regression, Random Forest, nearest neighbor classifier, SVM. Case Study: Predictive modelling in real-world applications, Practical use of validation techniques.	8	
IV	Clustering and Outlier Detection	Cluster Analysis: Basic Concepts; Partitioning Methods: K-Means, K Medoids; Hierarchical Methods: Agglomerative, Divisive, BIRCH; Density-Based Methods: DBSCAN. What are outliers? Types, Challenges; Outlier Detection Methods: Supervised, Semi Supervised, Unsupervised, Proximity based, Clustering Based.	7	CO4

		Self-Learning: Hierarchical methods: Chameleon, Density based methods: OPTICS, Grid based methods: STING, CLIQUE. Case Study: Clustering applications in customer segmentation and marketing, Study of challenges in clustering high-dimensional data.	7	
V	Frequent Pattern Mining	Basic Concepts: Market Basket Analysis, Frequent Itemset, Closed Itemset, and Association Rules; Frequent Itemset. Mining Methods: The Apriori Algorithm: Finding Frequent Itemset Using Candidate Generation, Generating Association Rules from Frequent Itemset, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemset, Mining Frequent Itemset using vertical data formats.	8	CO5
		Self-Learning: Association Mining to Correlation Analysis, lift, Introduction to Constraint-Based Association Mining. Case Study: Market Basket Analysis in retail and e-commerce, Generating and interpreting association rules using real datasets, Applications of association rule mining in recommendation systems.	8	
VI	Advanced Pattern Mining and Business Intelligence	Introduction to Advanced Pattern Mining: Mining Multilevel Association Rules and Multidimensional Association Rules. What is BI? Business intelligence architectures; Definition of decision support system; Development of a business intelligence system using Data Mining for business Applications like Fraud Detection, Recommendation System	7	CO6
		Self-Learning: Clickstream Mining, Market Segmentation, Retail industry, Telecommunications industry, Banking & finance CRM, Epidemic prediction, Fake News Detection, Cyberbullying, Sentiment Analysis etc. Case Study: Multilevel and multidimensional association rule mining, building a basic recommendation system using Python	7	

Text Books:

- 1 Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition. Learning
- 2 P. N. Tan, M. Steinbach, Vipin Kumar, "Introduction to Data Mining", Pearson Education.
- 3 Paulraj Ponniah "Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals" Wiley Publications
- 4 Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Vercellis, Wiley India Publications.
- 5 G. Shmueli, N.R. Patel, P.C. Bruce, "Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner", 2nd Edition, Wiley India.

References:

- 1 Michael Berry and Gordon Linoff "Data Mining Techniques", 2nd Edition Wiley Publications.
- 2 Michael Berry and Gordon Linoff "Mastering Data Mining- Art & science of CRM", Wiley Student Edition.
- 3 Vikram Pudi & Radha Krishna, "Data Mining", Oxford Higher Education.

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc21_cs06/preview

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: 2 Hours 30 Minutes
- Question paper consists of six compulsory questions, 10 marks each.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have two alternatives (Option A / Option B) from the same module.
- Both options should be of similar difficulty level and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the entire syllabus, all Course Outcomes, and different levels of learning as per Bloom's Taxonomy.

Course	Course	Teaching Scheme	Teaching Scheme (Contact Hours Per Semester)	Total Credits
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Note: -

- 1. Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
- 2. No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Code	Name	(Contact Hours Per Week)								(C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
15211503	Computer Networks	3	--	--	45	--	--	45	90	3

Rational:

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
15211503	Computer Networks	20	20	40	60	2.5	--	--	100

The Computer Networks course is designed to provide students with fundamental and advanced knowledge of networking concepts, communication models, protocols, and network design principles required in modern computing environments. The course helps students understand how data is transmitted, managed, and secured across interconnected systems using OSI and TCP/IP models, transmission media, routing protocols, IP addressing, transport and application layer services. It also develops analytical and practical skills in configuring networks, understanding network devices, implementing communication protocols, and designing organizational networks using technologies such as VLAN, VPN, DHCP, DNS, and socket programming. The course prepares students for real-world networking applications, higher studies, and industry requirements in areas such as network administration, cybersecurity, cloud computing, and IoT

Course Objectives:

1. Understand the division of network functionalities into layers.
2. Understand the types of transmission media along with data link layer concepts, design issues and protocols.
3. Analyze the strength and weaknesses of routing protocols and gain knowledge about IP addressing.
4. Understand the data transportation, issues and related protocols for end-to-end delivery of data.
5. Understand the data presentation techniques used in presentation layer & client/server model in application layer protocols.
6. Design a network for an organization using networking concepts

Course Outcomes: student will able to

1. Describe the functionalities of each layer of the models and compare the Models. (L1)

2. Categorize the types of transmission media and explain data link layer concepts, design issues and protocols. (L2, L3, L4)
3. Analyze the routing protocols and assign IP address to networks. (L4)
4. Explain the data transportation and session management issues and related protocols used for end-to-end delivery of data. (L1, L2)
5. List the data presentation techniques and illustrate the client/server model in application layer protocols. (L1, L3).
6. Use of networking concepts of IP address, Routing, and application services to design a network for an organization (L3)

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
	Prerequisite	- Basic knowledge of computer fundamentals and operating systems. - Basic understanding of data communication, Internet, and IP addressing concepts	0	
I	Introduction to Computer Networks	Introduction to Computer Networks, Goals of Computer Networks, Uses of Computer Networks, Network Topology and its Types: Bus, Star, Ring, Tree, Mesh. Network Hardware, Network Software, Network Classification: PAN, LAN, MAN, WAN and Comparison. Protocol Layering. Reference Models: OSI and its layers in detail, TCP/IP and its layers in detail, Comparison of OSI & TCP/IP, Network Devices: Router, Switch, Hub, Bridge, Repeater, Modem, Access Point (AP), Gateway, Firewall, Network Interface Card (NIC) and their comparison.	07	CO1
		Self-learning Topics: Designing a Computer Network for a School Campus, Comparison of Home, Office, and Banking Networks, Network Topology Analysis in Organizations.	07	
II	Physical Layer & Data Link Layer	Physical layer: Guided Media, Unguided Media, Wireless Transmission: Electromagnetic Spectrum. Switching: Circuit-Switched Networks, Packet Switching, Structure of a Switch DLL Design Issues: Services, Framing, Error Control, Flow Control, Error Detection and Correction (Hamming Code, Parity, CRC, Checksum) , Elementary Data Link protocols: Stop and Wait, Sliding Window (Go Back N, Selective Repeat), Piggybacking, HDLC Medium Access Protocols: Random Access, Controlled Access, Channelization.	08	CO2

		Ethernet Protocol: Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet, 10-Gigabit Ethernet.		
		Self-learning Topics: Selection of Transmission Media for a College Campus Network, Switching Techniques in Banking Network Communication., Design and Implementation of Network Infrastructure for a Smart Hospital.	08	
III	Network Layer	Network Layer Services, Packet Switching, Network Layer Performance, IPv4 Addressing (classful and classless), Subnetting, Super netting, IPv4 Protocol, DHCP, Network Address Translation (NAT). Routing Algorithms and Types of Routing: Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing, and Path Vector Routing. Protocols –RIP, OSPF, BGP. Next Generation IP: IPv6 Addressing, IPv6 Protocol, Transition from IPV4 to IPV6.	08	CO3
		Self-learning Topics IP Addressing and Network Design for a University Campus, Routing Protocol Implementation in a Multi-Branch Banking Network., Migration from IPv4 to IPv6 in a Smart City Network.	08	
IV	Transport Layer & Session Layer	Transport Layer: Transport Layer Services, Connectionless & Connection-oriented Protocols, Transport Layer protocols: User Datagram Protocol: UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, A TCP Connection, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timers. Session Layer: Session layer design issues, Session Layer protocol - Remote Procedure Call (RPC).	08	CO4
		Self-learning Topics Online Video Streaming Application Using UDP, Secure Online Banking System Using TCP, File Transfer and Network Congestion in Corporate Communication, Remote Healthcare System Using Session Layer and RPC.	08	

V	Presentation Layer & Application Layer	Presentation layer: Compression: Comparison between Lossy Compression and Lossless Compression, Huffman Coding, Speech Compression, LZW, RLE, Image Compression – GIF, JPEG. Application layer: Introduction to Application layer, Standard Client-Server Protocols: World Wide Web, HTTP, FTP, Electronic Mail: SMTP, POP3, IMAP, Domain Name System (DNS), SNMP Socket Programming: Introduction to Socket Programming, TCP vs UDP Sockets, Client-Server Communication Model.	07	CO5
		Self-learning Topics: Multimedia Content Delivery System for an E-Learning Platform, Corporate File Sharing and Email Communication System, Client-Server Chat Application Using Socket Programming	07	
VI	Network Design Concepts	Introduction to VLAN, VPN. A case study to design a network for an organization meeting the following guidelines: Networking Devices. IP addressing: Subnetting, Supernetting, Routing Protocols to be used, Services to be used: TELNET, SSH, FTP server, Web server, File server, DHCP server and DNS server.	07	CO6
		Self-learning Topics: Network Design for a Multi-Department College Campus, Corporate Branch Office Network with VPN Connectivity, Smart Hospital Network Infrastructure Design	07	

Text Books:

1. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.
2. Behrouz A. Forouzan, Data Communications and Networking ,4th Edition,Mc Graw Hill education.
3. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson Education.
4. Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Morgan Kaufmann.
5. William Stallings, Data and Computer Communications, Pearson Education.
6. Douglas E. Comer — Computer Networks and Internets

References:

1. S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2. B. A. Forouzan, “TCP/IP Protocol Suite”, Tata McGraw Hill edition, Third Edition.
3. Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGrawHill Second Edition.

