AC –
Item No. –

As Per NEP 2020

University of Mumbai

Syllabus for Major Vertical – 1, 4 & 5		
Name of the Programme – B.E. (Information Technology)		
Faculty of Engineering		
Board of Studies in Information Technology		
U.G. Third Year Programme	Exit Degree	B.Sc. Tech Engineering-Information Technology.
Semester		V & VI
From the Academic Year		2026-27

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University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	**Title of program** **O:_____**	**B.E. (Information Technology)**
2	**Exit Degree**	**B.Sc. Tech Engineering - Information Technology.**
3	**Scheme of Examination** **R: _____**	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	**Standards of Passing** **R: _____**	**40%**
5	**Credit Structure** **R: _____**	**Attached herewith**
6	**Semesters**	**Sem. V & VI**
7	**Program Academic Level**	**5.5**
8	**Pattern**	**Semester**
9	**Status**	**New**
10	**To be implemented from Academic Year**	**2026-27**

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Sd/-	**Sd/-**	**Sd/-**
Dr. Vaishali D. Khairnar	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS Chairman - Information Technology	**Associate Dean**	**Dean**
Faculty of Technology	**Faculty of Science & Technology**	**Faculty of Science & Technology**

Preamble

To meet the challenge of ensuring excellence and NEP 2020 policy in engineering education, the issue of quality needs to be addressed, debated, and taken forward systematically. Accreditation is the principal means of quality assurance in higher education. The major emphasis of the accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of the University of Mumbai has taken the lead in incorporating the philosophy of NEP 2020 education in the process of curriculum development.

The third-year engineering course consists of a core and elective training program to impart scientific and logical thinking training to learners in general, with a choice of course selection from the program core course, program elective course, multidisciplinary minor, IKS, PCE and vocational skill-enhanced course. Simultaneously, the objectives of NEP 2020 demand nurturing the core program, elective program, communication skills and skills required for the Information Technology Branch of engineering in the learner. Keeping this in view, a pool of courses is offered in Core Courses covering fundamentals required to understand core and modern engineering practices and emerging trends. Elective courses are offered to the learners to understand the concepts of emerging technology. This will help with the holistic development of learners through interdisciplinary skills development and mobility among other departments as real-time solutions. Considering the shift in pedagogy and the convenience of a stress-free learning process, a choice-based subject pool is offered in the coursework under the heads of Information Technology in Engineering for open electives and multidisciplinary minor courses in semester V and VI. Essentially, to give a glimpse of trends in the industry under vocational and enhanced skill practices, the pool is offered to nurture and develop creative skills in contemporary industrial practices. Criteria met in the structure is the opportunity for learners to choose the course of their interest in all disciplines.

Program Core Course and Program Elective Courses Cover Information Technology core and elective courses. Also, MDM is where a pool of subjects is given for selection. In addition to this learner will have IKS and PCE courses. Considering the present scenario, diverse choices need to be made available to fulfil the expectation of a learner to aspire for a career in the field of current trends of Technology and interdisciplinary research. The IKS course will be program-specific, which can be achieved in undergraduate training by giving an objective viewpoint to the learning technology, from ascent time and how it was learned and the process and transitioning a learner from a rote learner to a creative professional. For this purpose, PCE is introduced in the First Semester to orient communication skills to become skilled professionals for placement and higher education entrance exams. Considering the NEP-2020 structure of award of Certificate after U.G. First Year, U. G. Diploma after the Second Year and B.Sc. Tech Engineering after the Third Year at multiple exit-point pools of Vocational skills, is arranged to give exposure to the current Industry practices.

The faculty resolved that course objectives and course outcomes are to be clearly defined for every core and elective course so that all faculty members in affiliated higher education institutes understand the depth and approach of the course to be taught to the learners, which will enhance the learners' learning process. NEP 2020 grading system enables a much-needed shift in focus from teacher-centric to continuous-based learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on the holistic development of the learners through mobility and continuous evaluation, which will enhance the quality of education. Credit assignment for courses is based on a 15-week teaching-learning process for NEP 2020; however, the content of courses is to be taught in 12-13 weeks, and the remaining 2-3 weeks are to be utilized for revision, self-learning, tutorial, guest lectures, coverage of content beyond the syllabus, etc.

There was a concern that in the present system, the third-year syllabus must not be heavily loaded for the learner and it is of utmost importance that the learner entering into the third year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a learner to get accustomed to the new environment of a college and to create a bond between the teacher and the learner. The present curriculum will be implemented for the Third Year of Engineering from the academic year 2026-27. Subsequently, this system will be carried forward for Final Year Engineering in the academic years 2027-28, respectively.

Sd/-	**Sd/-**	**Sd/-**
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BoS Chairman - Information Technology	**Associate Dean**	**Dean**
Faculty of Technology	**Faculty of Science & Technology**	**Faculty of Science & Technology**

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B.Sc. Tech Engineering- Information Technology

Credit Structure (Sem. V & VI)

	R: _____C									
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**OJT, FP, CEP, CC,RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
5.5	V	PCC501:3 PCC502:3 PCC503:3 PCL501: 1 PCL502:1 PCL503:1	PEC501:3 PEL501:1	MDC:3 MDL:1	OE:2	--	IKS: 2	--	24	**B.Sc. Tech Engineering (Information Technology) 48**
	R:_____D									
	VI	PCC601:3 PCC602:3 PCL601:1 PCL602:1	PEC601:3 PEC602:3 PEL601:1 PEL602:1	MDC: 3 MDL:1	--	VSEC:2	AEC: 2	--	24	
	Cum Cr.	20	12	8	2	2	*2+2*	--	48	

Exit option: Award of BSc. Tech Engineering with 138 credits and additional 4 credits core **one** theory subject with 3 credits and **one** lab with 1 credit from one final year from where they want to take Exit degree. Along with theory and practical course student must compulsory do internship for **one month or 160 hours** which internship is equal to 4 credits.

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project]

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Semester
V & VI

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T.E. IT
Scheme

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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	--	--	--		--	25	--	25
Total		**100**	**100**	**200**	**300**	**10**	**200**	**125**	**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

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

Course Code	Course Name	Teaching Scheme (Contact Hours)				Credits Assigned			
		Theory	Practical	Tutorial	Total	Theory	Practical	Tutorial	Total
2346111	Security and Blockchain Technology	3	--	--	03	3	--	--	03
2346112	Cloud Computing	3	--	--	03	3	--	--	03
2346113X	PEC-2	3	--	--	03	3	--	--	03
2346114X	PEC-3	3	--	--	03	3	--	--	03
MDC601	Multidisciplinary Minor Course	3	--	--	03	3	--	--	03
2346115	Security and Blockchain Technology Lab	--	2	--	02	--	2	--	01
2346116	Cloud Computing Lab	--	2	--	02	--	2	--	01
2346117X	PEL-2	--	2	--	02	--	1	--	01
2346118X	PEL-3	--	2	--	02	--	1	--	01
MDL601	Multidisciplinary Minor Lab	--	2@	--	02	--	1	--	01
2346411	Innovation Lab (Mini Project)	--	4	--	04	--	1	--	02
2996511	Professional Skill	--	2* + 2	--	04	--	1	--	02
Total		**15**	**18**	**00**	**33**	**15**	**09**	**00**	**24**

* Two hours of practical class to be conducted for full class as demo/discussion.
@ 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 (Hrs)	Term Work (TW)	Oral & Practical	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
2346111	Security and Blockchain Technology	20	20	40	60	2	--	--	100
2346112	Cloud Computing	20	20	40	60	2	--	--	100
2346113X	PEC-2	20	20	40	60	2	--	--	100
2346114X	PEC-3	20	20	40	60	2	--	--	100
MDC601	Multidisciplinary Minor Course	20	20	40	60	2	--	--	100
2346115	Security and Blockchain Technology Lab	--	--	--	--	--	25	25	50
2346116	Cloud Computing Lab	--	--	--	--	--	25	25	50
2346117X	PEL-2	--	--	--	--	--	25	25	50
2346118X	PEL-3	--	--	--	--	--	25	25	50
MDL601	Multidisciplinary Minor Lab	--	--	--	--	--	25	25	50
2346411	Innovation Lab (Mini Project)	--	--	--		--	50	--	50
2996511	Professional Skill	--	--	--		--	25	--	25
Total		**100**	**100**	**200**	**300**	**10**	**200**	**200**	**825**

Course Code	Course Description
23461131	Advance Web Technology
23461132	Deep Learning
23461133	GIS and Drone Technologies

Lab Code	Lab Description
23461171	Advance Web Technology Lab
23461172	Deep Learning Lab
23461173	GIS & Drone Technologies Lab

23461134	Computer Vision
23461141	Software Testing and Quality Assurance
23461142	Natural Language Processing
23461143	Ethical Hacking and Digital Forensics
23461144	Augmented Reality / Virtual Reality

23461174	Computer Vision Lab
23461181	Automated Testing Lab
23461182	Natural Language Processing Lab
23461183	Ethical Hacking and Digital Forensics Lab
23461184	AR/VR Lab

Vertical – 1
Major

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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	-	-

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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

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		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.

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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.

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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

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		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

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		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:

Internal Assessment Test (IAT) for 20 marks each:

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End Semester Theory Examination:

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

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Course Code	Course Name	Teaching Scheme (Contact Hours)			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

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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.

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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:

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.

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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

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	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

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		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

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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.

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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.

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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

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		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

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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

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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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23451143	UI/UX Design	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					
23451143	UI/UX Design	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To emphasize the role of user-centred design in modern software systems & importance of good interface Design
2	To understand cognitive, social, emotional, and behavioural aspects influencing user interaction.
3	To apply structured methods for user research, requirement gathering, and analysis.
4	To design, prototype, and evaluate usable and accessible user interfaces.
5	To familiarize students with current UI/UX trends, tools, and industry standards.
6	To enable students to design intuitive, ethical, and inclusive digital experiences.

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	Understand usability problems and poor interface designs	L1, L2, L3
2	Identify user behaviour and interaction requirements	L1, L2, L3
3	Apply user research techniques to define design specifications	L1, L2, L3
4	Design wireframes and interactive prototypes	L1, L2, L3
5	Evaluate interfaces using usability and UX metrics	L1, L2, L3, L4, L5
6	Implement interfaces aligned with modern industry standards and accessibility guidelines	L1, L2, L3, L4

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Design Thinking Concept, Web Development Language	02	-
1	Introduction to User Interface and UX Design	Introduction to UI/UX, Evolution of UI: Command line interface to Graphical User Interface to Touch Screen to Voice enabled App to Multimodal Interface. Characteristics of Good and Bad Design. Usability, Learnability, Accessibility, and Delight. Overview of Interaction Design Lifecycle.	06	CO1

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		Importance of UI/UX in Product Development Lifecycle, Role of UI/UX. **Self-Learning Topics:** Analysis of Popular application on the basis of good /bad UI Design		
2	Understanding Human Factors and Interactive cognitive Aspects in UI/UX	Understanding Problem Space, Human perception, attention, memory, and cognition, Layout and Grid System, Conceptual Models, Mental Models, Emotional design and affective computing, social interaction, collaboration, and persuasive design, Inclusive and accessible design principles. **Self-Learning Topics:** Identify emotional triggers in real-world interfaces and study of Interactive Interfaces	06	CO2
3	User research Requirement Analysis Interpretation Design Translation	User research methods (Interviews, Survey, Observation, Personas etc) Competitive Analysis, User Centered Design, Task analysis and use cases, Translating requirements into design goals. **Self-Learning Topics:** UI requirement gathering for a real-world application. BE project can be taken in to consideration	06	CO3
4	Interaction Design Process & Prototyping	Design thinking process (Empathize, Define, Ideate, Prototype, Test), Information architecture and navigation design, Design System (Component Library, Auto Layout Concept) Prototyping: low-fidelity vs high-fidelity, Prototyping tools overview (Figma, Adobe XD, Sketch), Micro interactions and feedback mechanisms. **Self-Learning Topics:** Create wireframes and clickable prototypes, Study any two websites with usability concepts.	06	CO4, CO5
5	Design Principles, Standards & Modern UI Trends	Design principles: Consistency, Feedback, Simplicity, Visibility, Usability heuristics (Nielsen's Heuristics), UI guidelines and standards: ISO/IEC usability standards and WCAG overview & guidelines, Responsive and adaptive design, Dark patterns and ethical UI design, Current trends: Dark mode, Neumorphism, Glassmorphism, and Voice UI, Conversational UI, AI-assisted interfaces, UX Laws. **Self-Learning Topics:** Study how AI is used for personalization in application like Netflix or Amazon and Analyse it impacts on User Experience.	07	CO5
6	Evaluation Techniques & UX Metrics	Why and when to evaluate designs, Formative vs Summative evaluation, Usability testing methods, Heuristic evaluation and cognitive walkthrough,	06	CO6

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		UX metrics: SUS, NPS, Task Success Rate, DECIDE Framework and case studies. **Self-Learning Topics:** Compare two usability testing tools such as Maze and User Testing based on features, cost and testing Capabilities.		
			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. Alan Dix, Janet Finlay, Gregory D Abowd, Russell Beale, Human Computer Interaction, Peorson, 3rd Edition
2. Wilbert O. Galitz, The Essential Guide to User Interface Design‖, Wiley publication, 3rd Edition.
3. Jennifer Preece, Yvonne Rogers and Helen Sharp, Interaction Design, Wiley, ISBN 0-471-49278-7, 2002.

References:

1. Donald A. Norman, The design of everyday things, Basic books, 2013.
2. Jeff Johnson, Designing with the mind in mind‖, Morgan Kaufmann Publication, 2nd Edition, 2014.
3. Nilakshi Jain, Dhananjay Kalbande, UI Design: Key to captivate User Understanding, SYBGEN Learning, 2021.

Online References:

Sr. No.	Website Name	URL
1	NPTEL	https://onlinecourses.nptel.ac.in/noc21_ar05/preview
2	NPTEL	https://nptel.ac.in/courses/124/107/124107008/
3	NPTEL	https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ar10/
4	NPTEL	https://nptel.ac.in/courses/107/103/107103083/
5	Adobe	https://xd.adobe.com/ideas/process/

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23451144	Image Processing	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					
23451144	Image Processing	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To define image and its formation and debate about the roles of image processing in today's world.
2	To describe point, mask, and histogram processing techniques for image enhancement to improve digital image quality.
3	To explain the forward and reverse discrete image transforms and their application in image processing.
4	To make students understand the impacts and efficiency of lossless and lossy image compression techniques.
5	To describe and demonstrate the proper procedure for segmenting images and representing objects within them.
6	To illustrate how to shape and reshape objects in an image using morphological techniques.

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	Define image, explain its formation, and recall its types by calculating image parameters using a programming language.	L1, L2
2	Apply and differentiate point, mask, and histogram processing techniques suitable for enhancing images for a specific application.	L1, L2, L3
3	List and calculate discrete image transform coefficients and use them for enhancement, compression, and representation.	L1, L2, L3
4	Compute compression metrics to evaluate method efficiency and classify compression techniques into lossless and lossy methods.	L1, L2, L3, L4
5	Apply segmentation techniques to highlight the region of interest and determine descriptors like chain code and moments for representing objects.	L1, L2, L3, L4
6	To Integrate Morphological operations to enhance image processing applications	L1, L2, L3, L4

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Matrix Algebra: addition, multiplication, and inversion.	02	-
1	Introduction to Image Processing	**Image Fundamentals:** Image Definition, Steps and Components of Image Processing, Image	04	CO1

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		Sensing and Acquisition, Image Sampling and Quantization. Relationship Between Pixels: Adjacency, Connectivity, and Distance Measures. **Self-Learning Topics:** Different Image File Formats (BMP, JPEG, PNG) and common types of image noise (Gaussian, Salt-and-Pepper). Cloud based architecture of Image processing.		
2	Image Enhancement	**Point Processing Techniques:** Image Negative, Contrast Stretching, Thresholding, Gray Level Slicing, Bit Plane Slicing. **Mask Processing Techniques:** Filtering in Spatial Domain, 2D Correlation and Convolution, Smoothing Filters (Average, Weighted Average), Sharpening Filters, Order Statistic Filters (Min, Max, Median). **Histogram Processing:** Histogram Equalization and Histogram Specification/Matching. **Self-Learning Topics:** Application of Image Enhancement for Medical Imaging and Satellite Imagery.	06	CO2
3	Image Transforms	Discrete Fourier Transform (DFT): 2D-DFT Transform Pair, Properties (Translation, Rotation, Periodicity), Filtering in the Frequency Domain (Low-pass and High-pass). **Other Discrete Transforms:** Discrete Cosine Transform (DCT), Discrete Hadamard Transform, Discrete Haar Transform. **Self-Learning Topics:** Application of Transforms in compression, CBIR and image steganography.	08	CO3
4	Image Compression	**Fundamentals:** Entropy, Redundancy (Coding, Inter-pixel, Psycho-visual), Compression Ratio, Fidelity Criteria. **Lossless Compression:** Run-Length Encoding, Huffman Coding, Arithmetic Coding, LZW Coding, Lossless Predictive Coding. **Lossy Compression:** Lossy Predictive Coding, Vector Quantization, Introduction to JPEG Compression Standard. **Self-Learning Topics:** Block Transform Coding and the detailed JPEG-DCT compression pipeline.	07	CO4
5	Image Segmentation and Representation	Image Segmentation: Point, Line, and Edge Detection Methods (Gradient operators: Sobel, Prewitt), Hough Transform for line detection, Region-Based Segmentation (Region Growing, Region Splitting and Merging). Image	06	CO5

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		Representation: Chain Codes, Shape Numbers, Polygon Approximation, Statistical Moments. **Self-Learning Topics:** Otsu's Thresholding method and its application in Number Plate Recognition.		
6	Morphological Image Processing	**Basic Morphological Methods:** Structuring Elements, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transformation. **Advanced Morphological Methods:** Boundary Extraction, Thinning, Thickening, Pruning, Skeletonization. **Self-Learning Topics:** Gray Scale Morphology: Erosion and Dilation.	06	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. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Addison - Wesley Publishing Company, 4th Edition, 2017.
2. S. Jayaraman, S. Esakkirajan and T. Veerakumar, Digital Image Processing, MGH Publication, 2016.
3. Anil K. Jain, Fundamentals of Digital Image Processing, PHI, 1995.

References:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing using MATLAB, Pearson Education, 2004.
2. Milan Sonka, Digital Image Processing and Computer Vision, Thomson publication, Second Edition, 2007.
3. William K. Pratt, Digital Image Processing, John Wiley, 4e, 2007.
4. S. Sridhar, "Digital Image Processing," Oxford University Press, 2e, 2016.Author Full Name, Title of Book, Publisher, Edition / Year of Publication.

Online References:

Sr. No.	Website Name	URL
1	NPTEL	https://nptel.ac.in/courses/117105079
2	Coursera	https://www.coursera.org/specializations/image-processing
3	Scikit-image	https://scikit-image.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.**

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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.

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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

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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

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		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

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		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)

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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	-

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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

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		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

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		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.

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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

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		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

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		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

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		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.

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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

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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

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		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

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		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.

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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.

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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

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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

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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**	

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<u>Text Books</u>:

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23451183	UI/UX Design 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					
23451183	UI/UX Design Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To master industry-standard UI/UX design and collaborative prototyping tools.
2	To conduct practical user research and synthesize findings into actionable empathy artifacts.
3	To structure logical information architecture and user flows for intuitive navigation.
4	To apply core visual design principles and component-based design systems.
5	To design interactive, high-fidelity prototypes incorporating dynamic micro-interactions.
6	To evaluate interfaces through heuristic evaluation and quantitative usability testing.

