T.E. IT
Scheme

Semester
V

Program Structure for Third Year of Information Technology
UNIVERSITY OF MUMBAI (With Effect from 2026-2027)
SEMESTER V

Course Code	Course Name	Teaching Scheme (Contact Hours)				Credits Assigned			
		Theory	Practical	Tutorial	Total	Theory	Practical	Tutorial	Total
2345111	Software Engineering and Agile Practices	3	--	--	03	3	--	--	03
2345112	Artificial Intelligence and Machine Learning	3	--	--	03	3	--	--	03
2345113	Web Technology	3	--	--	03	3	--	--	03
2345114X	PEC-1	3	--	--	03	3	--	--	03
MDC501	Multidisciplinary Minor	3	--	--	03	3	--	--	03
2345115	DevOps Lab	--	2	--	02	--	1	--	01
2345116	AI & ML Lab	--	2	--	02	--	1	--	01
2345117	Web Lab	--	2	--	02	--	1	--	01
2345118X	PEL-1	--	2	--	02	--	1	--	01
MDL501	Multidisciplinary Minor Lab	--	2[@]	--	02	--	1	--	01
OECL501	To be taken from bucket provided by University from other Faculty	2[#]	--	--	02	2	--	--	02
2345511	India Knowledge System – As Per Program common to all Program - Group A	--	2[*] + 2	--	04		2	--	02
Total		**17**	**14**	**00**	**31**	**17**	**07**	--	**24**

[*] Two hours of practical class to be conducted for full class as demo/discussion.
[#] Institute shall offer a course for Open Elective from Science/Commerce/Management stream bucket provided by the University of Mumbai.
[@] Institute shall offer a course for MDM from other Engineering Boards Group.

Course Code	Course Name	Examination Scheme							
		Internal Assessment Test (IAT)			End Semester Exam Marks	End Semester Exam Duration (Hours)	Term Work (TW)	Oral & Practical	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
2345111	Software Engineering and Agile Practices	20	20	40	60	2	--	--	100
2345112	Artificial Intelligence and Machine Learning	20	20	40	60	2	--	--	100
2345113	Web Technology	20	20	40	60	2	--	--	100
2345114X	PEC-1	20	20	40	60	2	--	--	100
MDC501	Multidisciplinary Minor	20	20	40	60	2	--	--	100
2345115	DevOps Lab	--	--	--	--	--	25	--	25
2345116	AI & ML Lab	--	--	--	--	--	25	25	50
2345117	Web Lab	--	--	--	--	--	25	25	50
2345118X	PEL-1	--	--	--	--	--	25	25	50
MDL501	Multidisciplinary Minor Lab	--	--	--	--	--	25	25	50
OECL501	To be taken from bucket provided by University from other Faculty	--	--	--		--	50	--	50
2345511	India Knowledge System – As Per Program common to all Program - Group A	--	--	--		--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**225**	**100**	**825**

Course Code	Course Description
23451141	Cyber Security
23451142	Advanced Database Technologies
23451143	UI/UX Design
23451144	Image Processing

Lab Code	Lab Description
23451181	Cyber Security Lab
23451182	Advanced Database Technologies Lab
23451183	UI/UX Design Lab
23451184	Image Processing Lab

Vertical – 1
Major

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2345111	Software Engineering and Agile Practices	03	---	---	03	---	---	03

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
2345111	Software Engineering and Agile Practices	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To understand software engineering principles, process models, and development life cycles.
2	To understand requirement engineering processes, apply software design principles and architectural styles.
3	To learn project planning, estimation models and scheduling techniques.
4	To understand software risk management processes and software configuration management practices.
5	To understand software testing strategies, quality assurance practices, and maintenance techniques.
6	To introduce Agile methodologies and DevOps practices for effective software development and project management.

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

Sr. No.	Course Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Explain software engineering concepts, models, and development practices.	L1, L2
2	Develop SRS documents and design software architecture using appropriate design principles and models.	L1, L2, L3
3	Apply estimation models and prepare project schedules using suitable tracking techniques.	L1, L2, L3
4	Develop RMMM plans by identifying software risks and while demonstrate SCM processes for project control.	L1, L2, L3
5	Apply testing techniques to ensure software quality and explain maintenance strategies in software systems.	L1, L2, L3
6	Apply Agile frameworks and DevOps practices in software development and project tracking.	L1, L2, L3

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	None	-	-

1	Introduction to Software Engineering	Nature of Software, Software Engineering, Software Process, Generic Process Model, Prescriptive Process Models: The Waterfall Model, V-model, Incremental Process Models, Evolutionary Process Models, Concurrent Models **Self-Learning Topics:** Personal and Team Process Models	05	CO1
2	Requirement Engineering and Design Engineering	Software Requirements: Functional & non-functional Requirements Engineering: Elicitation, Analysis, Specification, Validation. Software requirement specification (SRS) Design Principles: Modularity, Abstraction, Coupling and Cohesion. Software Architecture Styles: Layered, MVC, Client-Server. **Self-Learning Topics:** Prioritizing requirements (Kano diagram) - Real life application case study. IEEE Standards for SRS, CASE Tools, Design Documentation.	07	CO2
3	Software Project Management	Project Planning, Scheduling, and Estimation Techniques Software Project Estimation: LOC, FP, Empirical Estimation Models - COCOMO II Model Project scheduling: Defining a Task Set for the Software Project, Timeline charts, Tracking the Schedule. **Self-Learning Topics:** Cost Estimation Tools and Techniques, Typical Problems with IT Cost Estimates.	06	CO3
4	Software Risk, Configuration Management	Risk Identification, Risk Assessment, Risk Projection, RMMM Software Configuration management, SCM repositories, SCM process. **Self-Learning Topics:** Configuration management for Web Apps	04	CO4
5	Software Testing and Maintenance	Levels of Testing: Unit, Integration, System, Acceptance. Static and Dynamic Testing Techniques overview Regression and Continuous Testing. Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough Maintenance Types: Corrective, Adaptive, Preventive, And Perfective. Software Reengineering and Refactoring.	07	CO5

		Self-Learning Topics: Test Strategies for Web Apps		
6	Agile Methodologies and Emerging Trends	Agile Manifesto and Principles, Scrum Framework: Roles, Artifacts, Events, Kanban and Lean Software Development, Extreme Programming (XP): Practices, Pair Programming, Test-Driven Development (TDD), Agile Metrics, Agile Project Tracking: Velocity, Burn-Up/Burn-Down Charts, Agile Testing overview DevOps and its Lifecycle, DevSecOps and Secure Software Development Lifecycle. **Self-Learning Topics:** Crystal Methodology, Scaled Agile Framework (SAFe), Agile Maturity Models	10	CO6
		Total Hours	39	
Note: No questions will be asked in the end-semester exam from self-study topics. However, students are encouraged to explore these topics for a better understanding of the course.				

Text Books:

1. Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill, 9th Edition.
2. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India, 5th Edition.
3. Pankaj Jalote, An integrated approach to Software Engineering, Springer/Narosa, 2005.
4. S.W. Ambler, Agile Modeling: Effective Practices for Extreme Programming and the Unified Process, Wiley, 2002.
5. Kim, Gene, The DevOps handbook: how to create world-class agility, reliability, and security in technology organizations, 2nd Edition.

References:

1. Ian Sommerville, Software Engineering, Addison-Wesley, 9th Edition.
2. Mike Cohn, Succeeding with Agile: Software Development Using Scrum, Addison-Wesley, 2013.
3. Sricharan Vadapalli, DevOps: Continuous Delivery, Integration, and Deployment with DevOps: Dive, Packt, 2018

Online References:

Sr. No.	Website Name	URL
1	Swayam	https://onlinecourses.nptel.ac.in/noc20_cs68/preview
2	NPTEL	https://nptel.ac.in/courses/106101061
3	Agile Alliance	https://www.agilealliance.org/
4	Scrum	https://www.scrum.org/
5	Azure	https://azure.microsoft.com/en-us/solutions/devops/tutorial
6	RedHat	https://www.redhat.com/en/topics/devops/what-is-devsecops

Assessment:

Internal Assessment Test (IAT) for 20 marks each:

- IAT will consist of two compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I the remaining syllabus content must be covered in the IAT-II.

End Semester Theory Examination:

- Question Paper will comprise a total **of six questions each carrying 15 marks. Question 1** will be **compulsory** and should **cover the maximum contents of the syllabus.**
- **Remaining questions** will be **mixed in nature.** (Part (a) and part (b) of each question must be from different modules. For example, if Q2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules).
- A total of **four questions** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2345112	Artificial Intelligence and Machine Learning	03	---	---	03	---	---	03

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
2345112	Artificial Intelligence and Machine Learning	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	Understand fundamental concepts of Artificial Intelligence and Machine Learning.
2	Apply problem-solving and search strategies to AI-based systems.
3	Analyze supervised and unsupervised learning algorithms.
4	Implement regression, classification, and clustering models.
5	Evaluate ML models using appropriate performance metrics.
6	Understand ethical, societal, and industrial implications of AI systems.