4. Khalid Sayood, Introduction to Data Compression, Third Edition, Morgan Kaufman.
5. Douglas E. Comer, *Computer Networks and Internets*, Pearson Education.
6. W. Richard Stevens, *TCP/IP Illustrated, Volume 1: The Protocols*, Addison-Wesley.
7. Larry L. Peterson and Bruce S. Davie, *Computer Networks: A Systems Approach*, Morgan Kaufmann.

Online References:

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

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: 2 Hours 30 Minutes
- Question paper consists of six compulsory questions, 10 marks each.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have two alternatives (Option A / Option B) from the same module.
- Both options should be of similar difficulty level and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the entire syllabus, all Course Outcomes, and different levels of learning as per Bloom's Taxonomy.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

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	
15212504	Web Analytics and Data Mining Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
15212504	Web Analytics and Data Mining Lab	--	--	--	--	--	25	25	50

Lab Objectives:

1. To study open-source tools for Web Analytics and the Semantic Web to analyze web usage and enhance intelligent web solutions.
2. To explore modern web application development using TypeScript, AngularJS, AJAX, and Flask for designing interactive and dynamic web applications.
3. To understand frontend-backend integration using REST APIs and MongoDB for building connected and data-driven web applications.
4. To understand and implement data modeling, visualization, and analysis techniques using appropriate tools and programming languages for effective data processing and interpretation.
5. To understand and implement classification and clustering techniques using appropriate tools and programming languages for effective data analysis and interpretation.
6. To explore Frequent Pattern Mining algorithms using Python or Java and apply the insights to a real-world case study through interactive Power BI dashboards for effective decision-making.

Lab Outcome

1. Understand and apply open-source tools for web analytics, semantic web applications, and TypeScript concepts in web application development. (L1, L2, L3)
2. Design and implement dynamic and single-page web applications using AngularJS and AJAX techniques. (L1, L2, L3)

3. Develop and deploy web applications using RESTful Web Services, MongoDB, and Flask for frontend-backend integration. (L1, L2, L3, L4)
4. Design and implement Star and Snowflake schemas using Power BI/Tableau, and apply data exploration and analysis techniques in Python/Java to interpret datasets effectively. (L1, L2, L3, L4, L5, L6)
5. Perform and evaluate classification (ID3, Naive Bayes) and clustering (K-means) techniques using WEKA and Python/Java to analyze and interpret data effectively. (L1, L2, L3, L4, L5)
6. Design, implement, and analyze frequent pattern mining algorithms and develop Power BI dashboards to present data insights effectively. (L1, L2, L3, L4, L5, L6)

Prerequisite: Object oriented Concept, Full Stack Java, Python.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Angular IDE, Visual Studio Code, Notepad++, Python Editors, MySQL, XAMPP, MongoDB JDK Open-source data mining and BI tools like WEKA, Rapid Miner, Pentaho, Power BI

List of Experiment

Sr. No.	Module	Detailed Content	Hours	LO Mapping
1	Web analytics and semantic	Study web analytics using open-source tools like Matomo, Open Web Analytics, AWStats, Countly, Plausible. Study Semantic Web Open-Source Tools like Apache TinkerPop, RDFLib, Apache Jena, Protégé, Sesame.	01	LO1
2	Javascript and typescript	Study and implementation of JavaScript for basic web programming: Variables, Operators, Conditions, Loops, Functions, Events, Classes and Objects, Arrays, String. Implement TypeScript programs Small code snippets for programs like hello world, Calculator using TypeScript. Inheritance example using TypeScript Access Modifiers example using TypeScript	04	LO2
3	React and Angular Js	Frontend Frameworks – Develop simple web applications using React (components, props, state)	04	LO2

		Implement AngularJS – Events and Validations in AngularJS. (Create functions and add events, adding HTML validators, using \$valid property of Angular, etc.) Create an application for like Students Record using AngularJS		
4	Nodejs, ExpressJs and MonogoDB	Perform any two: 1. Installation and Configuration of Node.js and Database Integration 2. Installation and Configuration 3. Filesystem 4. Building Web Applications using Express.js 5. Build a RESTful API using MongoDB.	02	LO3
5	Flask	Perform any two: 1. Design Feedback Form using Flask. 2. Design Weather App using Flask. 3. Web application using React and Flask. 4. Create a complete Machine learning web application using React and Flask.	04	LO3
6	AJAX	Perform any two: 1. Write a JavaScript program for a AJAX. 2. Write a program to use AJAX for user validation using and to show the result on the same page below the submit button. 3. Design and develop small web application using AJAX, HTML and JSP. 4. Case Study on Modern Web Application Architecture	03	LO2
7	Designing Data Warehouse	Tutorial on Design Star Schema and Snowflake Schema using Power BI / Tableau	02	LO4
8	Data preprocessing	Implement using tools or languages like JAVA/ python/R Data Exploration (boxplot) Data preprocessing (Binning)	02	LO4
9	Data Classification	Perform and Evaluate ID3 Classification using WEKA open-source tool. Implementation of Naive Bayesian Classification Algorithms using JAVA/ python.	02	LO5

10	clustering	Implementation of K-means clustering using Python/Java	02	LO5
11	Pattern Mining	Implementation of Frequent Pattern Mining Algorithm using Python / Java	02	LO6
12	Business Intelligence	Detailed case study and creation of dashboard using Power BI .	02	LO6

Text Books:

1. John Hebel, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, “Semantic Web Programming”, Wiley Publishing, Inc, 1st Edition, 2009.
2. Simon Holmes Clive Harber, “Getting MEAN with Mongo, Express, Angular, and Node”, Manning Publications, 2019 Edition.
3. Miguel Grinberg, “Flask Web Development: Developing Web Applications with Python”, O’Reilly, 2018 Edition.
4. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition.
5. G. Shmueli, N.R. Patel, P.C. Bruce, “Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner”, 1st Edition, Wiley India.
6. Paulraj Ponniah “Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals” Wiley Publications

References:

1. John Davies, Rudi Studer and Paul Warren, “Semantic Web Technologies Trends and Research in Ontology-based Systems”, Wiley, 2006 Edition.
2. Yakov Fain and Anton Moiseev, “TypeScript Quickly”, Manning Publications, 2020 Edition.
3. Steve Fenton, “Pro TypeScript: Application - Scale Javascript Development”, Apress, 2014 Edition.
4. P. N. Tan, M. Steinbach, Vipin Kumar, “Introduction to Data Mining”, Pearson Education
5. WEKA, RapidMiner Pentaho resources from the Web.