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	Operate modern collaborative design tools to manage workspaces and design assets.	L3
2	Construct comprehensive user personas, empathy maps, and journey maps based on qualitative research.	L6
3	Formulate information architecture and user flows utilizing card sorting methodologies.	L6
4	Design low-fidelity and high-fidelity wireframes applying visual design principles and UI kits.	L6
5	Develop interactive prototypes integrating standard transitions and complex micro-interactions.	L3
6	Execute heuristic evaluations and usability testing sessions to propose iterative, data-driven design improvements.	L5

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
PC with minimum 8 GB RAM (16 GB recommended), Internet Connection	Modern Web Browser, Figma (Cloud-based), FigJam / Miro (for whiteboarding).

Detailed Syllabus:

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Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Introduction to Figma: Setting up workspaces, understanding frames, constraints, and basic tools.	02	-
1	Introduction to User Interface and UX Design	**Contents:** Problem Definition & Empathy **Practical:** 1. To identify a localized problem and conduct 3-5 user interviews. Document findings. **Self-Learning Topics:** 3 problem statements from real-life observations, Apply 5W1H on a problem like "difficulty in online learning"	02	LO1, LO2
2	User research Requirement Analysis Interpretation Design Translation	**Contents:** Synthesis of Interview Data. Ideation & User Journey **Practical:** 1. To create at least two User Personas and one Empathy Map based on the interview data. 2. To map the current and ideal User Journey for the identified problem. **Self-Learning Topics:** top 5 patterns from given interview data, update a persona using interview findings. Identify emotional triggers in real-world interfaces and study of Interactive Interfaces	04	LO2
3	Interaction Design Process & Prototyping	**Contents:** Information Architecture. Wireframing (Low-Fi) **Practical:** 1. To conduct asn online Card Sorting exercise to build a Site Map or App Flow. 2. To sketch paper wireframes and translate them into low-fidelity digital wireframes. **Self-Learning Topics:** Study any two Website with respect to it information architecture. Label elements in an existing wireframe, Improve a poorly designed wireframe.	04	LO3, LO4
4	Design Principles, Standards & Modern UI Trends	**Contents:** Design Systems. Visual Design (High-Fi) **Practical:** 1. To create a basic UI kit/Design System (Typography scale, Colour palette, Buttons, Inputs).	04	LO4

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		2. To convert low-fidelity wireframes into high-fidelity UI screens applying Gestalt principles **Self-Learning Topics:** Analyse the UI consistency of 2 apps, Design 5 reusable UI components. High-Fidelity UI Design & Visual Styling, UI Design Systems & Component Styling in High-Fidelity Design		
5	Interaction Design Process & Prototyping	**Contents:** Prototyping, Micro interactions. **Practical:** 1. To link the high-fidelity screens to create an interactive, clickable prototype with transitions. 2. To design a complex interactive component (e.g., animated loading state or interactive form validation). **Self-Learning Topics**: Prototyping User Flows, Prototyping Tools. Components of Micro interactions, Psychology Behind micro interactions, Tools for Designing micro interactions	04	LO5
6	Design Principles, Standards, Evaluation Techniques & UX Metrics	**Contents:** Heuristic Evaluation, Usability Testing **Practical:** 1. To perform an evaluation of a peer's interface using Nielsen's 10 Heuristics. 2. To write a test plan, moderate a testing session with a real user, and calculate a SUS score. **Self-Learning Topics:** Steps in Conducting Heuristic Evaluation, Designing Test Scenarios & Tasks, Usability Metrics, Usability Testing vs Heuristic Evaluation, Heuristic Evaluation vs Usability Testing	04	LO6
		Total	**26**	

Text Books:

1. Tom Greever, Articulating Design Decisions, O'Reilly Media, 2nd Edition / 2020
2. Jon Yablonski, Laws of UX: Using Psychology to Design Better Products & Services, O'Reilly Media, 1st Edition 2020
3. Susan Weinschenk, 100 Things Every Designer Needs to Know About People, New Riders, 2nd Edition, 2020.

References:

1. Jenifer Tidwell, Charles Brewer, Aynne Valencia, Designing Interfaces: Patterns for Effective Interaction Design, O'Reilly Media, 3rd Edition
2. Alla Kholmatova, Design Systems: A practical guide to creating design languages for digital products, Smashing Magazine, 1st Edition

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Online References:

Sr. No.	Website Name	URL
1	Figma Learn (Official Tutorials)	https://help.figma.com/hc/en-us
2	Mobbin (UI Design Patterns)	https://mobbin.com/
3	Apple Human Interface Guidelines (HIG)	https://developer.apple.com/design/human-interface-guidelines/

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23451184	Image Processing 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					
23451184	Image Processing Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To understand the fundamentals of digital image representation and manipulation using programming languages
2	To implement various image enhancement techniques for improving image quality
3	To apply discrete image transforms for image analysis and processing
4	To implement image compression techniques for efficient storage and transmission
5	To explore image segmentation and representation methods for object identification
6	To apply morphological operations for shape analysis and feature extraction

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	Read, display, and manipulate digital images and analyze their basic properties	L1, L2, L3
2	Apply point, mask, and histogram processing techniques to enhance image quality	L2, L3, L4
3	Implement discrete image transforms and use them for image analysis	L2, L3, L4
4	Apply lossless and lossy compression techniques and evaluate compression performance	L3, L4, L5
5	Implement segmentation algorithms to extract regions of interest from images	L3, L4, L5
6	Apply morphological operations to extract shape features and process binary/gray-scale images	L3, L4, L5

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
Intel i7 16 GB MIMIMUM , Nvidia GPU platforms (Jatson Nano)	Python 3.7+, OpenCV, NumPy, SciPy, Matplotlib, Scikit-image, Jupyter Notebook / Google Colab / MATLAB with Image Processing Toolbox

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Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites		02	-
1	Introduction to Image Processing	**Contents:** Fundamentals of Image processing. Understanding of Digital Image Processing and pixel representation. Basic concepts from Linear Algebra and Geometry. **Practical:** 1. To perform basic arithmetic and logical operations on images 2. To calculate Euclidean, City-block (Manhattan), and Chessboard distances **Self-Learning Topics:** Perform the different sampling and quantization operation on images.	02	LO1
2	Image Enhancement	**Contents:** Digital Image Processing and pixel intensity values, grayscale images and thresholding concepts, image filtering, noise types such as Gaussian Noise and Salt-and-Pepper noise. Understanding of image histograms in Digital Image Processing and basic probability/statistics concepts used for intensity distribution transformation. **Practical:** 1. Implementation of gray level slicing (with and without background) 2. Implementation of averaging filter (low-pass) for noise reduction. Compare performance of filters on images with salt-and-pepper and Gaussian noise 3. To apply histogram equalization, and specification/matching to match target histogram **Self-Learning Topics:** Implement image negation, contrast stretching, dynamic range compression.	06	LO2
3	Image Transforms	**Contents:** Understanding Haar Wavelet Transform and Multiresolution Analysis in Digital Image Processing, Discrete Cosine Transform and Inverse Discrete Cosine Transform used for image transformation and compression. **Practical:** 1. To apply Haar Transform and analyze multi-resolution representation	04	LO3

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		2. To perform DCT and IDCT operation on image. **Self-Learning Topics:** Perform DFT and IDFT operation on image and Check all the transform matrix are unitary matrix		
4	Image Compression	**Contents:** Huffman Coding in Image Compression for lossless data compression using variable-length codes based on symbol frequency, Arithmetic Coding in Image Compression which represents a sequence of symbols as a single fractional value for efficient compression. **Practical:** 1. To apply Huffman coding for image compression 2. To apply Arithmetic coding for image compression **Self-Learning Topics:** Implement JPEG-like compression using DCT and quantization.	04	LO4
5	Image Segmentation and Representation	**Contents:** Edge Detection using gradient-based operators such as Roberts Cross Operator, Prewitt Operator, and Sobel Operator in Digital Image Processing, Region Growing technique in Image Segmentation used to group pixels into regions based on similarity criteria. **Practical:** 1. Implementation of edge detection using Roberts, Prewitt, and Sobel operators 2. To apply region growing algorithm for segmentation **Self-Learning Topics:** Implement Hough transform for linking the edges in an image.	04	LO5
6	Morphological Image Processing	**Contents:** Mathematical Morphology operations such as Erosion (morphology) and Dilation (morphology) used to process and analyze binary images, Hit-or-Miss Transform in Mathematical Morphology, used for detecting specific patterns in binary images. **Practical:** 1. Implementation of erosion and dilation on binary images 2. Implementation of hit-or-miss transform for pattern matching **Self-Learning Topics:**	04	LO6

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		Implementation of Boundary extraction, Thinning, Thickening, Pruning, and Skeletonization.		
		Total	**26**	

Text Books:

1. Digital Image Processing: Illustration using Python – S. Esakkirajan, T. Veerakumar, B. N. Subudhi; Springer Singapore, 1st Edition, 2025.
2. Digital Image Processing Using MATLAB, 3rd Edition – Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins; Gatesmark Publishing, 2020.
3. Digital Image Processing and Image Acquisition – Bernd Jähne; Springer Cham, 7th Edition, 2025.
4. Computer Vision: Algorithms and Applications – Richard Szeliski, Springer, 2nd Edition, 2022.

References:

1. Wilhelm Burger and Mark J. Burge, Digital Image Processing: An Algorithmic Introduction using Java, Springer, 2nd Edition, 2016.
2. Milan Sonka, Digital Image Processing and Computer Vision, Thomson publication, Second Edition, 2007.
3. William Pratt, Digital Image Processing, John Wiley, 4e, 2007.
4. S. Sridhar, "Digital Image Processing," Oxford University Press, 2e, 2016.

Online References:

Sr. No.	Website Name	URL
1	NPTEL	https://nptel.ac.in/courses/117105079
2	Coursera	https://www.coursera.org/specializations/image-processing
3	Scikit-image	https://scikit-image.org/
4	OpenCV Documentation	https://docs.opencv.org/
5	MATLAB Image Processing Toolbox	https://in.mathworks.com/products/image.html

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2346111	Security and Blockchain 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					
2346111	Security and Blockchain Technology	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	Demonstrate understanding of information security principles, cryptographic techniques, and security models used to protect digital systems.
2	Introduce authentication, access control, risk management, and governance frameworks for secure IT infrastructures.
3	Analyze the architecture and operational mechanisms of blockchain and distributed ledger technologies.
4	Evaluate and compare public and private blockchain platforms based on consensus mechanisms, scalability, and security features.
5	Enable students to design and deploy smart contracts using Solidity and blockchain development tools.
6	Evaluate security vulnerabilities, threats, and enterprise applications of blockchain technology.

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 information security concepts, cryptographic techniques and security models.	L2
2	Apply authentication, authorization and risk management mechanisms to design secure computing environments.	L3
3	Understanding fundamental concepts of DLT, blockchain architecture and consensus mechanisms.	L2
4	Evaluate major blockchain platforms' design principles, consensus mechanisms, and capabilities.	L2, L3, L4
5	Develop and deploy smart contracts using Solidity and blockchain development tools.	L3, L4
6	Understand blockchain security concepts and evaluate enterprise blockchain applications.	L2, L3, L4

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Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Computer Network, Database, Operating System	02	-
1	Security Fundamentals and Cryptography	Fundamentals of Information Security: CIA Triad, Threats, Vulnerabilities, and Risk. Introduction to cryptography, Classical Encryption techniques (substitution and transposition cipher) Block cipher algorithms: AES, DES Hashing: Hash functions, Hashing Techniques (HMAC, CMAC, SHA256, and SHA512) Digital Signatures: RSA, DSS, Digital Certificates: X.509 standard, and Public Key Infrastructure. **Self-Learning Topics:** Study of more classical cryptanalysis techniques, cryptographic attack models.	06	CO1
2	Authentication, access control and security governance.	Authentication & Access Control: Password management policies, Password attacks (Brute Force, Dictionary), Authentication Mechanisms, Single Sign-on (KerberosV4 and V5), Access Control Models (Bell-LaPadula, Biba). Risk Management & Security Governance: Risk Identification, Assessment and Mitigation, Security Policies, Standards and Procedures (ISO 27001), COBIT framework. Legal and Ethical aspects: IT Act 2000 and Amendments, Ethical and Privacy Issues. **Self-Learning Topics:** Recent malware studies, Digital forensics basics, Phishing and Social Engineering trends.	06	CO2
3	Foundations of Blockchain	Fundamentals: Definition and Evolution of Blockchain, DLT vs Blockchain, Blockchain characteristics and key concepts, types of blockchain. Blockchain Limitations: Blockchain Trilemma, CAP Theorem. Blockchain architecture: Layers, and components of a blockchain, Consensus algorithms (PoW, PoS, PoA). Block structure: Block definition, header components, block hash and block height, Genesis block, Merkle tree, linking blocks in the Blockchain.	05	CO3

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		Self-Learning Topics: Alternate Consensus algorithms, Interoperability in blockchain.		
4	Public and Private Blockchain Platforms	Bitcoin Blockchain: brief evolution, architecture, Bitcoin mining, Proof of Work and Hashcash in Bitcoin, Block Propagation and Relay, Transaction structure and Bitcoin Script in the Bitcoin Network. Ethereum Blockchain: brief evolution, architecture, Smart contracts, Ethereum Virtual Machine (EVM), and Ethereum Classic, Ethereum components, Mining, and transaction workflow. Hyperledger Blockchain: Hyperledger Ecosystem, Hyperledger Fabric architecture, and components, pBFT and DPOS, Permissioned blockchain networks. **Self-Learning Topics:** Lighting Network, Bitcoin Forks, Layer 2 (Polygon, Optimism), DAO Governance models, Property registry.	08	CO4
5	Smart Contracts development	Smart Contract: Definition and characteristics, types of smart contract, Smart contract lifecycle, Role and types of Oracles, Smart contract industry use cases, Opportunities and Risks. Smart Contract Deployment: Introduction to Truffle, Remix IDE, Ganache blockchain simulator and test networks for deployment. Solidity Programming: Development environment setup, basic programming concepts, program structure, variables and data types, functions and modifiers, Metamask (Ethereum Wallet) setup, deployment on test networks, Dapp integration. **Self-Learning Topics:** Smart Contract development using Java and Python, NFT Smart contracts.	07	CO5
6	Blockchain Security and Enterprise applications	Security concepts: security attributes of Blockchain (CIAR), Identity and access Management, authentication, and Regulatory Compliance. Bribery attack, Collusion attack, Finney attack, and 51% attack, Vulnerabilities in a smart contracts and Dapps, secure coding practices, Wallet security mechanisms, and Key Management strategies. Enterprise Blockchain Security and Use-cases: Financial services, Supply Chain management, Healthcare systems, and E-Governance.	05	CO6

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		Self-Learning Topics: Cross-chain security risks, Regulatory frameworks		
			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 Education, 6th Edition / 2013.
2. Behrouz A. Ferouzan, Cryptography & Network Security, Tata Mc Graw Hill, 2007.
3. Mark Stamp, Information Security Principles and Practice, Wiley publication, 2018.
4. Andreas M. Antonopoulos, Dr. Gavin Wood, Mastering Ethereum, Building Smart Contract and Dapps, O'reilly, 2018.
5. Chandramouli Subramanian, Asha A George, Abhillash K.A and Meena Karthikeyen, Blockchain Technology, Universities press, 1st Edition / 2020.
6. Ashwani Kumar, Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, BPB publications, 1st Edition / 2020.

References:

1. Bruce Schneier, Applied Cryptography, Protocols, Algorithms and Source Code in C, John Wiley & Sons, Inc, 2nd Edition.
2. Atul Kahate, Cryptography and Network Security, Tata Mc Graw Hill, 2nd Edition 2009.
3. Imran Bashir, Mastering Blockchain, Packt Publishing, 3rd Edition / 2020.
4. Andreas M. Antonopoulos, Mastering Bitcoin Unlocking Digital Cryptocurrencies, O'Reilly Media, 1st Edition / 2015.
5. Kumar Saurabh and Ashutosh Saxena, Blockchain Technology: Concepts and Applications, Wiley publication, 2020.

Online References:

Sr. No.	Website Name	URL
1	NPTEL Courses on Foundations of cryptography and security	www.swayam.gov.in/ nptel.ac.in/courses/106105162 nptel.ac.in/courses/106106221
2	Online courses on Introduction to Blockchain Technologies	https://onlinecourses.swayam2.ac.in/e-learning/preview/aic21_ge01 https://www.coursera.org/learn/blockchain-basics https://www.udemy.com/course/blockchain-developer/ https://www.udemy.com/course/learn-blockchain-technology-and-cryptocurrency-for-beginners/
3	Solidity Documentation	https://docs.soliditylang.org
4	Truffle	https://trufflesuite.com/
5	Remix IDE	https://remix.ethereum.org/
6	Polygon testnet	https://faucet.polygon.technology/
7	Metamask	https://metamask.io/

Assessment:

Internal Assessment Test (IAT) for 20 marks each:

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- 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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2346112	Cloud Computing	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					
2346112	Cloud Computing	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To understand and analyze the fundamental concepts, architecture, components, and types of cloud computing.
2	To define and analyze virtualization concepts and related technologies.
3	To understand cloud pricing models, perform TCO calculations, and evaluate SLAs.
4	To explore and describe the services provided by the Amazon Web Services cloud platform.
5	To understand and analyze the functionality of the OpenStack platform and serverless computing.
6	To describe the key aspects of security and privacy in cloud computing.

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 the fundamental concepts of cloud computing, including service models, deployment models, and architecture.	L1,L2,L3
2	Describe and apply virtualization techniques in cloud computing environments.	L1,L2,L3
3	Apply cloud pricing models, calculate Total Cost of Ownership (TCO), and evaluate Service Level Agreements (SLAs).	L1,L2,L3,L4
4	Describe and apply various services offered by the Amazon Web Services cloud platform.	L1,L2,L3,L4
5	Explain the functionality of the OpenStack platform and serverless computing.	L1,L2,L3
6	Analyze security and privacy issues in cloud computing environments.	L1,L2,L3

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Concepts of Computer Network, Network Security and Operating System, Data centers	02	-
1	Introduction to cloud computing	Introduction to cloud computing, need for cloud computing and its components, cloud & other similar configurations, cloud types: NIST and	06	CO1

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		Cloud Cube Model, characteristics of cloud computing, deployment models, service models, advantages and disadvantages of Cloud Computing. **Self-Learning Topics:** Study the role of Cloud Computing in startups/E-commerce / healthcare / education		
2	Virtualization & Containerization	Characteristics of virtualized environments; virtualization architecture and structure; implementation levels of virtualization; mechanisms of virtualization; advantages and limitations of virtualization; virtualization vs. cloud computing; fundamentals of containerization, container architecture, and comparison between virtualization and containerization. **Self-Learning Topics:** Explore real-world use cases of virtualization and containerization in industries such as IT services, e-commerce, or banking	07	CO2
3	Cloud Economics and Cost Management	Measuring the Cloud's Value Early adopters and new applications. The laws of cloud economics. Cloud computing obstacles. Behavioral factors relating to cloud adoption. Measuring cloud computing costs. Avoiding Capital Expenditures. Computing the Total Cost of Ownership. Specifying Service Level Agreements. Defining Licensing Models **Self-Learning Topics:** Understand FinOps (Cloud Financial Management) for cost optimization	04	CO3
4	Amazon Web Service Cloud Platform	Introduction to the AWS Cloud, AWS core services by categories. Compute Service: Introduction to EC2, EC2 Instances, EC2 Amazon Machine Images, Instance Types, Instance Lifecycle. Storage Service: Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups, Introduction to Glacier. Virtual Private Cloud: Introduction, Subnet, Elastic Network Interfaces, Internet Gateways, Route Tables, Security Groups. CloudWatch:Introduction, CloudWatch Metrics, CloudWatch Alarms. Database as a Service: Introduction to Amazon Relational Database Service (RDS), Database Engines, Database	9	CO4

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		Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types of Non-relational Databases, Introduction to DynamoDB, Features, Partition and Hash Keys. AWS Billing, Pricing Models and Cloud Cost Optimization. **Self-Learning Topics:** Comparison of AWS services with other cloud service platforms like Azure and GCP		
5	Openstack Cloud platform & Serverless Computing	Open source Cloud Platform: Introduction to Openstack cloud platform, Components and modes of Operations, Architecture of Openstack cloud platform. Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing. Serverless Computing: Introduction, Working with Serverless environment,Basics of serverless events and functions, AWS Lambda. Fog Computing. **Self-Learning Topics:** To study different open-source cloud computing platforms such as Eucalyptus, and OpenNebula.	06	CO5
6	Cloud Security & Privacy	Infrastructure security, Data security and storage, Identity and access management, privacy, audit compliance, Network Security in Cloud. **Self-Learning Topics:** To assess and analyze how the security and privacy is maintained in different cloud computing platforms.	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. Barrie Sosinsky, Cloud Computing Bible, Wiley-India, 1st Edition / 2011.
2. Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Mastering Cloud Computing, McGraw Hill Education, 1st Edition / 2017.
3. Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah, Cloud Computing Black Book, Dreamtech Press, 2nd Edition / 2014.
4. Joe Baron, AWS certified solution Architect, Sybex Inc publication, 2016.
5. Tim Mather, Subra Kumaraswamy, and Shahed Latif, Cloud Security and Privacy, O'Reilly Publication, 1st Edition / 2009.