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

Sr. No.	Course Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Explain AI foundations, intelligent agents, and problem-solving techniques.	L2
2	Apply search algorithms and optimization methods to real-world problems.	L3
3	Develop supervised learning models for regression and classification tasks.	L3
4	Implement unsupervised learning techniques for pattern discovery.	L4
5	Evaluate ML models using standard evaluation metrics and validation techniques.	L5
6	Analyze ethical issues, bias, fairness, and societal impacts of AI systems.	L4

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Linear Algebra, Probability, Statistics, and Calculus for ML	02	-
1	Introduction to Artificial Intelligence	Definition and Scope of AI. Applications of AI in Industry. Intelligent Agents: Types and Architectures. Problem Formulation in AI. AI vs ML vs DL. Introduction to Data Science in AI.	06	CO1

		Self-Learning Topics: Knowledge Representation and Reasoning Techniques, AI in Decision Making and Game Playing.		
2	Problem Solving & Search Strategies	State Space Representation. Uninformed Search Strategies: Breadth First Search, Depth First Search, Uniform Cost Search. Informed Search Strategies: Greedy Best First Search, A* Algorithm. Heuristic Functions. Constraint Satisfaction Problems (CSP). **Self-Learning Topics:** Heuristic Design and Optimization Techniques. Game Tree Search and Multi-Agent Systems. Metaheuristic and Evolutionary Search Algorithms	06	CO2
3	Supervised Learning	Introduction to Machine Learning. Types of Learning. Regression: Linear Regression, Multiple Regression. Classification: Logistic Regression, k-Nearest Neighbours (k-NN), Decision Trees, Random Forest, Support Vector Machine (SVM). Regularization Techniques. Bias-Variance Trade-off. **Self-Learning Topics:** Hyperparameter Optimization, Cross-Validation Techniques. Imbalanced Data Handling (SMOTE).	06	CO3
4	Unsupervised Learning	Clustering: K-Means Clustering, Hierarchical Clustering. Association Rule Mining. Dimensionality Reduction: Principal Component Analysis (PCA). Association Rule Learning (Apriori Algorithm). Gaussian Mixture Models (GMM). Feature Engineering Basics. **Self-Learning Topics:** DBSCAN, Independent Component Analysis (ICA). Clustering Validation and Ensemble Clustering.	07	CO4
5	Model Evaluation & Optimization	Training, Validation, Testing. Cross Validation Techniques. Confusion Matrix. Accuracy, Precision, Recall, F1-Score. ROC Curve and AUC. Overfitting and Underfitting. Hyperparameter Tuning and Model Optimization Techniques. **Self-Learning Topics:** Advanced Performance Metrics for Classification and Regression. Handling Imbalanced and Noisy Datasets.	06	CO5
6	Ethics, Emerging Trends & Applications	AI Ethics and Responsible AI. Bias and Fairness in AI. Transparency & Accountability. Introduction to Explainable AI (XAI). Human-in-the-Loop Systems. Generative AI. Quantum Machine	06	CO6

		Learning. Introduction to Deep Learning. AI in Healthcare, Finance, Smart Cities. **Self-Learning Topics:** Autonomous Systems, Algorithm Trading, AutoML and Neural Architecture Search. Privacy-Preserving and Secure AI.		
			Total Hours	39
Note: No questions will be asked in the end-semester exam from self-study topics. However, students are encouraged to explore these topics for a better understanding of the course.				

Text Books:

1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 3rd Edition
2. Ethem Alpaydin, Introduction to Machine Learning, The MIT Press, 2nd Edition.
3. Aurélien Géron, Hands‐On Machine Learning with Scikit‐Learn, Keras & TensorFlow. O'REILLY, 2nd Edition
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 1st Edition.
5. Trevor Hastie, Robert Tibshirani & Jerome Friedman, The Elements of Statistical Learning, Springer, 2nd Edition

References:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education, 1st Edition.
2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 1st Edition.
3. Charu C. Aggarwal, Artificial Intelligence, Springer, 1st Edition.

Online References:

Sr. No.	Website Name	URL
1	Coursera	https://www.coursera.org/specializations/deep-learning
2	Stanford University (free notes/lectures)	https://cs231n.github.io/
3	fast.ai	https://www.fast.ai/
4	PyTorch Tutorials	https://pytorch.org/tutorials/
5	MIT Deep Learning Book (Online)	http://www.deeplearningbook.org/

Assessment:

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End Semester Theory Examination:

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2345113	Web Technology	03	---	---	03	---	---	03

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
2345113	Web Technology	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To expose students to JavaScript to develop interactive web page development.
2	To orient students to Basics of REACT along with installation.
3	To expose students to Advanced concepts in REACT along with installation.
4	To orient students with practical knowledge of database management using MongoDB.
5	To orient students to Fundamentals of Node.js
6	To expose students to Node.js applications using express framework.

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

Sr. No.	Course Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Apply JavaScript to add functionality to web pages.	L1, L2, L3
2	Develop front end applications using basic React.	L1, L2, L3
3	Develop front end applications using functional components of React.	L1, L2, L3
4	Apply MongoDB in a full-stack application for storing, retrieving, and managing data using a back-end framework.	L1, L2, L3
5	Develop back-end applications using Node.js.	L1, L2, L3
6	Develop web based Node.js applications using Express.	L1, L2, L3

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Internet basics, HTTP/HTTPS, DNS, HTML, CSS	02	-
1	Introduction to JavaScript	Introduction to JavaScript, Constants, JS variables, JS Variable scopes, JS Data Types, JS Function, JS Array, Introduction to ES6, Difference between ES5 and ES6, Events, Arrow functions, Client-side Form validation using JavaScript, using properties and methods of built -in- objects. **Self-Learning Topics:** Asynchronous JavaScript, JSON.	06	CO1

2	React	Introduction to MERN stack application. Introduction to React, Installation, installing libraries, Folder and file structure, Components, Component lifecycle, State and Props, React Router and Single page applications, UI design, Forms, Events, Animations, Best practices. **Self-Learning Topics:** React vs Angular vs Vue	07	CO2
3	Advanced React	Functional components- Refs, use effects, Hooks, Flow architecture, Model-View Controller framework, Flux, Bundling the application. Web pack. **Self-Learning Topics:** React Native	06	CO3
4	MongoDB	Understanding MongoDB, MongoDB Data Types, Administering User Accounts, Configuring Access Control, CRUD Operations, Using Mongoose for Structured Schema and Validation. Using Express and Mongoose to interact with MongoDB, Web Security Basics: SQL Injection, XSS. **Self-Learning Topics:** Query optimization	07	CO4
5	Node.js	Environment setup, First app, Asynchronous programming, Callback concept, Event loops, REPL, Event emitter, Networking module, Buffers, Streams, File system, Web module. **Self-Learning Topics:** Next.Js framework	06	CO5
6	Express	Introduction, Express router, REST API, Generator, Authentication, sessions, Integrating with React. **Self-Learning Topics:** FastAPI	05	CO6
		Total Hours	39	
Note: No questions will be asked in the end-semester exam from self-study topics. However, students are encouraged to explore these topics for a better understanding of the course.				

Text Books:

1. Venkat Subramanian, Rediscovering JavaScript, Master ES6, ES7, and ES8, Pragmatic Bookshelf, 1st Edition, 2018.
2. Alex Banks and Eve Porcello, Learning React Functional Web Development with React and Redux, O'Reilly ,1st Edition, 2017.
3. Andrew Mead, "Learning Node.js Development", Packt Publishing, 1st edition, 2018
4. Ethan Brown, Web Development with Node and Express, O'Reilly, 2nd edition, 2019.
5. Shama Hoque, Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js, Packt Publishing,2nd Edition,2019.

References:

1. Amit Phaltankar, Juned Ahsan, Michael Harrison, Liviu Nedov, Sam Anderson, MongoDB Fundamentals, Packt Publishing, 2020.

2. Nabendu Biswas, Ultimate Full-Stack Web Development with MERN: Design, Build, Test and Deploy Production-Grade Web Applications with MongoDB, Express, React and NodeJS, Orange Education Pvt. Ltd., 1st Edition,2023

Online References:

Sr. No.	Website Name	URL
1	react.dev	https://react.dev/learn/installation
2	react.dev	https://react.dev/learn/creating-a-react-app
3	MongoDB	https://www.mongodb.com/docs/manual/tutorial/
4	Udemy	https://www.udemy.com/course/mern-stack-front-to-back/
5	nodejs.org	https://nodejs.org/en/learn/getting-started/introduction-to-nodejs

Assessment:

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End Semester Theory Examination:

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- **Remaining questions** will be **mixed in nature.** (Part (a) and part (b) of each question must be from different modules. For example, if Q2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules).
- A total of **four questions** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23451141	Cyber Security	03	---	---	03	---	---	03

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
23451141	Cyber Security	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To understand the fundamental concepts of cyber security including security principles, cyber threats, and basic AI-driven security approaches.
2	To apply cryptographic techniques and secure communication mechanisms for protecting data.
3	To analyze security features in operating systems, cloud environments, and access control models.
4	To study common web and network vulnerabilities and their prevention mechanisms.
5	To understand the fundamentals of network security, explore security devices and protocols, and analyze common network attacks in a controlled environment.
6	To understand cyber laws, security standards, and ethical practices in cyber security governance.

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

Sr. No.	Course Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Explain cyber security fundamentals including AI-driven security mechanisms and major categories of cyber threats.	L2
2	Apply cryptographic algorithms and secure communication concepts for data protection.	L3
3	Analyze operating system and cloud security mechanisms including authentication and access control models.	L4
4	Analyze common web application vulnerabilities and recommend secure design practices.	L4
5	Analyze network security architecture and attack methods using security tools and techniques.	L4
6	Explain security governance and standards.	L2

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Basics of Computer Networks, OS fundamentals, Web concepts, Basic Linux commands	02	-
1	Introduction to	Cyber space and cyber security Fundamentals- Cyber Crime Vs Information Security, CIA Triad	06	CO1

	Cyber Security & Threats	and security principles, Types of cyber-attacks, Malware types (Ransomware, Rootkits, Botnets), Advanced Persistent Threats (APT), Cyber Kill Chain Model, Social Engineering attacks, Introduction to AI in Cyber Security-Role of AI/ML in threat detection, AI-based malware and phishing detection, Introduction to AI in Intrusion Detection and User Behavior Analysis. **Self-Learning Topics:** Fundamentals of Zero Trust Security, Steganography.		
2	Cryptography & Secure Communication	Introduction to Cryptography-Classical vs Modern cryptography, goals of cryptography: confidentiality, integrity, authentication, and non-repudiation. Symmetric Key Cryptography-Concepts of symmetric encryption, block cipher and stream cipher, overview of algorithms: AES and DES. Asymmetric Key Cryptography-Concepts of public key cryptography, overview of algorithms: RSA and ECC, RSA algorithm steps (key generation, encryption, and decryption – conceptual level), key generation and key exchange concepts, applications of public key cryptography. Hash Functions-Modern hash functions: SHA-2, SHA-3, BLAKE2/BLAKE3, and password hashing algorithms (bcrypt, scrypt, Argon2) with applications in data integrity and authentication. Digital Signatures and Public Key Infrastructure (PKI)-Digital signature process, X.509 digital certificates, Certificate Authorities (CA), basic PKI architecture, and applications in secure communication. Secure Communication Protocols-Overview of TLS 1.2 and TLS 1.3, limitations of SSL, VPN concepts and types, and IPsec architecture (conceptual overview). **Self-Learning Topics:** Blockchain security basics	09	CO2
3	System Security and Cloud Security	Operating System Security Concepts: Basic security features in Windows and Linux, user accounts and permissions, importance of secure system configuration, access control and authentication concepts, overview of access control models (DAC, MAC, RBAC – conceptual), user authentication methods including password-based authentication and Multi-Factor Authentication (MFA), and the role of identity management in system security, Identity Federation and	07	CO3

