

III B.TECH I SEMESTER

S.No	Category	Course Code	Title	L	T	P	Credits
1	PC	23A3353T	NATURAL LANGUAGE PROCESSING	3	0	0	3
2	PC	23A3151T	OPERATING SYSTEMS & SYSTEM PROGRAMMING	3	0	0	3
3	PC	23A3152T	COMPUTER VISION & IMAGE PROCESSING	3	0	0	3
4	PC	23A0554T	INTRODUCTION TO QUANTUM TECHNOLOGIES AND APPLICATIONS	3	0	0	3
5	PE-I	23A305AT 23A315BT 23A335CT 23A315AT	Professional Elective-I 1. DATA VISUALIZATION 2. ADAPTIVE COMPUTATIONAL METHODS 3. EXPLORATORY DATA ANALYSIS WITH PYTHON 4. COMPUTATIONAL INTELLIGENCE	3	0	0	3
6	OE-I		Open Elective- I	3	0	0	3
7	PC	23A3153L	COMPUTER VISION & NATURAL LANGUAGE PROCESSING LAB	0	0	3	1.5
8	PC	23A3151L	AI & SYSTEM PROGRAMMING LAB	0	0	3	1.5
9	SEC	23A0555L	FULL STACK DEVELOPMENT - II	0	1	2	2
10	EC	23A0556L	TINKERING LAB FOR COMPUTER ENGINEERS	0	0	2	1
11	INTERN	23A0557I	EVALUATION OF COMMUNITY SERVICE INTERNSHIP	0	0	0	2
Total				18	1	10	26

Open Elective – I

S.No.	Course Code	Course Name	Offered by the Dept.
1	23A015DT	GREEN BUILDINGS	CIVIL
2	23A015ET	CONSTRUCTION TECHNOLOGY AND MANAGEMENT	
3	23A025ET	ELECTRICAL SAFETY PRACTICES AND STANDARDS	EEE
4	23A035FT	SUSTAINABLE ENERGY TECHNOLOGIES	ME
5	23A045DT	ELECTRONIC CIRCUITS	ECE
6	23A045ET	COMMUNICATION SYSTEMS	
7	23A055GT	QUANTUM TECHNOLOGIES AND APPLICATIONS	CSE & Allied
8	23AHS51T	MATHEMATICS FOR MACHINE LEARNING AND AI	Mathematics
9	23AHS52T	MATERIALS CHARACTERIZATION TECHNIQUES	Physics
10	23AHS53T	CHEMISTRY OF ENERGY SYSTEMS	Chemistry
11	23AHS54T	ENGLISH FOR COMPETITIVE EXAMINATIONS	Humanities
12	23AHS56T	ENTREPRENEURSHIP AND NEW VENTURE CREATION	

Note:

1. A student is permitted to register for Honors or a Minor in IV semester after the results of III Semester are declared and students may be allowed to take maximum two subjects per semester pertaining to their Minor from V Semester onwards.
2. A student shall not be permitted to take courses as Open Electives/Minor/Honours with content substantially equivalent to the courses pursued in the student's primary major.
3. A student is permitted to select a Minor program only if the institution is already offering a Major degree program in that discipline.

III B.TECH II SEMESTER

S.No	Category	Course Code	Title	L	T	P	Credits
1	PC	23A3161T	AI FOR CLOUD COMPUTING	3	0	0	3
2	PC	23A3162T	BIG DATA TECHNOLOGIES	3	0	0	3
3	PC	23A306ET	QUANTUM COMPUTING	3	0	0	3
4	PE-II	23A336AT 23A336BT 23A306CT 23A316BT	Professional Elective-II 1. GRAPH NEURAL NETWORKS 2. RECOMMENDER SYSTEMS 3. PREDICTIVE ANALYTICS 4. BLOCKCHAIN FOR AI	3	0	0	3
5	PE-III	23A316CT 23A316DT 23A306HT 23A316ET 23A316FT	Professional Elective-III 1. AI FOR FINANCE 2. REINFORCEMENT LEARNING 3. SOCIAL NETWORK ANALYSIS 4. AI IN CYBERSECURITY 5. GAME THEORY	3	0	0	3
6			Open Elective – II	3	0	0	3
7	PC	23A3163L	BIG DATA TECHNOLOGIES & CLOUD COMPUTING LAB	0	0	3	1.5
8	PC	23A306EL	QUANTUM COMPUTING LAB	0	0	3	1.5
9	SEC	23AHS65L	Skill Enhancement course SOFT SKILLS	0	1	2	2
10	AC	23AHS67T	Audit Course TECHNICAL PAPER WRITING & IPR	2	0	0	0
11	ES	23A0564L	WORKSHOP	0	0	0	0
Total				20	1	08	23
Mandatory Industry Internship of 08 weeks duration during summer vacation							

Open Elective – II

S.No.	Course Code	Course Name	Offered by the Dept.
1	23A016GT	DISASTER MANAGEMENT	CIVIL
2	23A016HT	SUSTAINABILITY IN ENGINEERING PRACTICES	
3	23A026IT	RENEWABLE ENERGY SOURCES	EEE
4	23A036KT	AUTOMATION AND ROBOTICS	ME
5	23A046GT	DIGITAL ELECTRONICS	ECE
6	23AHS61T	OPTIMIZATION TECHNIQUES FOR ENGINEERS	Mathematics
7	23AHS66T	MATHEMATICAL FOUNDATION OF QUANTUM TECHNOLOGIES	
8	23AHS62T	PHYSICS OF ELECTRONIC MATERIALS AND DEVICES	Physics
9	23AHS63T	CHEMISTRY OF POLYMERS AND APPLICATIONS	Chemistry
10	23AHS64T	ACADEMIC WRITING AND PUBLIC SPEAKING	Humanities

III B.TECH I SEMESTER

23A3353T

NATURAL LANGUAGE PROCESSING
(PROFESSIONAL CORE)
(Common to CSE(AI) and AI&ML)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- Basics of NLP, Morphology, Tokenization, N-gram Models
- POS Tagging, Parsing, Treebanks, Ambiguity Handling
- Word Sense Disambiguation, Semantic Parsing, Sentiment Analysis
- Machine Translation, Transformers, BERT/GPT, Ethical NLP
- Speech Recognition, Feature Extraction, Discourse Analysis

COURSE OUTCOMES

- Understand morphological processing and the structure of words and documents.
- Analyze syntactic structures using various parsing algorithms.
- Apply semantic parsing techniques to interpret natural language text.
- Understand predicate-argument structures and meaning representation systems.
- Apply cross-lingual language models and speech recognition techniques in NLP applications.

UNIT I - INTRODUCTION TO NLP

(09)

Introduction to NLP: Origins and Challenges, Language and Grammar in NLP, Regular Expressions and Finite-State Automata, Tokenization: Text Segmentation and Sentence Splitting, Morphological Parsing: Stemming and Lemmatization, Spelling Error Detection and Correction, Minimum Edit Distance and Applications, Statistical Language Models: Unigram, Bigram, and Trigram Models, Processing Indian Languages in NLP.

UNIT II - WORD-LEVEL AND SYNTACTIC ANALYSIS

(09)

Introduction, Part-of-Speech (POS) Tagging: Rule-Based, Stochastic and Transformation-Based Approaches, Hidden Markov Models (HMM) and Maximum Entropy Models for POS Tagging, Context-Free Grammar (CFG) and Constituency Parsing, Treebanks and Normal Forms for Grammar, Top-Down and Bottom-Up Parsing Strategies, CYK Parsing Algorithm, Probabilistic Context-Free Grammars (PCFGs), Feature Structures and Unification.

UNIT III - TEXT CLASSIFICATION AND INFORMATION RETRIEVAL

(09)

Naïve Bayes Classifier for Text Classification, Training and Optimization for Sentiment Analysis, Information Retrieval: Basic Concepts and Design Features, Information Retrieval Models: Classical, Non-Classical, and Alternative Models, Cluster Model, Fuzzy Model, and LSTM-Based Information, Retrieval, Word Sense Disambiguation (WSD) Methods: Supervised and Dictionary-Based Approaches.

UNIT IV - MACHINE TRANSLATION AND SEMANTIC PROCESSING

(09)

Introduction to Machine Translation (MT), Language Divergence and Typology in MT Encoder-Decoder Model for Machine Translation, Translating in Low-Resource Scenarios, MT Evaluation Metrics and Techniques, Bias and Ethical Issues in NLP and Machine Translation, Semantic Analysis and First-Order Logic in NLP, Thematic Roles and Selectional Restrictions in Semantics, Word Senses and Relations Between Senses.

UNIT V - SPEECH PROCESSING AND ADVANCED NLP MODELS

(09)

Speech Fundamentals: Phonetics and Acoustic Phonetics, Digital Signal Processing in Speech Analysis, Feature Extraction in Speech: Short-Time Fourier Transform (STFT), Mel-Frequency Cepstral Coefficients (MFCC) and Perceptual Linear Prediction (PLP), Hidden Markov Models (HMMs) in Speech Recognition.