Online References:

Sr no.	Website Name
1	https://www.kaggle.com/learn/overview
2	Python for Data Science https://onlinecourses.nptel.ac.in/noc21_cs33/preview

Term Work: Term Work shall consist of at least 10-12 practical’s based on the above list. Also Term work must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiment) + 5 (Assignment)+ 5 Marks (Attendance)

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

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	
15212505	Networking Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
15212505	Networking Lab	--	--	--	--	--	25	25	50

Lab Objectives:

1. To understand and analyze basic networking concepts, devices, and administration commands
2. To simulate and implement LAN topologies using Packet Tracer
3. To apply IP addressing techniques and subnetting in network design
4. To configure and analyze network protocols such as NAT and OSPF
5. To study network traffic, error detection techniques, and TCP/IP headers using protocol analyzers
6. To implement client-server communication using TCP/UDP and design a complete network system

Lab Outcomes:

1. Execute and analyze networking commands for configuration and troubleshooting. (L3, L4)
2. Demonstrate simulation and implementation of LAN topologies using Packet Tracer(L2)
3. Apply IP addressing and subnetting techniques for network configuration. (L3)
4. Configure and evaluate routing and translation protocols such as OSPF and NAT (L4)
5. Analyze network traffic, protocol headers, and error detection mechanisms. (L4)
6. Implement socket programming using TCP/UDP and design a complete network solution.(L6)

Prerequisite: C /Java

Hardware & Software Requirements:

Hardware Requirement:	Software requirement:
PC i3 processor and above, Network interface card (NIC), Internet connectivity	Cisco Packet Tracer, Wireshark, Operating System: Windows / Linux

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Programming Language (C/Java), Basic commands of windows and Unix/Linux operating system. Editor commands (eg nano/ vi editor etc)	00	-
I	Fundamentals of Computer Network	Understanding Basic networking Commands: ifconfig ,ip, traceroute, tracepath, ping, netstat, ss, dig, nslookup, route, host, arp, hostname, curl or wget, mtr, whois, tcpdump Execute and analyze basic networking commands.	02	LO1
II	Basics of Network simulation	Using Cisco Packet Tracer, these topologies can be designed and simulated to understand data flow, connectivity, and network performance.	04	LO2
III	Network Design	Network Design for an organization using the following concepts: Addressing (IP Address Assignment), Naming (DNS),Routing, Perform remote login using Telnet Server	05	LO3
IV	Simulation of Network Topology with different	Implementation of specific Network topology with respect to Number of nodes and physical layer configuration Graphical simulation of a network with Routing Protocols (Distance Vector/ Link State Routing) and traffic consideration (TCP, UDP) using NAM. Analysis	06	LO4

	Protocols	of network performance for quality of service parameters such as packet-delivery- ratio, delay and throughput. Comparative analysis of routing protocols with respect to QOS parameters using Xgraph/gnuplot for different load conditions.		
V	Protocol Analyzer	Study of various Network Protocol Analyzer Tools like Wireshark, tcp dump, Win dump, Microsoft Message Analyzer, Ettercap, Nirsoft Smart Sniff etc. Install one of the Network protocol analyzer tools and analyze the traffic Study various network protocol analyzer tools and analyze the network traffics using one of the network protocol analyzer tools.	06	LO5
VI	Socket Programming	Socket Programming with C/Java/python TCP Client, TCP Server UDP Client, UDP Server To study and Implement Socket Programming using TCP. To study and Implement Socket Programming using UDP Design a network for an organization using the concepts of Addressing (IP Address Assignment), Naming (DNS) and Routing. Also mention the internet working devices used	07	LO6

Text Books:

1. Data Communication & Networking Behrouz A. Forouzan McGraw Hill education. 5th Edition, 2014
2. Computer Networks Andrew S. Tanenbaum Pearson Education 5th Edition, 2014
3. Computer Networking: A Top- Down Approach Featuring the Internet James F. Kurose, K.
4. W. Ross Pearson Education 5th Edition, 2014

References

1. Computer Networks: A Systems Approach L. L. Peterson and B. S. Davie Elsevier India 5th Edition, 2012
2. Understanding communications and Networks W. A. Shay Cengage Learning 2nd Edition 2001
3. Introduction to Data Compression Khalid Sayood, Morgan Kaufman Elsevier Third Edition, 2011

Online References:

Sr no.	Website Name
1	https://www.javatoint.com
2	https://beginnersbook.com
3	https://nptel.ac.in
4	https://www.cse.iitk.ac.in/
5	https://www.cse.iitk.ac.in/
6	https://www.cse.iitk.ac.in/
7	https://www.cse.iitk.ac.in/

List of Experiment

Sr. No.	Experiment Title	LO Mapping
1	Network System Administration: Understanding working of various networking devices using packet tracer software	LO1
2	Execute and analyze basic networking commands (ifconfig ,ip, traceroute, tracepath, ping, netstat, ss, dig, nslookup, route, host, arp, hostname, curl or wget, mtr, whois, tcpdump.	LO1
3	Implementation of LAN topologies using Packet tracer.	LO2
4	Implementation of IP addressing (first IP address and last IP address of a given Subnet)	LO3
5	Implementation of Network Address translation on packet tracer software	LO4
6	Implementation of OSPF protocol using packet tracer	LO4
7	Implementation of RIP using packet tracer	LO4
8	Implementation of BGP using packet tracer	LO4
9	Study and Implementation of CRC technique.	LO5
10	Study and Implementation of Hamming code technique.	LO5
11	Study & Analysis of TCP/IP header using Wireshark.	LO5
12	To setup Network transaction with Wireshark for Protocol Analysis	LO5

	(ICMP, TCP, HTTP).	
13	Implement connection-oriented client server socket programming using TCP/IP.	LO6
14	Implementation of connectionless client server socket using UDP.	LO6
15	To design and configure given network. (Students should implement one Mini project Based experiment from the list or any other project in discussion with Faculty in-Charge)	LO6

Term Work: Term Work shall consist of at least 12 practical's 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: A Practical & Oral exam will be held based on the above syllabus.

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	
15212506	IDEA LAB -5 (Innovation Design Engineering and Apply)	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
15212506	IDEA LAB – 5 (Innovation Design Engineering and Apply)	--	--	--	--	--	25	25	50

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 structured assessment framework is implemented.

1. Project assessment is carried out using standardized IDEA Lab rubrics with multiple evaluation parameters.
2. One of the key parameters is **Engineering Subject-Based Assessment**, which focuses on the effective application of same-semester subject knowledge in project work, ensuring integration of theoretical learning with practical implementation.

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, 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 (Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- 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.

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

- Students must ensure that their IDEA Lab project meaningfully incorporates concepts from all core subjects of the current semester and maintain a project logbook as evidence of subject-wise application.
- Faculty in-charge must guide students to apply concepts from subjects studied in the same semester to their IDEA Lab projects.
- The term work evaluation will partially reflect the effective application of subject-specific knowledge.
- Faculty should regularly review the integration of academic content within the project work.

2) Implementation Strategy – IDEA Lab Learning Model

- A theme-based learning structure shall be implemented where each semester is anchored to a broad contextual domain such as Healthcare, Smart Cities, Energy, Agriculture, or Governance, providing the overall learning direction.
- From the identified theme, a system-level, open-ended problem statement shall be defined, serving as a solution-neutral framework that enables interdisciplinary thinking and innovation.
- The learning sequence shall follow a structured flow:
Theme → Problem Statement → Same Semester Subject Application → Design–Implementation Experience, ensuring progressive transformation from context to solution.
- Themes shall provide the context (defining the domain of work), while problem statements shall provide the purpose, enabling students to identify meaningful real-world challenges.
- Subjects shall be treated as engineering tools, where each subject contributes specific knowledge components to solve different aspects of the problem.
- Students shall be encouraged to take ownership of their learning and projects, fostering curiosity, exploration, social relevance, and a mindset of creative risk-taking.
- Structured brainstorming and ideation sessions shall be conducted at the beginning of the semester to guide students in problem identification and development of solution pathways through collaborative and interdisciplinary thinking.
- Guest lectures and expert talks shall be organized by inviting industry experts, researchers, and innovators aligned with the semester theme and subject areas to provide exposure to real-world challenges, trends, and opportunities.
- A mechanism shall be implemented to ensure uniqueness and originality of projects by systematically reviewing ideas to avoid duplication and encouraging novel, technology-

driven solutions.

- Platforms shall be created for collaborative learning and discussion, enabling students to present ideas, receive peer and mentor feedback, and refine solutions through iterative engagement.
- Content beyond syllabus for as subject shall be integrated with IDEA Lab themes and problem statements to ensure deeper interdisciplinary application and enhanced conceptual understanding.
- Preference shall be given to ensuring same-semester academic alignment, where subject faculty contribute to effective contextual integration of project-based learning.
- Continuous monitoring and documentation shall be ensured through logbooks, milestone tracking, and periodic progress reviews to maintain academic rigor and outcome alignment.
- Coordination with subject faculty shall be ensured for effective mapping of theoretical concepts into project execution and for evidence-based term work assessment.
- The IDEA Lab shall function as an institutional mechanism for implementing the CDIO (Conceive–Design–Implement–Operate) framework, promoting experiential and outcome-based learning through structured mini-projects.