		Authentication Operating System Security Concepts: Basic security features in Windows and Linux, user accounts and permissions, importance of secure system configuration, access control and authentication concepts, overview of access control models (DAC, MAC, RBAC – conceptual), user authentication methods including password-based authentication and Multi-Factor Authentication (MFA), and the role of identity management in system security, Identity Federation and Authentication Technologies-SAML, SCIM Identity Providers (IdP), Single Sign-On (SSO) Password Security and System Protection: Common password attacks (brute force and dictionary attacks), basic password protection techniques, importance of antivirus. Software Updates and Patch Management: Concept of vulnerabilities, importance of regular updates and patch management, and automated update mechanisms (conceptual overview). Introduction to Cloud Security: Introduction to cloud computing security, cloud service models (IaaS, PaaS, SaaS), cloud threats and risks, and Identity and Access Management (IAM) concepts. Shared Responsibility Model in cloud environments. **Self-Learning Topics:** Endpoint Detection and Response (EDR) and Introduction to DevSecOps.		
4	Web Application Security	Web application architecture overview, Session management and cookies, Browser security features and Content Security Policy (CSP) Common web vulnerabilities (based on OWASP Top 10):SQL Injection, Cross -Site Scripting (XSS), Cross-Site Request Forgery (CSRF), Broken Authentication (and basic access control issues). **Self-Learning Topics:** API Security Basics	04	CO4
5	Network Security	Network security overview and its types, Benefits and challenges in network security, Firewalls and their types, Intrusion Detection and Prevention Systems (IDS/IPS), IP Security, Common network attacks: DoS / DDoS, Man-in-the-Middle Attack ARP Spoofing. **Self-Learning Topics:** Zero Trust Network Access (ZTNA)	07	CO5

6	Cyber Laws & Ethics	Security Standards and Frameworks: Overview of major information security standards and frameworks including International Organization for Standardization ISO/IEC 27001, National Institute of Standards and Technology Cybersecurity Framework, U.S. Department of Health and Human Services HIPAA, PCI Security Standards Council PCI-DSS, DPDP act and Center for Internet Security CIS Controls (conceptual overview and applications). Cyber Laws – Fundamental Concepts: Need and role of cyber laws in digital systems, contract aspects in cyber law including e-contracts and digital transactions, security and privacy aspects in cyber law, and Intellectual Property Rights (IPR) in cyberspace covering software and digital content. **Self-Learning Topics:** Indian IT Act.Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	04	CO6
			Total Hours	39
Note: No questions will be asked in the end-semester exam from self-study topics. However, students are encouraged to explore these topics for a better understanding of the course.				

Text Books:

1. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson, 8th Edition.
2. Charles J. Brooks, Cybersecurity Essentials, Cisco Press, 2nd Edition.
3. Ross J. Anderson, Security Engineering: A Guide to Building Dependable Distributed Systems, Wiley, 3rd Edition.
4. Mark Stamp, Information Security: Principles and Practice, Wiley, 3rd Edition.

References:

1. Muthu Ramachandran, Guide to AI for Cybersecurity: Foundations and Technical Applications, Springer, 1st Edition.
2. Leslie F. Sikos, AI in Cybersecurity, Springer, 1st Edition.
3. Iqbal H. Sarker, AI- Driven Cybersecurity and Threat Intelligence, Springer, 1st Edition.
4. Mark Stamp, Information Security: Principles and Practice, Wiley, 3rd Edition.
5. Michael E. Whitman & Herbert J. Mattord, Principles of Information Security, Cengage Learning, 7th Edition.
6. Leslie F. Sikos, AI in Cybersecurity, Springer, 1st Edition.
7. Aboul Ella Hassanien, Artificial Intelligence for Cybersecurity, Springer, 1st Edition.
8. Muthu Ramachandran, Guide to AI for Cybersecurity: Foundations and Technical Applications, Springer, 1st Edition.
9. Farooq Ahmad, Machine Learning for Cybersecurity Cookbook, Packt Publishing, 2nd Edition.
10. Nina Godbole, Information Systems Security, Wiley, 4th Edition.
11. Atul Kahate, Cryptography and Network Security, McGraw-Hill Education, 4th Edition.

Online References:

Sr. No.	Website Name	URL
1	NIST Cybersecurity Framework	https://www.nist.gov/
2	OWASP	https://owasp.org/
3	CIS Security	https://www.cisecurity.org/
4	Cloud Security Alliance (CSA) – Industry-leading best practices, frameworks, and research on cloud security.	https://cloudsecurityalliance.org/
5	AI in Cybersecurity Research Hub – AI-based Threat Detection & Machine Learning Security	https://ai-cybersecurity.org/

Assessment:

Internal Assessment Test (IAT) for 20 marks each:

- IAT will consist of two compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I the remaining syllabus content must be covered in the IAT-II.

End Semester Theory Examination:

- Question Paper will comprise a total **of six questions each carrying 15 marks. Question 1** will be **compulsory** and should **cover the maximum contents of the syllabus.**
- **Remaining questions** will be **mixed in nature.** (Part (a) and part (b) of each question must be from different modules. For example, if Q2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules).
- A total of **four questions** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23451142	Advanced Database Technologies	03	---	---	03	---	---	03

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
23451142	Advanced Database Technologies	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To impart knowledge related to query processing and query optimization phases of a database management system.
2	To understand the basics of spatial, temporal and mobile databases and their applications.
3	To study the working principles of distributed databases.
4	To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.
5	To understand the process of data extraction, transformation and loading.
6	To learn the concept of emerging databases like NoSQL databases.

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

Sr. No.	Course Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Measure query costs and design alternate efficient paths for query execution.	L2
2	Have an introductory knowledge about the query processing in object-based databases and its usage.	L1
3	Design a distributed database system.	L2
4	Build a data Warehouse, process it through ETL and analyze using OLAP.	L3
5	Analyze data using OLAP operations so as to take strategic decisions.	L4
6	Use NoSQL database systems and manipulate the data associated with it.	L2

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Reviewing basic concepts of a Relational database, SQL concepts.	02	-
1	Query Processing and Optimization	Overview: Introduction, Query processing in DBMS, Steps of Query Processing, Measures of Query Cost Selection Operation, Sorting, Join Operation - Evaluation of Expressions - Query	06	CO1

		Optimization Overview: Goals of Query Optimization, Approaches of Query Optimization - Transformations Approaches of Query Optimization - Transformations of Relational Expression - Estimating Statistics of Expression Results, Choice of Evaluation Plans. **Self-Learning Topics:** Solve problems on query optimization.		
2	Advanced Database Systems	Object Oriented Databases, Need for Complex Data Types - The Object-Oriented Data Model, Object-Oriented Languages - Spatial Databases: Spatial Data Types, Spatial Relationships, Spatial Data Structures – Temporal Databases: Overview – Active Databases – Deductive Databases – Mobile Databases: Location and Handoff Management, Mobile Transaction Models - Multimedia Databases. **Self-Learning Topics:** Recursive Queries in SQL, Concurrency – Transaction Commit Protocols, Data Security concepts like Authentication, Authorization and encryption.	06	CO2
3	Distributed Databases	Introduction: Distributed Data Processing, Distributed Database System: Architecture, Types, Design Issues. Data Fragmentation, Allocation in distributed databases. **Self-Learning Topics:** Query Optimization in Distributed Databases.	04	CO3
4	Data Warehousing, Dimensional Modelling and OLAP	Data Warehouse Defined; Features of a Data Warehouse; Data Warehouse Architecture- Enterprise or centralized, federated and multi tired architectures; Data Warehouse and Data Marts; Data Warehousing Design Strategies, Data Modeling - Dimensional Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; Factless Fact Table, Updates To Dimension Tables, Primary Keys, Surrogate Keys & Foreign Keys. What is business intelligence, use of BI, Tools used in BI, Need for Online Analytical Processing; OLAP Operations in a cube: Roll-up, Drill-down, Slice, Dice, Pivot; OLAP Architectures: MOLAP, ROLAP, DOLAP and HOLAP. **Self-Learning Topics:** Explore life cycle of data warehouse development	09	CO4

5	ETL Process	Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Techniques of Data Loading. **Self-Learning Topics:** Find out various ETL tools for enterprise data management.	05	CO5
6	NoSQL Databases	NoSQL, CAP theorem, BASE property, NoSQL data architecture patterns: Key-value stores, Graph stores, Column family stores, Document stores. MongoDB Operation: Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding, Deployment – Using MongoDB with PHP / JAVA – Advanced MongoDB Features – Cassandra: Data Model, Key Space, Table Operations, CRUD Operations, CQL **Self-Learning Topics:** HIVE: Data types, Database Operations, Partitioning – HiveQL – OrientDB Graph database – OrientDB Features	07	CO6
		Total Hours	39	
Note: No questions will be asked in the end-semester exam from self-study topics. However, students are encouraged to explore these topics for a better understanding of the course.				

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw – Hill, 6th Edition.
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", PEARSON Education, 6th Edition.
3. Reema Thareja, "Data Warehousing", Oxford University Press, 1st Edition.
4. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw Hill, 3rd Edition.