References:

1. Kai Hwang, Geoffrey C. Fox, Jack Dongarra, Distributed and Cloud Computing from Parallel Processing to the Internet of Things, Morgan Kaufmann Publication, 2011.
2. Judith Hurwitz, Cloud Computing for Dummies, John Wiley & Sons, 2nd Edition / 2020.

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3. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly Publication, 1st Edition / 2011.
4. John R Vecca, Cloud computing security: foundation and challenges, CRC Press, 1st Edition / 2016.

Online References:

Sr. No.	Website Name	URL
1	AWS Documentation	https://docs.aws.amazon.com/
2	Cloud Security	https://cloudsecurityalliance.org/research/guidance/
3	NPTEL	https://onlinecourses.nptel.ac.in/noc21_cs14/preview

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461131	Advance 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					
23461131	Advance Web Technology	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To learn fundamental concepts of TypeScript including its architecture, environment setup, data types, control structures, functions, classes, and modules.
2	To understand the core concepts of AngularJS, including modules, directives, data binding, controllers, services, routing, and form validation for dynamic web development.
3	To understand the architecture and key concepts of Angular including components, modules, directives, services, routing, forms, and HTTP client integration.
4	To understand how to create scalable Next.js architectures
5	To introduce the fundamentals of the FastAPI framework.
6	To orient students to optimize web application performance using SEO strategies.

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 the concepts of TypeScript including data types, control structures, functions, classes, and modules for developing structured applications.	L1, L2, L3
2	Develop dynamic single-page web applications using AngularJS features such as modules, controllers, directives, dependency injection, routing, and services.	L1, L2, L3
3	Develop dynamic and modular web applications using Angular features such as components, services, routing, forms, and REST API integration.	L1, L2, L3
4	Construct scalable web applications using Next.js.	L1, L2, L3
5	Develop simple RESTful web APIs using the FastAPI framework.	L1, L2, L3
6	Analyze SEO performance metrics to improve the visibility of web applications.	L1, L2, L3, L4

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	JavaScript, MongoDB, NodeJS, ReactJS	02	-

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1	Typescript	Introduction to TypeScript including its internal architecture and environment setup, working with data types, variables, and operators, implementing decision-making statements and loops, developing functions, creating classes and objects using object-oriented concepts, and organizing code using TypeScript modules. **Self-learning Topics**: Advanced TypeScript Types (Union, Intersection, Literal Types) and Error Handling in TypeScript.	06	CO1
2	AngularJS	Introduction to AngularJS and its significance in modern web development, AngularJS modules, built-in and custom directives, expressions, data binding, filters, controllers, and scope. Dependency injection and services, form validation, routing using ng-Route (including ng-view), use of directives such as ng-repeat and ng-style, built-in helper functions, and integration of AngularJS with TypeScript. **Self-learning Topics**: Advanced routing configuration and AngularJS form customization	07	CO2
3	Angular	Angular JS versus Angular, Angular architecture, components, modules, templates, data binding, directives, pipes, services with dependency injection, routing, forms, HTTP client with RxJS, and basics of state management, testing, and deployment. **Self-Learning Topics:** State Management using NgRx and Angular material	07	CO3
4	Next.js	Introduction to Next.js & Setup, Next.js Basics and Built-In Components, Pages and Routing, Styling in Next.js, Data Fetching Methods, Optimizing Next.js Applications, State Management, Testing Next.js, API Routes, Securing App with Next Auth **Self-Learning Topics:** MongoDB with Next.js	07	CO4
5	FastAPI	Introduction to FastAPI, REST APIs with FastAPI, Working with Data and Files in FastAPI, Handling Request & Response Data in FastAPI, Database Integration in FastAPI using MongoDB. **Self-Learning Topics:** Swagger documentation of FastAPI.	05	CO5

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6	Search Engines and SEO	Architecture and working of search engines, search engine crawling, indexing, and ranking mechanisms, on-page and off-page SEO techniques, website performance using SEO tools, Basic SEO strategies for web applications. **Self-Learning Topics:** Web analytics	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. Boris Cherny, Programming TypeScript- Making Your Javascript Application Scale, O'Reilly, 1st Edition, 2019.
2. Adam Bretz and Colin J. Ihrig, Full Stack JavaScript Development with MEAN: MongoDB, Express, AngularJS, and Node.JS, SitePoint, 1st Edition, 2015.
3. Simon Holmes Clive Harber, Getting MEAN with Mongo, Express, Angular, and Node, Manning Publications, 1st Edition, 2017.
4. Shubham Jain and Mathew Dony Chittezhath, Modern Web Applications with Next.JS, Orange Education, 1st Edition, 2023.
5. Eric Enge, Stephan Spencer, Jessie Stricchiola, The Art of SEO: Mastering Search Engine Optimization, O'Reilly Media, 4th Edition, 2023.

References:

1. Yakov Fain and Anton Moiseev, TypeScript Quickly, Manning Publications ,1st Edition, 2020.
2. Brad Dayley, Brendan Dayley, Caleb Dayley, Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications, Addison-Wesley Professional, 2nd Edition, 2018
3. Michele Riva, Real-World Next.js: Build scalable, high-performance, and modern web applications using Next.js, the React framework for production, Packt Publishing Limited, 1st Edition, 2022.
4. Marko Aleksendrić, Shrey Batra, Rachelle Palmer, Shubham Ranjan, Full Stack FastAPI, React, and MongoDB, Packt Publishing, 2nd Edition, 2024.

Online References:

Sr. No.	Website Name	URL
1	AngularJS	https://docs.angularjs.org/tutorial
2	w3schools	https://www.w3schools.com/typescript/
3	Angular	https://angular.dev/tutorials
4	FastAPI	https://fastapi.tiangolo.com/tutorial/

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.**

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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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461132	Deep 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					
23461132	Deep Learning	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	Understand fundamentals of neural networks and deep learning architectures.
2	Analyze mathematical foundations behind deep learning models.
3	Implement various deep learning algorithms for real-world applications.
4	Design deep neural network architectures for image and text data.
5	Evaluate deep learning models using appropriate optimization techniques.
6	Examine ethical issues and emerging trends in deep learning.

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 the fundamentals of artificial neural networks and deep learning concepts.	L2
2	Apply forward propagation, backpropagation, and gradient descent algorithms to train neural networks.	L3
3	Analyze different deep learning architectures such as CNN, RNN, and Autoencoders.	L4
4	Design deep learning models for computer vision and NLP applications.	L6
5	Evaluate model performance using optimization and regularization techniques.	L5
6	Assess societal, ethical, and practical challenges in deploying deep learning systems.	L5

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Linear Algebra, Probability, Statistics, and Calculus for DL	02	-
1	Introduction to Deep Learning	Introduction to Artificial Neural Networks (ANN). Biological Neuron vs Artificial Neuron. Perceptron Model. Activation Functions (Sigmoid, ReLU,	06	CO1

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		Tanh, Softmax). Loss Functions. Gradient Descent and Variants. **Self-Learning Topics:** Advanced optimization algorithms, weight initialization strategies.		
2	Deep Neural Networks	Multi-Layer Perceptron (MLP). Weight initialization Techniques. Vanishing and Exploding Gradient Problem. Batch Normalization. Regularization Techniques (Dropout, L1, L2). Hyperparameter Tuning. **Self-Learning Topics:** Degradation problem in deep networks, Comparison of plain network vs residual network, normalization techniques used to stabilize and accelerate deep network training.	06	CO1, CO2
3	Convolutional Neural Networks	Introduction to Computer Vision. Convolution Operation. Padding and Stride. Pooling Layers. CNN Architecture (ResNet, DenseNet, EfficientNet). Transfer Learning and Fine-Tuning Strategies. Case Study: Image Classification & Image Segmentation (U-Net). Medical image diagnosis, facial recognition, autonomous driving. **Self-Learning Topics:** Object Detection (R-CNN, YOLO,SSD), MobileNet,	06	CO3
4	Recurrent Neural Networks	Sequential Data vs. Spatial Data, RNN Architecture. Backpropagation Through Time (BPTT). Long Short-Term Memory (LSTM). Gated Recurrent Unit (GRU). Bidirectional RNNs. Automatic image captioning, questioning answering system, end to end speech recognition. **Self-Learning Topics:** Attention Mechanism in Sequence Models, Sequence-to-Sequence (Seq2Seq) Models. Transformer Models vs RNN Architectures.	07	CO3, CO4
5	Advanced Deep Learning Models	Autoencoders. Variational Autoencoders (VAE). Generative Adversarial Networks (GANs). Graph Neural Networks (GNNs). Introduction to Transformers. Attention Mechanism. **Self-Learning Topics:** Vision Transformers (ViTs). GPT-3 & AlphaFold for Multimodal Learning.	05	CO4
6	Deployment, Ethics and Emerging Trends	Model Evaluation Metrics. Model Optimization and Fine-Tuning. MLOps and Model Lifecycle Management. Model Deployment Basics. Model Monitoring. Explainable AI (XAI) for Deep Learning Systems. Bias and Fairness. Edge AI and	07	CO5, CO6

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		Future Trends. Emerging Trends: Federated Learning, Foundation Models, Large Language Models (LLMs). Introduction to Agentic AI. **Self-Learning Topics:** Environmental Sustainability, AI Governance & Regulation, Physics-Informed Neural Networks (PINNs), Multimodal & Neuro-symbolic learning. Robotics & Physical 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. Ian Goodfellow, Yoshua Bengio & Aaron Courville, Deep Learning, The MIT Press, 1st Edition / 2019.
2. François Chollet, Deep Learning with Python, Manning Publications, 2nd Edition / 2021.
3. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, 1st Edition / August 2018.
4. Nikhil Buduma & Nicholas Locascio, Fundamentals of Deep Learning: Designing Next-Generation AI, O'Reilly, 2nd Edition / 2022.
5. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 1st Edition / 2009.

References:

1. Adrian Rosebrock, Deep Learning for Computer Vision, PyImageSearch, 1st Edition / 2017.
2. David Foster, Generative Deep Learning, O'Reilly, 2nd Edition / 2023.
3. Matthews & Kazanciyan, Machine Learning with TensorFlow, Packt Publishing, MEAP Edition / 2017.

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:

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.**

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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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461133	GIS and Drone 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					
23461133	GIS and Drone Technologies	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To understand the basic concepts of GIS and different types of spatial data.
2	To learn methods of collecting and managing geographical data using GPS, satellites, and databases.
3	To perform basic spatial analysis and mapping using GIS tools.
4	To understand the basic components and working of drones.
5	To learn how drone images are processed and used for mapping and analysis.
6	To explore real-world applications of GIS and drone technology in areas like smart cities, agriculture, and disaster 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	Understand GIS data models and coordinate systems.	L2
2	Manage and analyze spatial data using GIS tools.	L3
3	Perform spatial analysis and basic GIS programming.	L3
4	Understand drone hardware and regulatory framework.	L2
5	Process drone imagery for mapping applications.	L4
6	Integrate GIS and drone data for IT-based solutions.	L4

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Basic Programming Knowledge, Computer Fundamentals	02	-
1	Geographical Information System (GIS)	Introduction to GIS, Components of GIS (Hardware, Software, Data, People, Methods), Historical Development of GIS - Components of GIS - Data - Types of Data - Spatial and Non-spatial - Vector Data - Point, Line, Polygon - Raster Data - Database Structures - Vector and Raster Data Structures - Files - File Formats	06	CO1

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		Self-Learning Topics: Applications of GIS in IT, Smart Cities, Agriculture, Disaster Management		
2	Spatial Data Handling & Database Management	Spatial Data Types, Data Acquisition Methods (Satellite, Survey, Drone, GPS), Spatial Databases – Introduction to Spatial DBMS, SQL for Spatial Data, Georeferencing & Digitization, Data Cleaning and Preprocessing **Self-Learning Topics:** Basics of geotagging, Data accuracy and error handling in GIS	07	CO2
3	Spatial Analysis & GIS Programming	Spatial Analysis Concepts, Buffering, Overlay, Network Analysis, Thematic Mapping, Introduction to GIS using Python, Libraries: GeoPandas, Shapely (concept level), Automation in GIS **Self-Learning Topics:** Web GIS basics, Creating simple thematic maps	07	CO3
4	Fundamentals of Drone Technology	Introduction to UAV / Drone Technology, Types of Drones (Fixed Wing, Multi-rotor), Drone Components (Frame, Motors, Propellers, Battery, Controller, GPS), Flight Planning Concepts, Drone Regulations in India (DGCA basics), Safety & Ethical considerations **Self-Learning Topics:** Overview of DGCA drone rules, Study of drone communication systems	07	CO4
5	Drone Data Processing & Remote Sensing	Aerial Imaging Basics, Image Stitching (Photogrammetry concept), Orthomosaic Creation, 3D Mapping Basics, Remote Sensing Fundamentals, Satellite vs Drone Imaging, NDVI concept **Self-Learning Topics:** Basics of photogrammetry, Study of popular drone mapping software	05	CO5
6	Integration of GIS, Drones & Emerging Technologies	IoT + GIS, AI/ML in Geospatial Analysis, Real-Time Mapping Systems, Smart Cities Case Studies, Web GIS, Future Trends in Geospatial Technology **Self-Learning Topics:** AI applications in geospatial analysis, Web-based GIS dashboards, Future trends in geospatial technology	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:

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1. Peter A. Burrough, Rachael A. McDonnell, Christopher D. Lloyd, Principles of Geographical Information Systems, Oxford University Press, 3rd Edition / 2015.
2. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 3rd Edition / 2020.
3. Paul G. Fahlstrom, Thomas J. Gleason, Mohammad H. Sadraey, Introduction to UAV Systems, Wiley & Sons, 5th Edition / 2022.

References:

4. C.P. Lo & Albert K. W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India, 1st Edition / 2002.
5. Kang-Tsung Chang, Introduction to Geographic Information Systems, McGraw-Hill, 9th Edition / 2019.

Online References:

Sr. No.	Website Name	URL
1	WILDLABS – Free Mini Course on Drones & GIS	https://wildlabs.net/courses/free-drone-gis-mini-course-geowing-academy
2	GISRSStudy – GIS & Remote Sensing Tutorials	https://gisrsstudy.com/
3	Aeroyantra — Free Online GIS & Drone Mapping Tools	https://gis.aeroyantra.com/
4	NPTEL Course	https://nptel.ac.in/courses/105107206

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461134	Computer Vision	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					
23461134	Computer Vision	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To review image processing techniques for computer vision.
2	To understand shape and region analysis
3	To understand Hough Transform and its applications to detect lines, circles, ellipses.
4	To understand three-dimensional image analysis techniques.
5	To understand motion analysis.
6	To implement computer vision algorithms for real-world problems.

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 and apply fundamental image processing techniques required for computer vision.	L1, L2,L3
2	Analyse shapes and regions using suitable algorithms.	L1, L2, L4
3	Apply Hough Transform for line, circle, and ellipse detections.	L1, L2,L3
4	Analyse 3D vision techniques.	L1, L2,L3,L4
5	Describe motion analysis methods.	L1,L2
6	Develop applications using computer vision techniques for real world problems.	L3,L4,L5

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Fundamental of digital image processing and Computer graphics	02	-
1	Fundamental of Computer Vision	The Nature of Vision, Convolutions and Point Spread Functions, The Role of Filters in Industrial Applications of Vision, Comparison between Image Processing and Computer Vision. Corner and Interest Point Detection, Co-occurrence Matrix.	04	CO1

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		Self-Learning Topics: Various image processing techniques, algorithms and applications, Vision as Inverse Graphics.		
2	Shapes and Regions	Binary Shape Analysis, Connectedness, Object Labelling and Counting, Size Filtering, Distance Functions, Skeletons and Thickening and Thinning, Hole Filling. Boundary Tracking Procedures, Shape Models and Shape Recognition, Boundary Length Measures, Boundary Descriptors, Fourier Descriptors, Region Descriptors. **Self-Learning Topics:** Application of Skeletons for Shape Recognition, Boundary Tracking Procedures, Local Maxima and Data Compression.	08	CO2
3	Hough Transforms	Line Detection, Hough Transform (HT) for Line Detection, Line Localization, Line Fitting, RANSAC for Straight Line Detection, HT Based Circular Object Detection, Ellipse Detection, Generalized Hough Transform (GHT), Spatial Matched Filtering, GHT for Ellipse Detection, Object Location. **Self-Learning Topics:** Compare classical Hough methods with CNN-based approaches like LSD (Line Segment Detector) and Stacked Hough Networks.	07	CO3
4	3D Vision	Methods for 3D Vision, Projection Schemes, Shape from Shading, Photometric Stereo, Shape from Texture, Shape from Focus, Active Range Finding, Surface Representations, Point- Based Representation, Volumetric Representations, 3D Object Recognition, 3D Reconstruction, SIFT Algorithms. **Self-Learning Topics:** Explain 3D object recognition, alignments, Techniques like, Three-3D Object Recognition Schemes.	07	CO4
5	Introduction to Motion	Triangulation, Bundle Adjustment, Translational Alignment, Parametric Motion, Spline-Based Motion, Optical Flow, Layered Motion, Stereo from Motion, The Kalman Filter. **Self-Learning Topics:** Explore RAFT (Recurrent All-Pairs Field Transforms) and Flow Former for accurate motion estimation. Study algorithms like DeepSORT, and Transformer-based trackers for surveillance and autonomous driving.	06	CO5

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6	Applications and Case studies	Case study of Application: Face Recognition, Surveillance, Foreground Background Separation, Human Tracking, Image and Video Occlusion, Road Markings. **Self-Learning Topics:** computer vision in medical diagnostics , Security and surveillance, agriculture and Drone used for surveys.	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. Emeritus Roy Davies, Computer Vision: Principles, Algorithms, Applications, Learning, Academic Press, 5th Edition / 2017.
2. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, Pearson, 2nd Edition / 2012.
3. Simon. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 1st Edition / 2012.

References:

1. Mark. Nixon and Alberto. Aguado, Feature Extraction & Image Processing for Computer Vision, Academic Press, 4th Edition / 2020.
2. Ramesh. Jain, Rangachar Kasturi, Brain Schunck, Machine Vision, Indo American Books, 2016.