TEXTBOOKS (CORE LEARNING MATERIALS)

1. Daniel Jurafsky & James H. Martin – Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Pearson Education, 2023.
2. Tanveer Siddiqui & U.S. Tiwary – Natural Language Processing and Information Retrieval, Oxford University Press.

REFERENCE BOOKS (SUPPLEMENTARY LEARNING)

1. T.V. Geetha – Understanding Natural Language Processing – Machine Learning and Deep Learning Perspectives, Pearson, 2024.
2. Akshay Kulkarni & Adarsha Shivananda – Natural Language Processing Recipes - Unlocking Text Data with Machine Learning and Deep Learning using Python, Apress, 2019.

WEB LINKS AND VIDEO LECTURES (E-RESOURCES)

1. <https://www.youtube.com/watch?v=M7SWr5xObkA>
2. https://onlinecourses.nptel.ac.in/noc23_cs45/preview
3. <https://archive.nptel.ac.in/courses/106/106/106106211/>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A3353T.1	3	2	-	2	3	-	-	-	-	-	-	2	3	2
23A3353T.2	3	3	3	2	3	-	-	-	-	-	-	2	3	2
23A3353T.3	3	3	3	3	3	-	-	-	-	-	-	2	3	3
23A3353T.4	3	2	2	2	2	-	-	1	1	1	1	2	3	3
23A3353T.5	2	2	3	3	3	1	-	2	1	1	1	2	3	3

III B.TECH I SEMESTER

23A3151T	OPERATING SYSTEMS & SYSTEM PROGRAMMING	L	T	P	C
	(PROFESSIONAL ELECTIVE-I)	3	0	0	3
	(Common to CSE(AI) and AI&ML)				

COURSE OBJECTIVES

1. To introduce the fundamentals of operating systems, process management, and synchronization techniques.
2. To explain memory, file, and storage management techniques including paging, segmentation, and file system structures.
3. To explore I/O systems, device management, system protection, and provide a practical overview of Unix/Linux systems.
4. To understand the architecture and components of system software including language processors, assemblers, macro processors, linkers, and loaders.
5. To analyze the concepts of system programming including scanning, parsing, compilation, and process-level system programming in Unix/Linux.

COURSE OUTCOMES

1. Describe the structure and functions of operating systems and apply scheduling and synchronization techniques to manage processes and resolve deadlocks.
2. Explain memory management and virtual memory concepts, and analyze file and storage system structures and algorithms.
3. Illustrate I/O system operations, protection mechanisms, and demonstrate basic Unix/Linux commands and shell scripting.
4. Identify and describe components of system software including language processors, assemblers, macro processors, linkers, and loaders.
5. Analyze the compilation process and implement basic system-level programming concepts like process creation, file I/O, and concurrency mechanisms.

UNIT I - FUNDAMENTALS OF OPERATING SYSTEMS AND PROCESS MANAGEMENT

(09)

Introduction to Operating Systems: Definition and Basics, Generations and Types of Operating Systems, OS Structure: Layered, Monolithic, Microkernel, OS Services, System Calls, System Boot, System Programs, Virtual Machines, **Process Management:** Process Concepts, Process States, Process Control Block, Context Switching, Threads and Multithreading, Process Scheduling: Scheduling Criteria and Scheduling Algorithms, Multiprocessor Scheduling: Types and Performance Evaluation, **Process Synchronization and Deadlocks:** Race Conditions, Critical Section, Mutual Exclusion, Peterson's Solution, Semaphores, Monitors Classic IP, C Problems: Reader-Writers, Dining Philosophers, Deadlocks: Definition, Characteristics, Prevention, Avoidance, Detection and Recovery.

UNIT II - MEMORY, FILE, AND STORAGE MANAGEMENT

(09)

Memory Management: Logical vs. Physical Address Mapping, Contiguous Memory Allocation, Internal and External Fragmentation, Compaction, Paging and Page Tables, Segmentation, Virtual Memory: Demand Paging, Page Faults, Page Replacement Algorithms, Thrashing and Working Set Model, **File System Management:** File Concepts, Access Methods, File Types and Operations, Directory Structure, File System Structure, Allocation Methods, Free-Space Management, Directory Implementation. **Storage Management:** Mass Storage: Disk Structure, RAID Levels, Disk Scheduling Algorithms, Swap Space Management, Stable Storage, Tertiary Storage Structure.

UNIT III - I/O SYSTEMS, SECURITY, AND UNIX/LINUX OVERVIEW

(09)

I/O System Management: I/O Hardware: Devices, Device Controllers, Direct Memory Access, I/O Software: Interrupt Handlers, Device Drivers, Device-Independent I/O Software, **System Protection and Security:** Security Environment, Security Design Principles, User Authentication, Protection Mechanisms, Protection Domain, Access Control List, **Unix/Linux Overview & Case Studies:** Development of Unix/Linux, Role of Kernel, System Calls, Elementary Linux Commands, Shell Programming, Directory Structure, System Administration.

UNIT IV - SYSTEM SOFTWARE AND LANGUAGE PROCESSING

(09)

Overview of System Software: Software and Software Hierarchy, Systems Programming and Machine Structure, Interfaces, Address Space, and Computer Languages, System Software Development and Recent Trends, **Language Processors:** Programming Languages and Language Processing, Symbol Tables and Data Structures for Language Processing, Search and Allocation Data Structures, **Assemblers and Macro Processors:** Elements of Assembly Language Programming, Design and Types of Assemblers, Macro Definitions, Expansion, Nested Macros, and Advanced Macro Features, Design of Macro Assemblers and Macro Processors, **Linkers and Loaders:** Concept of Linking and Relocation, Linking in MS-DOS, Dynamic Linking, Loading Schemes: Sequential, Direct, Absolute, Relocating, and Linking Loaders, Comparison of Linkers and Loaders.

UNIT V - SYSTEM PROGRAMMING

(09)

Scanning and Parsing: Programming Language Grammars and Classification, Ambiguity in Grammatical Specification, Scanning, Parsing, **Compilers and Interpreters:** Compilation Process, Semantic Gap, Binding, and Scope Rules, Memory Allocation, Compilation of Expressions & Control Structures, Code Optimization, Overview of Interpreters and Debuggers, **Operating System Command & Shell Basics:** C Development Tools, Machine-Level Representation of Data and Programs, **System-Level Programming and Concurrency:** File I/O, Process Creation & Control (fork, exec), Pipes, Signals, and Basic Threading.

TEXTBOOKS

1. Operating System Concepts (9th or 10th Edition) by Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne in publisher: Wiley
2. Operating Systems: A Concept-Based Approach (3rd Edition) by D. M. Dhamdhere publisher: McGraw Hill

REFERENCE BOOKS

1. Real-Time Systems: Theory and Practice by Rajib Mall, Publisher: Pearson
2. System Software: An Introduction to Systems Programming (3rd Edition) by Leland L. Beck & D. Manjula, Publisher: Pearson.

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A3151T.1	3	2	3	3	2	-	-	-	-	1	-	2	3	2
23A3151T.2	3	3	2	2	2	-	-	-	-	1	-	2	3	2
23A3151T.3	3	2	3	2	3	-	-	-	-	2	-	2	3	3
23A3151T.4	2	2	3	2	3	-	-	-	-	1	-	2	3	2
23A3151T.5	3	2	3	3	3	-	-	-	1	2	-	2	3	3

III B.TECH I SEMESTER

23A3152T	COMPUTER VISION & IMAGE PROCESSING	L	T	P	C
	(Professional Core)	3	0	0	3
	(Common to CSE(AI))				

COURSE OBJECTIVES

- Introduce fundamental concepts of image processing and computer vision.
- Develop proficiency in applying algorithms for image analysis and interpretation.
- Explore techniques for feature extraction, object recognition, and scene understanding.
- Understand the integration of machine learning methods in computer vision applications.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

1. Understand image formation, representation, and apply basic image processing and frequency domain techniques for image enhancement and restoration.
2. Apply edge detection, segmentation, morphological, and texture analysis techniques for extracting features from images.
3. Analyze 3D vision and motion using techniques like stereo vision, optical flow, and camera calibration for scene understanding and depth estimation.
4. Evaluate object recognition approaches and machine learning models including traditional and deep learning techniques used in computer vision.
5. Implement advanced computer vision applications such as image compression, face recognition, and medical image analysis using case studies.

UNIT I – INTRODUCTION TO COMPUTER VISION AND IMAGE PROCESSING (09)

Overview of Computer Vision and Image Processing: Definitions and scope, Historical development and applications, Image Formation and Representation: Image acquisition methods, Sampling and quantization, Color spaces and models, Fundamentals of Image Processing: Point operations (brightness and contrast adjustments), Histogram processing, Spatial filtering techniques Fourier Transform and Frequency Domain Processing: Discrete Fourier Transform (DFT), Filtering in the frequency domain, Image restoration concept.