References:

1. Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", Wiley India, 2nd Edition.
2. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling", Wiley India, 3rd Edition.
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.
5. Stefano Ceri, Giuseppe Pelagatti, "Distributed Databases: Principles and Systems", Tata McGraw-Hill Education, 2017

Online References:

Sr. No.	Website Name	URL
1	NPTEL	https://onlinecourses.nptel.ac.in/noc26_cs39/preview
2	NPTEL	https://onlinecourses.nptel.ac.in/noc25_cs131/preview

3	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs80/preview
4	Coursera	https://www.coursera.org/learn/introduction-to-databases

Assessment:

Internal Assessment Test (IAT) for 20 marks each:

- IAT will consist of two compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I the remaining syllabus content must be covered in the IAT-II.

End Semester Theory Examination:

- Question Paper will comprise a total **of six questions each carrying 15 marks. Question 1** will be **compulsory** and should **cover the maximum contents of the syllabus.**
- **Remaining questions** will be **mixed in nature.** (Part (a) and part (b) of each question must be from different modules. For example, if Q2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules).
- A total of **four questions** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2345115	DevOps Lab	---	02	---	---	01	---	01

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
2345115	DevOps Lab	---	---	---	---	---	25	---	25

Lab Objectives:

Sr. No.	Lab Objectives
1	To understand and implement the Agile Software Development Lifecycle using Jira and integrate it with DevOps tools for continuous project management.
2	To perform version control operations using Git and apply collaboration workflows for software development.
3	To design and configure Continuous Integration / Continuous Deployment pipelines using Jenkins, GitHub Actions, and containerization tools like Docker.
4	To automate provisioning, configuration, container orchestration and cloud resource management using Ansible, Kubernetes, Terraform, AWS Lambda.
5	To understand and implement automated monitoring, software testing using Selenium, PyTest, and JUnit, and to perform Static Application Security Testing (SAST) by integrating Jenkins with SonarQube within a CI/CD pipeline.
6	To integrate and implement a complete end-to-end DevOps pipeline through a mini project covering planning, building, testing, deployment, and monitoring.

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

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Apply Agile methodologies and use Jira for sprint planning, task tracking, and integrating with DevOps workflows.	L1, L2, L3
2	Use Git effectively for version control, source code management, and collaborative team development.	L1, L2, L3
3	Build and manage automated CI/CD pipelines for application development, testing, packaging, and deployment using Docker.	L1, L2, L3, L4, L5, L6
4	Create and integrate automated cloud infrastructure solutions using Ansible, Kubernetes and Terraform for provisioning and orchestration.	L1, L2, L3, L4, L5, L6
5	Create and integrate automated CI/CD workflows by automating test execution, monitoring processes, performing static code analysis, and embedding quality and security checks to ensure reliable, secure, and high-quality software delivery.	L1, L2, L3, L4, L5, L6

6	Develop and demonstrate an end-to-end DevOps pipeline mini-project integrating all stages of DevOps from code commit to deployment and monitoring.	L1, L2, L3, L4, L5, L6

Hardware & Software Requirements:

Hardware Requirement:	**Software Requirement:**
PC with following configuration 1. Inteli3 core or above 2. 4 GB RAM or above 3. 500 GB HDD 4. Network interface card	1. Linux /Windows Operating System 2. Virtual Box/ VMware /KVM

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Knowledge of Programming, Computer Networks, Web Programming.	02	-
1	Agile Project Management & DevOps Integration	**Contents:** Fundamentals of Agile and Scrum, Jira for Agile project lifecycle management, creating epics, user stories, tasks, sprints, Planning, assigning, tracking sprint progress, Integrating Jira with CI/CD pipelines, Agile reporting: Burndown chart, velocity chart. **Practical:** 1. To study and Implement Agile Software Project lifecycle using Jira / Trello. **Self-Learning Topics:** Kanban vs Scrum, Agile ceremonies: Sprint review, retrospective	02	LO1
2	Version Control & Collaboration using Git	**Contents:** Introduction to Git, GitHub, Basic operations: clone, commit, push, pull, Branching strategies and merging, Git workflows: Feature branching, Git Flow, Handling merge conflicts, GitHub Actions basics. **Practical:** 1. To perform version control operations using Git. **Self-Learning Topics:** GitHub Issues & Project Boards, Webhooks in GitHub	02	LO2
3	CI/CD Automation using Jenkins & Containerization using Docker	**Contents:** Understanding CI/CD and DevOps pipelines, Jenkins installation and job creation, GitHub webhook integration, CI pipeline: build → test → package, Docker fundamentals: images, containers, Creating Dockerfiles, Multi-service deployment using Docker Compose	04	LO3

		Practical: 1. To set up Continuous Integration Pipeline using Jenkins / GitHub Actions. 2. To containerize applications using Docker. **Self-Learning Topics:** Jenkinsfile (Pipeline as Code), Publishing images to Docker Hub/ECR		
4	Configuration Automation, Orchestration & Cloud Provisioning	**Contents:** Ansible automation: inventory, playbooks, roles, Provisioning and configuring applications, Kubernetes concepts: Pods, Deployment, Service, Ingress, Managing containerized apps in Kubernetes, terraform basics: providers, resources, state files, Automating cloud infrastructure creation. **Practical:** 1. To automate software provisioning and configuration using Ansible. 2. To deploy and manage containers using Kubernetes. 3. To provision cloud infrastructure AWS / GCP /Microsoft Azure using Terraform. **Self-Learning Topics:** Helm Charts, Terraform Cloud / Remote state management.	06	LO4
5	Automation Testing, Monitoring, Serverless Computing & DevSecOps Fundamentals	**Contents:** Automation Testing Tools- Selenium / PyTest / Junit, Monitoring tools: Prometheus, Grafana, Nagios, Exporters, dashboards, alerting, AWS Lambda fundamentals and deployment. DevSecOps Fundamentals, Static Application security Testing (SAST), Sonarqube. **Practical:** 1. To Test Automation using Selenium / PyTest / Junit 2. To understand Static Application security Testing (SAST) process and integrate Jenkins to SonarQube for static Code analysis. 3. To implement monitoring using Prometheus / Grafana / Nagios. **Self-Learning Topics:** CloudWatch metrics for serverless apps.	06	LO5
6	End-to-End DevOps Pipeline	**Contents:** Designing a full DevOps automation pipeline, Integrating Agile → Git → CI → CD → Containers → Kubernetes → Monitoring, Cloud deployment using AWS/GCP/Azure, Pipeline	04	LO6

		security basics (DevSecOps), Documentation, demonstration & evaluation. **Practical:** 1. To design and implement an end-to-end DevOps pipeline. **Self-Learning Topics:** Industry-grade DevOps architecture, Cost-efficient cloud deployment strategies		
		Total	**26**	

Text Books:

1. Kim, Gene, The DevOps handbook: how to create world-class agility, reliability, and security in technology organizations, It Revolution Press, 2016.
2. Robert C. Martin, "Agile Software Development, Principles, Patterns and Practices", Prentice Hall, First International Edition.
3. Deepak Gaikwad, Viral Thakkar. DevOps Tools from Practitioner's Viewpoint, Wiley, 2020.

References:

1. Sricharan Vadapalli, DevOps: Continuous Delivery, Integration, and Deployment with DevOps: Dive., Packt, 2018

Online References:

Sr. No.	Website Name	URL
1	devops.com	https://devops.com/most-popular-open-source-devops-tools/
2	Github.com	https://github.com/bregman-arie/devops-resources?
3	Github.io	https://seblum.github.io/mlops-engineering-book/?

Assessment:

- **Term Work:** Term Work shall consist of at least 10-12 Practicals based on the above list. In addition, Term Work Journal must include at least 02 Assignments.
- **Term Work Marks:** 25 Marks (Total) = 15 Marks (Experiments) + 05 Marks (Assignments) + 05 Marks (Attendance)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2345116	AI & ML Lab	---	02	---	---	01	---	01

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
2345116	AI & ML Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	Implement basic AI search and problem-solving algorithms.
2	Develop supervised machine learning models using real datasets.
3	Apply unsupervised learning techniques for clustering and pattern discovery.
4	Perform data preprocessing and feature engineering.
5	Evaluate and compare machine learning models using performance metrics.
6	Deploy basic ML models for practical real-world applications.

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

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Design and implement search algorithms for AI problems.	L6
2	Build regression and classification models using standard ML libraries.	L6
3	Apply clustering and dimensionality reduction techniques on datasets.	L3
4	Perform model validation and interpret evaluation metrics.	L6
5	Analyze model performance and optimize parameters.	L4
6	Develop mini-projects integrating AI/ML concepts for real-world applications.	L6

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
Intel Core i5 8th Gen+, 8 GB RAM minimum (16 GB recommended), 40 GB free storage	Development: Jupyter Notebook / JupyterLab, VS Code with Python extension

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Basics of Python Programming. Fundamentals of Data Structures and Algorithms. Elementary Statistics and Linear Algebra. Basic Knowledge of Probability and Data Handling.	02	-

1	Introduction to Artificial Intelligence	**Contents:** Installation and configuration of Python programming environment for AI/ML development using Anaconda, Jupyter Notebook, and Google Colab. Setup of essential libraries such as NumPy, Pandas, Matplotlib, Scikit-learn, TensorFlow/Keras. **Practical:** 1. Python & ML Environment Setup. **Self-Learning Topics:** Anaconda vs pip environments; Jupyter Notebook & Colab features; ML library functions (NumPy, Pandas, Matplotlib, Scikit-learn); Virtual environments & reproducibility**.**	02	LO1
2	Problem Solving & Search Strategies	**Contents:** Uninformed Search Strategies: Breadth First Search, Depth First Search, Uniform Cost Search. Informed Search Strategies: Greedy Best First Search, A* Algorithm. Heuristic Functions. **Practical:** 1. Implementation of Breadth First Search & Depth First Search. Performance comparison. 2. Implementation of A* algorithm. Heuristic function design. **Self-Learning Topics:** Heuristic Design and Optimization Techniques. Game Tree Search and Multi-Agent Systems. Metaheuristic and Evolutionary Search Algorithms	04	LO1
3	Supervised Learning	**Contents:** Linear Regression, Multiple Regression. Classification: Logistic Regression, k-Nearest Neighbors (k-NN), Decision Trees, Random Forest, Support Vector Machine (SVM). **Practical:** 1. Implementation of Simple Linear Regression & Multiple Linear Regression. 2. To implement Binary classification problem & Confusion matrix generation. 3. To implement k-Nearest Neighbors (k-NN). Distance metrics & Model training and testing. 4. To implement Decision Tree Classifier. Calculate Gini Index and Entropy. Model training and visualization. 5. To implement Support Vector Machine (SVM). Linear and Non-linear SVM. Kernel functions & Decision boundary visualization.	08	LO2