Implementation Notes:

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

3) Guidelines for Assessment

Assessment Month	Marks
Month 1 (Formative 1)	25 marks
Month 2 (Formative 2)	25 marks
Month 3 (Formative 3)	25 marks

Total Assessment Structure

Component	Marks	Assessed By
Term work – Project Execution	25 Marks	Project Guide – Average of all innovation
Viva Voce (Final Evaluation)	25 Marks	External Examiner

Criteria	Excellent (10)	Good (8)	Satisfactory (6)	Needs Improvement (4)
1. Innovation	Highly original and disruptive idea solving a real-world or futuristic problem	Novel idea with a creative approach to a known problem	Moderately innovative; adapts existing solutions	Common or repetitive idea with minimal novelty
2. Design	User-centric, systematic design with professional-level tools, prototyping, or simulations	Logical structure; clearly presented using standard tools	Functional design but limited user perspective or refinement	Poor or confusing design with lack of user consideration
3. Engineering	Applies concepts from all same-semester subjects with clear integration and interdisciplinary depth	Applies knowledge from 4 or more subjects with relevance	Applies 2–3 subjects with moderate clarity	Applies 1 subject with weak or shallow connection
4. Implementation	Complete, fully functional prototype with rigorous testing and real-world validation	Working model with minor errors; partially tested	Prototype is incomplete; basic testing or debug attempt	Poorly implemented; fails to function properly
5. Application	Strong real-world relevance with alignment to SDGs/National Missions; impact clearly identified	Clear practical use-case with user/market relevance	Some practical value but limited clarity on impact	Vague or irrelevant application; weak user connect

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	
1522150701	Computer Graphics & Multimedia System	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semest er Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
1522150701	Computer Graphics & Multimedia System	20	20	40	60	2.5	--	--	100

Rationale:

This syllabus is designed to build a strong foundation in computer graphics and multimedia systems, starting from basic concepts and gradually progressing to advanced transformations, rendering techniques, and multimedia processing. It balances theory, algorithms, and practical implementation, preparing students for both higher studies and industry applications like game development, animation, UI/UX, and media systems.

Course Objectives:

- 1 To equip students with the fundamental knowledge and basic technical competence in the field of Computer Graphics.
- 2 To emphasize on understanding Computer Graphics Algorithms.
- 3 To prepare the student for advanced areas in the field of Computer Graphics.
- 4 To introduce students for professional avenues in the field of Computer Graphics.
- 5 To introduce students about basic fundamentals and key aspects of the Multimedia system.
- 6 To equip the students for various techniques of Multimedia.

Course Outcomes:

1. Describe the basic concepts of Computer Graphics. (L1, L2)
2. Demonstrate various algorithms for basic graphics primitives. (L1, L2, L3)
3. Apply 2-D geometric transformations on graphical objects. Use various Clipping algorithms on graphical objects. (L1, L2, L3)
4. Explore 3-D geometric transformations and curve representation techniques. (L1, L2, L3)
5. Describe the basics of Multimedia Systems. (L1, L2)
6. Explore the Digital images audio & video and their related concepts. (L1, L2, L3)

Prerequisite: Basic knowledge of mathematics.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Introduction to Computer Graphics.	Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, Raster scan & random scan displays, Architecture of raster graphics system with display processor, Architecture of random scan systems, Graphics pipeline and frame buffer concept.	7	CO1
		Self-learning Topics: - Study the working of some Raster scan display devices	7	
II	Output Primitives and Filling Techniques.	Scan conversions of point, line and circle: DDA algorithm and Brenham algorithm for line drawing, Midpoint algorithm for circle, Aliasing, Antialiasing techniques like Pre filtering and post filtering, super sampling, and pixel phasing.	8	CO2
		Filled Area Primitive: Scan line Polygon Fill algorithm, inside outside tests, Boundary Fill and Flood fill algorithm Compiler Optimizations, Loop Optimization, Function Inlining, Memory Access Optimization, Avoiding Branches.		
		Self-learning Topics: Implementation of DDA and Bresenham's line algorithm for dotted line, dashed line, Dash-dot line etc	8	
		Basic 2D transformations: - Translation, Scaling, Rotation, Reflection. Matrix representation and Homogeneous Coordinates. Composite	7	CO3

III	Two-Dimensional Transformations and Clipping	transformation. Viewing transformation pipeline and Window to Viewport coordinate transformation. Clipping operations: Point clipping, Line Clipping. Line clipping algorithms: Cohen- Sutherland, Liang- Barsky, Polygon Clipping Algorithms: Sutherland- Hodgeman		
		Self-learning Topics: Implementation of 2D transformations like translation, rotation and scaling. Implementation of clipping algorithm	7	
IV	3D Transformation, curves and fractals	3D Transformations: Translation, Rotation, Scaling. Reflection, Composite transformations: Rotation about an arbitrary axis. Bezier Curve, B-Spline Curve. Fractal-Geometry: Fractal Dimension, Hilbert's curve, Koch Curve.	7	CO4
		Self-learning Topics: Implementation of 3D transformations, Bezier curve, Koch curve	7	
V	Introduction to Multimedia systems	Overview, Objects and Elements of Multimedia, Applications of Multimedia, Multimedia Systems Architecture – IMA, Workstation, Network, Types of Medium (Perception, Representation, Storage, Transmission.), Interaction Techniques.	8	CO5
		Self-learning Topics: -Study the objects and elements of multimedia.	8	
VI	Digital Image, audio & video	Digital Image Representation (2D format, resolution) Types of Images (monochrome, gray, color), File formats: JPG. Compression Techniques: fundamentals (coding, inter pixel and psychovisual redundancies). Types – lossless and lossy Compression, Lossless Compression Algorithms– Shannon-Fano, Lossy Compression Algorithm – JPEG Digital Audio Basic Sound Concepts: computer representation of sound. File Formats – WAV Digital Video Basics of Digital Video, Digitization of Video, File Formats: MPEG Video.	8	CO6
		Self-learning Topics: -Implementation of compression algorithms, Analysis of Digital audio	8	

		and digital video file formats.		
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Text Books:

- 1 Hearn & Baker, “Computer Graphics C version”, 2nd Edition, Pearson Publication.
- 2 James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, “Computer Graphics Principles and Practice in C”, 2nd Edition, Pearson Publication
- 3 Rajesh K. Maurya, “Computer Graphics”, Wiley India Publication.
- 4 Multimedia System Design, Prabhat K. Andleigh & Kiran Thakrar, PHI
- 5 Fundamentals of Multimedia, Ze-Nian Li & Mark S. Drew, PHI.

References:

- 1 D. Rogers, “Procedural Elements for Computer Graphics”, Tata McGraw-Hill Publications.
- 2 Samit Bhattacharya, “Computer Graphics”, Oxford Publication
- 3 Multimedia Communication Systems: Techniques, Standards & Networks, K. R. Rao, Zoran S. Bojkovic & Dragorad A. Milovanovic, TMH.
- 4 Multimedia Systems, K. Buford, PHI.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/106/106/106106090/
2.	https://nptel.ac.in/courses/106/103/106103224/
3.	https://nptel.ac.in/courses/106/102/106102065/
4.	https://onlinecourses.swayam2.ac.in/nou21_cs04/preview
5.	https://nptel.ac.in/courses/117/105/117105083/

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: 2 Hours 30 Minutes
- Question paper consists of six compulsory questions, 10 marks each.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have two alternatives (Option A / Option B) from the same module.
- Both options should be of similar difficulty level and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the entire syllabus, all Course Outcomes, and different levels of learning as per Bloom's Taxonomy.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks =**

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	

Total – 100 Marks

2. No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.

									Hour	
152215 702	Distributed Computing	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
152215702	Distributed Computing	20	20	40	60	2.5	--	--	100

Rationale :

With the rapid growth of networked and cloud-based systems, distributed computing has become a fundamental part of modern computing infrastructure. This course provides students with essential knowledge of distributed system architecture, communication mechanisms, synchronization, and resource management. It enables learners to understand how large-scale systems such as cloud platforms and distributed databases operate efficiently and reliably. The course also focuses on fault tolerance, security, and real-world applications, preparing students to design and develop scalable and robust distributed applications for industry needs.

Course Objectives

- 1 To understand the fundamental concepts and architecture of distributed systems.
- 2 To learn communication models, protocols, and service interaction mechanisms used in distributed systems.
- 3 To understand synchronization, coordination, and consensus techniques for managing distributed processes and resources.
- 4 To study resource management and scheduling in distributed systems.
- 5 To explore distributed file systems, databases, and consistency models.
- 6 To understand fault tolerance and security issues in distributed computing.