UNIT II – Image Analysis Techniques (09)

Edge Detection and Feature Extraction: Gradient operators (Sobel, Prewitt), Canny edge detector, Corner and interest point detection, Image Segmentation: Thresholding methods, Region-based segmentation, Clustering techniques (K-means, Mean-Shift), Morphological Image Processing: Erosion and dilation, Opening and closing operations, Applications in shape analysis, Texture Analysis, Statistical methods (co-occurrence matrices), Transform-based methods (Gabor filters), Applications in pattern recognition

UNIT III – 3D VISION AND MOTION ANALYSIS (09)

Stereo Vision: Epipolar geometry, Disparity mapping, Depth estimation techniques, Structure from Motion (SfM): Feature tracking across frames, 3D reconstruction from motion, Applications in scene understanding, Optical Flow and Motion Analysis: Lucas-Kanade method, Horn-Schunck method, Motion segmentation, Camera Calibration and 3D Reconstruction: Intrinsic and extrinsic parameters, Calibration techniques, 3D point cloud generation

UNIT IV – OBJECT RECOGNITION AND MACHINE LEARNING IN VISION**(09)**

Feature Descriptors and Matching: Scale-Invariant Feature Transform (SIFT), Speeded-Up Robust Features (SURF), Feature matching algorithms, Object Detection and Recognition: Template matching, Deformable part models, Convolutional Neural Networks (CNNs), Introduction to Machine Learning for Vision: Supervised and unsupervised learning, Support Vector Machines (SVMs), Decision trees and random forests, Deep Learning Architectures: Autoencoders, Recurrent Neural Networks (RNNs), Generative Adversarial Networks (GANs)

UNIT V – APPLICATIONS AND ADVANCED TOPICS**(09)**

Image Compression: Lossy and lossless compression techniques, Standards (e.g., JPEG, PNG), Morphological Image Processing: Dilation, erosion, opening, and closing operations., Applications in shape analysis, Case Studies: Face recognition systems., Automated visual inspection, Medical image analysis.

TEXTBOOKS

1. Gonzalez, R. C., & Woods, R. E. (2008). Digital Image Processing (3rd ed.). Pearson Prentice Hall. Stony Brook University Szeliski, R. (2010).
2. Computer Vision: Algorithms and Applications. Springer

REFERENCE BOOKS

1. Forsyth, D. A., & Ponce, J. (2002). Computer Vision: A Modern Approach. Prentice Hall.
2. Shapiro, L. G., & Stockman, G. C. (2001). Computer Vision. Prentice Hall.

ONLINE LEARNING RESOURCES

1. Coursera: Introduction to Computer Vision and Image Processing. [Link Coursera](#)
2. Stanford University: CS231n: Deep Learning for Computer Vision. [Link CS231n.stanford.edu](#)
3. MIT OpenCourseWare: Introduction to Computer Vision. [Link](#)

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A3152T.1	3	2	2	2	3	-	-	-	-	-	-	2	3	2
23A3152T.2	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A3152T.3	3	3	3	3	3	-	-	-	-	-	-	2	3	3
23A3152T.4	3	3	3	3	3	-	-	1	1	1	1	2	3	3
23A3152T.5	3	3	3	3	3	1	-	1	1	1	1	3	3	3

III B.TECH I SEMESTER

	INTRODUCTION TO QUANTUM TECHNOLOGIES AND APPLICATIONS	L	T	P	C
23A0554T	(Qualitative Treatment) (Common to all branches)	3	0	0	3

COURSE OBJECTIVES

- Introduce fundamental quantum concepts like superposition and entanglement.
- Understand theoretical structure of qubits and quantum information.
- Explore conceptual challenges in building quantum computers.
- Explain principles of quantum communication and computing.
- Examine real-world applications and the future of quantum technologies.

COURSE OUTCOMES

- Explain core quantum principles in a non-mathematical manner.
- Compare classical and quantum information systems.
- Identify theoretical issues in building quantum computers.
- Discuss quantum communication and computing concepts.
- Recognize applications, industry trends, and career paths in quantum technology.

UNIT 1 - INTRODUCTION TO QUANTUM THEORY AND TECHNOLOGIES (09)

The transition from classical to quantum physics, Fundamental principles explained conceptually: Superposition, Entanglement, Uncertainty Principle, Wave-particle duality, Classical vs Quantum mechanics – theoretical comparison, Quantum states and measurement: nature of observation, Overview of quantum systems: electrons, photons, atoms, The concept of quantization: discrete energy levels, Why quantum? Strategic, scientific, and technological significance, A snapshot of quantum technologies: Computing, Communication, and Sensing, National and global quantum missions: India's Quantum Mission, EU, USA, China.

UNIT 2 - THEORETICAL STRUCTURE OF QUANTUM INFORMATION SYSTEMS (09)

What is a qubit? Conceptual understanding using spin and polarization, Comparison: classical bits vs quantum bits, Quantum systems: trapped ions, superconducting circuits, photons (non- engineering view), Quantum coherence and decoherence – intuitive explanation, Theoretical concepts: Hilbert spaces, quantum states, operators – only interpreted in abstract, The role of entanglement and non-locality in systems, Quantum information vs classical information: principles and differences, Philosophical implications: randomness, determinism, and observer role.

UNIT 3 - BUILDING A QUANTUM COMPUTER – THEORETICAL CHALLENGES AND REQUIREMENTS (09)

What is required to build a quantum computer (conceptual overview)? Fragility of quantum systems: decoherence, noise, and control, Conditions for a functional quantum system: Isolation, Error management, Scalability, Stability, Theoretical barriers:

Why maintaining entanglement is difficult, Error correction as a theoretical necessity, Quantum hardware platforms (brief conceptual comparison), Superconducting circuits, Trapped ions, Photonics, Vision vs reality: what's working and what remains elusive, The role of quantum software in managing theoretical complexities

UNIT 4 - QUANTUM COMMUNICATION AND COMPUTING – THEORETICAL PERSPECTIVE

(09)

Quantum vs Classical Information, Basics of Quantum Communication, Quantum Key Distribution (QKD), Role of Entanglement in Communication, The Idea of the Quantum Internet – Secure Global Networking, Introduction to Quantum Computing, Quantum Parallelism (Many States at Once), Classical vs Quantum Gates, Challenges: Decoherence and Error Correction, Real- World Importance and Future Potential.

UNIT 5 - APPLICATIONS, USE CASES, AND THE QUANTUM FUTURE

(09)

Real-world application domains: Healthcare (drug discovery), Material science, Logistics and optimization, Quantum sensing and precision timing, Industrial case studies: IBM, Google, Microsoft, PsiQuantum, Ethical, societal, and policy considerations, Challenges to adoption: cost, skills, standardization, Emerging careers in quantum: roles, skillsets, and preparation pathways, Educational and research landscape – India's opportunity in the global quantum race

TEXTBOOKS

1. Michael A. Nielsen, Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 10th Anniversary Edition, 2010.
2. Eleanor Rieffel and Wolfgang Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2011.
3. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019.

REFERENCE BOOKS

1. David McMahon, Quantum Computing Explained, Wiley, 2008.
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, An Introduction to Quantum Computing, Oxford University Press, 2007.
3. Scott Aaronson, Quantum Computing Since Democritus, Cambridge University Press, 2013.
4. Alastair I.M. Rae, Quantum Physics: A Beginner's Guide, Oneworld Publications, Revised Edition, 2005.
5. Eleanor G. Rieffel, Wolfgang H. Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2011.
6. Leonard Susskind, Art Friedman, Quantum Mechanics: The Theoretical Minimum, Basic Books, 2014.
7. Bruce Rosenblum, Fred Kuttner, Quantum Enigma: Physics Encounters Consciousness, Oxford University Press, 2nd Edition, 2011.
8. Giuliano Benenti, Giulio Casati, Giuliano Strini, Principles of Quantum Computation and Information, Volume I: Basic Concepts, World Scientific Publishing, 2004.
9. K.B. Whaley et al., Quantum Technologies and Industrial Applications: European Roadmap and Strategy Document, Quantum Flagship, European Commission, 2020.
10. Department of Science & Technology (DST), Government of India, National Mission on Quantum Technologies & Applications – Official Reports and Whitepapers, MeitY/DST Publications, 2020 onward.

ONLINE LEARNING RESOURCES

- [IBM Quantum Experience and Qiskit Tutorials](#)
- [Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley](#)
- [edX – The Quantum Internet and Quantum Computers](#)
- [YouTube – Quantum Computing for the Determined by Michael Nielsen](#)
- Qiskit Textbook – IBM Quantum

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A0554T.1	3	2	1	2	1	-	-	-	-	2	-	3	3	2
23A0554T.2	3	3	2	2	2	-	-	-	-	2	-	3	3	3
23A0554T.3	2	3	2	3	2	-	-	-	-	2	-	3	3	3
23A0554T.4	2	3	3	3	3	-	-	-	-	3	-	3	3	3
23A0554T.5	1	2	2	2	3	2	2	2	2	3	2	3	2	3

III B.TECH I SEMESTER

23A305AT

DATA VISUALIZATION
(PROFESSIONAL ELECTIVE-I)
(Common to AI&DS, CSE(AI) and AI&ML)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the principles, techniques, and tools of data visualization.
- To develop the ability to transform data into visual insights using different types of charts and plots.
- To introduce the cognitive and perceptual foundations of effective data visualization.
- To apply tools and programming environments (like Python, Tableau, or Power BI) for creating interactive and dynamic visualizations.
- To analyze real-world datasets and effectively communicate data-driven findings visually.