Online References:

Sr. No.	Website Name	URL
1	Swayam courses	https://onlinecourses.nptel.ac.in/noc22_cs89/preview
2	Coursera.org	https://www.coursera.org/learn/computer-vision-basics
3	onlinecourses.nptel	https://onlinecourses.nptel.ac.in/noc19_ee55/preview https://onlinecourses.nptel.ac.in/noc19_cs58/preview

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461141	Software Testing and Quality Assurance	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					
23461141	Software Testing and Quality Assurance	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To understand fundamental concepts of software testing, STLC, bug life cycle, and verification and validation in software quality assurance.
2	To understand black box and white box testing techniques and validation levels.
3	To understand test management practices, software testing metrics, and test suite management for effective testing processes.
4	To understand test automation concepts, tool selection criteria, and the use of software testing tools.
5	To understand how testing methods can be used in a specialized environment.
6	To understand software quality management concepts, quality factors, and quality standards.

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 testing concepts, STLC phases, bug classification, and apply verification and validation techniques to ensure software quality.	L1, L2
2	Apply testing techniques and validation methods to detect defects in software.	L1, L2,L3
3	Apply test planning, testing metrics, and test suite prioritization techniques to manage the software testing process effectively.	L1, L2, L3
4	Use appropriate automation testing tools and strategies to support the software testing process.	L1, L2, L3
5	Apply the software testing techniques in the real time environment.	L1, L2, L3
6	Explain quality factors and apply quality standards such as ISO and Six Sigma for improving software quality.	L1, L2

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping

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0	Prerequisites	Software Engineering Concepts, Basics of programming Language	02	-
1	Testing Methodology	Introduction: Goals of Software Testing, Software Testing Definitions (Error, Defect, Failure, Root Cause), Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies, Software Testing Terminology, Software Testing Life Cycle (STLC), Classification of Bugs and its Life Cycle, Software Testing methodology Verification and Validation: Verification and Validation concept, activities, and their role in early defect prevention, Verification requirements, Verification of high level design, Verification of low level design, validation. **Self-Learning Topics:** Study any system/application, find requirement specifications and design the system. Select software testing methodology suitable to the application.	07	CO1
2	Testing Techniques	Dynamic Testing: Black Box Testing: Boundary Value Analysis, Equivalence Class Testing, State Table Based testing, Cause-Effect Graphing Based Testing, Error Guessing. White Box Testing Techniques: need, Logic Coverage Criteria, Basis Path Testing, Graph Matrices, Loop Testing, Data Flow testing, Mutation testing. Static Testing Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing. Regression Testing: Progressive vs. Regressive, Regression Testing, Regression Testability, Objectives of Regression Testing, Regression Testing Types, Define Problem, Regression Testing Techniques. **Self-learning Topics:** Select the test cases (positive and negative scenarios) for the selected system and Design Test cases for the system using any two studied testing techniques.	09	CO2
3	Managing the Test Process	Test Management: test organization, structure and of testing group, test planning, detailed test design and test Specification. Software Metrics: need, definition and Classification of software matrices. Testing Metrics for Monitoring and Controlling the Testing Process: attributes and corresponding	08	CO3

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		metrics, estimation model for testing effort, architectural design, information flow matrix used for testing, function point and test point analysis. Efficient Test Suite Management: minimizing the test suite and its benefits, test suite minimization problem, test suite prioritization its type, techniques and measuring effectiveness. Root Cause Analysis (RCA) **Self-Learning Topics:** Design quality matrix for your selected system		
4	Test Automation	Automation and Testing Tools: need, categorization, selection and cost in testing tool, Test Automation Strategy & ROI, guidelines for testing tools. Study of testing tools: JIRA, Bugzilla, TestDirector and IBM Rational Functional Tester, Selenium, Apache JMeter etc. **Self-Learning Topics:** Write down test cases, execute and manage using studied tools	05	CO4
5	Testing for specialized environment	Agile Testing: Agile Testing and its Life Cycle, Testing in Scrum phases, Challenges in Agile Testing Testing Web based Systems: Web based system, web technology evaluation, differences between traditional software and web based software, and challenges in testing for web based software, strategies for testing web-based applications. **Self-Learning Topics:** AI Assisted Testing, Advance automation testing	04	CO5
6	Quality Management	Software Quality Management: Relationship between Testing, Quality Assurance, and Quality Management Product Quality: McCall's quality factors and criteria. Process Quality: Overview of ISO9000:2000 and SIX sigma **Self-Learning Topics:** Case Studies to Identify Quality Attributes Relationships for different types of Applications (Web based, Mobile based etc.)	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:

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1. Naresh Chauhan, Software Testing Principles and Practices, Oxford University Press, 2nd Edition.
2. Kshirasagar Naik, Priyadarshi Tripathy, Software Testing and quality assurance theory and practice, Wiley Publication, 1st Edition.

References:

1. Willam E. Perry, Effective Methods for Software Testing, Wiley Publication, 3rd Edition
2. Nageswara Rao Pusuluri, Software Testing Concepts and Tools, Dreamtech press, 2006.
3. Glenford J. Myers, Corey Sandler, Tom Badgett, The Art of Software Testing, Wiley Publication, 3rd Edition

Online References:

Sr. No.	Website Name	URL
1	Swayam	https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed75
2	Coursera	https://www.coursera.org/specializations/software-testing-automation
3	NPTEL	https://nptel.ac.in/courses/106105150
4	Selenium	https://www.selenium.dev/
5	Apache	https://jmeter.apache.org/usermanual/index.html
6	Atlassian	Collaboration software for software, IT and business teams | Atlassian

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461142	Natural Language Processing	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					
23461142	Natural Language Processing	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To understand the fundamentals of Natural Language Processing and linguistic knowledge levels.
2	To apply text pre-processing and statistical language modelling techniques.
3	To understand vector space semantics and word representation models.
4	To implement and compare text classification techniques.
5	To understand morphological processing techniques.
6	To understand Syntax analysis and Discourse techniques.

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 levels of NLP, ambiguity, and challenges in language processing.	L1,L2
2	Apply text pre-processing and language modelling techniques.	L1,L2, L3
3	Apply morphological and syntactic parsing techniques.	L3
4	Analyse syntax and discourse techniques.	L5
5	Analyse semantic vector representations and embedding models.	L3,L4
6	Evaluate text classification models.	L3

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Probability & Statistics basics, Automata Theory: Regular Expression, Finite Automata, Machine Learning Fundamentals	02	-
1	Introduction to NLP	Introduction to Natural Language Processing (NLP) system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP.	06	CO1

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		Self-Learning Topics: NLP applications in Indian languages, Low-resource NLP		
2	Text Processing	Word Tokenization and Segmentation, Lemmatization, Bag of words, N-gram language model, N-gram for spelling correction. Edit distance Dynamic Programming Approach, Weighted Edit Distance, Finding Dictionary Entries with Small Edit Distances, Noisy Channel Model, Non-word errors Real-word errors. Evaluation of Language Models. **Self-Learning Topics:** Subword tokenization (BPE)	06	CO2
3	Computational Morphology	Morphological Processes, Morphological Analysis- Inflectional morphology & Derivational morphology, Regular expression, Finite State Automata, Finite State Transducer, Morphological parsing with FST, Lexicon free FST Porter stemmer, Two - level Morphology. **Self-Learning Topics:** Morphological analysers for Hindi/Marathi	06	CO5
4	Syntax Analysis	Introduction to POS Tagging, Probabilistic Tagging, Markov Models, Hidden Markov Models (HMM) for POS Tagging, Conditional Random Fields (CRF), Named Entities and Named Entity Tagging, Context-Free Grammars-Derivation **Self-Learning Topics:** Regional Languages POS Tree Bank	06	CO3
5	Semantic Parsing and Lexical Semantics	Words and Vectors, Term Frequency-Inverse Document Frequency (TFIDF), Word2vec, Continuous Bag of Words, ELMO, GloVe Vector Visualizing Embedding's, Semantic properties of embedding's, Bias and Embedding's Evaluating Vector Models, Cosine for measuring similarity, Pointwise Mutual Information (PMI), PPMI vector models. Word Senses -Relations Between Senses, WordNet: A Database of Lexical Relations, Word Sense Disambiguation Alternate WSD algorithms and Tasks. Constituency Parsing, Dependency Parsing, Discourse Coherence: Coherence Relation, Discourse Structure Parsing, Centering and Entity-Based Coherence, Global Coherence.	07	CO3,CO6

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		Self-Learning Topics: Bias mitigation in embeddings, Cross-lingual embeddings. Prompt Engineering, Large Language Models (LLMs).		
6	Text Classification	Text classification definition and datasets, Generative text classifiers (Naïve Bayes) Discriminative text classifiers (Support Vector Machine), Bag-of-words Generative Classifier, BOW Discriminative Model, Multi-class Classification: Softmax, Gradient Descent, Statistical significance testing, Dataset understanding and creation. **Self-Learning Topics:** Transformer-based classification	06	CO4
			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. Daniel Jurafsky & James H. Martin, Speech and Language Processing, Pearson, 3rd Edition / 2000.
2. Steven Bird, Ewan Klein & Edward Loper, Natural Language Processing with Python, O'Reilly, 2009.
3. Yoav Goldberg, Neural Network Methods for NLP, Morgan & Claypool, 2017.

References:

1. Christopher Manning & Hinrich Schütze, Foundations of Statistical NLP, The MIT Press, 1999.
2. Jacob Eisenstein, Introduction to NLP, MIT Press, 2019.

Online References:

Sr. No.	Website Name	URL
1	Stanford NLP	https://nlp.stanford.edu/
2	Hugging Face	https://huggingface.co/
3	NLTK Documentation	https://www.nltk.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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461143	Ethical Hacking and Digital Forensics	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					
23461143	Ethical Hacking and Digital Forensics	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To understand the penetration testing and principles behind ethical hacking.
2	To understand reconnaissance strategies and vulnerability scanning techniques for identifying system security weaknesses.
3	To explain the fundamentals of digital forensics, digital evidence and incident response.
4	To apply forensic duplication techniques and analyze digital evidence
5	To understand the network attacks along with tools and techniques required to perform network forensics.
6	To generate a forensics report after investigation.

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	Define and describe the fundamental concepts of Ethical Hacking and Penetration Testing.	L1
2	Explain reconnaissance and vulnerability assessment concepts and interpret security weaknesses identified through scanning methodologies.	L2, L3
3	Explain digital forensic principles, evidence handling procedures, and the incident response process in cyber investigations.	L2, L3
4	Apply forensic duplication and evidence acquisition techniques for the collection and analysis of digital evidence.	L3, L4
5	Analyse digital evidence from routers, logs, and mobile devices to reconstruct incidents.	L4
6	Analyse digital investigation findings and organize them into logically structured, legally defensible documentation.	L5

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Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Networks, Basics of Cryptography, Overview of cybersecurity	01	-
1	Foundation of Ethical Hacking and Penetration Testing	Introduction to Ethical Hacking, Goals of Ethical Hacking, Types of Hackers: White Hat, Black Hat, Grey Hat, Phases of Ethical Hacking, Difference between Hackers, Crackers and Phreakers, Social Engineering Attacks. Introduction to Vulnerability Assessment and Penetration Testing (VAPT), Need for Vulnerability Assessment, Types of Penetration Testing, Penetration Testing Methodologies (PTES, OSSTMM, NIST), Difference between VA and PT. Impact of cybercrime on e-governance and e-commerce. **Self-Learning Topics:** Exploring various Social Engineering tools like *Social-Engineer Toolkit (SET), Call Spoofing Tools, Browser Exploitation Framework* (BeEF), penetration testing tools like *Metasploit, Burp Suite*	04	CO1
2	Reconnaissance, Scanning and Vulnerability Assessment	Information Gathering, Footprinting, Vulnerability Scanning and Enumeration, Password cracking, keyloggers (SN), Active Vs. Passive Vulnerability scanning, Enumeration Techniques: SNMP, SMB, LDAP, DNS Enumeration. Network Scanning Techniques: Port Scanning, Service Detection **Self-Learning Topics:** Exploring the Google Dorking & Search Engine Reconnaissance, Reconnaissance Automation using scripting (Python/Bash basics)	06	CO2
3	Digital Forensics, Digital Evidences and Incident Response Fundamentals	**Introduction to Digital Forensics:** Need and Objectives of Digital Forensics, Phases involved in Digital Forensics, Types of Digital Forensics, Rules of Digital Forensic, Anti Forensics, Role of AI in Digital Forensics **Introduction to Digital evidences:** Digital Evidence and its Types, Rules of Digital Evidences, Chain of Custody, Challenges in digital evidence Handling. **Incident Response Process:** Incident and Incident Response, Incident Response Methodology, Roles of CSIRT in handling incident.	06	CO3

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		Self-Learning Topics: Exploring Cloud Forensics (*AWS, Azure, GCP environments*), Digital Evidence Admissibility in Cyber Law, Zero Trust Architecture & Incident Handling.		
4	Forensic Duplication and Computer Forensic	**Forensic Duplication:** Forensic Image Formats, Traditional Duplication Vs Forensic duplication, Need for the forensic duplication, Live System Duplication, Data imaging and hashing, Image Acquisition, File Recovery & Data Carving. **Computer Forensics:** Introduction to Computer Forensics, Evidence collection (Disk and file system, Memory, Registry, Logs etc), Evidence Analysis and Examination (Window, Linux, Email, Web, Malware), Media Analysis Hard drives, RAM, flash memory, PDAs etc, AI-Assisted Disk and Memory Analysis, Challenges in Computer Forensics, **Self-Learning Topics:** Explore the Hardware Write-Blockers & Forensic Imaging Tools and Forensic Duplication for IoT Devices *Chip-off imaging, JTAG based acquisition*	10	CO4
5	Network and Mobile Forensic	**Network Forensics:** Introduction, Exploiting Network Based Vulnerabilities: DNS Cache Poisoning, SNMP Exploits, SMTP Exploits, FTP Exploits. Sources of Network based evidences, Investigating Routers. Introduction to Wireless forensics, exploiting wireless vulnerabilities, Wireless Network Hacking: WEP, WPA, WPA2 Attacks, Tools used in network forensics, Challenges in Network forensics, **Mobile Forensics:** Introduction, Evidence Collection and Acquisition, Analysis of Evidences, Challenges in mobile forensics, Tools used in mobile forensics, Traditional Mobile Forensics vs AI-Enabled Mobile Forensics. **Self-Learning Topics:** Exploring Wireless Hacking Tools, Evil Twin Attacks (Rogue Access Points) and Tools / Techniques used in mobile forensics	08	CO5

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6	Report Generation	Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report. Self-Learning Topics: For an incident write a forensic report and understand Documentation standards in cyber investigations	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. Cory Altheide, Harlan Carvey, Digital forensics with open source tools, Syngress Publishing Inc., 2011.
2. John Sammons, The Basics of Digital Forensics: The Premier for Getting Started in Digital Forensics, Syngress, 2nd Edition, 2015.
3. Clint P Garrison, Digital Forensics for Network, Internet, and Cloud Computing: A forensic evidence guide for moving targets and data, Syngress Publishing, Inc., 2010.
4. Bill Nelson,Amelia Phillips,Christopher Steuart, Guide to Computer Forensics and Investigations, Cengage Learning, 2014.
5. Debra Littlejohn Shinder Michael Cross Scene of the Cybercrime: Computer Forensics.Handbook, Syngress Publishing, Inc., 2nd Edition / 2008.

References:

1. Saurabh Kumar Pandey, Cyber Security and Ethical Hacking, New Delhi, India: Wiley India, 2019.
2. Dr. Vivek Sood, Computer Security and Cyber Laws. New Delhi, India: McGraw Hill Education India, 2019.

Online References:

Sr. No.	Website Name	URL
1	Coursera	Course Title: Introduction to Cybersecurity Tools & Cyberattacks https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks
2	Google Dorking & OSINT Recon	Overview of reconnaissance concepts and Google dork examples https://github.com/Vanessapan001/pentest-1-Introduction-to-Pentesting-and-OSINT
3	Suviksan L&D Winter Training 2025	active vs passive recon, vulnerability scanning overview https://www.nielit.gov.in/sites/default/files/Patna/Winter%20Training%20PPT%20%26%20Broucher%20Content.pdf?utm_source=chatgpt.com
4	Terabyte Systems	Penetration Testing tools: https://terabyte.systems/posts/essential-penetration-testing-tools-security-professionals/?utm_source=chatgpt.com

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.

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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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461144	Augmented Reality / Virtual Reality	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					
23461144	Augmented Reality / Virtual Reality	20	20	40	60	02	---	---	100

Course Objectives:

Sr. No.	Course Objectives
1	To introduce the fundamental principles AR-VR-MR
2	To understand the techniques and tools used in AR,VR, MR, and ER for developing AR applications.
3	To familiarize students with industry-standard development environments to facilitate hands-on learning and describe the technology for multimodal user interaction and authoring in AR
4	To enable students to understand the pipeline of 3D modelling, texturing, and real-time rendering specifically optimized for immersive headsets.
5	To enable students to understand the virtual world representation and rendering techniques.
6	To familiarize students with interaction techniques, navigation methods, and emerging VR technologies along with associated ethical, safety, and usability considerations.