		Self-Learning Topics: Hyperparameter Optimization, Cross-Validation Techniques. Imbalanced Data Handling (SMOTE).		
4	Unsupervised Learning	**Contents:** K-Means Clustering, Hierarchical Clustering. Association Rule Mining. Dimensionality Reduction: Principal Component Analysis (PCA). **Practical:** 1. Implementation of K-Means Clustering with Cluster formation using Elbow method. 2. Implementation of Principal Component Analysis (PCA). Dimensionality reduction & Variance analysis. **Self-Learning Topics:** DBSCAN, Independent Component Analysis (ICA). Clustering Validation and Ensemble Clustering.	04	LO2, LO3
5	Model Evaluation & Optimization	**Contents:** Training, Validation, Testing. Cross Validation Techniques. Confusion Matrix. Accuracy, Precision, Recall, F1-Score. ROC Curve and AUC. Overfitting and Underfitting. Hyperparameter Tuning and Model Optimization Techniques. **Practical:** 1. To implement Model Validation Techniques. Train-Test Split. Cross Validation. ROC Curve and AUC. **Self-Learning Topics:** Advanced Performance Metrics for Classification and Regression. Handling Imbalanced and Noisy Datasets.	02	LO4
6	AI/ML Applications & Mini Project	**Contents:** AI Ethics and Responsible AI. Bias and Fairness in AI. Transparency & Accountability. Introduction to Deep Learning. AI in Healthcare, Finance, Smart Cities. **Practical:** 1. **Mini Project:** Design and implementation of a complete AI/ML solution involving data preprocessing, model development, evaluation, and result interpretation for a real-world problem. Integration of suitable algorithms, visualization techniques, and performance analysis in a practical application setting.	04	LO5, LO6

		Self-Learning Topics: Autonomous Systems, Algorithm Trading, AutoML and Neural Architecture Search.		
		Total	**26**	

Text Books:

1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 4th Edition.
2. Nils J. Nilsson, Principles of Artificial Intelligence, Morgan Kaufmann, 1st Edition.
3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly, 3rd Edition.
4. Sebastian Raschka, Vahid Mirjalili, Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn and TensorFlow, Packt Publishing, 3rd Edition.

References:

1. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson, 6th Edition.
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI (Prentice Hall of India), 1st Edition.
3. Emmanuel Ameisen, Building Machine Learning Powered Applications, O'Reilly, 2020.
4. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

Online References:

Sr. No.	Website Name	URL
1	AIMA Python code	https://github.com/aimacode/aima-python
2	Stanford CS221 AI (problem sets align with practicals)	https://cs221.stanford.edu
3	MIT OpenCourseWare 6.034 AI	https://ocw.mit.edu/courses/6-034-artificial-intelligence
4	Google Machine Learning Crash Course.	https://developers.google.com/machine-learning/crash-course
5	Kaggle – Free ML notebooks, datasets, competitions	https://www.kaggle.com/
6	Coursera – Machine Learning and AI courses	https://www.coursera.org/

Assessment:

- **Term Work:** Term Work shall consist of at least 10-12 Practicals based on the above list. In addition, Term Work Journal must include at least 02 Assignments.
- **Term Work Marks:** 25 Marks (Total) = 15 Marks (Experiments) + 05 Marks (Assignments) + 05 Marks (Attendance)
- **Oral Exam:** An Oral Exam will be held based on the above list of Practicals.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2345117	Web Lab	---	02	---	---	01	---	01

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
2345117	Web Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To expose students to JavaScript to make web pages interactive.
2	To orient students to React for developing front end applications.
3	To orient students to React for developing front end applications.
4	To expose the fundamentals of NoSQL databases using MongoDB.
5	To orient students to Node.js for developing backend applications.
6	To orient students to Express.js and its role in Node.js web application development.

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

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Utilize JavaScript to develop interactive web pages.	L3
2	Construct front end applications using React	L3
3	Construct front end applications using components of React	L3
4	Utilize MongoDB with back-end applications using Node.js/Express	L3
5	Construct back end applications using Node.js	L3
6	Construct web applications using Node.js and its applications using Express.	L3

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
Intel i5/i7 processor, 8 GB or more RAM, A stable internet connection for installing packages, accessing, and deploying applications. The system should support Windows 10/11 or Linux operating systems	Visual Studio Code (VS Code), Nodejs, NPM, MongoDB, Postman

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Responsive web application using HTML5 & CSS3.	02	-
1	Introduction to JavaScript	**Contents:** Introduction to JavaScript, Constants, JS variables, JS Variable scopes, JS Data Types, JS Function, JS Array, Introduction to ES6, Difference	04	LO1

		between ES5 and ES6, Events, Arrow functions, Client-side Form validation using JavaScript, using properties and methods of built -in- objects. **Practical:** 1. To design registration form using bootstrap and perform Validations with JavaScript. 2. To design a web application to demonstrate various functions in JavaScript. (Arrow Function/Anonymous Functions). 3. To develop and demonstrate JavaScript with POP-UP boxes and functions for the following problems: a) Input: Click on Display Date button using on-click () function. Output: Display date in the textbox b) Input: A number n obtained using prompt. Output: Factorial of n number using alert c) Input: A number n obtained using prompt. Output: A multiplication table of numbers from 1 to 10 of n using alert d) Input: A number n obtained using prompt and add another number using confirm. Output: Sum of the entire n numbers using alert **Self-Learning Topics:** Asynchronous JavaScript, JSON		
2	React Basics	**Contents:** Introduction to MERN stack application. introduction to React, Installation, installing libraries, Folder and file structure, Components, Component life-cycle, State and Props, React Router and Single page applications, UI design, Forms, Events, Animations, Best practices **Practical:** 1. Installation React JSX & Develop web application using Functional components in React JS.: 2. To demonstrate the use of Props and States in ReactJs application. **Self-Learning Topics:** React vs Angular vs Vue	04	LO2
3	Advanced React	**Contents:** Functional components- Refs, use effects, Hooks, Flow architecture, Model-View Controller framework, Flux, Bundling the application. Web pack.	04	LO3

		Practical: 1. To demonstrate the use of Props and States in ReactJs application. 2. To create a Single Page Application using Advanced React. **Self-Learning Topics:** React Native		
4	MongoDB	**Contents:** Understanding MongoDB, MongoDB Data Types, Administering User Accounts, Configuring Access Control, CRUD Operations, Using Mongoose for Structured Schema and Validation. Using Express and Mongoose to interact with MongoDB, Web Security Basics: SQL Injection, XSS **Practical:** 1. Installation & Setup MongoDB. Create collections and Documents. 2. To perform CRUD operations using MongoDB 3. To develop a Node.js application using Express.js and Mongoose to connect with MongoDB. **Self-Learning Topics:** Query optimization	04	LO4
5	Node.js	**Contents:** Environment setup, First app, Asynchronous programming, Callback concept, Event loops, REPL, Event emitter, Networking module, Buffers, Streams, File system, Web module. **Practical:** 1. Installation of Node.js, Verify installation using node -v and npm -v 2. To write and execute a simple "Hello World" program 3. To create and run a basic HTTP server 4. To perform arithmetic operations in Node REPL 5. To demonstration of File system, Buffers and Streams 6. To develop web applications using Callbacks, Event loops using Node.Js. **Self-Learning Topics:** Next.Js framework	04	LO5
6	Express	**Contents:** Introduction, Express router, REST API, Generator, Authentication, sessions, Integrating with React. **Practical:**	04	LO6

		1. To build REST API using Express and Test APIs using Postman 2. Connecting Backend with React. Create React application, Fetch data from back-end using Fetch /Axios, Display dynamic data in UI. 3. Deployment of a MERN Stack Web Application on a Cloud Platform. **Self-Learning Topics:** FastAPI		
		Total	**26**	

Text Books:

1. DT Editorial Services, HTML 5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery), Dreamtech Press, 2nd Edition, 2016
2. Alex Banks and Eve Porcello, Learning React Functional Web Development with React and Redux, O'Reilly, 1st Edition, 2017
3. Andrew Mead, Learning Node.js Development, Packt Publishing, 2018
4. Ethan Brown, Web Development with Node and Express, O'Reilly, 2nd Edition, 2019

References:

1. Vasan Subramanian, Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Apress, 2nd edition, 2019
2. David Hows, Peter Membrey, Eelco Plugge, Tim Hawkins, MongoDB: The Definitive Guide, O'Reilly, 3rd Edition, 2015

Online References:

Sr. No.	Website Name	URL
1	https://react.dev	https://react.dev/learn/installation
2	https://react.dev	https://react.dev/learn/creating-a-react-app
3	https://www.coursera.org/	https://www.coursera.org/specializations/packt-mern-stack-front-to-back-full-stack-react-redux-and-node-js

Assessment:

- **Term Work:** Term Work shall consist of at least 10-12 Practicals based on the above list. In addition, Term Work Journal must include at least 02 Assignments.
- **Term Work Marks:** 25 Marks (Total) = 15 Marks (Experiments) + 05 Marks (Assignments) + 05 Marks (Attendance)
- **Oral Exam:** An Oral Exam will be held based on the above list of Practicals.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23451181	Cyber Security Lab	---	02	---	---	01	---	01

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
23451181	Cyber Security Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To provide hands-on experience in setting up a cyber security laboratory environment and understanding basic cyber security threats.
2	To develop practical knowledge of cryptographic techniques and tools used for secure communication.
3	To implement system and cloud security mechanisms such as authentication, access control, and vulnerability scanning.
4	To demonstrate common web application vulnerabilities and perform web security testing using standard tools.
5	To implement network security mechanisms including packet analysis, firewall configuration, and intrusion detection systems.
6	To perform security assessment for identifying cyber security threats and mitigation mechanisms while adhering to ethical security practices.