COURSE OUTCOMES

- Interpret different types of data and recognize the appropriate visualization methods.
- Design effective and interactive data visualizations using various tools.
- Apply visual encoding and perceptual principles in presenting complex data.
- Analyze and visualize real-world data sets using Python libraries and dashboards.
- Create visual stories and dashboards for effective communication of insights.

UNIT I - INTRODUCTION TO DATA VISUALIZATION & PERCEPTION (09)

Introduction to Data Visualization, Importance and Scope of Data Visualization, Data Types and Sources, Visual Perception: Pre-attentive Processing, Gestalt Principles, Data-Ink Ratio, Data Density, Lie Factor, Visualization Process and Design Principles, Tools Overview: Tableau, Power BI, Python Libraries.

UNIT II - VISUALIZATION TECHNIQUES FOR CATEGORICAL & QUANTITATIVE DATA (09)

Charts for Categorical Data: Bar Charts, Pie Charts, Column Charts, Charts for Quantitative Data: Histograms, Line Charts, Boxplots, Scatter Plots, Bubble Charts, Heatmaps, Choosing the Right Chart Type, Best Practices in Labeling, Coloring, and Scaling.

UNIT III - MULTIDIMENSIONAL, TEMPORAL AND HIERARCHICAL DATA VISUALIZATION (09)

Visualizing Multivariate Data: Parallel Coordinates, Radar Charts, Time-Series Visualization: Time Plots, Animation over Time, Geographic Data Visualization: Maps, Choropleths, Hierarchical Data: Treemaps, Sunburst Charts, Network and Graph Visualization.

UNIT IV - DATA VISUALIZATION USING PYTHON AND DASHBOARDS (09)

Introduction to Matplotlib, Seaborn, and Plotly, Creating Static and Interactive Charts, Pandas Visualization Capabilities, Dashboards with Dash, Streamlit, Power BI, Case Studies: Real-world Dataset Visualization.

UNIT V - STORYTELLING WITH DATA AND ETHICAL VISUALIZATION

(09)

Storytelling and Narrative Techniques in Visualization, Dashboards and Reporting, Misleading Visualizations and Bias, Ethical Principles in Data Visualization, Final Project: Create a Storytelling Dashboard with Real Data.

TEXTBOOKS

1. Tamara Munzner, Visualization Analysis and Design, CRC Press, 2014.
2. Nathan Yau, Data Points: Visualization That Means Something, Wiley, 2013.

REFERENCE BOOKS

1. Alberto Cairo, The Truthful Art: Data, Charts, and Maps for Communication, New Riders, 2016.
2. Cole Nussbaumer Knaflic, Storytelling with Data: A Data Visualization Guide for Business Professionals, Wiley, 2015.
3. Claus O. Wilke, Fundamentals of Data Visualization, O'Reilly, 2019.
4. Rohan Chopra, Hands-On Data Visualization with Bokeh, Packt Publishing, 2019.

ONLINE LEARNING RESOURCES

1. NPTEL: Data Visualization - IIT Madras
2. Coursera: Data Visualization with Python by IBM

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A305AT.1	3	2	-	2	2	-	-	-	-	2	-	2	3	2
23A305AT.2	2	3	3	2	3	-	-	1	1	2	1	2	3	3
23A305AT.3	2	2	3	2	3	-	-	2	-	2	1	2	3	3
23A305AT.4	3	3	3	3	3	-	-	-	-	2	1	2	3	3
23A305AT.5	2	2	3	2	3	-	-	2	2	3	2	-	-	-

III B.TECH I SEMESTER

23A315BT

**ADAPTIVE COMPUTATIONAL METHODS
(PROFESSIONAL ELECTIVE-I)**
(Common to AI&DS, CSE(AI) and AI&ML)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- Understand the concepts of soft computing techniques and how they differ from traditional AI techniques.
- Introduce the fundamentals of fuzzy logic and fuzzy systems.
- Familiarize with artificial neural networks and their architectures.
- Learn genetic algorithms and their role in optimization.
- Explore hybrid systems integrating fuzzy logic, neural networks, and genetic algorithms.

COURSE OUTCOMES

- Understand the components and applications of soft computing.
- Apply fuzzy logic concepts to real-world problems.
- Build and train various neural network models.
- Implement genetic algorithms for problem-solving and optimization.
- Design hybrid systems using soft computing techniques.

UNIT I - INTRODUCTION TO SOFT COMPUTING AND FUZZY LOGIC (09)

Introduction to Soft Computing: Definition, Components, Differences with Hard Computing, Applications of Soft Computing, Fuzzy Logic: Crisp Sets vs Fuzzy Sets, Membership Functions, Fuzzy Set Operations, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems: Mamdani and Sugeno Models, Defuzzification Techniques.

UNIT II - ARTIFICIAL NEURAL NETWORKS – I (09)

Introduction to Neural Networks: Biological Neurons vs Artificial Neurons, Architecture of Neural Networks: Feedforward, Feedback, Learning Rules: Hebbian, Delta, Perceptron Learning Rule, Single Layer Perceptron and its Limitations, Multi-Layer Perceptron: Backpropagation Algorithm, Applications of Neural Networks.

UNIT III - ARTIFICIAL NEURAL NETWORKS – II (09)

Hopfield Networks and Associative Memories, Radial Basis Function Networks, Self-Organizing Maps (SOM), Recurrent Neural Networks (RNNs) – Basic Concepts, Convolutional Neural Networks (CNNs) – Overview and Applications, Practical Use Cases in Image and Pattern Recognition.

UNIT IV - GENETIC ALGORITHMS AND OPTIMIZATION (09)

Introduction to Genetic Algorithms, GA Operators: Selection, Crossover, Mutation, Fitness Function and Evaluation, Schema Theorem, Elitism, Applications in Function Optimization, Scheduling, and Robotics, Introduction to Particle Swarm Optimization (PSO).

UNIT V - HYBRID SYSTEMS AND ADVANCED TOPICS**(09)**

Hybrid Systems: Neuro-Fuzzy Systems, Fuzzy-GA, GA-ANN, ANFIS: Architecture and Learning, Case Studies on Hybrid Systems, Introduction to Deep Learning in Soft Computing, Real-World Applications: Forecasting, Control Systems, Medical Diagnosis, Image Processing.

TEXTBOOKS

1. S. N. Sivanandam, S. N. Deepa, —Principles of Soft Computing, Wiley India, 3rd Edition
2. Timothy J. Ross, —Fuzzy Logic with Engineering Applications, Wiley, 4th Edition
3. S. Rajasekaran and G. A. Vijayalakshmi Pai, —Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI

REFERENCE BOOKS

1. Laurene Fausett, —Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson
2. David E. Goldberg, —Genetic Algorithms in Search, Optimization and Machine Learning, Pearson
3. Simon Haykin, —Neural Networks and Learning Machines, Pearson, 3rd Edition
4. Bart Kosko, —Neural Networks and Fuzzy Systems, Prentice Hall

ONLINE LEARNING RESOURCES

1. NPTEL – Soft Computing by Prof. S. Sengupta (IIT Kharagpur)
2. Coursera – Neural Networks and Deep Learning (Andrew Ng)

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A315BT.1	3	2	-	1	2	-	-	-	-	1	-	2	3	2
23A315BT.2	3	3	2	2	3	-	-	2		1	-	2	3	3
23A315BT.3	3	3	3	2	3	-	-	-	1	2	-	2	3	3
23A315BT.4	3	3	3	3	3	-	-	1		1	-	2	3	3
23A315BT.5	3	3	3	3	3	-	-	2	2	2	1	2	3	3

III B.TECH I SEMESTER

23A335CT	EXPLORATORY DATA ANALYSIS WITH PYTHON (PROFESSIONAL ELECTIVE-I) <i>(Common to AI&DS, CSE(AI) and AI&ML)</i>	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the principles and practices of Exploratory Data Analysis (EDA) using Python.
- To teach techniques for data cleaning, preprocessing, transformation, and visualization.
- To apply statistical techniques and visual methods to discover patterns and relationships.
- To gain experience using popular Python libraries such as NumPy, Pandas, Matplotlib, and Seaborn.
- To prepare datasets for further machine learning and predictive modeling.

COURSE OUTCOMES

- Understand and apply key concepts of EDA and data preprocessing.
- Perform exploratory analysis using Python libraries and interpret results.
- Handle missing data, outliers, and categorical features effectively.
- Create meaningful visualizations to support data-driven insights.
- Use EDA as a foundation for data science workflows.