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	Identify and compare different Augmented Reality and Mixed Reality Technologies.	L1,L2
2	Demonstrate proficiency in setting up and navigating industry-standard development environments and SDKs for XR.	L1,L2
3	Analyse Augmented Reality applications using appropriate authoring tools, interface principles, and emerging AR technologies	L3
4	Describe the architecture, components, and working principles of Virtual Reality systems and associated hardware interfaces.	L1, L2
5	Apply visual, aural, and haptic rendering techniques for representing and generating immersive virtual environments.	L1,L2,L3
6	Evaluate interaction methods, navigation techniques, and emerging VR technologies while considering issues such as cybersickness, safety, and ethical implications.	L5

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Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	C Programming	02	-
1	Introduction to Augmented Reality (AR)	Definition and Scope, A Brief History of Augmented Reality, Architecture of AR, Related Fields of AR (like Mixed Reality, Virtual Reality, Immersive Reality, Extended Reality) and Their comparison, General Architecture of Mixed Reality System, Algorithm Steps in Mixed Reality, Displays (Multimodal Displays, Spatial Display Model, and Visual Displays), Strong vs Weak AR, Augmented Reality Hardware (Sensors, Processors, Displays), Ingredients of an AR Experience Dimensionality, Depth Cues, Registration and Latency, Working of Augmented Reality, Applications of AR, Challenges in AR. **Self-Learning Topics:** Case study of a single application using AR technologies	05	CO1
2	Augmented Reality Software and Mobile Augmented Reality	Software Components, Software Tools for Content Creation, Interaction in Augmented Reality, Augmented Reality Techniques: Marker based and Marker less tracking, Markerless Tracking & SLAM, Mobile Augmented Reality, Advanced Spatial Concepts, Output Modalities, Input Modalities, Tangible Interfaces, Virtual User Interfaces on Real Surfaces, Multi-view Interfaces, Haptic Interaction, Multimodal Interaction. **Self-Learning Topics:** Explore Augmented Reality Software and Mobile Augmented Reality	06	CO2
3	Authoring Techniques and Design Considerations in Augmented Reality	Requirement of AR Authoring, Elements of Authoring, Stand-alone, Authoring Solutions, Plug-in Approaches, Web Technology and dynamic content, AR applications and future visions, Designing an AR application, Technology adoption and acceptance, applications augmented reality. **Self-Learning Topics:** Case study on use of OpenCV for AR App Development	06	CO3
4	Introduction to Virtual Reality	History of VR and MR, Classical components and design of a VR system, Important factors in a virtual reality system, Types of virtual reality systems, advantages of virtual reality, VR Input devices, Graphics display interfaces, Sound	07	CO4

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		display and interface, Examples of input devices, Haptic feedback, Graphical rendering pipeline, Haptic rendering pipeline, OpenGL rendering pipeline, Applications of virtual reality. **Self-Learning Topics:** Feedback mechanisms in VR environment.		
5	Representing and Rendering the Virtual World	Representation of Virtual World: Visual Representation in Virtual Reality, Aural and Haptic Representation in Virtual Reality. Rendering Systems: Visual Rendering Systems: Visual Rendering Methods, Geometrically Based Rendering Systems, Non-geometric Rendering Systems, Rendering Complex Visual Scenes, Computer Graphics System Requirements. Aural Rendering Systems: Visual Rendering Methods, Rendering Complex Sounds, Sound-Generation Hardware, Internal Computer Representation. Haptic Rendering Systems: Haptic Rendering Methods, Rendering Complex Haptic Scenes with Force Displays, Haptic Rendering Techniques, Culling Techniques, Anti-Aliasing in VR: Multi-sample Anti-Aliasing (MSAA) vs. Post-processing effects.Introduction to Real-time rendering techniques, Graphics processing units (GPU) in VR **Self-Learning Topics:** Foveated Rendering in Virtual Reality, Spatial Audio Rendering Techniques in VR.	07	CO5
6	Interacting with the VR and VR Experience	User Interface Metaphors, manipulating a Virtual World, Properties of Manipulation, Manipulation Operations, navigating in a Virtual World-Way finding and Travelling, Classes of Travel Methods Interacting with Others-Shared Experience, Collaborative Interaction, interacting with the VR System, Immersion, distinguishing between technical capabilities (Immersion) and the psychological state of "being there" (Presence). Latency & Fidelity: The importance of "Motion-to-Photon" latency (the <20ms rule) to maintain immersion. The "Uncanny Valley" in XR: Why hyper-realism can sometimes backfire in user experience.	06	CO6

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		Musculoskeletal Issues: Emerging VR Technologies: Metaverse platforms, Digital twins, Spatial computing, VR in Industry 4.0 Ethics, Privacy & Safety Standards, Cybersickness (VRSickness), Visual Pathologies, Musculoskeletal Issues. **Self-Learning Topics**: study of Haptic rendering techniques and immersive interaction systems.		
			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. Rajesh K. Maurya, Computer Graphics with Virtual Reality, Wiley India Publication, 2018.
2. William R Sherman and Alan B Craig, Understanding Virtual Reality: Interface, Application and Design", (The Morgan Kaufmann Series in Computer Graphics), Morgan Kaufmann Publishers, San Francisco, CA, 2002.
3. Steven M. LaValle, Virtual Reality, Cambridge University Press, 2016.
4. Dieter Schmalstieg and Tobias Höllerer, Principles and Practice - Augmented Reality, Addison-Wesley, 2016.
5. Sanni Siltanen, Theory and applications of marker-based augmented reality, Julkaisija –Utgivare. 2012.
6. Allan Fowler, William Sherif, Beginning iOS AR Game Development: Developing Augmented Reality Apps with Unity and C#, Apress Publications, 1st Edition / 2018.

References:

1. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
2. Grigore C. Burdea and Philippe Coiffet, Virtual Reality Technology, Wiley India Publication, 2003.
3. Tony Parisi, Learning Virtual Reality, O'Reilly Media, 2015.
4. Steve Aukstakalnis, Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley Professional, 2016

Online References:

Sr. No.	Website Name	URL
1	Swayam	https://nptel.ac.in/courses/106/106/106106138/
2	Coursera	https://www.coursera.org/learn/introduction-virtual-reality
3	Oculus	Oculus VRC (Virtual Reality Check) Guidelines: A checklist used by professional developers to ensure their apps don't cause motion sickness or physical strain.
4	Coursera	https://www.coursera.org/learn/augmented-reality https://www.coursera.org/specializations/unity-xr
5	XR Association (XRA) Developers Guide	XR Association (XRA) Developers Guide: Focuses on the "Safety and Wellbeing" standards for the industry, including accessibility and physical safety.

Assessment:

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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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2346115	Security and Blockchain Technology 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					
2346115	Security and Blockchain Technology Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To provide hands-on experience with classical and modern cryptographic techniques used in information security.
2	To develop the ability to analyze common cybersecurity threats and vulnerabilities using security tools.
3	To configure and operate a local blockchain development environment.
4	To design, implement, and test smart contracts using Solidity and blockchain development frameworks.
5	To develop decentralized applications (DApps) by integrating blockchain smart contracts with Web3 technologies.
6	To apply blockchain technology for solving real-world enterprise problems through a domain-based mini project.

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	Implement and analyze classical and modern cryptographic algorithms.	L3
2	Analyze and evaluate authentication mechanisms and perform security analysis using practical tools.	L4
3	Set up and operate a local blockchain network for smart contract testing.	L3
4	Develop and deploy smart contracts using Solidity and blockchain development tools.	L5
5	Design and integrate decentralized applications with Web3 frameworks.	L5
6	Develop a blockchain-based solution for enterprise use cases through a capstone project.	L5

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Hardware & Software Requirements:

Hardware Requirement:	**Software Requirement:**
PC with following Configuration 1. Intel Core i3/i5/i7 Processor 2. 8 GB RAM 3. 500 GB Harddisk	1. Windows or Linux Desktop OS 2. Python / Java / Node.j 3. Solidity Compiler 4. Remix IDE 5. MetaMask Wallet 6. Web3.js or Web3.py

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Basic programming in Java, Python, JavaScript	02	-
1	Security Fundamentals, and Cryptography	**Contents:** Classical Ciphers (Vigenère, Playfair). **Practical:** 1. Implementation of monoalphabetic substitution cipher and cryptanalysis using frequency analysis. 2. Encrypt and decrypt messages using Playfair and Vigenère algorithms and analyze their security limitations. **Self-Learning Topics:** Study of more classical cryptanalysis techniques, cryptographic attack models.	02 02	LO1
2	Hashing, Encryption and Authentication	**Contents: R**SA implementation, Digital Signatures: RSA, DSS, SHA-256 hashing, HMAC implementation, and applications. **Practical:** 1. Implementation of RSA algorithm for encryption/decryption and demonstrate digital signature creation and verification 2. Implementation of SHA-256 hashing and HMAC authentication to verify data integrity. **Self-Learning Topics:** Recent malware studies, Digital forensics basics, Phishing and Social Engineering trends.	02 02	LO2
3	Foundations of Blockchain (Local)	**Contents:** Blockchain definition, characteristics, & key concepts. Block structure: Block definition, header components, block hash, block height, Genesis block, Merkle tree, linking blocks in the Blockchain. **Practical:**	02 02	LO3

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		1. Implementation of simple blockchain in Python/Java demonstrating block structure, hashing, and block linking. 2. Implementation of Merkle Tree structure to verify transaction integrity in blockchain systems. **Self-Learning Topics:** Alternate Consensus algorithms, Interoperability in blockchain.		
4	Smart Contract Development and Remix IDE	**Contents:** Solidity development environment setup, basic programming concepts, program structure, variables and data types, functions and modifiers, Metamask (Ethereum Wallet) setup, deployment on test networks **Practical:** 1. Write and test a simple smart contract using Remix IDE and MetaMask wallet. **Self-Learning Topics:** Smart Contract development using Java and Python, Property registry.	02	LO4
5	Smart Contract Deployment and Dapp integration	**Contents:** Smart Contract Deployment on Ganache blockchain simulator / other test networks, integration with Dapp. Web3.js / Web3.py integration, Ethereum Test Networks (Sepolia), **Practical:** 1. Deploy the developed smart contract on Sepolia/Polygon testnet and interact with it using MetaMask. 2. Build a simple Dapp integrating smart contracts with Web3.js/Web3.py interface. **Self-Learning Topics:** Polygon Testnet, Cryptocurrencies, and NFT contracts.	02 02	LO5
6	Capstone-project based on Enterprise use cases	**Contents:** Capstone Project Implementation & Demonstration based on the application of blockchain in different domains (Education, Insurance, Energy). **Practical:** 1. Design and Implementation of domain-based blockchain solution (Education, Supply Chain, Insurance, etc.).	06	LO6
		Total	**26**	

<u>Text Books</u>:

1. William Stallings and Lawrie Brown, Computer Security, Principles and Practice, Pearson, 4th Edition
2. Mayukh Mukhopadhyay, Ethereum Smart Contract Development, Packt Publication, 2018.

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3. Ritesh Modi, Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Packt Publication, 1st Edition / 2018.
4. Akhil Mittal, Smart Contract Development with Solidity and Ehthereum, BPB Publication, 1st Edition / 2020.

References:

1. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security + Hands-on Information Security Lab Manual, 4th Edition / 2011.
2. Chris Dannen, Introducing Ethereum and Solidity, APress, 1st Edition / 2017.
3. Kevin Solorio, Randall Kanna & David Hoover, Hands-On Smart Contract Development with Solidity and Ethereum, O'Reilly Media, 2019.

Online References:

Sr. No.	Website Name	URL
1	IIT Virtual Labs	IITB virtual Lab: http://cse29-iiith.vlabs.ac.in/
2	Blockchain demo	https://andersbrownworth.com/blockchain/
3	Public / Private Keys	https://andersbrownworth.com/blockchain/public-private-keys/
4	Solidity Documentation	https://docs.soliditylang.org
5	Truffle	https://trufflesuite.com/
6	Remix IDE	https://remix.ethereum.org/
7	Polygon testnet	https://faucet.polygon.technology/
8	Metamask	https://metamask.io/

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2346116	Cloud Computing 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					
2346116	Cloud Computing Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To understand the key concepts of virtualization and containerization.
2	To analyze cloud cost and Total Cost of Ownership (TCO) using tools provided by Amazon Web Services.
3	To implement Infrastructure as a Service (IaaS) by configuring compute, storage, and networking resources in cloud environments.
4	To explore cloud service models (PaaS and SaaS) and apply Infrastructure as Code (IaC) techniques for efficient cloud provisioning and management.
5	To develop and deploy event-driven applications using serverless computing (Function as a Service - FaaS) on cloud platforms.
6	To understand cloud security issues and implement basic measures to mitigate security threats.

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	Implement virtualization and containerization techniques in cloud environments.	L3
2	Estimate cloud costs, compare them with traditional systems, and analyze cloud economics concepts.	L4
3	Provision and configure compute, storage, and networking resources using Infrastructure as a Service (IaaS).	L3
4	Apply cloud service models (PaaS and SaaS) and Infrastructure as Code (IaC) for deploying and managing cloud resources.	L3
5	Develop and deploy event-driven serverless applications using Function as a Service (FaaS).	L3
6	Analyze cloud security issues and apply appropriate mechanisms to mitigate them.	L4

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Hardware & Software Requirements:

Hardware Requirement:	**Software Requirement:**
PC with following Configuration, Intel Core i5/i7, Minimum 8 GB RAM & recommended 16 GB RAM, 500 GB Hard disk	Operating System Cloud Platforms

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites			-
1	Cloud Computing Overview, Virtualization & Containerization	**Contents:**Introduction and overview of Cloud Computing, Virtualization & Containerization **Practical:** 1. To study and implement Hosted Virtualization using VirtualBox. 2. To study and Implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi. 3. To install and configure containerization tools such as Docker and Podman, create custom container images, and deploy containerized applications, and to integrate with cloud-based container registry services (such as Amazon Elastic Container Registry ECR) to understand lightweight virtualization and cloud container deployment. **Self-Learning Topics:** Comparison of Type-1 and Type-2 hypervisors with real-world use cases	06	LO1
2	Cloud Economics and Cost Management	**Contents:** Cloud Economics and Cost Management **Practical:** 1. To estimate and analyze cloud computing costs and Total Cost of Ownership (TCO) using cloud cost management tools. **Self-Learning Topics:** Understanding Service Level Agreements (SLA) in Cloud Computing	02	LO2
3	Infrastructure as a Service	**Contents:** Infrastructure as a Service **Practical:** 1. To provision and configure virtual compute instances on a cloud platform under Infrastructure as a Service using AWS/Microsoft Azure/Google cloud. 2. To deploy and host a static website on cloud virtual machines (IaaS model).	04	LO3

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		Self-Learning Topics: Key components of Infrastructure as a Service (IaaS): Virtual machines, Storage, and Networking		
4	Platform as a service, Software as a Service, Infrastructure as a Code	**Contents:** Platform as a service, Software as a Service, Infrastructure as a Code **Practical:** 1. To study and Implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service. 2. To design and deploy a generative AI based content generation application using managed cloud foundation models 3. To automate cloud resource provisioning and management using Infrastructure as Code (IaC) principles by integrating Terraform with cloud platforms such as Amazon Web Services / Microsoft Azure / Google Cloud Platform. **Self-Learning Topics:** Architecture and key features of Platform as a Service (PaaS) for application development and deployment, Use cases of PaaS and SaaS in real-world applications	06	LO4
5	Serverless Computing	**Contents:** Serverless Computing **Practical:** 1. To develop and deploy an event-driven serverless application using Function as a Service (FaaS) by implementing cloud functions with AWS Lambda, Azure Functions, and Google Cloud Functions 2. To configure monitoring alerts that trigger serverless functions, which in turn send automated notifications using AWS SNS, Azure Service Bus, and Google Cloud Pub/Sub, thereby understanding event-driven serverless architectures. **Self-Learning Topics:** Comparison of serverless computing with traditional and VM-based architectures	04	LO5
6	Cloud Security	**Contents:** Cloud Security **Practical:** 1. To study and Implement Security as a Service on AWS/Azure. 2. To implement Identity and Access Management (IAM) practices on AWS/Microsoft Azure/ Google Cloud Platform.	04	LO6

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		3. To implement security mechanisms such as Multi-Factor Authentication (MFA) and Security Group configurations using Amazon Web Services / Microsoft Azure /Google Cloud Platform to enhance access control and network security. **Self-Learning Topics:** Shared Responsibility Model in cloud security, Security challenges in multi-tenant cloud environments		
		Total	**26**	

Text Books:

1. Bernard Golden, Amazon Web Services for Dummies, John Wiley & Sons, Inc., 2013.
2. Michael Collier, Robin Shahan, Fundamentals of Azure, Microsoft Azure Essentials, Microsoft Press, 2015.
3. Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Mastering Cloud Computing, Tata McGraw-Hill Education, 2013.
4. Barrie Sosinsky, Cloud Computing Bible, Wiley publishing, 1st Edition / 2011.
5. John Paul Mueller, AWS for Admins for Developers, John Wiley & Sons, Inc., 1st Edition / 2016.
6. Ken Cochrane, Jeeva S. Chelladhurai, Neependra Khare, Docker Cookbook, Packt Publication, 2nd Edition.
7. Jonathan Baier, Getting Started with Kubernetes, Packt Publication, Second Edition / 2018.

References:

1. Aurobindo Sarkar and Amit Shah, Learning AWS: Design, Build, and Deploy Responsive Applications Using AWS Cloud Components, Packt Publishing, 2nd Edition / 2015.

Online References:

Sr. No.	Website Name	URL
1	AWS	https://docs.aws.amazon.com/
2	MS Azure	https://docs.microsoft.com/en-us/azure
3	NIST Cloud computing Reference Architecture	https://www.nist.gov/system/files/documents /itl/cloud/NIST_SP-500-291_Version2_2013_June18_FINAL.pdf

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461171	Advance Web Technology 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					
23461171	Advance Web Technology Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To understand fundamental concepts of TypeScript including data types, control structures, functions, classes, and modules.
2	To explore core concepts of AngularJS such as modules, directives, controllers, and routing.
3	To describe the practical use of Angular components, directives, services, routing, forms, and HTTP client in building web applications.
4	To provide practical knowledge for designing and developing web applications using Next.js.
5	To perform basic REST API using FastAPI framework.
6	To explore SEO tools for analysing, monitoring, and optimizing website performance and search engine visibility.

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	Develop TypeScript application using variables, functions, object-oriented concepts, and modules.	L3
2	Develop dynamic web applications using AngularJS components.	L3
3	Construct Angular applications using components, services, routing, form validation.	L3
4	Develop dynamic web applications using Next.js features.	L3
5	Apply FastAPI concepts to design and implement REST APIs.	L3
6	Utilize SEO tools to analyze and optimize website performance for improved search engine ranking and visibility.	L3

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
Intel i5/i7 Processor, 8 GB or more RAM, a stable internet connection for installing	Visual Studio Code (VS Code), Nodejs, NPM, MongoDB, Postman, FASTAPI,Angular,Next.js

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packages, accessing, and deploying applications. The system should support Windows 10/11 or Linux operating system	

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Web Technology Fundamentals	02	-
1	Typescript	**Contents:** Introduction to TypeScript, environment setup, working with data types, variables, and operators, implementing decision-making statements and loops, developing functions, creating classes and objects using object-oriented concepts, and organizing code using TypeScript modules. **Practical:** 1. To develop programs using let, const, and different operators (arithmetic, relational, logical) in TypeScript. 2. To create a TypeScript class with properties, constructors, and methods and instantiate objects. 3. Implementation of inheritance using extends and demonstrate public, private, and protected access modifiers. 4. To create and import/export modules in typescript. **Self-Learning Topics:** Error Handling in TypeScript.	06	LO1
2	AngularJS	**Contents:** AngularJS modules, built-in and custom directives, expressions, data binding, filters, controllers, and scope. form validation, routing using ng-Route (including ng-view), use of directives such as ng-repeat and ng-style, built-in helper functions, and integration of AngularJS with TypeScript. **Practical:** 1. To create a form-based application to demonstrate two-way data binding in Angular Js. 2. To develop a multi-page Single Page Application (SPA) using routing (ng-route) in Angular Js.	06	LO2

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		3. To build an application demonstrating built-in filters such as currency, date, uppercase, lowercase, and limitTo in Angular Js. **Self-Learning Topics:** Advanced routing configuration		
3	Angular	**Contents:** Angular architecture, components, modules, templates, data binding, directives, pipes, services with dependency injection, HTTP client with RxJS, and basics of state management, testing, and deployment. **Practical:** 1. To develop an Angular application using multiple components and demonstrate component interaction. 2. To create application using built-in directives such as *ngIf, *ngFor, and ngClass 3. To develop an Angular application that uses HTTP Client with RxJS to fetch data from a REST API and implement basic state management to store and share the retrieved data across components **Self-Learning Topics:** State Management using NgRx and Angular material	04	LO3
4	Next.js	**Contents:** Introduction to Next.js & Setup, Next.js Basics and Built-In Components, Pages and Routing, Styling in Next.js, Data Fetching Methods, Optimizing Next.js Applications, State Management, Testing Next.js, API Routes. **Practical:** 1. To design and develop a web application using Next.js implementing styling and data fetching (SSG/SSR). 2. To design and develop a web application using Next.js implementing file-based routing, dynamic routing, API routes, and navigation **Self-Learning Topics:** MongoDB with Next.js	04	LO4
4	FastAPI	**Contents:** Introduction to FastAPI, REST APIs with FastAPI, Working with Data and Files in FastAPI, Handling Request & Response Data in FastAPI,	04	LO5

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		Database Integration in FastAPI using MongoDB. **Practical:** 1. To develop a basic REST API using FastAPI for handling GET and POST requests and returning JSON responses. 2. To perform database integration in FastAPI using MongoDB for storing and retrieving data through REST API endpoints **Self-Learning Topics:** Swagger documentation of FastAPI.		
5	Search Engines and SEO	**Contents:** Website performance using SEO tools, Basic SEO strategies for web applications. **Practical:** 1. To install and explore SEO tools (matomo/Lighthouse/Google SEO) for optimizing website performance. **Self-Learning Topics:** Web analytic	02	LO6
		Total	**26**	

Text Books:

1. Boris Cherny, Programming TypeScript- Making Your JavaScript Application Scale, O'Reilly Media Inc, 1st Edition, 2019.
2. Adam Bretz and Colin J. Ihrig, Full Stack JavaScript Development with MEAN, SitePoint Pty. Ltd. 1st Edition, 2015.
3. Simon Holmes Clive Harber, Getting MEAN with Mongo, Express, Angular, and Node, Manning Publications,1st Edition, 2017.
4. Shubham Jain and Mathew Dony Chittezhath, Modern Web Applications with Next.JS, Orange Education, 1st Edition, 2023.
5. Peter Kent, SEO for Dummies, Wiley Publication, 7th Edition, 2020.