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

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Apply fundamental cyber security concepts to set up a virtual cyber security laboratory environment and identify basic cyber threats.	L3
2	Apply cryptographic tools and techniques to perform encryption, decryption, and cryptanalysis for secure communication.	L3
3	Analyze system and cloud security mechanisms including authentication, access control, and vulnerability scanning in a controlled environment.	L4
4	Analyze web application vulnerabilities using standard web security testing tools.	L4
5	Analyze network security mechanisms and their implementation in a controlled environment.	L4
6	Apply security assessment techniques to identify cyber security threats and mitigation mechanisms in a controlled environment.	L3

Hardware & Software Requirements:

Hardware Requirement:	**Software Requirement:**
Computer Systems with minimum 8 GB RAM (16 GB recommended for virtual labs), Processor: Intel i5 / Ryzen 5 or higher Internet Connectivity (for updates and security repositories), LAN Network Connectivity.	**Operating Systems**: Windows 10/11 or Linux (Ubuntu) **Virtualization Software**: Oracle VirtualBox or VMware Workstation Player **Linux Security Environment**: Kali Linux (Virtual Machine) along with a target operating system such as **Ubuntu Linux / Metasploitable / Windows** for performing security testing in a controlled environment **Cryptography and Cryptanalysis Tools**- Crypttool, OpenSSL **Network Packet Analyzer:** Wireshark, Tcpdump, Network Scanning Tool: Nmap **Cloud Platform Account (any one)**: Amazon Web Services (AWS Free Tier), Microsoft Azure (Azure for Students), Google Cloud Platform (gcp cloud services) **Access Control Mechanism and Network Security Tools**-SQUID, iptables/ UFW (Linux-firewall configuration), SNORT Intrusion Detection System, Windows Defender Firewall (basic firewall configuration), IPsec utilities for secure communication implementation **Web and Vulnerability Testing Tools**- DVWA (Damn Vulnerable Web Application), OWASP Juice Shop, OWASP ZAP OpenVAS / Nikto (basic vulnerability scanning) **Social Engineering Testing Tools**-SET Toolkit (Social Engineering Toolkit in Kali Linux – controlled lab usage)

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Linux operating system, Computer Network	02	-
1	Introduction to Cyber Security & Threats	**Contents:** Cyber security fundamentals, cyber threats, social engineering techniques, and virtual lab environment. **Practical:** 1. Installation and setup of a virtual cyber security lab environment. 2. Simulation of social engineering attacks using the Social-Engineer Toolkit in a controlled Kali Linux environment.	04	LO1

		Self-Learning Topics: Fundamentals of Zero Trust Security, Steganography.		
2	Cryptography & Secure Communication	**Contents:** Classical and modern cryptography concepts and cryptanalysis fundamentals. **Practical:** 1. To perform basic cryptanalysis and security evaluation of encryption techniques using CrypTool and visualization features. 2. Implementation of basic cryptographic operations using OpenSSL for encryption, decryption, and message digest generation. **Self-Learning Topics:** Blockchain security basics.	02	LO2
3	System Security and Cloud Security	**Contents:** Authentication methods, password security, cloud access control, vulnerability assessment concepts. **Practical:** 1. Implementation of cloud security using cloud storage access control and Multi-Factor Authentication (MFA) 2. Implementation of identity and access control in a cloud storage environment through secure file sharing and permission management. 3. To perform vulnerability scanning and basic analysis of a target system using open-source security tools in a virtual environment. 4. Demonstration of password strength testing and password cracking tools. **Self-Learning Topics:** Endpoint Detection and Response (EDR), DevSecOps fundamentals.	06	LO3
4	Web Application Security	**Contents:** Web application architecture and OWASP Top-10 vulnerabilities. **Practical:** 1. Demonstration of SQL Injection and Blind SQL Injection attack. 2. Demonstration of Cross-Site Scripting (XSS) vulnerability. 3. To explore Web Application Vulnerability Scanning using OWASP Foundation Tools (e.g., OWASP ZAP / Juice Shop). 4. Implementation and Analysis of Web Access Control using Access Control Lists (ACLs) & Log Analysis of Squid Proxy.	04	LO4

		Self-Learning Topics: API Security basics.		
5	Network Security	**Contents:** Network attacks, packet analysis, firewall configuration, intrusion detection systems, and secure communication protocols. **Practical:** 1. To study IP Spoofing and ARP Spoofing over a Local Area Network in Controlled environment. 2. To explore Advanced Packet Capturing and Protocol Analysis using Tcpdump and Wireshark for Network Security Monitoring in promiscuous mode. 3. To perform network discovery and security assessment using network scanning tools. 4. Implementation and Evaluation of Network Access Control Mechanisms using Firewall Policies, and Intrusion Detection Systems. 5. Implementation and Evaluation of Secure Network Communication using IPsec for Confidentiality, Data Integrity, Authentication, and Secure Tunnelling. 6. Evaluation of Defence and Mitigation Mechanisms against DoS Attacks Generated using hping3 through Firewall Rules, Intrusion Detection Systems, and Network Monitoring. **Self-Learning Topics:** Zero Trust Network Access (ZTNA).	06	LO5
6	Cyber Laws & Ethics	**Contents:** Cyber security standards, ethical practices, and legal aspects of cyber security investigations. **Practical:** 1. To study and analysis of vulnerability assessment reports and security compliance practices. **Self-Learning Topics:** Information Technology Act 2000, IT Act 2008 Amendments, and Digital Personal Data Protection Act 2023.	02	LO6
		Total	**26**	

Text Books:

1. Michael T. Simpson, Nicholas D. Antill, Robert S. Wilson, Hands-On Ethical Hacking and Network Defense, Cengage Learning India, 4th Edition.
2. Bryan Sullivan, Vincent Liu, Web Application Security: A Beginner's Guide, McGraw-Hill Education, 3rd Edition.
3. Sarhan M. Musa, Network Security and Cryptography, Mercury Learning & Information, 1st Edition.

4. Paul C. van Oorschot, Computer Security and the Internet: Tools and Jewels from Malware to Bitcoin, Springer Nature, 1st Edition.
5. Behrouz A. Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, McGraw-Hill Education, 4th Edition.
6. William Stallings, Cryptography and Network Security, Pearson Education, 7th Edition.
7. Atul Kahate, Cryptography and Network Security, McGraw-Hill Education, 4th Edition.

References:

1. Matt Walker, CEH Certified Ethical Hacker All-in-One Exam Guide, McGraw-Hill Education, 5th Edition.
2. Daniel Regalado, Ryan Linn, John Wagnon, Security Architectures and Implementation in Cloud Computing with CDCC 2.0, CRC Press, 1st Edition.
3. Peter Kim, The Hacker Playbook 3: Practical Guide to Penetration Testing, Secure Planet LLC, 3rd Edition.
4. Patrick Engebretson, The Basics of Hacking and Penetration Testing, Syngress, 3rd Edition.
5. Eric Cole, Network Security Bible, Wiley, 2nd Edition.
6. Johannes Ullrich, Web Application Security: A Complete Guide, Apress, 1st Edition.

Online References:

Sr. No.	Website Name	URL
1	OWASP Foundation	https://owasp.org
2	National Institute of Standards and Technology Cybersecurity Publications	https://nvlpubs.nist.gov
3	Kali Linux Documentation	https://www.kali.org/

Assessment:

- **Term Work:** Term Work shall consist of at least 10-12 Practicals based on the above list. In addition, Term Work Journal must include at least 02 Assignments.
- **Term Work Marks:** 25 Marks (Total) = 15 Marks (Experiments) + 05 Marks (Assignments) + 05 Marks (Attendance)
- **Oral Exam:** An Oral Exam will be held based on the above list of Practicals.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23451182	Advanced Database Technologies Lab	---	02	---	---	01	---	01

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
23451182	Advanced Database Technologies Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To learn the fundamental concepts of Open-Source Database Management Systems (DBMS).
2	To understand how spatial and temporal data are stored and retrieved in databases.
3	To explore the use of open-source databases in the development of mobile applications.
4	To study the techniques used to distribute database tables across multiple systems.
5	To understand the methods for storing and retrieving objects in an object-oriented database.
6	To learn how data is stored and retrieved in a NoSQL database environment.

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

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxonomy
1	Explain the basic concepts of Open-Source Database Management Systems (DBMS).	L2
2	Demonstrate the process of storing and retrieving spatial and temporal data in databases.	L2
3	Apply open-source databases in developing backend support for mobile applications	L3
4	Analyze the techniques used for distributing database tables across multiple systems.	L4
5	Implement methods for storing and retrieving objects in object-oriented databases.	L3
6	Use NoSQL databases to store, query, and retrieve data effectively.	L3

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
Computer System with minimum Intel i3 / equivalent processor, 4 GB RAM or higher. 500 GB Hard Disk or higher.	MYSQL, MongoDB

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Reviewing basic concepts of a Relational database, SQL concepts (DDL, DML, and DCL).	02	-
1	Query Processing and Optimization	**Contents:** Steps of Query Processing, Measures of Query Cost, Selection/Join Operations, Evaluation of Expressions, Transformation of Relational Expressions, Choice of Evaluation Plans. **Practical:** 1. Implementation of MySQL Database Creation, Table Creation, and Complex Querying to analyze execution plans. **Self-Learning Topics:** Solve problems on query optimization cost estimation.	02	LO1
2	Advanced Database Systems	**Contents:** Object-Oriented Data Models, Spatial Databases (Relationships/Structures), Temporal Databases, Mobile Databases (Location/Handoff Management). **Practical:** 1. Implementation of Spatial data storage and retrieval in MySQL 2. Implementation of temporal data storage and retrieval in MySQL. 3. Implementation of object storage and retrieval in MySQL. **Self-Learning Topics:** Recursive Queries in SQL, Concurrency & Transaction Commit Protocols.	06	LO2
3	Distributed Databases	**Contents:** Distributed Data Processing, Architecture, Fragmentation, and Allocation in distributed databases. **Practical:** 1. Implementation of MySQL Replication and Fragmented Data Management in Distributed Databases. 2. Implementation of Mobile Database Query Processing using open-source DB (MongoDB/MySQL) **Self-Learning Topics:** Query Optimization in Distributed Databases.	04	LO3