UNIT I – INTRODUCTION TO EDA AND PYTHON ENVIRONMENT (09)

Introduction to Data Science and EDA, Importance of EDA in Data Science Life Cycle, Setting up Python Environment: Jupyter, Anaconda, VS Code, Introduction to NumPy and Pandas: Arrays, Series, DataFrames, Data loading, viewing, basic operations (info, describe, shape).

UNIT II – DATA WRANGLING AND PREPROCESSING (09)

Handling Missing Data (mean, median, drop, interpolation), Dealing with Duplicates, Outliers, and Anomalies, Encoding Categorical Variables (Label, One-hot), Data Transformation: Scaling, Normalization, Binning, Data Types Conversion and Data Type Casting.

UNIT III – UNIVARIATE AND BIVARIATE ANALYSIS (09)

Measures of Central Tendency and Dispersion, Distribution Plots: Histograms, Boxplots, KDE, Bar Charts, Count Plots, Pie Charts, Bivariate Analysis: Scatter Plots, Pair Plots, Heatmaps, Correlation and Covariance Analysis.

UNIT IV – DATA VISUALIZATION TECHNIQUES (09)

Visualization with Matplotlib and Seaborn, Customizing Plots: Titles, Legends, Labels, Themes, Advanced Visuals: Violin Plots, Strip Plots, Swarm Plots, Multivariate Visualization and Subplots, Plotly and Interactive Visualizations (basic overview).

UNIT V – EDA CASE STUDIES AND REAL-TIME DATASETS (09)

Step-by-step EDA on Sample Datasets (Titanic, Iris, Sales, etc.), Outlier Detection Techniques, Feature Engineering Techniques in EDA, EDA Report Generation using Python Notebooks, Preparing Data for Machine Learning Models.

TEXTBOOKS

1. Jake VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly, 2016.
2. Wes McKinney, Python for Data Analysis, 2nd Edition, O'Reilly, 2018.

REFERENCE BOOKS

1. Joel Grus, Data Science from Scratch, O'Reilly, 2019.
2. Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, 2nd Edition, O'Reilly, 2019.
3. Allen B. Downey, Think Stats: Probability and Statistics for Programmers, O'Reilly, 2014.

ONLINE LEARNING RESOURCES

1. NPTEL Course – Data Science for Engineers
2. Coursera – Applied Data Science with Python Specialization (University of Michigan)

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A335CT.1	3	3	2	2	3	-	-	-	-	1	-	2	3	2
23A335CT.2	3	2	2	2	3	-	-	-	-	2	-	2	3	3
23A335CT.3	3	3	3	2	3	-	-	-	-	1	-	2	3	3
23A335CT.4	2	2	3	3	3	-	-	-	-	2	-	2	3	3
23A335CT.5	2	3	3	3	3	-	-	-	-	2	-	2	3	3

III B.TECH I SEMESTER

23A315AT	COMPUTATIONAL INTELLIGENCE (PROFESSIONAL ELECTIVE-I) <i>(Common to CSE(AI))</i>	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Understand the concepts and foundations of computational intelligence.
- Study neural networks, fuzzy logic systems, and evolutionary algorithms.
- Explore hybrid systems and their applications.
- Apply computational intelligence techniques to real-world problem-solving.
- Analyze the effectiveness of various computational intelligence approaches.

COURSE OUTCOMES

- Describe and differentiate neural networks, fuzzy logic, and evolutionary computation. (Understand)
- Apply neural and fuzzy systems for real-time decision-making. (Apply)
- Analyze complex problems using soft computing tools. (Analyze)
- Develop hybrid intelligent systems. (Create)
- Evaluate and compare the performance of CI-based systems. (Evaluate)

UNIT I - INTRODUCTION TO COMPUTATIONAL INTELLIGENCE AND ARTIFICIAL NEURAL NETWORKS (09)

Definition and Scope of Computational Intelligence (CI), Components of CI: Neural Networks, Fuzzy Logic, Evolutionary Computation, Biological Neuron vs. Artificial Neuron, McCulloch-Pitts Model, Perceptron, Adaline and Madaline, Multilayer Feedforward Networks, Backpropagation Algorithm, Applications of ANN in Pattern Recognition and Classification.

UNIT II - FUZZY LOGIC AND FUZZY SYSTEMS (09)

Introduction to Fuzzy Logic and Fuzzy Sets, Membership Functions, Fuzzy Set Operations, Fuzzy Rules and Inference Systems, Fuzzification and Defuzzification, Fuzzy Control Systems, Fuzzy Reasoning and Approximate Reasoning

UNIT III - EVOLUTIONARY COMPUTATION TECHNIQUES (09)

Basics of Evolutionary Algorithms (EA), Genetic Algorithms (GA): Operators, Encoding, Fitness Function, Selection, Crossover and Mutation, Convergence Criteria, Genetic Programming (GP), Differential Evolution (DE), Applications of GA and GP

UNIT IV - SWARM INTELLIGENCE AND HYBRID SYSTEMS (09)

Swarm Intelligence: Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Behavior of Swarms and Collective Intelligence, Comparison of Evolutionary Algorithms and Swarm Techniques, Hybrid Systems: Neuro-Fuzzy, Fuzzy-GA, ANN-GA Systems, Case Studies in Hybrid Systems

UNIT V - APPLICATIONS OF COMPUTATIONAL INTELLIGENCE

(09)

CI in Image and Signal Processing, CI for Optimization Problems and Robotics, CI in Biomedical Engineering and Finance, Intelligent Agents and Decision-Making Systems, Real-time Applications and Emerging Trends in CI.

TEXTBOOKS

1. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI Learning.
2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley India.

REFERENCE BOOKS

1. S.N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley India.
2. Simon Haykin, Neural Networks and Learning Machines, Pearson.
3. James Kennedy and Russell C. Eberhart, Swarm Intelligence, Morgan Kaufmann.
4. Andries P. Engelbrecht, Computational Intelligence: An Introduction, Wiley.

ONLINE LEARNING RESOURCES

1. NPTEL - Computational Intelligence
2. Coursera – Computational Intelligence
3. YouTube: IIT Lectures on Soft Computing and CI

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A315AT.1	3	2	2	2	2	-	-	-	-	-	-	2	3	2
23A315AT.2	3	3	3	3	3	-	-	1	1	1	1	2	3	3
23A315AT.3	3	3	3	3	3	-	-	1	-	-	-	3	3	3
23A315AT.4	3	3	3	3	3	-	-	1	1	1	1	3	3	3
23A315AT.5	3	3	3	3	3	-	-	1	1	1	1	3	3	3

III B.TECH I SEMESTER

23A015DT

GREEN BUILDINGS
(OPEN ELECTIVE-I)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To understand the fundamental concepts of green buildings, their necessity, and sustainable features.
2. To analyze green building concepts, rating systems, and their benefits in India.
3. To apply green building design principles, energy efficiency measures, and renewable energy sources.
4. To evaluate air conditioning systems, HVAC designs, and energy modeling for sustainable buildings.
5. To assess material conservation strategies, waste management, and indoor environmental quality in green buildings.

COURSE OUTCOMES

1. Understand the importance of green buildings, their necessity, and sustainable features.
2. Analyze various green building practices, rating systems, and their impact on environmental sustainability.
3. Apply principles of green building design to enhance energy efficiency and incorporate renewable energy sources.
4. Evaluate HVAC systems, energy-efficient air conditioning techniques, and their role in sustainable building design.
5. Assess material conservation techniques, waste reduction strategies, and indoor air quality management in green buildings.

UNIT I - INTRODUCTION TO GREEN BUILDING

(09)

Necessity of Green Buildings, Benefits of Green Buildings, Green Building Materials and Equipment in India, Key Requisites for Constructing A Green Building, Important Sustainable Features for Green Buildings.

UNIT II - GREEN BUILDING CONCEPTS AND PRACTICES

(09)

Indian Green Building Council, Green Building Movement in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities and Benefits: Opportunities of Green Buildings, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy-Saving Approaches in Buildings, LEED India Rating System, and Energy Efficiency.

UNIT III - GREEN BUILDING DESIGN

(09)

Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximizing System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources, Eco-Friendly Captive Power Generation for Factories, Building Requirements.

UNIT IV - AIR CONDITIONING

(09)

Introduction, CII Godrej Green Business Centre, Design Philosophy, Design Interventions, Energy Modeling, HVAC System Design, Chiller Selection, Pump Selection, Selection of Cooling towers, Selection of Air Handling Units, Pre-Cooling of Fresh Air, Interior Lighting Systems, Key Features of The Building, Eco-Friendly Captive Power Generation for Factories, Building Requirements.

UNIT V - MATERIAL CONSERVATION

(09)

Handling of Non-Process Waste, Waste Reduction During Construction, Materials With Recycled Content, Local Materials, Material Reuse, Certified Wood, Rapidly Renewable Building Materials and Furniture. Indoor Environment Quality and Occupational Health– Air Conditioning, Indoor Air Quality, Sick Building Syndrome, tobacco Smoke.