References:

1. Yakov Fain and Anton Moiseev, TypeScript Quickly, Manning Publications, 1st Edition, 2020.
2. Steve Fenton, Pro TypeScript: Application - Scale JavaScript Development, Apress, 2014.
3. Brad Dayley, Brendan Dayley, Caleb Dayley, Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications, Addison- Wesley Professional, 2nd Edition, 2018.
4. Michele Riva, Real-World Next.js: Build scalable, high-performance, and modern web applications using Next.js, the React framework for production, Packt Publishing Limited, 1st Edition, 2022.
5. Marko Aleksendrić, Shrey Batra, Rachelle Palmer, Shubham Ranjan, Full Stack FastAPI, React, and MongoDB, Packt Publishing, 2nd Edition, 2024

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Online References:

Sr. No.	Website Name	URL
1	AngularJs	https://angularjs.org
2	Udemy	https://www.udemy.com/course/understanding-typescript/
3	RealPython	https://realpython.com/fastapi-python-web-apis/
4	Google for Developers	https://developers.google.com/search/docs/fundamentals/seo-starter-guide

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461172	Deep Learning 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					
23461172	Deep Learning Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	Implement artificial neural network models using deep learning frameworks.
2	Apply backpropagation and optimization techniques for model training.
3	Develop CNN and RNN models for image and sequential data.
4	Perform data pre-processing and augmentation for deep learning tasks.
5	Evaluate and fine-tune deep learning models for improved performance.
6	Design and implement a mini project using deep learning techniques.

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	Implement artificial neural networks and perform forward and backward propagation.	L3
2	Develop and train deep neural network models using optimization techniques.	L5
3	CNN and RNN architectures for image and sequential data processing.	L4
4	Design deep learning solutions for computer vision and NLP applications.	L6
5	Evaluate model performance using appropriate metrics and tuning strategies.	L5
6	Build and present a complete deep learning mini project integrating preprocessing, training, and evaluation.	L6

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
Minimum: Intel Core i5 / AMD Ryzen 5, 8 GB RAM, 50 GB free storage (for local setup). Recommended: GPU-enabled system (NVIDIA GTX 1060 / RTX 3060+) with CUDA 11.8+ for deep learning practicals.	Python 3.9+ (Anaconda Distribution recommended for package management). Jupyter Notebook / JupyterLab or Google Colab (cloud-based, no GPU setup needed)

Detailed Syllabus:

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Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Basic Knowledge of Neural Networks and Optimization Concepts. Probability, Statistics and Calculus for DL.	02	-
1	Introduction to Deep Learning	**Contents:** Introduction to Artificial Neural Networks (ANN). Perceptron Model. Activation Functions (Sigmoid, ReLU, Tanh, Softmax). 1. To design and implement a Single Layer Perceptron model for solving a binary classification problem and analyze its learning behavior using different activation functions. **Self-Learning Topics:** Advanced optimization algorithms, weight initialization strategies.	02	LO1
2	Deep Neural Networks	**Contents:** Multi-Layer Perceptron (MLP). Weight initialization Techniques. Vanishing and Exploding Gradient Problem. Batch Normalization. Regularization Techniques (Dropout, L1, L2). 1. To implement a Multi-Layer Perceptron (MLP) using forward propagation and backpropagation algorithm for classification of a given dataset and evaluate model performance. 2. To implement and compare different optimization algorithms such as Gradient Descent, Stochastic Gradient Descent (SGD), and Adam optimizer for training a neural network and analyze convergence behavior. 3. To implement L1, L2 regularization and Dropout in a neural network model and compare model performance with and without regularization techniques. **Self-Learning Topics:** Degradation problem in deep networks.	04	LO2
3	Convolution Neural Networks	**Contents:** CNN Architecture (ResNet, DenseNet, EfficientNet). Transfer Learning and Fine-Tuning Strategies. 1. To design and implement a Convolutional Neural Network (CNN) model for image classification using a standard dataset and evaluate its accuracy and loss metrics. 2. To implement transfer learning using a pre-trained deep learning model and fine-tune it for a custom image classification task.	04	LO3

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		Self-Learning Topics: Object Detection (R-CNN, YOLO,SSD).		
4	Recurrent Neural Networks	**Contents:** RNN Architecture. Long Short-Term Memory (LSTM). Gated Recurrent Unit (GRU). 1. To design and implement a Recurrent Neural Network (RNN) for sequential data processing such as time series prediction or text classification. 2. To implement Long Short-Term Memory (LSTM) or Gated Recurrent Unit (GRU) network for sequence prediction and compare its performance with basic RNN. **Self-Learning Topics:** Sequence-to-Sequence (Seq2Seq) Models. Transformer Models vs RNN Architectures.	04	LO3
5	Advanced Deep Learning Models	**Contents:** Autoencoders. Variational Autoencoders (VAE). Generative Adversarial Networks (GANs). Graph Neural Networks (GNNs). 1. To implement an Autoencoder model for dimensionality reduction and analyze reconstruction loss and compressed feature representation. 2. To implement a basic Generative Adversarial Network (GAN) for generating synthetic data samples and analyze generator and discriminator loss. **Self-Learning Topics:** Vision Transformers (ViTs). GPT-3.	04	LO4
6	Deployment, Ethics and Emerging Trends	**Contents:** Model Evaluation Metrics. Model Optimization and Fine-Tuning. MLOps and Model Lifecycle Management. Model Deployment Basics. Model Monitoring. 1. To evaluate deep learning models using performance metrics such as Confusion Matrix, Accuracy, Precision, Recall, F1-score, and ROC curve, and visualize training and validation curves. 2. Mini Project: To design and develop a complete deep learning application including data preprocessing, model design, training, hyperparameter tuning, evaluation, and result interpretation for a real-world problem.	06	LO5, LO6

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		Self-Learning Topics: Environmental Sustainability, AI Governance & Regulation, Multimodal & Neuro-symbolic learning. Robotics & Physical AI.		
		Total	**26**	

Text Books:

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, Publisher, O'Reilly, 3rd Edition / 2022.
2. Eli Stevens, Luca Antiga & Thomas Viehmann, Deep Learning with PyTorch, Manning, 1st Edition / 2020.
3. François Chollet, Deep Learning with Python, Manning, 3rd Edition / 2025.

References:

1. Ivan Vasilev, Daniel Slater & Gianmario Spacagna, Python Deep Learning, Packt, 2nd Edition / 2019.
2. Umberto Michelucci, Applied Deep Learning with TensorFlow 2.0, Apress, 2nd Edition / 2022.
3. David Foster, Generative Deep Learning, O'Reilly, 2nd Edition / 2023.

Online References:

Sr. No.	Website Name	URL
1	Google Colab Examples for Deep Learning	https://colab.research.google.com
2	Stanford University (free notes/lectures)	https://cs231n.github.io/
3	Fast.ai – Practical Deep Learning for Coders	https://www.fast.ai/
4	PyTorch Tutorials	https://pytorch.org/tutorials/
5	MIT Deep Learning Book (Online)	http://www.deeplearningbook.org/
6	DeepLearning.AI Labs	https://www.deeplearning.ai

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461173	GIS & Drone 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					
23461173	GIS & Drone Technologies Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To provide hands-on experience with GIS software tools for spatial data handling and mapping.
2	To enable students to perform spatial analysis using real-world datasets.
3	To develop skills in managing and visualizing geospatial databases.
4	To understand basic drone data acquisition and image processing techniques.
5	To analyze and interpret drone imagery for mapping applications.
6	To integrate GIS and drone data for solving practical IT-based problems.

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	Install and use GIS software for spatial data visualization and editing.	L1, L2
2	Create and manage vector and raster datasets.	L3
3	Perform spatial analysis operations such as buffering and overlay.	L4
4	Develop thematic maps for data interpretation.	L4
5	Process basic drone imagery for mapping applications.	L4
6	Apply GIS and drone data techniques to solve real-world problems.	L5, L6

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
• Minimum Intel i5 / Ryzen 5 Processor • 8 GB RAM (16 GB recommended) • 500 GB HDD / 256 GB SSD (SSD preferred) • Dedicated Graphics Card (2 GB minimum recommended) • 64-bit Operating System Support Server / High-Performance System (16–32 GB RAM	1. QGIS-Open-source GIS software for spatial analysis and mapping. 2. GRASS GIS -Open-source tool for geospatial data management and analysis. 3. Spatial Database PostgreSQL + PostGIS Extension 4. Open-source spatial database system.

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• High storage capacity for spatial datasets Drone Kit -Quadcopter or Multirotor Drone • GPS-enabled Flight Controller • HD Camera / Multispectral Camera (if available) • Remote Controller • Spare Batteries GPS Device (Handheld) • For basic coordinate data collection	

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Basic Programming Knowledge, Computer Fundamentals	02	-
1	Introduction to GIS and QGIS	**Contents:** Introduction to GIS Software, Understanding map layers and spatial data organization, Layer Management in QGIS **Practical:** 1. To demonstrate the use of QGIS software interface for performing basic operations. 2. To create vector data layers (Point, Line, Polygon) and develop digitized maps using spatial features in QGIS. 3. To Perform Layer Organization and Management in QGIS Environment **Self-Learning Topics:** Open-source GIS, GIS Interface, GIS Layers, Spatial Data	06	LO1
2	Georeferencing and Spatial Database Management	**Contents:** Fundamentals of vector data models including point, line, and polygon spatial representations used in GIS mapping. Basics of geo-referencing and coordinate systems. **Practical:** 1. To Apply Vector Data Modeling Concepts by Creating Point, Line, and Polygon Layers in QGIS 2. Apply Georeferencing Techniques and Coordinate Reference Systems (CRS) in QGIS **Self-Learning Topics:** Coordinate Systems, Map Projection, Vector Models, Digitization	04	LO2
3	Spatial Analysis	**Contents:** Introduction to spatial analysis techniques. Basics of overlay operations in GIS	04	LO3

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		Practical: 1. To Create buffer zones around roads, rivers, or landmarks using QGIS. 2. To Perform overlay analysis using multiple map layers in QGIS. **Self-Learning Topics:** Overlay Methods, Buffer Techniques		
4	Thematic Mapping and Visualization	**Contents:** Concepts of thematic mapping and classification methods. **Practical:** 1. To Create thematic maps using colors and symbols in QGIS. **Self-Learning Topics:** Data Classification, Map Symbolization	02	LO4
5	Remote Sensing and Web GIS	**Contents:** Introduction to satellite imagery and vegetation analysis. **Practical:** 1. Load satellite imagery and perform basic NDVI analysis in QGIS. **Self-Learning Topics:** Vegetation Indices, Remote Sensing	04	LO5
6	Introduction to Web GIS and Python GIS	**Contents:** Introduction to Web GIS and GIS programming concepts and labeling for spatial visualization. **Practical:** 1. Create a simple interactive map using Leaflet or perform basic spatial data operations using Python. **Self-Learning Topics:** Web Mapping, Spatial Automation	04	LO6
		Total	**26**	

Text Books:

1. Peter A. Burrough, Rachael A. McDonnell, Christopher D. Lloyd, Principles of Geographical Information Systems, Oxford University Press, 3rd Edition / 2015.
2. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 3rd Edition / 2020.
3. Paul G. Fahlstrom, Thomas J. Gleason, Mohammad H. Sadraey, Introduction to UAV Systems, Wiley & Sons, 5th Edition / 2022.

References:

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1. George Joseph, Fundamentals of Remote Sensing, Universities Press, 2nd Edition / 2004.
2. David R. Green, Unmanned Aerial Remote Sensing, CRC Press, 1st Edition / 2018.

Online References:

Sr. No.	Website Name	URL
1	QGIS Official Website	https://qgis.org/
2	OpenDroneMap	https://www.opendronemap.org/
3	ESA SNAP (Sentinel Application Platform)	https://step.esa.int/

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461174	Computer Vision 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					
23461174	Computer Vision Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To review image processing techniques for computer vision.
2	To describe shape and region analysis.
3	To explain Hough Transform and its applications to Edge linking lines, circles, ellipses.
4	To describe three-dimensional image analysis techniques.
5	To describe motion analysis.
6	To implement computer vision algorithms for real-world problems.

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	Implement fundamental image processing techniques required for computer vision.	L1,L2,L3
2	Analyse shapes and regions using suitable algorithms.	L2,L3,L4
3	Apply Hough Transform for edge linking of line, circle and ellipse detections.	L2,L3
4	Apply and analyse 3D vision techniques.	L2,L3,L4
5	Implement motion analysis algorithms.	L2,L3,L4
6	Develop applications using computer vision techniques.	L2,L3,L5

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
Minimum I7 processor with 16 GB ram	MATLAB / Open CV, Python.

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Fundamental of digital image processing , Computer graphics, MATLAB / Open CV and Python	02	-

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1	Fundamental of Computer Vision	**Content:** Comparison between Image Processing and Computer Vision. Corner and Interest Point Detection, Co-occurrence Matrix. **Practical:** 1. To apply Corner and Interest Point Detection technique 2. Implementation of Co-occurrence Matrix method **Self-Learning Topics:** Various image processing techniques, algorithms and applications, Vision as Inverse Graphics.	02	LO1
2	Shapes and Regions	**Content:** Binary Shape Analysis, Object Labelling and Counting, Size Filtering, Skeletons and Thickening and Thinning, Boundary Tracking Procedures, Shape Models and Shape Recognition, Boundary Length Measures, Boundary Descriptors **Practical:** Implementation and Processing of Shapes and Regions algorithms 1. Skeletons and Thickening and Thinning 2. Boundary Detection Procedures. 3. Object Labelling and Counting. **Self-Learning Topics:** Application of Skeletons for Shape Recognition, Boundary Tracking Procedures, Boundary Length Measures, Distance Functions.	04	LO2
3	Hough Transforms	**Content:** Line Detection, Hough Transform (HT) for Line Detection, RANSAC for Straight Line Detection, HT Based Circular Object Detection, Ellipse Detection. **Practical:** 1. Implementation of Line Detection through Hough. Transforms or edge linking to Hough Transforms. 2. Implementation of HT for Circular Object Detection 3. Implementation of HT Ellipse Detection technique. 4. To apply RANSAC algorithm for straight line detection. **Self-Learning Topics:** Spatial Matched Filtering, Hole Detection, Object Location Stacked Hough Networks.	06	LO3

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4	3D Vision Algorithms	**Content:** Methods for 3D Vision, Photometric Stereo, Shape from Texture, Shape from Focus, Point- Based Representation, Volumetric Representations, 3D Object Recognition, 3D Reconstruction, SIFT Algorithms. **Practical:** 1. Implementation of 3D Vision Methods and conversion of 2D into 3D vision. 2. Implementation of applying texture method on 3D image. 3. Implementation of SIFT algorithm. **Self-Learning Topics:** 3D object recognition, alignments, Techniques like, 3D Object Recognition Schemes.	04	LO4
5	Introduction to Motion	**Content:** Triangulation, Bundle Adjustment, Translational Alignment, Parametric Motion, Spline-Based Motion, Optical Flow, Layered Motion, Stereo from Motion. **Practical:** 1. Implementation to measure distance between two Human in motion. 2. Implementation of spline-based motion algorithm. 3. Implementation of Optical Flow method for motion detection. **Self-Learning Topics:** Flow Former for accurate motion estimation, Transformer-based trackers for surveillance and autonomous driving.	04	LO5
6	Applications and Case studies	**Content:** Implementation of Application Like Face Recognition, Specific Examples on Surveillance, Foreground Background Separation, Road Markings. **Practical:** 1. Implementation of face Recognition application. 2. Implementation of real world Application Development for Surveillance. **Self-Learning Topics:** computer vision in medical diagnostics, Security and surveillance, agriculture and Drone used for surveys.	04	LO6
		Total	**26**	

<u>Text Books</u>:

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1. Emeritus Roy Davies, Computer Vision: Principles, Algorithms, Applications, Learning, Academic Press, 5th Edition / 2017.
2. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, Pearson, 2nd Edition / 2012.
3. Simon. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 1st Edition / 2012.

References:

1. Mark. Nixon and Alberto. Aguado, Feature Extraction & Image Processing for Computer Vision, Academic Press, 4th Edition / 2020.
2. Ramesh. Jain, Rangachar Kasturi, Brain Schunck, Machine Vision, Indo American Books, 2016.

Online References:

Sr. No.	Website Name	URL
1	Vlabs.ac.in	https://cse19-iiith.vlabs.ac.in/
2	Swayam courses	https://onlinecourses.nptel.ac.in/noc22_cs89/preview
3	onlinecourses.nptel	https://onlinecourses.nptel.ac.in/noc19_cs58/preview https://onlinecourses.nptel.ac.in/noc19_ee55/preview

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461181	Automated Testing 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					
23461181	Automated Testing Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To understand software testing concepts and perform test planning, test case design, and defect tracking using industry tools such as Jira, Bugzilla, or TestLink.
2	To understand the fundamentals of Selenium WebDriver and automation testing concepts for web applications.
3	To develop automated test scripts using Selenium tools and frameworks for validating web application functionality.
4	To implement data-driven testing and generate automated test reports using frameworks such as TestNG.
5	To evaluate application performance and functionality using performance testing and API testing tools such as JMeter and Postman.
6	To explore advanced and AI-powered testing tools for intelligent and automated software testing.