4	Data Warehousing & OLAP	**Contents:** Warehouse Architecture (Multi-tiered), Dimensional Modelling, Star and Snowflake Schemas, Fact and Dimension Tables, BI Tools, OLAP Operations (Roll-up, Drill-down, Slice, Dice). **Practical:** 1. To design a Star/Snowflake schema for a specific business case (e.g., Sales/Finance) and perform OLAP operations. **Self-Learning Topics:** Explore the life cycle of data warehouse development.	04	LO4
5	ETL Process	**Contents:** Challenges in ETL, Data Extraction (Immediate vs. Deferred), Data Transformation tasks, Techniques of Data Loading. **Practical:** 1. To implement a basic ETL pipeline: Extracting data from CSV/SQL, transforming types, and loading into a target schema. **Self-Learning Topics:** Find out various ETL tools (Talend, Informatica) for enterprise data management.	02	LO5
6	NoSQL Databases	**Contents:** CAP theorem, BASE property, Data Architecture Patterns (Key-value, Graph, Column family, Document). MongoDB & Cassandra Operations. **Practical:** 1. Implementation of MongoDB Exercises: CRUD operations, Indexing, Sharding, and Deployment. 2. Implementation of Cassandra Exercises: Table Operations, CRUD Operations, and CQL Types. **Self-Learning Topics:** HIVE Database Operations and Partitioning.	06	LO6
		Total	**26**	

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan," Database System Concepts", McGraw – Hill, 6th Edition.
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", PEARSON Education, 6th Edition.
3. Theraja Reema, "Data Warehousing", Oxford University Press, 1st Edition.
4. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw Hill, 3rd Edition.

References:

1. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition.
2. Peter Rob, Carlos Coronel, “Database Systems Design, Implementation and Management”, Thomson Learning, 9th Edition.

Online References:

Sr. No.	Website Name	URL
1	Swayam NPTEL	https://www.nptel.ac.in
2	Coursera	https://www.coursera.org

Assessment:

- **Term Work:** Term Work shall consist of at least 10-12 Practicals based on the above list. In addition, Term Work Journal must include at least 02 Assignments.
- **Term Work Marks:** 25 Marks (Total) = 15 Marks (Experiments) + 05 Marks (Assignments) + 05 Marks (Attendance)
- **Oral Exam:** An Oral Exam will be held based on the above list of Practicals.

IKS

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2345511	Indian Knowledge System – As Per Program common to all Program -Group A	--	2*+2	--	--	2	--	2

Course Code	Course Name	Theory					Term Work	Practical / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II					
2345511	Indian Knowledge System – As Per Program common to all Program - Group A	--	--	--	--	--	50	--	50

*** Two hours of practical class to be conducted for full class as demo/discussion.**

Rationale:

The proposed IKS modules contextualize core engineering principles across Computer, IT, EXTC, Electronics, and Electrical engineering—within scientifically analyzable Indian knowledge traditions. By mapping indigenous practices to modern technical frameworks, students critically examine foundational engineering concepts through interdisciplinary and systems-based perspectives. This approach strengthens conceptual understanding, promotes analytical reinterpretation of traditional knowledge using contemporary tools, and aligns engineering education with culturally rooted yet technically rigorous inquiry.

Prerequisite: --

Course Objectives:

1. Provide foundational knowledge of Indian acoustic practices.
2. To Understand Ancient Indian use of renewable energy.
3. Introduce Sanskrit grammar in simple language, with special attention to its rule-based structure.
4. Learners should be able to explain key contributions of ancient Indian mathematics in simple language.
5. Understand how Indian traditions of logic, language, knowledge organization, design thinking, governance, sustainability, and wellbeing can support modern IT solutions.
6. Understand the basic structure of Sanskrit grammar and relate selected grammatical ideas to computational modules used in information technology.

Course Outcomes:

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

1. Analyze traditional Indian acoustic practices and interpret their relevance to frequency analysis.
2. Apply the traditional knowledge to modern energy solutions and sustainable engineering.

3. Apply Indian Knowledge Systems in linguistics, Sanskrit-based NLP, traditional number systems, measurement practices, and ancient rainfall prediction techniques using calendars, nakshatras, and natural indicators.
4. Apply basic modular arithmetic, pattern recognition, and place-value ideas to simple IT examples such as coding, data representation, and checksums.
5. Apply basic concepts of Indian Knowledge Systems such as logic, language, knowledge organization, ethics, sustainability, and responsible decision-making to design simple technology-based solutions like apps, chatbots, databases, or awareness tools.
6. Apply basic Sanskrit grammar concepts and Pāṇinian rule-based principles to understand formal grammar, algorithms, and simple computational language processing applications in IT.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	-	-	-
I	**Acoustic Science in Vedic Chanting and Indian Music**	I.1 Concept of Nāda (Sound) and Shruti • Physical interpretation: frequency, pitch, harmonic content • Shruti system (22 microtones) and frequency discrimination I.2 Resonance and Architectural Acoustics • Temple architecture and echo control • Natural acoustic amplification • Relation to reverberation time and standing waves I.3 Structured Sound Encoding in Vedic Recitation • Pada, Krama, Ghana patha recitation methods • Built-in redundancy → error detection and correction • Parallel to digital communication redundancy schemes **Self-Study:** Study of sounds and analysis in time and frequency domains.	10	CO1
II	**Tradition**	1. Introduction to IKS in renewable energy 2. Ancient Indian use of renewable energy a) Solar Energy: Solar Architecture, Solar Heating Systems	10	CO2

		b) Wind Energy: Ancient Windmills, Wind-Powered Water Lifting c) Water (Hydro) Energy: Ancient Watermills, Irrigation Systems d) Bioenergy: Biomass Fuel, Bioenergy Production 3. Integration of ancient Traditional knowledge of renewable energy with Modern Technologies. **Students shall study the following to understand the use of ancient technologies in Renewable Energy:** • Gujarat Windmills • Watermills in the Indus Valley • Konark Sun Temple		
III	**Linguistics, Number Systems, and rainfall Prediction**	Linguistics: • Components of language • Panini's work on Sanskrit grammar • Role of Sanskrit in Natural Language Processing Number System and Units of Measurement • Number system in India- Historical Evidence • Decimal System • Unique Approaches to represent Numbers- Katapayadi System • Pingala and the Binary System Ancient Indian techniques for predicting Rainfall • Introduction • Elements of the Indian Calendar • Panchang and Nakshtras • Non-bio indicators and Bio indicators **Self-Learning:** • An Ecosystem for Sanskrit Language Processing	10	CO3

		• Salient Features of the Indian Numeral System • Salient Features of the Indian Numeral System • Measurement for Time Distance and Weight • Measurement of Time- An Illustration from Purana		
IV	**Mathematics Foundations in Ancient India and Its Relevance to Information Technology**	4.1 Historical context and number ideas: Indian knowledge systems, the development of numeration, zero as placeholder and number, decimal place value. 4.2 Major contributors and procedural mathematics: Aryabhata, Brahmagupta, Bhaskara II, and examples of rule-based or sutra-like calculation methods in plain language. 4.3 Algorithmic thinking and computation: Historical mathematical procedures connect to algorithms, flowcharts, decomposition, and computational logic. 4.4 Modular arithmetic, binary-style ideas, and data representation: Clock arithmetic, remainders, cyclic reasoning, two-state representation, bits, bytes, and simple binary conversion. 4.5 Relevance to IT and synthesis: Coding, checksums/parity, simple cryptography idea, data representation, and how ancient mathematical thinking supports modern IT problem-solving. **Self-Learning Topics and Activities:** • Zero and place value in daily life • Algorithmic thinking • Modular arithmetic • Binary representation	10	CO4
V	**Indian Logic and its applications in Information Technology**	5.1 Introduction to IKS and its relevance to contemporary technology. 5.2 Indian logic, language, and computation with simple examples.	10	CO5

		5.3 Knowledge organization, data, and decision-making. 5.4 Ethics, society, sustainability, and responsible digital systems. 5.5 Mini activity where students design a small app, chatbot, database, or awareness tool using one IKS principle. **Self-Learning Topics and Activities:** • Basic ideas of Nyaya logic: observation, inference, debate, and evidence. • Introduction to Paninian grammar and why structured language matters in NLP. • Traditional knowledge classification and its connection with databases and knowledge graphs. • Technology for Indian languages, heritage preservation, digital museums, and public services. • Design thinking activity: identify a local problem and propose an IKS-inspired IT solution.		
VI	**Sanskrit Grammar and Computational Modules**	6.1 Introduction to Indian Knowledge Systems, Sanskrit as structured language, and relevance to IT. 6.2 Basic Sanskrit grammar concepts: sounds, words, roots, suffixes, sandhi, and sentence structure. 6.3 Pāṇinian grammar as a rule-based system; relation with algorithms and formal grammar. 6.4 Computational modules: tokenization, morphology, parsing, language rules, and NLP examples. 6.5 Demonstration of Sanskrit digital tools, reflection activity, and discussion on interdisciplinary applications. **Self-Learning Topics and Activities:** • Basic Sanskrit alphabet and sound classification. • Simple sandhi examples and word joining rules.	10	CO6

		• Introduction to Pāṇini and the Aṣṭādhyāyī. • Dhātu, pratyaya, pada, and kāraka in simple terms. • Basics of natural language processing: tokenization, morphology, and parsing. • Exploration of Sanskrit digital dictionaries and Sanskrit reader tools. • Comparison of grammar rules and computer program rules.		

Text and Reference Books or Articles:

1. Acoustics of Chants, Conch-Shells, Bells & Gongs in Worship Spaces. Available: https://www.academia.edu/38208102/Acoustics_of_Chants_pdf?utm_source=chatgpt.com

2. V. R. S. Nalluri, V. J. K. S. Sonti, and G. Sundari, "Analysis of frequency dependent Vedic chanting and its influence on neural activity of humans," International Journal of Reconfigurable and Embedded Systems, vol. 12, no. 2, pp. 230–239, Jul. 2023, doi: 10.11591/ijres.v12.i2.pp230-239.