TEXT BOOKS

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
2. Green Building Hand Book by tom woolley and Sam kimings, 2009.

REFERENCE BOOKS

1. Complete Guide to Green Buildings by Trish riley
2. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009
3. Energy Conservation Building Code –ECBC-2020, published by BEE

ONLINE LEARNING RESOURCES

- <https://archive.nptel.ac.in/courses/105/102/105102195/>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A015DT.1	3	-	-	-	-	2	3	-	-	-	-	-	3	3
23A015DT.2	-	3	-	-	2	-	3	-	-	-	-	2	3	3
23A015DT.3	-	-	3	3	3	-	3	-	-	-	-	-	3	3
23A015DT.4	-	-	3	3	3	-	3	-	-	-	-	-	3	3
23A015DT.5	-	-	-	-	-	3	3	3	2	-	-	-	-	3

III B.TECH I SEMESTER

	CONSTRUCTION TECHNOLOGY AND MANAGEMENT	L	T	P	C
23A015ET	(OPEN ELECTIVE-I)	3	0	0	3
	(Common to all branches)				

COURSE OBJECTIVES

1. To understand project management fundamentals, organizational structures, and leadership principles in construction.
2. To analyze manpower planning, equipment management, and cost estimation in civil engineering projects.
3. To apply planning, scheduling, and project management techniques such as CPM and PERT.
4. To evaluate various contract types, contract formation, and legal aspects in construction management.
5. To assess safety management practices, accident prevention strategies, and quality management systems in construction.

COURSE OUTCOMES

1. Understand project management fundamentals, organizational structures, and leadership principles in construction.
2. Analyze manpower planning, equipment management, and cost estimation in civil engineering projects.
3. Apply planning, scheduling, and project management techniques such as CPM and PERT.
4. Evaluate various contract types, contract formation, and legal aspects in construction management.
5. Assess safety management practices, accident prevention strategies, and quality management systems in construction.

UNIT I – INTRODUCTION (09)

Project forms, Management Objectives and Functions; Organizational Chart of a Construction Company; Manager's Duties and Responsibilities; Public Relations; Leadership and Team - Work; Ethics, Morale, Delegation and Accountability.

UNIT II - MAN AND MACHINE (09)

Man-Power Planning, Training, Recruitment, Motivation, Welfare Measures and Safety Laws; Machinery for Civil Engineering., Earth Movers and Hauling Costs, Factors Affecting Purchase, Rent, and Lease of Equipment, and Cost Benefit Estimation.

UNIT III - PLANNING, SCHEDULING AND PROJECT MANAGEMENT (09)

Planning, Scheduling and Project Management: Planning Stages, Construction Schedules and Project Specification, Monitoring and Evaluation; Bar-Chart, CPM, PERT, Network- formulation and Time Computation.

UNIT IV – CONTRACTS

(09)

Types of Contracts, formation of Contract – Contract Conditions – Contract for Labour, Material, Design, Construction – Drafting of Contract Documents Based On IBRD/ MORTH Standard Bidding Documents – Construction Contracts – Contract Problems – Arbitration and Legal Requirements Computer Applications in Construction Management: Software for Project Planning, Scheduling and Control.

UNIT V - SAFETY MANAGEMENT

(09)

Safety Management – Implementation and Application of QMS in Safety Programs, ISO 9000 Series, Accident Theories, Cost of Accidents, Problem Areas in Construction Safety, Fall Protection, Incentives, Zero Accident Concepts, Planning for Safety, Occupational Health and Ergonomics.

TEXT BOOKS

1. Construction Project Management, SK. Sears, GA. Sears, RH. Clough, John Wiley and Sons, 6th Edition, 2016.
2. Construction Project Scheduling and Control by Saleh Mubarak, 4th Edition, 2019
3. Pandey, I.M (2021) Financial Management 12th edition. Pearson India Education Services Pvt. Ltd.

REFERENCE BOOKS

1. Brien, J.O. and Plotnick, F.L., CPM in Construction Management, Mcgraw Hill, 2010.
2. Punmia, B.C., and Khandelwal, K.K., Project Planning and control with PERT and CPM, Laxmi Publications, 2002.
3. Construction Methods and Management: Pearson New International Edition 8 th Edition Stephens Nunnally.
4. Rhoden, M and Cato B, Construction Management and Organisational Behaviour, Wiley-Blackwell, 2016.

ONLINE LEARNING RESOURCES

- <https://archive.nptel.ac.in/courses/105/104/105104161/>
- <https://archive.nptel.ac.in/courses/105/103/105103093/>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A015ET.1	3	-	-	-	-	2	-	2	2	-	-	-	3	3
23A015ET.2	-	3	-	-	2	-	-	-	-	-	-	2	3	3
23A015ET.3	-	-	3	3	3	-	-	-	-	2	-	-	3	3
23A015ET.4	-	-	3	3	3	-	-	2	-	-	-	-	3	3
23A015ET.5	-	-	-	-	-	3	3	3	2	-	-	-	-	3

III B.TECH I SEMESTER

	ELECTRICAL SAFETY PRACTICES AND STANDARDS	L	T	P	C
23A025ET	(OPEN ELECTIVE-I) (Common to all branches)	3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamental concepts of electrical safety, including the physiological effects of electric shock, arc flash, and electrical blast hazards.
- To familiarize students with safety components, protective equipment, and preventive measures for electrical hazards, including insulation, grounding, and fire safety.
- To impart knowledge on grounding and bonding techniques as per electrical safety standards for both equipment and system grounding.
- To develop awareness of safety practices in various environments such as domestic, industrial, and public spaces, with emphasis on first aid and emergency response.
- To educate students on national and international electrical safety standards, including compliance with regulatory frameworks such as NFPA, OSHA, IEEE, and Indian Electricity Rules.

COURSE OUTCOMES

- Understanding the Fundamentals of Electrical Safety
- Identifying and Applying Safety Components
- Analyzing Grounding Practices and Electrical Bonding
- Applying Safety Practices in Electrical Installations and Environments
- Evaluating Electrical Safety Standards and Regulatory Compliance

UNIT I - INTRODUCTION TO ELECTRICAL SAFETY (08)

Fundamentals of Electrical Safety-Electric Shock- physiological effects of electric current - Safety requirements –Hazards of electricity- Arc - Blast- Causes for electrical failure.

UNIT II - SAFETY COMPONENTS (08)

Introduction to conductors and insulators- voltage classification -safety against over voltages- safety against static electricity-Electrical safety equipment's - Fire extinguishers for electrical safety.

UNIT III – GROUNDING (08)

General requirements for grounding and bonding- Definitions- System grounding- Equipment grounding - The Earth - Earthing practices- Determining safe approach distance-Determining arc hazard category.

UNIT IV - SAFETY PRACTICES (08)

General first aid- Safety in handling hand held electrical appliances tools- Electrical safety in train stations- swimming pools, external lighting installations, medical locations-Case studies.

UNIT V - STANDARDS FOR ELECTRICAL SAFETY (08)

Electricity Acts- Rules & regulations- Electrical standards-NFPA 70 E-OSHA standards-IEEE standards- National Electrical Code 2005 – National Electric Safety code NESC-Statutory requirements from electrical inspectorate.

TEXT BOOKS

1. Massimo A.G.Mitolo, —Electrical Safety of Low-Voltage Systems, McGraw Hill, USA, 2009.
2. Mohamed El-Sharkawi, —Electric Safety - Practice and Standards, CRC Press, USA, 2014.

REFERENCE BOOKS

1. Kenneth G.Mastrullo, Ray A. Jones, —The Electrical Safety Program Book, Jones and Bartlett Publishers, London, 2nd Edition, 2011.
2. Palmer Hickman, —Electrical Safety-Related Work Practices, Jones & Bartlett Publishers, London, 2009.
3. Fordham Cooper, W., —Electrical Safety Engineering, Butterworth and Company, London, 1986.
4. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, —Electrical Safety Hand book, McGraw-Hill, New York, USA, 4th edition, 2012.

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A025ET.1	3	2	-	-	-	2	2	-	-	-	-	2	2	-
23A025ET.2	3	2	2	-	2	2	2	-	-	-	-	2	2	-
23A025ET.3	3	3	2	2	-	2	2	-	-	-	-	2	3	-
23A025ET.4	2	3	2	2	2	3	3	-	-	-	-	2	3	-
23A025ET.5	3	3	2	2	2	3	3	-	-	-	-	3	3	-

III B.TECH I SEMESTER

	SUSTAINABLE ENERGY TECHNOLOGIES	L	T	P	C
23A035FT	(OPEN ELECTIVE-I)	3	0	0	3
	<i>(Common to all branches)</i>				

COURSE OBJECTIVES

- 1 Demonstrate the importance the impact of solar radiation, solar pvmodules
- 2 Understand the principles of storage in PV systems
- 3 Discuss solar energy storage systems and their applications.
- 4 Get knowledge in wind energy and bio-mass
- 5 Gain insights in geothermal energy, ocean energy and fuel cells.