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 software testing techniques and defect management tools to validate application requirements.	L3
2	Explain and apply the concepts of Selenium WebDriver, testing frameworks, and web element identification techniques	L3
3	Develop and execute automated test scripts using Selenium WebDriver for web application testing.	L3
4	Implement data-driven automated testing frameworks and generate test reports using TestNG and external datasets.	L3
5	Evaluate software systems using performance testing and API testing tools to ensure system reliability and responsiveness.	L4
6	Explore and utilize AI-based testing tools for intelligent test automation.	L3

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Hardware & Software Requirements:

Hardware Requirement:	**Software Requirement:**
Intel Core i5 or higher, Minimum 8 GB RAM (Recommended: 16 GB), Minimum 256 GB SSD, LAN / Wi-Fi connectivity with Internet access, Local server or cloud environment for testing web applications(Optional)	OS-Windows 10 / Ubuntu / MacOS, Java JDK (Version 8 or above), IDE- Eclipse / IntelliJ IDEA / VS Code Testing Tools: Selenium WebDriver, TestNG / Junit, JMeter / BlazeMeter, Postman, Jira / Bugzilla / TestLink, Apache POI Library, AI Testing Tools (TestRigor / Applitools),

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Software Development Life Cycle (SDLC), Software Testing Life Cycle (STLC), Basics of Java Programming, HTML/DOM structure.	02	-
1	Test Planning & Defect Management	**Contents:** Fundamentals of Test Strategy, Requirement Analysis, Test Case Design techniques, Defect Life Cycle, Severity vs. Priority. **Practical:** 1. To develop a Test Plan and Test Strategy for a selected application (Eg. E-commerce, Banking, or Library Management System) by analyzing the requirement specifications and identifying relevant test scenarios and test cases. 2. To perform Defect Tracking and Management using tools such as Jira, Bugzilla, or TestLink for logging, tracking, and reporting identified defects. **Self-Learning Topics:** Agile Testing Methodologies.	04	LO1
2	Automation Setup & GUI Testing	**Contents:** Introduction to Automation, Tool environment setup (Java, Selenium, TestNG), GUI Testing principles, Usability testing. **Practical:** 1. To design and execute test cases for validating the functionality, usability, and GUI features of a given application. 2. To study, install, and configure automation testing tools such as Java, Eclipse/IntelliJ, Selenium WebDriver, TestNG, and browser drivers, and execute a simple Selenium program to open a browser and navigate to a website.	04	LO2

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		Self-Learning Topics: Comparison of various Automation Tools (Selenium vs Playwright).		
3	Element Identification & Basic Interactivity	**Contents:** Understanding Locators (XPath, CSS, ID), WebElement methods, Interaction with basic UI components, Handling Static elements. **Practical:** 1. To write Selenium scripts to identify web elements using different locators such as ID, Name, ClassName, XPath, and CSS Selector. 2. Automate interactions with web elements such as textbox, buttons, and links using methods like click(), sendKeys(), clear(), getText(). **Self-Learning Topics:** Absolute vs Relative XPath.	04	LO3
4	Advanced Web Component Handling	**Contents:** Handling Select classes, Synchronization in Selenium (Waits), Handling Windows, iFrames, and Alerts. **Practical:** 1. To write Selenium scripts to handle checkboxes, radio buttons, and dropdown menus using Select class. 2. Automate handling of JavaScript alerts, frames/iFrames, and multiple browser windows or pop-ups. 3. Implementation of Implicit Wait, Explicit Wait, and Fluent Wait in Selenium scripts and compare them with Thread.sleep(). **Self-Learning Topics:** Exception handling in Selenium.	04	LO4
5	Data-Driven, Performance & API Testing	**Contents:** TestNG Framework, Data-Driven Testing (DDT) concepts, Introduction to REST API, Request-Response validation, Status Codes. Performance Testing metrics (Latency, Throughput), Load vs Stress Testing, **Practical:** 1. Implementation of Data-Driven Testing using TestNG and external data sources (Excel/CSV) and generate test reports.	06	LO5

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		2. To perform API Testing and validation of RESTful services using tools such as Postman to verify request-response handling and status codes. 3. To conduct Performance and Load Testing of a web application using tools such as JMeter/BlazeMeter to measure system responsiveness, scalability, and stability under varying loads. **Self-Learning Topics:** JSON parsing and Assertions in Postman.		
6	AI-Driven Software Testing	**Contents:** Introduction to AI in Testing, Open source AI Testing Tools, Self-healing scripts. **Practical:** 1. To explore AI-powered Test Automation tools (e.g., TestRigor, Applitools) for creating intelligent test scripts. **Self-Learning Topics:** Visual Regression Testing using AI.	02	LO6
		Total	**26**	

Text Books:

1. Navneesh Garg, Test Automation Using Selenium WebDriver with Java: Step-by-Step Guide, AdactIn Group Pvt. Ltd, 1st Edition / 2014.
2. Sujay Raghavendra, Python Testing with Selenium: Learn to Implement Different Testing Techniques Using Selenium WebDriver, Apress (Springer Nature), 1st Edition / 2021.
3. Robin Gupta, Ultimate Selenium WebDriver for Test Automation, Orange Education / AVA Publishing, 2024.

References:

3. Adithya Garg and Ashish Mishra, A Practitioner's Guide to Test Automation Using Selenium, Tata McGraw Hill Education, 1st Edition, 2015
4. Satya Avasarala, Selenium WebDriver Practical Guide, Packt Publishing, 1st Edition, 2014.
5. Henry Codwell, Selenium Testing, Martin Chavez Publishing, 2025.

Online References:

Sr. No.	Website Name	URL
1	Selenium Official Website	https://www.selenium.dev
2	TestNG Documentation	https://testng.org/
3	Apache JMeter Official Website	https://jmeter.apache.org

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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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461182	Natural Language Processing 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					
23461182	Natural Language Processing Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To understand and implement fundamental text pre-processing and normalization techniques used in Natural Language Processing.
2	To build statistical language models.
3	To implement word embedding models.
4	To perform text classification using ML techniques.
5	To implement POS tagging and parsing models.
6	To design and evaluate a complete end-to-end NLP system for real-world applications such as sentiment analysis, spam detection, or topic classification.

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	Perform text pre-processing using Python	L3
2	Build N-gram language models	L3
3	Implement TF-IDF and Word2Vec	L3
4	Build and evaluate text classifiers	L4
5	Implement POS tagging and parsing	L5
6	Design and evaluate a complete NLP pipeline for a real-world task	L5

Hardware & Software Requirements:

Hardware Requirement:	Software Requirement:
Minimum 8 GB RAM, i5 Processor or above.	Python, NLTK, Scikit-learn, Gensim SpaCy, Matplotlib / Seaborn.

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Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Installation & NLP toolkit familiarization	04	-
1	Text preprocessing	**Contents:** Tokenization, stop word removal, stemming, lemmatization **Practical:** 1. Text preprocessing (tokenization, stop word removal, stemming, lemmatization) **Self-Learning Topics:** Types of tokenization, Porter Stemmer vs Lemmatizer, Handling noisy text (emoji, slang)	02	LO1
2	Language Modelling	**Contents:** Build unigram, bigram models, calculate probabilities and perplexity, Levenstein distance, spelling correction techniques **Practical:** 1. To build N-gram language model & calculate perplexity. 2. Implementation of Edit Distance & spelling correction. **Self-Learning Topics:** Smoothing techniques (Laplace, Kneser-Ney), Applications of language models, Dynamic programming approach, Autocorrect systems in search engines	04	LO2
3	Text Representation	**Contents:** Vectorization using TF-IDF, similarity computation, Training Word2Vec using Gensim, CBOW & Skip-gram. **Practical:** 1. Implementation of TF-IDF & cosine similarity 2. To train Word2Vec model using Gensim **Self-Learning Topics:** Bag-of-Words vs TF-IDF, Applications in search engines, Word embeddings vs traditional methods, Pretrained embeddings (GloVe, FastText)	04	LO3
4	NLP Applications	**Contents:** Sequence-to-sequence models, translation tasks, Rule-based chatbot, ML-based chatbot basics, evaluate models using precision, recall, F1-score **Practical:**	06	LO4

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		1. Neural Machine Translation (Translate between languages. 2. To build a Chatbot (Rule-based + ML-based) 3. To compare classifiers using Precision, Recall, F1-score. **Self-Learning Topics:** Encoder Decoder Architecture, Attention Mechanism, Intent recognition, Dialog management systems, Confusion matrix, Accuracy vs F1-score trade-offs		
5	NLP Sequence Models	**Contents:** Hidden Markov Model for POS tagging, NER using SpaCy statistical model **Practical:** 1. POS Tagging using Hidden Markov Model 2. Named Entity Recognition using SpaCy (statistical model). **Self-Learning Topics:** Viterbi algorithm, Probabilistic sequence labelling, Rule-based vs ML-based NER, Applications in information extraction	04	L05
6	NLP System Development	**Contents:** Build complete NLP pipeline (preprocessing → model → evaluation) **Practical:** 1. End-to-End NLP System (Sentiment / Spam / Topic Detection) **Self-Learning Topics:** End-to-end pipeline design, Model deployment basics, Real-world NLP applications	02	LO1-LO6
		Total	**26**	

Text Books:

1. Ewan Klein, Edward Loper, Natural Language Processing with Python – O'Reilly, 2009.
2. Rebecca Hwa & Daniel Jurafsky Speech and Language Processing (3rd edition draft) – Pearson / 2026.

References:

1. Yoav Goldberg, Graeme Hirst, Neural Network Methods for Natural Language Processing, Morgan & Claypool, 2017.
2. Eisenstein, Jacob, Introduction to Natural Language Processing, MIT Press, 2019.

Online References:

Sr. No.	Website Name	URL
1	NLTK Documentation & Tutorials	https://www.nltk.org/
2	Kaggle NLP Notebooks	https://www.kaggle.com/search?q=nlp
3	GitHub Repositories	nltk-text-classification

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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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461183	Ethical Hacking and Digital Forensics 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					
23461183	Ethical Hacking and Digital Forensics Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To understand and apply Digital Forensic Fundamentals.
2	To understand security threats & attacks for applying password & access recovery techniques ethically.
3	To perform Forensic Acquisition and Preservation.
4	To analyze and recover Digital Evidence.
5	To analyze file systems, Windows Registry, email, and web browser artifacts to reconstruct user activities.
6	To create a forensic investigation reports suitable for organizational and legal requirements.

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 different types of computer viruses, malware behaviours, and infection mechanisms relevant to digital forensics.	L2
2	Apply foot printing and reconnaissance techniques using appropriate tools to identify potential vulnerabilities in target systems.	L3
3	Perform evidence acquisition and preservation in digital forensics using standard forensic tools to ensure data integrity.	L3, L4
4	Analyse File system, Email and Web browser evidences to reconstruct user activity during forensic investigations.	L4
5	Analyse digital evidence from routers, logs, and mobile devices to reconstruct incidents.	L4,L5
6	Develop structured and professional digital forensic investigation reports suitable for organizational and legal requirements.	L6

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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	Windows 10/ Windows 11 (64-bit) Or Ubuntu Kali Linux Setup (Dual Boot OR Virtual Machine setup recommended.)

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	Prerequisites	Computer Networks, Basics of Cryptography, Fundamentals of Cybersecurity.	02	-
1	Ethical Hacking and Penetration Testing	**Contents:** Introduction to Vulnerability Assessment and Penetration Testing (VAPT), Need for Vulnerability Assessment, Types of Penetration Testing, Difference between VA and PT. **Practical:** (any 2 practical needs to be conducted) 1. Setting Pentester lab for vulnerability assessment. 2. To identify vulnerabilities in a web application using open-source penetration testing tools OWASP ZAP. 3. Demonstration of Trojan Horse. 4. Simulation of phishing attack. **Self-Learning Topics:** Exploring various Social Engineering tools like Social-Engineer Toolkit (SET), Browser Exploitation Framework (BeEF), penetration testing tools like Metasploit, BurpSuite etc.	04	LO1
2	Information Gathering & Password Cracking	**Contents:** Information Gathering, Footprinting, Importance of information gathering in penetration testing, Types of reconnaissance: Passive reconnaissance, Active reconnaissance, Domain footprinting and website profiling. Introduction to password security concepts, Authentication mechanisms and password policies, Password strength and complexity, Ethical and legal considerations in password testing. **Practical:** (any 2 practical needs to be conducted) 1. Performing reconnaissance to find all the relevant information on website and target device using information gathering tools	04	LO2

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		2. Demonstration of Password forensics tool to get an access to a windows machine. 3. Demonstration of Password Forensic tools to crack a rar and zip password protected files. **Self-Learning Topics:** Exploring various password cracking tools like Hydra, Hashcat, Maltego, dnsenum etc.		
3	Digital Evidence, Acquisition, Disk Analysis	**Contents:** Introduction to Digital Evidence, Concept of Forensic Imaging, Importance of preserving digital evidence, Chain of custody in digital investigations, Disk imaging formats (RAW, E01, AFF). Disk cloning concepts in forensic investigation, Difference between disk cloning and disk imaging, identifying partitions and file systems, Maintaining data integrity during cloning, **Practical:** (any 3 practical needs to be conducted) 1. Performing Forensic Disk Imaging and Acquisition. 2. Performing digital forensic investigation using Winhex Tool for Disk Cloning. 3. Performing digital forensic investigation using Winhex Tool for Recovering, Analysing and Documenting Digital Evidence. 4. Implementing the steps for hiding and extracting any text file behind an image file/ Audio file using Command Prompt and Exifreader on given case study. **Self-Learning Topics:** Metadata analysis for digital investigations, Digital Evidence Admissibility in Cyber Law, Zero Trust Architecture & Incident Handling.	04	LO3
4	Computer and Internet Application Forensics	**Contents:** Introduction to File System, Basics of file system structures (FAT, NTFS, EXT), Understanding file system metadata and artifacts, Introduction to Email Forensics, Structure of an email message (header and body), Understanding email header fields (From, To, Received, Return-Path), Tracing sender IP addresses through header analysis,Browser artifacts and user activity traces, Types of browser evidence:Browsing history, Cookies, Download history, Cached files **Practical:** (any 2 practical needs to be conducted) 1. Performing file system analysis using FSSTAT	04	LO4

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		2. Performing Email Forensics and Header Analysis Using Open-Source Tools. 3. Performing web browser forensic using Autopsy. **Self-Learning Topics:** Exploring various file system analysis and Email investigation tools like *Sleuth Kit, X-Ways Forensics, Bulk Extractor, MailXaminer, MXToolbox, Maltego, Email Header Analyzer etc.*		
5	Network and Mobile Forensics	**Contents:** Introduction, Exploiting Network Based Vulnerabilities: DNS Cache Poisoning, SNMP Exploits, SMTP Exploits, FTP Exploits. Sources of Network based evidences, Investigating Routers. Introduction, Evidence Collection and Acquisition, Analysis of Evidences, Challenges in mobile forensics, Tools used in mobile forensics. **Practical:** 1. Performing Mobile forensics using Open Source tools like ADB, Autopsy. 2. Router Investigation using Open Source Tools on Windows **Self-Learning Topics:** Exploring Wireless Hacking Tools, Evil Twin Attacks (Rogue Access Points) and Tools / Techniques used in mobile forensics.	04	LO5
6	Forensic Report Generation	**Contents:** Layout of an Investigative Report, Guidelines for Writing a Report, Importance of forensic documentation in cyber investigations, Role of reports in legal proceedings and investigations, Characteristics of a good forensic report (accuracy, clarity, completeness) **Practical:** 1. Preparing a structured and professional forensic investigation report. 2. Documenting digital evidence and maintain Chain of Custody during forensic investigation. **Self-Learning Topics:** For an incident write a forensic report and understand Documentation standards in cyber investigations.	04	LO6
		Total	**26**	

<u>Text Books</u>:

1. Kevin Mandia, Chris Prosise, Incident Response and computer forensics, TataMcGrawHill, 2006.

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2. Skoudis. E., Perlman. R., Counter Hack: A Step-by-Step Guide to Computer Attacks and Effective Defenses, Prentice Hall Professional Technical Reference, 2001.
3. Bill Nelson, Amelia Philips and Christopher Steuart, Guide to computer forensics investigation, Course Technology, 4th Edition / 2009.
4. Eoghan Casey, Handbook Computer Crime Investigation's Forensic Tools and Technology, Academic Press, 1st Edition / 2001.
5. Bill Nelson, Amelia Phillips, Christopher Steuart, Guide to Computer Forensics and Investigations, Cengage India Private Limited, 6th Edition / 2020.

References:

1. Nina Godbole and Sunit Belapure, PEC6023: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives. New Delhi, India: Wiley India Pvt. Ltd., 2011.
2. Akashdeep Bhardwaj & Keshav Kaushik, Practical Digital Forensics, BPB Publications, 2023.
3. S. Sharma, Ethical Hacking and Cyber Security. New Delhi, India: S. K. Kataria & Sons, 2019.

Online References:

Sr. No.	Website Name	URL
1	Virtual Labs, IIT Bombay	http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Security/
2	Virtual Labs, IIT Bombay	http://vlabs.iitb.ac.in/vlabsdev/vlab_bootcamp/bootcamp/The_Four_Wizards/
3	Virtual Labs :A Ministry of Education, Govt. of Bharat Initiative	Virtual Computer Forensic lab: https://cf-amrt.vlabs.ac.in/List%20of%20experiments.html

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
23461184	AR/VR Lab	---	02	---	---	02	---	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					
23461184	AR/VR Lab	---	---	---	---	---	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
1	To experience and analyze immersive environments using industry-standard HMDs (Meta Quest 2).
2	To master the integration of 3D assets, physics, and scripting within an XR development environment.
3	To implement diverse tracking mechanisms (Marker-based, Marker less, and Spatial) in a single project.
4	To design and optimize immersive user interfaces and interaction metaphors.
5	To analyze and mitigate common XR design pitfalls like latency, drift, and cyber sickness.
6	To demonstrate a complete XR workflow, from environment setup to final device deployment.

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	Describe how to navigate VR environments and explain hardware-specific design constraints.	L1, L2
2	Create the project theme and identify required 3D assets for a custom application.	L3, L5, L6
3	Apply realistic physics and lighting features in Unity to build and navigate 3D virtual environments.	L3, L4
4	Apply interactive scripting techniques to handle user input and environmental events.	L3, L4, L5
5	Design 3D user interfaces that follow comfort and health safety standards.	L3, L4, L6
6	Build a final, working "Mini-Project" demonstrating end-to-end XR skills.	L3, L4, L6

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	Windows 10/ Windows 11 (64-bit) Or Ubuntu

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Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content and Experiment List	Hours	LO Mappings
0	**Prerequisite**	Basics of Computer Graphics, Object-Oriented Programming (C#)	02	
1	XR System Setup and Hardware Familiarization	**Contents:** XR System Setup and Hardware Familiarization **Practical:** 1. Introduction to AR/VR devices (HMDs, controllers, sensors) 2. Setup and calibration of VR devices (Meta Quest / equivalent) 3. Guardian system, IPD adjustment, navigation 4. Exploration of VR environment and safety guidelines 5. Understanding XR development ecosystem (Unity, SDKs) **Self-learning Topic**: Comparative Study and Hands-on Reflection on XR Devices	4	LO1
2	XR Development Environment and Scene Creation	**Content:** XR Development Environment and Scene Creation **Practical:** 1. Installation and configuration of Unity and XR plugins 2. Understanding Unity interface (Hierarchy, Scene, Inspector) 3. Creation of 3D scenes using primitives and assets 4. Importing and managing 3D models 5. Scene composition and spatial arrangement **Self-learning Activity:** Design and Build a Thematic Virtual Scene	4	LO2, LO3
3	Physics, Interaction and Scripting in XR	**Content:** Physics, Interaction and Scripting in XR **Practical:** 1. Applying physics (Rigidbodies, Colliders) in XR environments 2. Object interaction with environment 3. Basics of scripting (C#) in Unity 4. Event handling and user input 5. Interaction techniques (Ray-casting, Grab) **Self-learning Activity:** Develop an Interactive Object Behavior Scenario	4	LO3, LO4

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4	Augmented Reality Implementation	**Content:** Augmented Reality Implementation **Practical:** 1. Marker-based AR (Image tracking) 2. Introduction to AR Foundation 3. AR object placement and tracking 4. Understanding SLAM and markerless tracking (conceptual exposure) 5. Integration of AR and VR components in applications **Self-learning Topic:** Create a Marker-Based AR Experience	4	LO4
5	User Interface Design and User Experience in XR	**Content:** User Interface Design and User Experience in XR **Practical:** 1. Designing 3D UI (World-space canvas) 2. UI interaction principles in XR 3. Human factors: comfort, ergonomics, usability 4. Cybersickness causes and mitigation strategies 5. Optimization techniques for XR applications **Self-learning Topic**: Evaluate and Redesign XR User Interface	4	LO5
6	Integration, Testing and Deployment of XR Applications	**Content:** Integration, Testing and Deployment of XR Applications **Practical:** 1. Integration of all modules into a complete XR application 2. Testing and debugging XR applications 3. Performance optimization 4. Deployment on target devices (APK / standalone VR) 5. Demonstration of final mini-project **Self-learning:** End-to-End XR Application Development and Demonstration	4	L06
		Total	**26**	

<u>Text Books</u>:

1. Rajesh K. Maurya, Computer Graphics with Virtual Reality, Wiley India Publication, 2018.
2. William R Sherman and Alan B Craig, Understanding Virtual Reality: Interface, Application and Design", (The Morgan Kaufmann Series in Computer Graphics), Morgan Kaufmann Publishers, San Francisco, CA, 2002.
3. Steven M. LaValle, Virtual Reality, Cambridge University Press, 2016.
4. Dieter Schmalstieg and Tobias Höllerer, Principles and Practice - Augmented Reality, Addison-Wesley, 2016.
5. Sanni Siltanen, Theory and applications of marker-based augmented reality, Julkaisija –Utgivare, 2012.