3. The Garland Encyclopedia of World Music: South Asia. Available: https://api.pageplace.de/preview/DT0400.9781351544399_A30892028/preview-9781351544399_A30892028.pdf?utm_source=chatgpt.com

4. J. Pattanayak, Y. Belur, and J. Ilavarasu, "Acoustic and psychological effects of Omkar chanting in novice Indian adults: A quasi-experimental study," Journal of Clinical and Diagnostic Research, 2025, doi: 10.7860/JCDR/2025/77365.21111. Available: https://www.jcdr.net/articles/PDF/21111/77365_CE%5BRa1%5D_F%28IS%29_QC%28PS_SS%29_PF1%28AB_IS%29_redo_PFA%28IS%29_PB%28AB_IS%29_PN%28IS%29.pdf?utm_source=chatgpt. com

5. "Indian Knowledge System: Integrating Heritage with Engineering" by Gagan Bansa, Deep Science Publishing; ISBN: 978-93-49307-77-3 E-ISBN: 978-93-49307-29-2;

6. The textbook of Indian Knowledge Systems, University of Mumbai, ISBN: 978-93-5915-553-1

7. Introduction to Indian Knowledge System: Concepts and Applications, Mahadevan, B., Bhat, Vinayak Rajat, Nagendra Pavana R.N. by PHI Learning Pvt Ltd. Delhi, ISBN: 978-93-91818-20-3

8. Echoes of the Monsoon: Ancient Indian techniques for predicting Rainfall, Janak Joshi, Kandarp

9. Parmar, Lakhan Jain, Sharmistha Bhowmik and Bindu Bhatt, DOI: https://www.doi.org/10.22271/27067483.2025.v7.i7a.386.

10. Kim Plofker, Mathematics in India: A clear historical overview of Indian mathematical developments, suitable for faculty use and advanced self-learners.

11. George Gheverghese Joseph, The Crest of the Peacock: An accessible introduction to non-European mathematical traditions, including India.

12. Charles Petzold, Code: The Hidden Language of Computer Hardware and Software: A beginner-friendly bridge from numbers and symbols to data representation and computing.

13. Simon Singh, The Code Book: Useful for simple explanations of ciphers, encryption, and the mathematics behind communication security.

14. T. A. Sarasvati Amma, Geometry in Ancient and Medieval India: A more specialized reference for deeper exploration of traditional mathematical methods.

15. Mahadevan, B., Bhat, V. R., and Nagendra Pavana R. N. Introduction to Indian Knowledge System: Concepts and Applications. PHI Learning.

16. Kapur, K., and Singh, A. K. (Eds.). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla.

17. Bora, M. C. Bharatiya Knowledge Systems. Khanna Publishing House.

18. Rao, S. S. Engineering and Technology in Ancient India. Indian National Science Academy / related academic editions.

19. Selected open articles or chapters from IKS Division / AICTE / Ministry of Education resources may be used as supplementary reading.

20. S. D. Joshi and J. A. F. Roodbergen, The Aṣṭādhyāyī of Pāṇini.

21. V. N. Jha, The Philosophy of Sanskrit Grammar.

22. Peter M. Scharf, Sanskrit Syntax and Discourse Structures.

23. Daniel Jurafsky and James H. Martin, Speech and Language Processing — for introductory NLP concepts.

24. Rajeev Sangal, Akshar Bharati, and Vineet Chaitanya, Natural Language Processing: A Paninian Perspective.

Other Online Resources:

Sr. No.	Website Name
1.	NPTEL course page: For a structured academic overview of mathematics in India. https://nptel.ac.in/courses/111101080
2.	NPTEL YouTube playlist: For lecture-based learning that can support flipped or self-paced study. https://www.youtube.com/playlist?list=PLbMVogVj5nJThf31TNSQzuN7zqxe7HdRN
3.	IKS India: For broader Indian Knowledge Systems context and additional learning resources. https://www.nist.gov/cryptography
4.	Responsible AI and India-context resources: https://indiaai.gov.in/
5.	IKS Division, Ministry of Education / AICTE: https://iksindia.org/
6.	NPTEL: Introduction to Pāṇinian Grammar URL: https://onlinecourses.nptel.ac.in/noc24_hs44/preview
7.	Sanskrit Heritage Reader URL: https://sanskrit.inria.fr/

List of Practical and List of Assignments:

Sr No	List of Experiments	Hrs
01	Record a temple bell sound, conch sound, or classical "Sa" note and analyze it by plotting its time-domain waveform and frequency spectrum, identifying the fundamental frequency and harmonics, and comparing the observed harmonic structure with theoretical frequency ratios of Just Intonation and Equal Temperament.	04
02	Observe the movement of sunlight and shadow around a building, monument, or open courtyard at different times of the day, record the shadow directions and lengths, and analyze how solar position can guide orientation, time estimation, and passive architectural planning in the context of traditional Indian solar design.	04
03	Examine images, plans, or a simple model of the Konark Sun Temple or any sun-oriented structure, identify how geometry, orientation, and sunlight interaction are used in the design, and prepare a visual explanation of how ancient solar architecture supports modern sustainable building concepts.	04
04	Construct a small paper or cardboard windmill, test its rotation under natural wind or fan airflow at different speeds, and document how blade movement demonstrates the basic principle of converting wind energy into mechanical motion, linking it to traditional wind-powered systems and modern turbines.	04
05	Build a simple working model using cups, straws, thread, or cardboard to simulate water lifting or channel-based irrigation, observe how water can be moved with minimal energy input, and relate the model to ancient Indian irrigation systems and watermill-based practices.	04
06	Survey homes or nearby community spaces to identify traditional biomass fuels such as wood, agricultural residue, or cow-dung cakes, record their current use, benefits, and limitations, and compare the observed practices with modern ideas of bioenergy and sustainable fuel management..	04
07	Pronounce and classify selected Sanskrit sounds into vowels and consonants using a simple sound chart, group them according to articulation patterns, and analyze how this systematic sound organization supports pronunciation training, language learning, and speech-processing applications.	04
08	Create all possible combinations of short and long syllabic patterns of a fixed length, tabulate them systematically, and compare the resulting patterns with binary 0/1 combinations to understand how ancient combinatorial thinking connects with digital representation.	04
09	Solve real-life problems based on clocks, calendars, weekdays, or repeated events using modular arithmetic, record the remainder-based reasoning used in each case, and explain how cyclic patterns support time management, scheduling, and introductory cryptographic logic.	04
10	Convert selected decimal numbers into binary form, arrange them in bit patterns, append parity bits for even or odd parity, and interpret how binary representation and simple error-detection methods are used in digital systems for reliable data storage and transmission.	04
11	Use a basic Sanskrit dictionary, transliteration tool, or reader tool to input selected words, observe the output such as root, meaning, or grammatical analysis, and	04

	describe how such tools support language technology and digital preservation.	
12	Select a real-life problem such as fake-news verification, waste segregation, or campus awareness, identify observation, evidence, inference, and conclusion using the basic framework of Indian logic, and represent the reasoning process as a decision tree, chatbot flow, or awareness tool concept.	04
13	Take a simple historical or rule-based calculation procedure associated with Indian mathematics, rewrite it as a sequence of input-process-output steps, and convert it into a flowchart to demonstrate the connection between procedural mathematics and modern algorithmic thinking.	04
14	Represent selected large and small numbers using a place-value table, deliberately insert or remove zero in different positions, and analyze how zero functions both as a number and as a placeholder, showing its importance in arithmetic, accounting, and digital data representation.	04

Sr No	**List of Assignments**	**Hrs**
01	Study the concepts of Nāda and Shruti, temple acoustics, and Vedic recitation methods, and briefly explain their relation to modern concepts of frequency, resonance, reverberation, and redundancy/error correction in digital communication systems. Also write a short note on how Indian Knowledge Systems demonstrate scientific understanding of sound and communication.	01
02	Study the ideas of solar architecture in traditional Indian structures such as the Konark Sun Temple or courtyard-based houses, and explain how sunlight, orientation, shading, and ventilation were used for thermal comfort and energy efficiency. Also write a short note on how these traditional design ideas are relevant to modern sustainable architecture and climate-responsive planning..	01
03	Study one traditional Indian renewable energy practice such as wind-powered water lifting, watermills, solar heating, or biomass use, and compare it with one modern renewable energy technology. Explain how traditional knowledge systems supported sustainable living and discuss how these ideas can inspire present-day energy conservation and green technology.	01
04	Study the basic ideas of Pāṇinian grammar as a structured rule-based system, and explain how concepts such as sounds, roots, suffixes, and word formation relate to modern ideas in natural language processing, machine translation, and language analysis. Also write a short note on why Sanskrit grammar is often considered relevant to computational linguistics.	01
05	Study the historical development of zero as both a number and a placeholder, and explain how the decimal place-value system simplified arithmetic and record keeping. Also write a short note on how zero and place value continue to be essential in digital computation, data storage, and computer-based numerical processing.	01
06	Study the basic ideas of Indian logic, especially observation, inference, debate, and evidence in the Nyāya tradition, and explain how these ideas support careful reasoning and decision-making. Also write a short note on how such logical methods can be applied in present-day contexts such as data analysis, fake-news verification, ethical decision-making, and responsible digital systems.	01
07	Identify one idea from Indian Knowledge Systems in the syllabus, such as	01

	renewable energy, Indian numeration, Indian logic, or Sanskrit grammar, and propose a simple real-life solution such as an app, chatbot, awareness campaign, digital archive, poster, database, or educational tool based on that idea. Explain the problem being addressed, the IKS principle used, and how the proposed solution can be useful in present-day society.	
08	Study the basic Sanskrit grammar concepts of sounds, words, roots, suffixes, sandhi, and sentence structure, and explain how grammar rules work like structured instructions. Also compare grammar rules with computer program rules, and briefly discuss how tokenization, morphology, and parsing in computational systems resemble traditional rule-based language analysis.	01

Assessment:

- **Term Work:** Term work shall consist of at least 10-12 practical's based on above list. Also Term Work Journal must include at least 4 assignments
- **Term Work Marks:** 50 Marks (Total marks) = 25 Marks (Experiment) + 20 Marks (Assignments) + 5 Marks (Attendance)