Course Outcomes

1. Explain and understand the concepts and architecture of distributed systems. (L1, L2)
2. Apply and demonstrate communication and synchronization techniques in distributed environments. (L3)
3. Analyze and examine distributed algorithms and resource management strategies. (L4)

4. Evaluate and compare distributed file systems and database management techniques (L4, L5)
5. Analyze and evaluate fault tolerance and security mechanisms in distributed systems.(L4, L5)
6. Design and develop basic distributed applications and solutions. (L5, L6)

Prerequisite: Operating System, Computer Networks, Data Structures, DBMS

DETAILED SYLLABUS:

Module	Module	Detailed Contents of Module	Hrs.	COs
0	Prerequisite	Basic knowledge of Operating Systems and Computer Networks is required. Basic programming concepts, Data structures, and fundamentals of DBMS and concurrency.		
I	Introduction to Distributed System	Introduction and evolution of Distributed Computing and its need., Characteristics of distributed systems: resource sharing, scalability, concurrency, transparency. Goals and challenges: heterogeneity, openness, security, fault tolerance. Types of distributed systems: cluster computing, grid computing, cloud computing. Distributed system architectures: client–server architecture, Peer-to-peer and multi-tier architectures. Middleware concepts, role of middleware and examples.	7	CO1
		Self-Learning Topics: Comparison of cluster, grid, and cloud computing, Middleware technologies in Distributed Computing	7	
II	Communication in Distributed Systems	Interprocess communication, message passing models, sockets, Remote Procedure Call (RPC), Remote Method Invocation (RMI), group communication, middleware platforms, REST-based communication and service-oriented architecture.	8	CO2
		Self-Learning Topics: REST vs SOAP communication models in Distributed Systems, Practical use of RPC and RMI frameworks.	8	
III	Synchronization and Coordination	Introduction to synchronization in Distributed Systems and need for clock synchronization, Physical clocks and clock synchronization techniques, Logical clocks and Lamport timestamps, Vector clocks and their applications, Distributed mutual exclusion algorithms: Lamport and Ricart–Agrawala, Leader election algorithms in distributed systems, Distributed deadlock detection and basic consensus algorithms.	8	CO3

		Self-Learning Topics: Comparison of logical clocks and vector clocks in Distributed Systems, Applications of consensus algorithms	8	
IV	Resource management and scheduling	Resource management and need for scheduling in Distributed Systems, Distributed scheduling techniques, Load balancing techniques, Load sharing algorithms, Task allocation strategies, Process migration and thread management, Virtualization concepts in distributed computing.	7	CO4
		Self-Learning Topics: Load balancing in cloud environments in Distributed Systems, Role of virtualization in distributed computing	7	
V	Distributed File Systems and Databases	Architecture of Distributed File Systems, File service models, Consistency models in distributed systems, Data-centric consistency models, Client-centric consistency models, Replication strategies, Distributed databases and transaction management, Case studies: Network File System and Google File System.	8	CO5
		Self-Learning Topics: Comparison of consistency models in Distributed Systems, Working of Google File System and modern distributed storage systems	8	
VI	Fault Tolerance and Security	Types of failures in Distributed Systems, Fault tolerance techniques, Check pointing and recovery mechanisms, Replication techniques for reliability, Secure communication in distributed systems, Authentication and security challenges in distributed environments, Distributed platforms such as Cloud Computing.	7	CO6
		Self Learning Topics: Security challenges in Distributed Systems, Fault tolerance in cloud-based distributed platforms	7	

Text Books

- 1 Distributed Systems: Concepts and Design – George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, Pearson Education.
- 2 Distributed Systems: Principles and Paradigms – Andrew S. Tanenbaum and Maarten Van Steen, Pearson.
- 3 Distributed Computing – Oxford University Press.

Reference Books

- 1 Distributed Systems – Maarten Van Steen and Andrew S. Tanenbaum.

- 2 Distributed Computing: Principles, Algorithms and Systems – Ajay D. Kshemkalyani and Mukesh Singhal.
- 3 Distributed Systems: An Algorithmic Approach – Sukumar Ghosh.

Digital Links / Online Resources

1.	NPTEL – Distributed Systems course lectures.
2.	MIT OpenCourseWare – Distributed Systems course materials.
3.	Coursera – Distributed Systems and Cloud Computing courses.
4.	edX – Distributed Computing and Cloud Systems courses.
5.	Apache Hadoop documentation and tutorials.

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: 2 Hours 30 Minutes
- Question paper consists of six compulsory questions, 10 marks each.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have two alternatives (Option A / Option B) from the same module.
- Both options should be of similar difficulty level and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the entire syllabus, all Course Outcomes, and different levels of learning as per Bloom's Taxonomy.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact	Teaching Scheme (Contact Hours Per Semester)	Total Credits (C)
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		Hours Per Week								(Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
152215703	Advance Data Management Technologies	3	--	--	45	--	-	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
152215703	Advance Data Management Technologies	20	20	40	60	2.5	--	--	100

Rationale:

With the rapid growth of digital technologies, large volumes of data are generated, stored, and processed by organizations across various sectors. Efficient management, storage, and analysis of this data have become essential for supporting decision making and building data-driven applications. This course provides students with knowledge of advanced database concepts such as query processing and optimization, distributed databases, data warehousing, ETL processes, and modern data management technologies including Big Data and NoSQL databases. It enables learners to understand how large-scale data systems are designed and managed in real-world environments and prepares them to develop efficient, scalable, and secure data management solutions for modern enterprises.

Course Objectives:

1. To understand the concepts of query processing and query optimization in a Database Management System.
2. To learn advanced database management techniques including access control mechanisms and emerging database models such as temporal, mobile, and spatial databases.
3. To understand the architecture, design issues, and concepts of distributed database systems.
4. To understand how organizations manage and analyze large volumes of data using data

warehousing, dimensional modeling, and business intelligence techniques.

5.To understand the ETL (Extract, Transform, Load) process used in data integration and data warehousing systems.

6.To gain basic knowledge of modern data management technologies such as Big Data and NoSQL databases.

Course Outcomes:

1. Describe the concepts of query processing, query cost evaluation, and query optimization techniques used in database management systems. (L1)
2. Identify advanced database management techniques including access control mechanisms, database security models, and emerging database models such as mobile, temporal, and spatial databases. (L1, L2)
3. Recognize the architecture, design issues, data fragmentation, and data allocation techniques used in distributed database systems. (L1, L2)
4. Apply data warehousing concepts, dimensional modeling techniques, and business intelligence approaches to organize and manage enterprise data effectively. (L1, L2, L3)
5. Illustrate the role of ETL processes and OLAP operations in data integration, data analysis, and decision support systems. (L1, L2)
6. Implement modern data management solutions using Big Data concepts and NoSQL database technologies for large-scale data applications. (L1, L2, L3)

Prerequisite: Reviewing basic concepts of a Relational database, SQL concepts

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Query Processing and Optimization in DBMS	ETL Process: Introduction to ETL (Extract, Transform, Load) Process, Importance of ETL in Data Warehousing, Challenges in ETL Functions. Data Extraction and Identification of Data Sources, Immediate Data Extraction and Deferred Data Extraction. Data Transformation: Tasks Involved in Data Transformation such as data cleaning, filtering and integration. Data Loading – Techniques of Data Loading including initial loading and incremental loading in Data Warehousing Systems.	07	CO1
		Self-learning Topics: Study commonly used ETL tools for enterprise data	07	

		management and understand their basic features. Explore simple examples of ETL workflows used in data warehousing projects. Perform a basic case study on ETL implementation in an organization, focusing on how data is collected from different sources, transformed into a consistent format, and loaded into a data warehouse for analysis.		
II	Advanced Data Management and Security Techniques	Advanced Database Access Protocols: Discretionary Access Control based on granting and revoking privileges, Mandatory Access Control and Role-Based Access Control (RBAC), and Remote Database Access Protocols. Advanced Database Models: Overview of advanced database models such as Mobile Databases, Temporal Databases, and Spatial Databases, along with an introduction to Distributed Databases and Cloud Databases.	08	CO2
		Self-Learning Topics: Study data security concepts such as Authentication, Authorization, and Encryption, and explore the basic concepts of Database Privacy and Data Protection. Learn about common database security threats such as SQL Injection, data breaches, and unauthorized access. Explore basic techniques for database backup and recovery and study simple case studies related to data security practices used in organizations to protect sensitive data.	08	
III	Distributed Databases	Introduction: Distributed Data Processing, Distributed Database Systems: Architecture, Types of Distributed Databases, and Design Issues in Distributed Databases. Distributed Database Design: Data Fragmentation (Horizontal, Vertical, and Hybrid), Data Allocation in Distributed Databases, Data Replication Techniques, and Distributed Query Processing. Transaction Management:	07	CO3

		Transaction Management in Distributed Databases, Basic Concepts of Data Consistency and Concurrency Control in Distributed Environments.		
		Self-learning Topics: Study query optimization techniques used in distributed databases and understand the basic concepts of the CAP Theorem in distributed systems. Explore how distributed databases manage data consistency, availability, and partition tolerance in large-scale environments. Perform a case study on distributed database applications used in large organizations or cloud-based platforms, focusing on how distributed data storage and processing improve system scalability and reliability.	07	
IV	Data Warehousing and Business Intelligence	Data Warehousing: Need for Data Warehousing, Definition of Data Warehouse, Relevance of Data Warehousing in the age of Big Data, Features of a Data Warehouse. Data Warehouse Architecture – Enterprise/Centralized, Federated and Multi-tier Architectures. Data Warehouse and Data Marts, Data Warehousing Design Strategies. Dimensional Modelling: Dimensional Data Model, Star Schema, Snowflake Schema, Fact Tables and Dimension Tables, Factless Fact Tables, Updates to Dimension Tables, Primary Keys, Surrogate Keys and Foreign Keys, and basic query execution in dimensional models. Business Intelligence and OLAP: Introduction to Business Intelligence (BI), Uses of BI, Tools used in BI. Need for Online Analytical Processing (OLAP). OLAP Operations in a Cube – Roll-up, Drill-down, Slice, Dice, and Pivot. OLAP Architectures – MOLAP, ROLAP, DOLAP and HOLAP.	08	CO4