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6. Allan Fowler, William Sherif, Beginning iOS AR Game Development: Developing Augmented Reality Apps with Unity and C#, Apress Publications, 1st Edition / 2018.

References:

1. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
2. Grigore C. Burdea and Philippe Coiffet, Virtual Reality Technology, Wiley India Publication, 2003.
3. Tony Parisi, Learning Virtual Reality, O'Reilly Media, 2015.
4. Steve Aukstakalnis, Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley Professional, 2016.

Online References:

Sr. No.	Website Name	URL
1	Swayam	https://nptel.ac.in/courses/106/106/106106138/
2	Coursera	https://www.coursera.org/learn/introduction-virtual-reality
3	Oculus	Oculus VRC (Virtual Reality Check) Guidelines: A checklist used by professional developers to ensure their apps don't cause motion sickness or physical strain.
4	Coursera	https://www.coursera.org/learn/augmented-reality https://www.coursera.org/specializations/unity-xr
5	XRA	xra-primer-2.0-web-v2.pdf
6	Valem Tutorials	Valem Studio : VR/AR Learning - Game Dev - Consulting https://youtu.be/exc-73Mna3A?si=c7aWHUdyT7M0U2t1
7	Dilmer Valecillos	Dilmer Valecillos (YouTube / LearnXR) Dilmer Valecillos YouTube Channel
8	FreeCodeCamp	Augmented Reality Full Course

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.

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Vertical - 4

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2346411	Innovation Lab (Mini Project)	---	04	---	---	02	---	02

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					
2346411	Innovation Lab (Mini Project)	---	---	---	---	---	50	---	50

Course Objectives:

Sr. No.	Course Objectives
1	To enable students to identify real-world problems through need-based surveys, literature review, and structured requirement analysis.
2	To develop skills in formulating clear problem statements and project objectives based on feasibility, innovation, and societal relevance.
3	To train students in designing and planning project execution using tools such as Gantt charts, PERT/CPM, and structured methodologies.
4	To provide hands-on experience in developing and implementing functional prototypes or models using appropriate engineering tools and domain-specific technologies.
5	To enhance teamwork, leadership, and project management skills through collaborative group work, progress tracking, and review presentations.
6	To cultivate professional competencies in documentation, technical communication, validation, and evaluation of project outcomes with sustainability and continuous learning focus.

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	Formulate a real-world problem by conducting need-based surveys and demonstrating professional responsibility in problem selection.	L2, L3, L4
2	Implement appropriate engineering methods to develop a functional solution while collaboratively exhibiting ethical teamwork behaviour.	L2, L3, L4, L5, L6
3	Demonstrate effective leadership or collaboration by actively coordinating project tasks and responding constructively to group dynamics.	L2, L3, L4
4	Validate experimental results through analytical techniques and justify findings with disciplined technical documentation.	L2, L3, L4, L5, L6
5	Evaluate the societal and environmental impact of the developed solution while applying sustainable engineering practices.	L3, L4, L5
6	Execute project activities using standard engineering tools while exhibiting commitment towards continuous self-directed learning.	L2, L3, L4, L5, L6

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Guidelines for Innovation Lab (Mini Project):

1	Students shall form a group of 3 to 4 students. While forming a group less than three or more than four students shall not be allowed, as it is a group activity.
2	Interdisciplinary project is also allowed.
3	Students should do survey and identify needs, which shall be converted into problem statement for project in consultation with faculty supervisor/head of department/internal committee of faculties.
4	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of project.
5	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisor may give inputs to students during project activity; however, focus shall be on self-learning.
7	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
8	Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
9	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
10	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the project.
11	The goal is to develop a product and create avenues for IP filing.

Term Work:

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of project to be evaluated on continuous basis, minimum two reviews in the semester.			
In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.			
Distribution of Term work marks shall be as below:			**Marks**
1	Marks awarded by guide/supervisor based on logbook		5
2	Marks awarded by review committee (Average of Review 1 & Review 2)		40
Project Review - 1			
1	Identification of Problem		4
2	Requirement analysis and Feasibility of the proposed work		4
3	Literature Review		4
4	Objectives of the proposed work		4
5	Methodology of the proposed work		4
	Total Marks		**20**
Project Review - 2			
	a	Planning of project work and team structure	4
	b	Design Methodology	4
	c	Conceptual and Technical Demonstration	4
	d	Presentation: Oral delivery, contact with audience, slides, timing	4
	e	Quality of answers	4
	Total Marks		**20**
	Quality of Project Report		**5**

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Online References:

Sr. No.	URL
1	https://www.geeksforgeeks.org/project-idea-college-network/?ref=ml_lbp
2	https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/ai-project-ideas
3	https://roadmap.sh/backend/project-ideas
4	https://webflow.com/blog/website-ideas
5	https://gist.github.com/MWins/41c6fec2122dd47fdfaca31924647499
6	https://www.projectpro.io/article/artificial-intelligence-project-ideas/461
7	https://github.com/The-Cool-Coders/Project-Ideas-And-Resources
8	https://nevonprojects.com/project-ideas/software-project-ideas/
9	https://roadmap.sh/projects

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Vertical - 5

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IKS

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2346511	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					
2346511	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.

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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

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		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

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		• 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

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		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

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		• 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_P F1%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.

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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/

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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

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	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

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	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)

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2346511	Professional Skill	--	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					
2346511	Professional Skill	--	--	--	--	--	25	--	25

Course Rationale:

This course equips engineering students with professional communication, ethical values and soft skills essential for global industry demands. It enhances technical writing, presentation and interpersonal abilities through practical sessions, fostering confidence, teamwork and social responsibility as competent engineering professionals.

Course Objectives:

Sr. No.	Course Objectives
1	Develop effective speaking, presentation, group discussion and interview skills required for employability and professional success.
2	Analyse and evaluate AI-generated content for accuracy, bias, credibility and ethical professional use.
3	Prepare clear, concise and professional technical/business documents such as resumes, reports, SOP and formal correspondence.
4	Demonstrate managerial and collaborative skills required for conducting meetings, preparing proposals and workplace communication.
5	Apply interpersonal, critical thinking, negotiations, time management, leadership, decision-making and adaptability skills for lifelong learning and career growth.
6	Exhibit ethical values, intellectual property awareness, digital responsibility and professionalism in workplace practices.

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	Demonstrate effective speaking skills through participation in group discussions, interviews, presentations and collaborative activities.	L2
2	Analyse and evaluate AI-generated content in terms of quality, bias, reliability and ethical use for academic and professional purposes.	L4
3	Create professional documents such as resumes, cover letters, statements of purpose, reports and other technical/business correspondence using standard formats.	L6
4	Organise and execute professional meetings, proposals and technical papers using appropriate workplace communication strategies and digital tools.	L6

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5	Apply and demonstrate interpersonal skills such as leadership, critical thinking, negotiation, decision-making, time management and adaptability to support career growth and lifelong learning.	L3
6	Exhibit ethical practices, digital responsibility and awareness of intellectual property rights in professional environments.	L4

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
1	Employability Skills: Advanced Speaking	**1.1. Group Discussions (GDs)** • Purpose, Evaluation parameters, GD etiquette • Types: Factual (Regular & Controversial), Abstract, Case-based (Textual & Picture-based) and Role-plays (Textual & Cue-card-based) • Online GDs and digital collaboration etiquette (Zoom, Google-Meet, MS Teams etc.) **1.2. Personal Interviews** • Planning and preparation for Technical and HR interviews • Interview types: Structured, Stress, Behavioural and Case-based • Virtual interviews, AI-assisted interview simulations and post-interview reflections (Google Interview Warmup, Yoodli, Pramp etc.) **1.3. Presentation Strategies** • Purpose, Audience analysis, Content organisation • Slide design, Text, Infographics and AI-based presentation design (Canva, Beautiful.ai, Gamma AI etc.) • Division of roles, collaborative preparation and seamless transitions	8	CO1
2	Critical AI Literacy	• **Nature of AI Generated Language -** Understanding AI-generated language as probabilistic output and distinguishing between Fluency and Accuracy while identifying risks such as AI Slop and Hallucination	4	CO2

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		• **Evaluating AI Content -** Differentiating between Evidence and Assertion and applying verification strategies to assess Accuracy, Clarity and Depth • **Bias, Framing and Information Silos -** Understanding linguistic Bias, Framing, Information Silos and Selective Exposure that shape AI responses and limit perspective • **Drafting, Editing and Prompt Engineering with AI** - Using AI for Drafting and Editing through effective Prompt Engineering while maintaining originality, specificity and professional voice • **Identifying Low-Quality AI Content** - Identify markers of low-quality AI content, such as repetition, lack of depth, and absence of concrete detail, while applying ethical practices that distinguish Assistance from Substitution and ensure responsible AI use		
3	Employability Skills: Advanced Technical Writing	**3.1. Cover Letter & Resume** • Difference between Bio-data, Resume and CV • Resume types: Chronological, Functional and Hybrid • Resume structure and content • Digital resumes, Application Tracking System (ATS) friendly formatting and LinkedIn portfolio integration **3.2. Reports** • **Purpose:** Importance of reports in engineering and industry decision-making Classification of Reports: Subject Matter - Technical, R&D, Operations, Finance, Marketing etc. Time Interval - Periodic, One-time, Special Function - Informational, Examinational and Analytical Reader Writer Relationship – Administrative, Professional and Independent Format – Memo, Letter, Short, Long, E-Reports, Digital Dashboards	8	CO3

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		Digital and AI-aided reporting formats (Power BI, Google Data Studio, ChatGPT etc. for summaries) Parts of a Long Formal Report Prefatory Parts: Title Fly, Title Page, Letter of Transmittal, Table of Contents, List of Illustrations, Executive Summary Report Proper (Main Body): Introduction, Intervening chapters with headings as per the topic, Result & Analysis, Summary (Informational) Or Summary & Conclusions (Examinational) **Or** Summary, Conclusions & Recommendations (Analytical) Appended Parts: Appendix, List of References, Glossary, Index • **Language and Style of Reports** Tense, person and voice appropriate to reports Numbering and labelling conventions for figures, tables, charts, equations etc. Referencing formats (APA, MLA etc.) Plagiarism checks (Turnitin, Grammarly, other AI-detectors etc.) **3.3. Statement of Purpose (SOP)** • **Purpose:** SOPs for international internships, funding for research programs and higher education • **Structure:** Paragraph 1 - Hook (introducing yourself in a unique manner and demonstrating your passion for the field) Paragraph 2 - Academic Background Paragraph 3 - Research-oriented Endeavours Paragraph 4 - All-round Development Paragraph 5 - Reasons for choosing the Program and Institution Paragraph 6 - Conclusion and Thank-you note		
4	Workplace Managerial Skills	**4.1. Conducting Business Meetings** • **Types of Meetings:** Executive Meetings - Decide Management Meetings - Implement Committee Meetings - Recommend Review Meetings - Evaluate Planning Meetings - Design the future Crisis Meetings - Resolve urgency	6	CO4

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		• **Roles and Responsibilities:** Chair - Leads meeting, maintains order, ensures decisions Secretary - Records minutes, documents decisions, tracks actions Core Members - Discuss issues, contribute ideas, make decisions Specialists - Provide expertise, clarify issues, support decisions • **Documentation:** Notice, Agenda and Minutes • **Meeting Platforms and AI Assistance:** Virtual and hybrid meeting management, online etiquette, use of collaborative tools (Google Meet, Slack, Trello etc.) Digital documentation, e-Minutes and collaborative platforms like Notion or Microsoft OneNote **4.2. Writing Proposals** • **Types:** Solicited vs. Unsolicited • **Format:** Memo, Short and Long • **Parts of a Short Proposal:** Purpose of the proposal Need for the proposal (SWOT analysis) Description of the plan (budget, timeline etc.) Evidence of ability to deliver Benefits to both parties Conclusion **4.3. Structuring and Formatting Technical Papers** **Components:** Title, Author(s) & Affiliations, Abstract, Keywords/Index Terms, Introduction, Sections with different headings, Results, Discussion, Conclusion, Acknowledgement, References, Biography • Formatting and referencing (IEEE style) • Use of AI tools for grammar check, plagiarism validation and submission to international conferences		
5	21st Century Professional Skills	**5. Interpersonal Skills** Emotional Intelligence • Critical thinking, Reflection & Self Analysis	6	CO5

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		• Leadership and Motivation Strategies • Conflict Management and Negotiation • Time Management • Anger and Stress Management • Decision Making and Adaptability		
6	Digital Ecosystems and Ethics	**6.1. Intellectual Property Rights (IPR)** **Categories:** Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits and Trade Secrets • AI-generated content ownership, open-source ethics, digital rights management • Social Media Content and Legal Responsibility **6.2. Case Studies on Corporate and Engineering Ethics** Real-world ethical dilemmas • Corporate Social Responsibility (CSR) • Environmental Social Governance (ESG) • Sustainability and Green Engineering • AI Ethics in Design and Automation	4	CO6

ASSESSMENTS

List of Compulsory Assignments for Term Work:

Module 1: GD documentation with Topic, Type and Highlights in 5 bullet points

Module 2: Assignment on Prompt Engineering

Module 3: A - Cover Letter, Resume and B - Statement of Purpose

Module 4: Meeting Documentation (Notice, Agenda & Minutes)

Module 5: Activities on Interpersonal Skills

Module 6: Case study on Ethical Dilemma

(To be conducted in the form of short notes, quizzes, role plays, case studies, presentations or MCQs)

SUGGESTED ASSIGNMENTS

Module No. & Title	Assignments and Activities
Module 1 Employability Skills: Advanced Speaking	• Conduct 4-5 types of Group Discussions and attach the summary and photographs as proof of activity • Prepare group presentation slides, based on the report topic (Examinational or Analytical) using the latest presentation software

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	(PowerPoint, Canva, Prezi etc.) and engage students in giving critical feedback • Present an 'Elevator Pitch 'for either self-introduction or product or new business idea • Conduct mock interviews
Module 2 Critical AI Literacy	• Select an essay/article/video generated by AI (or give a general prompt) and analyse and detect AI bias (gender pronouns, gender-based occupational stereotypes, racial identifiers, historical bias etc.) • Differentiate between weak and strong prompts • Source verification task • AI versus human writing analysis
Module 3 Employability Skills: Advanced Technical Writing	• Draft a professional Cover Letter and Resume • Write a Statement of Purpose (SOP) for higher studies or internships • Develop or enhance a LinkedIn profile showcasing technical and project achievements • Prepare a book-format analytical/informational report using IEEE/APA/MLA referencing and plagiarism check tools (Grammarly/Turnitin). Main body should be minimum 20 pages excluding the Preparatory and Appended parts
Module 4 Workplace Managerial Skills	• Conduct a mock meeting with assigned roles (Chairperson, Secretary, Members) and generate documentation with the help of the latest software • Write a short proposal addressing an engineering or sustainability problem • A quiz on the formatting aspects of a Technical Paper
Module 5 21st Century Professional Skills	• Activities for developing team work, leadership, emotional intelligence etc. • Problems and Puzzles on Critical thinking • Case-studies or Role-plays or Questionnaires on Conflict Resolution, Negotiation Skills and Decision Making • Application of SWOT analysis • Eisenhower Matrix to analyse a daily time log
Module 6 Digital Ecosystems and Ethics	• Conduct an awareness quiz on IPR laws and ethical business practices. • Analyse a corporate ethics case study • Digital footprint audit of Self Profile • Fake News and Deep Fake verification task

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IMPORTANT NOTE

1. The main project/book report should contain a minimum of 20 pages, excluding prefatory and appended matter.
2. Each project group must consist of a minimum of 4 and a maximum of 6 students.
3. End-semester presentation will be based on the book/project report.

GUIDELINES FOR TERM WORK MARKS DISTRIBUTION

Components	Marks 25	Description
6 Compulsory Assignments	**5**	Based on completion and quality of module-wise tasks.
Attendance & Participation	**5**	Class engagement, teamwork, and professionalism.
GD	**5**	Based on group and individual performance
Report Hardcopy	**5**	Quality, structure and originality of the report
Oral Report Presentation	**5**	Based on group and individual performance

RECOMMENDED RESOURCES:

1. Raman, M., & Sharma, S. (2022). Technical communication: Principles and practice (4th ed.). Oxford University Press.
2. Anderson, P. V. (2018). Technical communication: A reader-centred approach (9th ed.). Cengage Learning.
3. Lesikar, R. V., Flatley, M. E., & Rentz, K. (2008). Basic business communication (11th ed.). McGraw-Hill.
4. Institute of Electrical and Electronics Engineers. (2020). IEEE code of ethics. IEEE.
5. American Society of Mechanical Engineers. (2021). ASME code of ethics of engineers. ASME.
6. Guffey, M. E., & Loewy, D. (2018). Essentials of business communication (11th ed.). Cengage Learning.
7. Sharma, R. C., & Mohan, K. (2017). Business correspondence and report writing (4th ed.). Tata McGraw-Hill Education.
8. Ram, A. (2018). Place mentor: Tests of aptitude for placement readiness. Oxford University Press.
9. Kumar, S., & Lata, P. (2018). Communication skills: A workbook. Oxford University Press.
10. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Cengage Learning.
11. Crawford, K. (2021). Atlas of AI: Power, politics, and the planetary costs of artificial intelligence. Yale University Press.
12. Kearns, M., & Roth, A. (2019). The ethical algorithm: The science of socially aware algorithm design. Oxford University Press.

ONLINE RESOIRCES:

1. Ravichandran, T. (n.d.). Enhancing soft skills and personality [NPTEL course]. National Programme on Technology Enhanced Learning. https://nptel.ac.in

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2. Ravichandran, T. (n.d.). Developing soft skills and personality [SWAYAM MOOC]. SWAYAM. https://swayam.gov.in
3. Coursera. (n.d.). Business communication for success [Online course]. https://www.coursera.org
4. edX. (n.d.). Business communication for success [Online course]. https://www.edx.org
5. All India Council for Technical Education. (n.d.). Employability enhancement and life skills modules. AICTE NEAT. https://neat.aicte-india.org
6. Indian Institute of Technology Guwahati. (n.d.). Virtual English and communication virtual lab. Virtual Labs. https://ve-iitg.vlabs.ac.in/
7. Indian Institute of Technology Bombay. (n.d.). Professional communication virtual lab. Virtual Labs. http://vlabs.iitb.ac.in/vlabs-dev/labs/communication/
8. TCS iON. (n.d.). Communication skills [Online course]. https://www.tcsion.com/courses/tcs-ion/communication-skills/
9. TCS iON. (n.d.). Introduction to soft skills [Online course]. https://www.tcsion.com/courses/interview-and-job-prep/introduction-to-soft-skills/
10. TCS iON. (n.d.). Presentation skills [Online course]. https://www.tcsion.com/courses/tcs-ion/presentation-skills/

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QUESTION PAPER PATTERN

(External and Internal)

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Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 – 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sd/-
Dr. Vaishali D. Khairnar
BoS Chairman - Information Technology
Faculty of Technology

Sd/-
Dr. Deven Shah
Associate Dean
Faculty of Science & Technology

Sd/-
Prof. Shivram S. Garje
Dean
Faculty of Science & Technology

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