T.E. IT
Scheme

Semester
VI

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**	**125**	**825**

Course Code	Course Description
23461131	Advance Web Technology
23461132	Deep Learning
23461133	GIS and Drone Technologies
23461134	Computer Vision
23461141	Software Testing and Quality Assurance
23461142	Natural Language Processing
23461143	Ethical Hacking and Digital Forensics
23461144	Augmented Reality / Virtual Reality

Lab Code	Lab Description
23461171	Advance Web Technology Lab
23461172	Deep Learning Lab
23461173	GIS & Drone Technologies Lab
23461174	Computer Vision Lab
23461181	Automated Testing Lab
23461182	Natural Language Processing Lab
23461183	Ethical Hacking and Digital Forensics Lab
23461184	AR/VR Lab

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

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

		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

		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:

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

End Semester Theory Examination:

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

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

		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

		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.

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.

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

		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

		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:

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End Semester Theory Examination:

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

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

		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

		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.

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

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

		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

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.

End Semester Theory Examination:

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

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

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

		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**	

Text Books:

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

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.

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

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

		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

		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.

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:

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

		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

		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.

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.

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

		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

Assessment:

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

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

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

		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

		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**	

Text Books:

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

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.

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

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**

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

AEC

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

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

		• **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

		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

		• **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

		• 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

	(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

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

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/