COURSE OUTCOMES

- 1 Illustrate the importance of solar radiation and solar PV modules.
- 2 Discuss the storage methods in PV systems.
- 3 Explain the solar energy storage for different applications.
- 4 Understand the principles of wind energy, and bio-mass energy.
- 5 Attain knowledge in geothermal energy, ocean energy and fuel cells.

UNIT I - SOLAR RADIATION

(09)

Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems.

SOLAR PV MODULES AND PV SYSTEMS

PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

UNIT II - STORAGE IN PV SYSTEMS

(09)

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.

UNIT III - SOLAR ENERGY COLLECTION

(08)

Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT IV - WIND ENERGY

(09)

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

UNIT V - GEOTHERMAL ENERGY

(09)

Origin, Applications, Types of Geothermal Resources, Relative Merits.

OCEAN ENERGY: Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges.

FUEL CELLS: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

TEXT BOOKS

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH.
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006.

REFERENCES

1. Principles of Solar Engineering - D.Yogi Goswami, Frank Kreith& John F Kreider / Taylor & Francis.
2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd.
3. Renewable Energy Technologies -Ramesh & Kumar /Narosa.
4. Non-conventional Energy Source- G.D Roy/Standard Publishers.

ONLINE LEARNING RESOURCES

- <https://nptel.ac.in/courses/112106318>
- <https://youtube.com/playlist?list=PLyqSpQzTE6M-ZgdjYukayF6QevPv7WE-r&si=-mwIa2X-SuSiNy13>
- https://youtube.com/playlist?list=PLyqSpQzTE6M-ZgdjYukayF6QevPv7WE-r&si=Apfjx6oDfz1Rb_N3
- https://youtu.be/zx04Kl8y4dE?si=VmOvp_OgqisILTAF

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A035FT.1	3	2	-	-	-	2	3	-	-	-	-	2	2	-
23A035FT.2	3	2	2	-	-	2	2	-	-	-	-	2	2	-
23A035FT.3	3	2	2	-	-	2	3	-	-	-	-	2	2	-
23A035FT.4	2	2	2	-	-	3	3	-	-	-	-	2	2	-
23A035FT.5	2	2	2	-	-	3	3	-	-	-	-	3	2	-

III B.TECH I SEMESTER

23A045DT

ELECTRONIC CIRCUITS
(OPEN ELECTIVE-I)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To understand semiconductor diodes, their characteristics and applications.
2. To explore the operation, configurations, and biasing of BJTs.
3. To study the operation, analysis, and coupling techniques of BJT amplifiers.
4. To learn the operation, applications and uses of feedback amplifiers and oscillators.
5. To analyze the characteristics, configurations, and applications of operational amplifiers.

COURSE OUTCOMES

1. Understand semiconductor diodes, their characteristics and applications.
2. Explore the operation, configurations, and biasing of BJTs.
3. Gain knowledge about the operation, analysis, and coupling techniques of BJT amplifiers.
4. Learn the operation, applications and uses of feedback amplifiers and oscillators.
5. Analyze the characteristics, configurations, and applications of operational amplifiers.

UNIT I - SEMICONDUCTOR DIODE AND APPLICATIONS

(09)

Introduction, PN junction diode – structure, operation and VI characteristics, Half-wave, Full-wave and Bridge Rectifiers with and without Filters, Positive and Negative Clipping and Clamping circuits (Qualitative treatment only).

Special Diodes: Zener and Avalanche Breakdowns, VI Characteristics of Zener diode, Zener diode as voltage regulator, Construction, operation and VI characteristics of Tunnel Diode, LED, Varactor Diode, Photo Diode.

UNIT II - BIPOLAR JUNCTION TRANSISTOR (BJT)

(09)

Principle of Operation, Common Emitter, Common Base and Common Collector Configurations, Transistor as a switch and Amplifier, Transistor Biasing and Stabilization - Operating point, DC & AC load lines, Biasing - Fixed Bias, Self Bias, Bias Stability, Bias Compensation using Diodes.

UNIT III - SINGLE STAGE AMPLIFIERS

(08)

Classification of Amplifiers - Distortion in amplifiers, Analysis of CE, CC and CB configurations with simplified hybrid model.

Multistage amplifiers: Different Coupling Schemes used in Amplifiers - RC coupled amplifiers, Transformer Coupled Amplifier, Direct Coupled Amplifier; Multistage RC coupled BJT amplifier (Qualitative treatment only).

UNIT IV - FEEDBACK AMPLIFIERS

(09)

Concepts of feedback, Classification of feedback amplifiers, Effect of feedback on amplifier characteristics, Voltage Series, Voltage Shunt, Current Series and Current Shunt Feedback Configurations (Qualitative treatment only).

Oscillators: Classification of oscillators, Condition for oscillations, RC Phase shift Oscillators, Generalized analysis of LC Oscillators-Hartley and Colpitts Oscillators, Wien Bridge Oscillator.

UNIT V - OP-AMP

(09)

Classification of IC'S, basic information of Op-amp, ideal and practical Op-amp, 741 op- amp and its features, modes of operation-inverting, non-inverting, differential.

Applications of op-amp : Summing, scaling and averaging amplifiers, Integrator, Differentiator, phase shift oscillator and comparator.

TEXTBOOKS

1. Electronics Devices and Circuits, J.Millman and Christos. C. Halkias, 3rd edition, Tata McGraw Hill, 2006.
2. Electronics Devices and Circuits Theory, David A. Bell, 5th Edition, Oxford University press. 2008.

REFERENCE BOOKS

1. Electronics Devices and Circuits Theory, R.L.Boylestad, LouisNashelsky and K.Lal Kishore, 12th edition, 2006, Pearson, 2006.
2. Electronic Devices and Circuits, N.Salivahanan, and N.Suresh Kumar, 3rd Edition, TMH, 2012
3. Microelectronic Circuits, S.Sedra and K.C.Smith, 5th Edition, Oxford University Press.

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A045DT.1	3	2	-	-	-	-	-	-	-	-	-	2	2	-
23A045DT.2	3	2	2	-	-	-	-	-	-	-	-	2	2	-
23A045DT.3	3	2	2	-	-	-	-	-	-	-	-	2	2	-
23A045DT.4	3	2	2	-	-	-	-	-	-	-	-	2	2	-
23A045DT.5	3	2	3	2	2	-	-	-	-	-	-	3	3	-

III B.TECH I SEMESTER

23A045ET

COMMUNICATION SYSTEMS
(OPEN ELECTIVE-I)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To understand the fundamentals of communication systems and amplitude modulation techniques.
2. To learn about the angle modulation techniques and bandwidth considerations in communication systems.
3. To gain knowledge on pulse analog modulation and multiple access techniques used in digital communication systems.
4. To examine pulse modulation and digital modulation techniques used in modern communication systems.
5. To study wireless communication systems, cellular networks, and GSM technology

COURSE OUTCOMES

At the end of the course, the student will be able to

1. Comprehend the fundamentals of communication systems and amplitude modulation techniques.
2. Learn the angle modulation techniques and bandwidth considerations in communication systems.
3. Gain knowledge on pulse analog modulation and multiple access techniques used in digital communication systems.
4. Get familiar with pulse modulation and digital modulation techniques used in modern communication systems.

Unit I - ANALOG COMMUNICATION-I

(10)

Elements of communication systems, need for Modulation, Modulation Methods, Baseband and carrier communication Amplitude Modulation (AM), Generation of AM signals, Rectifier detector, Envelope detector, sideband and carrier power of AM,

UNIT II - ANALOG COMMUNICATION-II

(9)

Double side band suppressed carrier (DSB- SC) modulation & its demodulation, Switching modulators, Ring modulator, Balanced modulator, Single sideband (SSB) transmission, VSB Modulation.

Unit III - ANGLE MODULATION & DEMODULATION

(10)

Concept of instantaneous frequency Generalized concept of angle modulation, Bandwidth of angle modulated waves- Narrow band frequency modulation (NBFM); and Wide band FM (WBFM), Phase modulation, Pre-emphasis & De-emphasis.

Unit IV- DIGITAL COMMUNICATIONS-I (QUALITATIVE APPROACH ONLY)

(9)

Pulse analog modulation techniques, Generation and detection of Pulse amplitude modulation, Pulse width modulation, Pulse position modulation

Multiple Access Techniques: Introduction to multiple access techniques, FDMA, TDMA, CDMA, SDMA: Advantages and applications.

Unit V - DIGITAL COMMUNICATIONS-II (QUALITATIVE APPROACH ONLY)

(10)

CMOS Logic: Pulse Code Modulation, DPCM, Delta modulation, Adaptive delta modulation, Overview of ASK, PSK, QPSK, BPSK and M-PSK techniques.