		Self-learning Topics: Explore the life cycle of Data Warehouse development, including stages such as requirement analysis, data collection, data integration, ETL processing, data storage, and reporting. Study how organizations plan, design, and implement data warehouse systems for effective decision support. Conduct a case study on a real-world data warehouse application (such as in banking, retail, or healthcare sectors) and analyze how data from multiple sources is integrated and used for business intelligence and strategic decision making.	08	
V	ETL Process and Data Integration	ETL Process: Introduction to ETL (Extract, Transform, Load) Process, Challenges in ETL Functions, Data Extraction and Identification of Data Sources, Immediate Data Extraction and Deferred Data Extraction. Data Transformation and Loading: Tasks involved in Data Transformation, Techniques of Data Transformation, and Techniques of Data Loading in Data Warehousing systems.	07	CO5
		Self-learning Topics: Explore various ETL tools used for enterprise data management and perform a case study on ETL processes used in data warehousing projects, focusing on how data is extracted from multiple sources, transformed for analysis, and loaded into a data warehouse for business intelligence applications.	07	
VI	Big data and NoSQL	Big Data: Introduction to Big Data, Types and Characteristics of Big Data. NoSQL Databases: Introduction to NoSQL, CAP Theorem, BASE Properties. NoSQL Data Architecture Patterns: Key-Value Stores, Column Family Stores, Document Stores, and Graph Databases.	08	CO6
		Self-learning Topics: Explore the working of popular NoSQL databases such as Google Bigtable, Apache Cassandra, MongoDB, and Neo4j.	08	

		Perform a case study on the use of NoSQL databases in large-scale applications, such as handling large datasets, real-time data processing, and social network data management.		
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Textbooks:

1. Korth, Silberchatz, Sudarshan, :”Database System Concepts”, 6th Edition, McGraw – Hill
2. Elmasri and Navathe, “Fundamentals of Database Systems”, 6th Edition, PEARSON Education.
3. Theraja Reema, “Data Warehousing”, Oxford University Press.
4. Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems” 3rd Edition - McGraw Hill

References:

1. Paulraj Ponniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India.
2. Ralph Kimball, Margy Ross, “The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling”, 3rd Edition. Wiley India.
3. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition.
4. Peter Rob and Carlos Coronel, “Database Systems Design, Implementation and Management”, Thomson Learning, 9th Edition.

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO’s and **IAT-II** will cover the remaining three CO’s (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: 2 Hours 30 Minutes
- Question paper consists of six compulsory questions, 10 marks each.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have two alternatives (Option A / Option B) from the same module.
- Both options should be of similar difficulty level and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the entire syllabus, all Course Outcomes, and different levels of learning as per Bloom’s Taxonomy.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**

- 2. No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

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	
152215704	Principles of Analog and Digital Communication	3	--	--	45	--	-	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
152215704	Principles of Analog and Digital Communication	20	20	40	60	2.5	--	--	100

Rationale:

The subject **Principles of Analog and Digital Communication** helps students understand how information is transmitted using analog and digital systems. It covers modulation, noise, sampling, and multiplexing, which are essential for modern communication technologies like mobile phones, TV, and the internet.

Course Objectives:

- 1 Study the basics of Communication Systems and noise.
- 2 Acquire the knowledge of analog modulation technique AM and study the block diagram of transmitter and receiver.
- 3 Acquire the knowledge of analog modulation technique FM and study the block diagram of transmitter and receiver.
- 4 Study the Sampling theorem and Pulse Analog and digital modulation techniques
- 5 Learn the concept of multiplexing and digital band pass modulation techniques
- 6 Gain the core idea of electromagnetic radiation and propagation of waves.

Course Outcomes:

- 1 Explain analog, digital communication systems and types of noise. (L1, L2)
- 2 Describe transmission and reception of AM. (L1, L2, L3)
- 3 Describe transmission and reception of FM, (L1, L2, L3)
- 4 Explain Sampling theorem and pulse modulation systems. (L1, L2, L3)
- 5 Explain multiplexing and digital band pass modulation techniques. (L1, L2)
- 6 Describe electromagnetic radiation and propagation of waves. (L1, L2)

Prerequisite: Basic of electrical engineering.

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Introduction to communication systems and noise	Basics of analog communication and digital communication systems (Block diagram), Types of Communication channels. Introduction to Fourier Transform, its properties. Types of Noise, Noise parameters –Signal to noise ratio, Noise factor, Noise figure, Friss formula and Equivalent noise temperature	08	CO1
		Self-learning Topics: Applications areas of analog and digital communication. Signal Representation & Classification Energy vs power signals, Periodic vs non-periodic signals, Even and odd signals. Deterministic vs random signals, Bandwidth Concepts	08	
II	Amplitude modulation Techniques.	AM: Need for modulation, Amplitude Modulation Techniques: DSBFC AM, DSBSC-AM, SSB SC AM- block diagram, spectrum, waveforms, bandwidth, Power calculations. AM Generation: AM generation using Diode, generation of DSB using Balanced modulator, Generation of SSB using Phase Shift Method. AM Transmitter (Block Diagram) AM Receivers – Block diagram of TRF receivers and Super heterodyne receiver and its characteristics- AM Receiver characteristics: Sensitivity, Selectivity, Fidelity, Image frequency and	08	CO2

		its rejection and double spotting		
		Self-learning Topics: Efficiency of AM Systems, Implementation complexity Real-World Applications of AM Radio broadcasting Aviation communication Shortwave transmission	08	
III	Frequency Modulation Techniques	FM: Principle of FM- waveforms, spectrum, bandwidth. Pre- emphasis and de-emphasis in FM, FM generation: Direct method –Varactor diode Modulator, Indirect method (Armstrong method) block diagram and waveforms. FM demodulator: Foster Seeley discriminator, Ratio detector. Self-learning Topics: Use FM in Modern Communication Technology. Challenges faced by radio business. Applications of FM Communication: FM radio broadcasting TV sound transmission Two-way radio systems (walkie-talkies)	08 08	CO3
IV	Pulse Analog Modulation and Digital Modulation	Sampling theorem for low pass and band pass signals, Anti- aliasing filter, PAM, PWM and PPM generation And Degeneration. Quantization process, Pulse code modulation, Delta modulation, Adaptive delta modulation. Self-learning Topics: Introduction to Line Codes, ISI and EYE diagram. Pulse Modulation in Communication Systems. Applications of PAM, PWM, and PPM Use in telemetry and control systems	07 07	CO4
V	Multiplexing and Band Pass Modulation Techniques	Principle of Time Division Multiplexing, Frequency Division Multiplexing, Orthogonal Frequency Division Multiplexing and its applications ASK, FSK, PSK Self-learning Topics: Multiplexing in communication systems. QPSK Generation and detection. Use of shift keying techniques in communication	07 07	CO5

VI	Radiation and Propagation of Waves	Electromagnetic radiation, fundamentals, types of propagation, ground wave, sky wave, space wave tropospheric scatter propagation. Introduction to wireless communication.	07	CO6
		Self-learning Topics: Application of Electromagnetic spectrum in service sector and mobile communication	07	

Text Books:

- [1]. George Kennedy, Bernard Davis, SRM Prasanna, Electronic Communication Systems, Tata McGraw Hill, 5th Ed
- [2]. Simon Haykin, Michael Moher, Introduction to Analog & Digital Communications, Wiley India Pvt. Ltd., 2nd Ed.
- [3]. Wireless Communication and Networking, Vijay Garg

References:

- [1]. Wayne Tomasi, Electronic Communications Systems, Pearson Publication, 5th Ed.
- [2]. B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University
- [3]. Herbert Taub, Donald L Schilling, Goutam Saha, Principles of Communication Systems, Tata McGraw Hill, 3rdEd.
- [4]. K Sam Shanmugam, Digital and Analog Communication Systems, Wiley India Pvt. Ltd, 1st Ed.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.classcentral.com
3.	http://www.vlab.co.in/

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: 2 Hours 30 Minutes
- Question paper consists of six compulsory questions, 10 marks each.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have two alternatives (Option A / Option B) from the same module.
- Both options should be of similar difficulty level and assess similar learning outcomes.

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- Internal choice may be provided within questions.
- Questions should cover the entire syllabus, all Course Outcomes, and different levels of learning as per Bloom's Taxonomy.

Note: -

- 1. Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
- 2. No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course	Course	Teaching	Teaching Scheme	Total
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Code	Name	Scheme (Contact Hours Per Week)			(Contact Hours Per Semester)					Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
152215705	Green IT	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
152215705	Green IT	20	20	40	60	2.5	--	--	100

Rationale:

Most of the engineering branches are off-spring of Information Technology and related fields, which increasingly rely on computers, networks, software, and data centers. With the rapid growth of IT, energy consumption, electronic waste, and carbon footprint have become major environmental concerns. This course on Green IT introduces students to the principles, strategies, and practices of sustainable computing. It equips learners with the knowledge to design energy-efficient software, implement green data centers, adopt green networking and cloud computing solutions, and leverage AI/ML for sustainability, enabling them to contribute to environmentally responsible IT solutions and promote sustainability in their professional practice.

Course Objectives:

1. To understand the concepts and fundamentals of Green IT, including environmental impacts, green hardware, software, and enterprise strategies.
2. To learn sustainable software practices, green data centers, energy-efficient storage, and methods to measure sustainability metrics.
3. To understand green networking, cloud computing, and how ICT infrastructure can be made energy-efficient.
4. To learn the development and implementation of Green IT strategies, sustainable IT services, and organizational sustainability frameworks.
5. To explore semantic web technologies, environmental data management, and green initiatives, and industry standards.

6. To study the implementation of Green IT in communication, social media, smart grids, AI/ML applications, smart cities, and future sustainable technologies.

Course Outcomes:

1. Describe the fundamentals of Green IT, including environmental impacts, green hardware and software, eco-labeling, and enterprise strategies. (L1)
2. Identify sustainable software practices, green data centers, energy-efficient storage systems, and methods to measure software and data center sustainability metrics. (L1, L2)
3. Recognize objectives of green network protocols, green cloud computing, and strategies for energy-efficient ICT infrastructure. (L1, L2)
4. Apply Green IT strategies, sustainability hierarchy models, capability maturity frameworks, and sustainable IT services for organizational and enterprise greening. L1, L2, L3)
5. Illustrate environmental sustainability initiatives using semantic web technologies, green cloud services, green building standards, NGO initiatives, and green ICT tools. (L1, L2)
6. Implement Green IT in practical scenarios, including AI/ML applications for sustainability, smart cities, smart grids, RFID-based environmental monitoring, green supply chain management, and enterprise sustainability strategies. (L1, L2, L3)

Prerequisite: Environmental Studies

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Fundamentals of Green IT and Green Devices	Environmental Impacts of IT, Holistic Approach to Greening IT, Green IT Standards and Eco-Labeling, Enterprise Green IT Strategy, Green IT: Burden or Opportunity? Green device or Hardware: Life Cycle of a Device or Hardware, Reuse, Recycle and Dispose Green Software: Introduction, Energy-Saving Software Techniques	7	CO1
		Self-learning Topics: Evaluating and Measuring Software Impact to Platform Power, Environmental Concerns and Sustainable Development	7	
II	Sustainable Software and Green Data Centers	Sustainable Software, Software Sustainability Attributes and Metrics Green Data center: Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, Green Data Centre Metrics Green Data Storage: Introduction, Storage Media Power Characteristics, Energy Management Techniques for Hard Disks, System-Level Energy Management	8	CO2

		Self-learning Topics: Sustainable Software Methodology, Sustainable Software: A Case Study, Data Centre Management Strategies: A Case Study, Case Study: Green Computing Initiatives in Google Data Centers	8	
III	Green Networking and Green Cloud Computing	Introduction, Objectives of Green Network Protocols, Green Network Protocols and Standards Green Cloud Computing: What is Cloud Computing, Cloud Computing and Energy Usage Model, Features of Clouds Enabling Green Computing, Towards Energy Efficiency of Cloud Computing, Green Cloud Architecture	7	CO3
		Self-learning Topics: System-Level Energy Management, Case Study: IaaS Provider, Case Study: Green Cloud Infrastructure of Amazon Web Services, System-Level Energy Management in Computer Networks	7	
IV	Green IT Strategies and Sustainable IT Services	Approaching Green IT Strategies, Business Drivers of Green IT Strategy Multilevel Sustainable Information, Sustainability Hierarchy Models, Product Level Information, , Measuring the Maturity of Sustainable ICT: A Capability Maturity Framework for SICT. Background: Readiness and Capability Development of the G-Readiness. Factors Driving the Development of Sustainable IT, Sustainable IT Services (SITS), SITS Strategic Framework Organizational and Enterprise Greening, Sustainable IT Roadmap Developing a City Sustainability Plan: A Case Study	8	CO4
		Self-learning Topics: Individual and Functional Level Information, Business Dimensions for Green IT Transformation, Metrics and Measurements in Green Strategies, Framework, Measuring an Organization's G-Readiness, SITS Leadership and Best Practices	8	
V	Environmental Sustainability through Semantic Web	Semantic Web Technologies: Information Management for Environmental Sustainability, Ecosystem of Software Tools, Examples of Managing Data, Challenges and Guiding Principles.	7	CO5
		Strategizing Green Initiatives, Implementation of Green IT, Industry Associations and Standards Bodies, Green Building Standards, Social Movements and Greenpeace Self-learning Topics: Role of NGOs in		

	and Green Initiatives	Environmental Sustainability, Information Assurance, Green Data Centers, Case Study: Managing Green IT, environmental Data Management Tools, Green Cloud Services and Web Applications – Energy-efficient web hosting and cloud resource management.	7	
VI	Implementatio n of Green IT and Future Trends	Communication and social media The Regulatory Environment and IT Manufacturers, non-regulatory Government Initiatives, Role of AI and ML in Environmental Sustainability, AI Techniques for Sustainable Development, Challenges of Using AI in Environmental Applications Awareness to Implementation, Greening by IT - Using RFID for Environmental Sustainability, Smart Grids, Smart Buildings and Homes, Green Supply Chain and Logistics, Enterprise-Wide Environmental Sustainability, AI in Smart Cities for Sustainable Development, Machine Learning for Energy Consumption Optimization. AI for Climate Change Prediction and Analysis Green IT: A Megatrend? A Seven-Step Approach to Creating Green IT Strategy, Research and Development Directions	8	CO6
		Self-learning Topics: Environmental Data Sources and Data Analytics, AI and ML in Green IT Web Applications – Predictive analytics for carbon footprint reduction. Big Data for Environmental Monitoring, AI-Based Decision Support Systems for Sustainability	8	

Text Books:

1. San Murugesan, G. R. Gangadharan, Harnessing Green IT, WILEY 1st Edition-2013
2. Mohammad Dastbaz Colin Pattinson Babak Akhgar, Green Information Technology A Sustainable Approach, Elsevier 2015
3. Reinhold, Carol Baroudi, and Jeffrey Hill Green IT for Dummies, Wiley 2009

References:

1. Mark O'Neil, Green IT for Sustainable Business Practice: An ISEB Foundation Guide, BCS
2. Jae H. Kim, Myung J. Lee Green IT: Technologies and Applications, Springer, ISBN: 978-3-642-22178-1
3. Elizabeth Rogers, Thomas M. Kostigen the Green Book: The Everyday Guide to Saving the Planet One Simple Step at a Time, Springer

Online References:

Sr. No.		Website Name								
Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning)
		L	T	P	L	T	P	SL	Notional Learning	
		Offers courses like “Green Computing,” “Sustainable IT” and “AI for Earth.”								
	4.	Springer and ResearchGate – https://www.springer.com/ & https://www.researchgate.net/ Research papers on Green IT, sustainable software, and AI/ML applications in sustainability.								
	5.	Green IT Amsterdam – https://www.greenitamsterdam.com/ Insights on Green IT trends, case studies, and enterprise sustainability strategies.								
	6.	UN Environment Programme – ICT for Environment – https://www.unep.org/resources Global perspective on ICT and environmental sustainability initiatives.								

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- Question paper consists of six compulsory questions, 10 marks each.
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- Both options should be of similar difficulty level and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the entire syllabus, all Course Outcomes, and different levels of learning as per Bloom's Taxonomy.

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									Hour	Hour/30)
15412509	MAD & PWA Lab	--	--	2	--	--	30	--	30	1

Lab Objectives:

1. Learn the basics of the Flutter framework.
2. Develop the App UI by incorporating widgets, layouts, gestures and animation
3. Create a production ready Flutter App by including files and firebase backend service.

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
15412509	MAD & PWA Lab	--	--	--	--	--	25	--	25

4. Learn the Essential technologies, and Concepts of PWAs to get started as quickly and efficiently as possible
5. Develop responsive web applications by combining AJAX development techniques with the jQuery JavaScript library.
6. Understand how service workers operate and also learn to Test and Deploy PWA.

Lab Outcomes:

1. Understand cross platform mobile application development using Flutter framework. (L1, L2)
2. Design and Develop interactive Flutter App by using widgets, layouts, gestures and animation. (L3)
3. Analyze and Build production ready Flutter App by incorporating backend services and deploying on Android / iOS (L3, L4)
4. Understand various PWA frameworks and their requirements. (L1, L2)
5. Design and develop a responsive User Interface by applying PWA Design techniques (L3)
6. Develop and Analyze PWA Features and deploy it over app hosting solutions (L3,L4)

Prerequisite: HTML/HTML5, CSS3, JavaScript

Hardware & Software Requirements:

Hardware Requirement:	Software requirement:
PC i3 processor and above	JDK 8 and above, Android studio, Flutter SDK, AngularJs, React, Vue, PWA Builder, Google Chrome Browser, Github account. Internet Connection.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Basics of Flutter Programming	Introduction of Flutter, Understanding Widget Lifecycle Events, Dart Basics, Widget Tree and Element Tree, Basics of Flutter installation, Flutter Hello World App.	02	LO1
II	Developing Flutter UI: Widgets, Layouts, Gestures, Animation, AI Voice Assistant	USING COMMON WIDGETS: SafeArea, AppBar, Column, Row, Container, Buttons, Text, Richtext, Form, Images and Icon. BUILDING LAYOUTS: high level view of layouts, Creating the layout, Types of layout widgets. APPLYING GESTURES: Setting Up Gesture Detector, Implementing the Draggable and Drag Target Widgets, Using the Gesture Detector for Moving and Scaling ADDING ANIMATION TO AN APP: Using Animated Container, using Animated CrossFade, Using Animated Opacity, Using Animation Controller, Using Staggered Animation CREATING AN APP'S NAVIGATION USING AI VOICE ASSISTANT: Using the Navigator, Using the Named Navigator Route, Using the Bottom Navigation Bar, Using the TabBar and TabBar View, Voice Simulation Using AI	06	LO2
III	Creating Production Ready Apps Using AI Personalization	Working with files: Including libraries in your Flutter app, including a file with your app, Reading/Writing to files, Using JSON. Using Firebase with Flutter: Adding the Firebase and Firestore Backend, Configuring the Firebase Project, adding a Cloud Firestore		

		Database and Implementing Security Testing and Deploying of Flutter Application Using AI Personalization: Widget testing, Deploying Flutter Apps on Android / iOS	04	LO3
IV	Introduction to Progressive Web App	Introduction to Progressive Web App • Why Progressive Web App • Characteristics of PWA • PWAs and Hybrid Apps vs. Mobile Apps • PWA Requirements: HTTPS, Service Workers, and Web App Manifest • PWA framework tools Use cases	02	LO4
V	Creating Responsive UI	Creating Responsive UI using JQuery Mobile / Material UI / Angular UI / React UI • Understanding the concept of responsive web design • Comparing responsive, fluid, and adaptive web • keys to great Progressive Web App UX • Responsive Design – The Technicalities • Flexible grid-based layout • Flexible images and video Smart use of CSS splitting the website behavior (media queries)	06	LO5
VI	Web App Manifest & Service Workers	Web App Manifest: Understand the basic format and workings of the Web App Manifest file. • Using an App Manifest to Make your App Installable. • Understanding App Manifest Properties. • Simulating the Web App on an Emulator. • Installing the Web App – Prerequisites. • Understanding manifest.json Service Workers: Making PWAs work offline with Service workers • Introduction to Service Workers • Service Workers Lifecycle (Registration, Installation and Activation) • Implement Service Workers Features (Events) • Handling cached content • Enabling offline functionality • Serving push notifications • Loading cached content for new users	06	LO6

	• Background synchronization • Using IndexedDB in the Service Worker • Geo-fencing Deploy a PWA to GitHub Pages as a free SSL enabled static app hosting solution. • Initializing the PWA as a Git repo • Testing with Lighthouse Deploying via GitHub Pages Deploy a PWA to GitHub Pages as a free SSL enabled static app hosting solution. • Initializing the PWA as a Git repo • Testing with Lighthouse • Deploying via GitHub Pages		
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Text Books:

- 1 Beginning Flutter, a Hands-on Guide to App Development, Marco L. Napoli, Wiley, 2020.
- 2 Beginning App Development with Flutter: Create Cross-Platform Mobile Apps, By Rap Payne, 2019
- 3 Progressive Web Application Development by Example: Develop fast, reliable, and engaging user experiences for the web, Packt Publishing Limited ,2018
- 4 Building Progressive Web Apps,O'Reilly 2017.
- 5 Progressive Web Apps with Angular: Create Responsive, Fast and Reliable PWAs Using Angular, Apress; 1st ed. edition (28 May 2019).
- 6 AI Engineering: Building Applications with Foundation Models, Chip Huyen, O'Reilly (Updated 2026).
- 7 AI and Machine Learning For Coders: A Programmer's Guide to Artificial Intelligence, Laurence Moroney, O'Reilly.

References:

- 1 Flutter in Action by Eric Windmill, MANING, 2019.
- 2 Google Flutter Mobile Development Quick Start Guide.Packt,2019.
- 3 Learning Progressive Web Apps: Building Modern Web Apps Using Service Workers, Addison- Wesley Professional, 2020.
- 4 Google Developers - Flutter AI Toolkit: A comprehensive resource for integrating AI chat-related widgets and multimodal models like Gemini into Flutter apps.
- 5 Firebase Documentation for Vertex AI.
- 6 Alan AI Platform Documentation.

Online References:

Sr. No.	Website/Reference link
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1.	https://flutter.dev/docs/reference/tutorials
2.	https://www.tutorialspoint.com/flutter/index.html
3.	https://www.javatpoint.com/flutter
4.	https://www.tutorialspoint.com/jquery_mobile/jqm_panel_responsive.html
5.	https://www.w3schools.com/css/css_rwd_intro.asp
6	https://developers.google.com/web/updates/2015/12/getting-started-pwa
7	https://www.w3schools.com/react/
8	https://angular.io/docs
9	https://flaviocopes.com/service-workers/
10	https://blog.logrocket.com/how-to-build-a-progressive-web-app-pwa-with-node-js/
11	Voice AI Assistant App Tutorial - YouTube
12	Official Pub.dev Package
13	alan_voice Flutter Package
14	Integrating Generative AI with Firebase Vertex AI
15	Flutter CRM & AI Agent Template

Suggested List of Experiments

Sr. No.	Experiment Title
1	To install and configure Flutter Environment.
2	To design Flutter UI by including common widgets.
3	To create an interactive Form using form widget.
4	To design a layout of Flutter App using layout widgets
5	To include icons, images, charts in Flutter app.
6	Applying Navigation, Routing, and Gesture Control via Voice Assistant Integration.
7	To Connect Flutter UI with fireBase database

8	To test and deploy production ready Flutter App on Android platform
9	Designing a Responsive E-commerce UI with AI-powered User Personalization.
10	To write meta data of your Ecommerce PWA in a Web app manifest file to enable “add to home screen feature”.
11	To code and register a service worker, and complete the install and activation process for a new service worker for the E-commerce PWA
12	To implement Service worker events like fetch, sync and push for E-commerce PWA.
13	To study and implement deployment of Ecommerce PWA to GitHub Pages.
14	To use google Lighthouse PWA Analysis Tool to test the PWA functioning.
15	To deploy an Ecommerce PWA using SSL enabled static hosting solution.

Assignment 1: MAD (Any one)

- 1 To Study basics of Dart language and design basic Flutter App
- 2 To include Files and JSON data in App
- 3 To build interactive App by including Flutter Gestures and Animations
- 4 Design a workflow for an ai-powered user personalization engine for an e-commerce pwa. how would you use data from firestore (e.g., past purchase history) to dynamically re-rank product cards on the home screen?

Assignment 2: PWA (Any one)

To study the requirement for progressive web application for Ecommerce using the concept of service worker, Webapp Manifest and framework tools.

To Design a wireframe for simple PWA for E-commerce website.

Design Case study for successful real-life implementation of PWA.

Compare on-device Speech-to-Text (STT) vs. Cloud-based STT for implementing a Voice Assistant. Which approach would you choose for a low-bandwidth user in a rural area, and why?

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also, Term Work Journal must include at least 2 assignments as mentioned in above syllabus.

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

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T.Y. B. Tech Syllabus

SEM VI