PRESCRIBED TEXTBOOKS

1. H Taub, D. Schilling and Gautam Sahe, —Principles of Communication Systems, TMH, 2007, 3rd Edition.
2. George Kennedy and Bernard Davis, —Electronics & Communication System, 4th Edition, TMH 2009.
3. Wayne Tomasi, —Electronic Communication System: Fundamentals Through Advanced, 2nd edition, PHI,2001.

REFERENCE BOOKS

1. Simon Haykin, —Principles of Communication Systems, John Wiley, 2nd Edition.
2. Sham Shanmugam, —Digital and Analog communication Systems, Wiley-India edition,2006.
3. Theodore. S.Rappoport, —Wireless Communications, Pearson Education, 2nd Edition,2002

CO-PO MAPPING

COURSE OUTCOMES	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A045ET. 1	3	3	3	3	-	-	-	-	-	-	-	2	-	3
23A045ET. 2	3	3	3	3	-	-	-	-	-	-	-	2	-	3
23A045ET. 3	3	3	3	3	-	-	-	-	-	-	-	2	-	3
23A045ET. 4	3	3	3	3	-	-	-	-	-	-	-	2	-	3
23A045ET. 5	3	3	3	3	-	-	-	-	-	-	-	2	-	3

III B.TECH I SEMESTER

23A055GT	QUANTUM TECHNOLOGIES AND APPLICATIONS (OPEN ELECTIVE-I) (Common to all branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the fundamentals of quantum mechanics relevant to quantum technologies.
2. To explain key quantum phenomena and their role in enabling novel technologies.
3. To explore applications in quantum computing, communication, and sensing.
4. To encourage understanding of emerging quantum-based technologies and innovations.

COURSE OUTCOMES

1. Understand key quantum mechanical concepts and phenomena.
2. Comprehend the structure and function of quantum algorithms and circuits.
3. Explore applications in quantum communication and cryptography.
4. Appreciate the role of quantum technologies in modern engineering systems.

UNIT I - FUNDAMENTALS OF QUANTUM MECHANICS (07)

Classical vs Quantum Paradigm, Postulates of Quantum Mechanics, Wavefunction and Schrödinger Equation (Time-independent), Quantum states, Superposition, Qubits, Measurement, Operators, and Observables, Entanglement and Non-locality.

UNIT II - QUANTUM COMPUTING (07)

Qubits and Bloch Sphere, Quantum Logic Gates: Pauli, Hadamard, CNOT, and Universal Gates, Quantum Circuits, Basic Algorithms: Deutsch-Jozsa, Grover's, Shor's (conceptual), Error Correction and Decoherence.

UNIT III - QUANTUM COMMUNICATION AND CRYPTOGRAPHY (07)

Teleportation & No-Cloning, BB84 Protocol, Quantum Networks & Repeaters, Classical vs Quantum Cryptography, Challenges in Implementation.

UNIT IV - QUANTUM SENSORS AND METROLOGY (07)

Quantum Sensing: Principles and Technologies, Quantum-enhanced Measurements, Atomic Clocks, Gravimeters, Magnetometers, NV Centers, Industrial Applications.

UNIT V - QUANTUM MATERIALS AND EMERGING TECHNOLOGIES (07)

Quantum Materials: Superconductors, Topological Insulators, Quantum Devices: Qubits, Josephson Junctions, National Quantum Missions (India, EU, USA, China), Quantum Careers and Industry Initiatives.

TEXTBOOKS

1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang (Cambridge University Press).
2. "Quantum Mechanics: The Theoretical Minimum" by Leonard Susskind and Art Friedman (Basic Books).

REFERENCE BOOKS

4. "Quantum Computing for Everyone" by Chris Bernhardt (MIT Press).
5. "Quantum Physics: A Beginner's Guide" by Alastair I.M. Rae.
6. "An Introduction to Quantum Computing" by Phillip Kaye, Raymond Laflamme, and Michele Mosca.
7. IBM Quantum Experience and Qiskit Documentation (<https://qiskit.org/>).

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A055GT.1	3	2	-	-	-	-	-	-	-	-	-	2	2	-
23A055GT.2	3	2	2	-	-	-	-	-	-	-	-	2	2	-
23A055GT.3	3	2	2	-	-	-	-	-	-	-	-	2	2	-
23A055GT.4	3	2	2	-	-	-	-	-	-	-	-	2	2	-
23A055GT.5	3	2	3	2	2	-	-	-	-	-	-	3	3	-

III B.TECH I SEMESTER

23AHS51T	MATHEMATICS FOR MACHINE LEARNING AND AI (OPEN ELECTIVE-I) (Common to all branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To provide a strong mathematical foundation for understanding and developing AI/ML algorithms.
2. To enhance the ability to apply linear algebra, probability, and calculus in AI/ML models.
3. To equip students with optimization techniques and graph-based methods used in AI applications.
4. To develop critical problem-solving skills for analysing mathematical formulations in AI/ML.

COURSE OUTCOMES

1. Apply linear algebra concepts to ML techniques like PCA and regression.
2. Analyze probabilistic models and statistical methods for AI applications.
3. Implement optimization techniques for machine learning algorithms.
4. Utilize vector calculus and transformations in AI-based models.
5. Develop graph-based AI models using mathematical representations.

UNIT I - LINEAR ALGEBRA FOR MACHINE LEARNING (08)

Review of Vector spaces, basis, linear independence, Vector and matrix norms, Matrix factorization techniques, Eigenvalues, eigenvectors, diagonalization, Singular Value Decomposition (SVD) and Principal Component Analysis (PCA).

UNIT II - PROBABILITY AND STATISTICS FOR AI (08)

Probability distributions: Gaussian, Binomial, Poisson. Bayes' Theorem, Maximum Likelihood Estimation (MLE), and Maximum a Posteriori (MAP). Entropy and Kullback-Leibler (KL) Divergence in AI, Cross entropy loss, Markov chains.

UNIT III - OPTIMIZATION TECHNIQUES FOR ML (08)

Multivariable calculus: Gradients, Hessians, Jacobians. Constrained optimization: Lagrange multipliers and KKT conditions. Gradient Descent and its variants (Momentum, Adam) Newton's method, BFGS method.

UNIT IV - VECTOR CALCULUS & TRANSFORMATIONS (08)

Vector calculus: Gradient, divergence, curl. Fourier Transform & Laplace Transform in ML applications.

UNIT V - GRAPH THEORY FOR AI (08)

Graph representations: Adjacency matrices, Laplacian matrices. Bayesian Networks & Probabilistic Graphical Models. Introduction to Graph Neural Networks (GNNs).

TEXTBOOKS

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press, 2020.
2. Pattern Recognition and Machine Learning by Christopher Bishop, Springer.

REFERENCE BOOKS

1. Gilbert Strang, Linear Algebra and Its Applications, Cengage Learning, 2016.
2. Jonathan Gross, Jay Yellen, Graph Theory and Its Applications, CRC Press, 2018.

WEB REFERENCES

- MIT– Mathematics for Machine Learning <https://ocw.mit.edu>
- Stanford CS229 – Machine Learning Course <https://cs229.stanford.edu/>
- DeepAI – Mathematical Foundations for AI <https://deepai.org>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS51T.1	3	3	2	2	1	-	-	-	-	-	-	1	-	-
23AHS51T.2	3	3	2	3	2	-	-	-	-	-	-	2	-	-
23AHS51T.3	3	3	3	3	2	1	-	-	-	-	-	2	-	-
23AHS51T.4	3	3	2	2	1	-	-	-	-	-	-	1	-	-
23AHS51T.5	3	3	3	3	2	-	-	-	-	-	-	2	-	-

III B.TECH I SEMESTER

23AHS52T	MATERIALS CHARACTERIZATION TECHNIQUES (OPEN ELECTIVE-I) <i>(Common to all branches)</i>	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To provide exposure to different characterization techniques.
2. To explain the basic principles and analysis of different spectroscopic techniques.
3. To elucidate the working of Scanning electron microscope - Principle, limitations and applications.
4. To illustrate the working of the Transmission electron microscope (TEM) - SAED patterns and its applications.
5. To educate the uses of advanced electric and magnetic instruments for characterization.

COURSE OUTCOMES

At the end of the course, the student will be able to

1. Analyze the crystal structure and crystallite size by various methods.
2. Analyze the morphology of the sample by using a Scanning Electron Microscope.
3. Analyze the morphology and crystal structure of the sample by using Transmission Electron Microscope.
4. Explain the principle and experimental arrangement of various spectroscopic techniques.
5. Identify the construction and working principle of various Electrical & Magnetic Characterization Technique.

UNIT I - STRUCTURE ANALYSIS BY POWDER X-RAY DIFFRACTION (09)

Introduction, Bragg's law of diffraction, Intensity of Diffracted beams, Factors affecting Diffraction, Intensities, Structure of polycrystalline Aggregates, Determination of crystal structure, Crystallite size by Scherer and Williamson-Hall (W-H) Methods, Small angle X- ray scattering (SAXS) (in brief).

UNIT II - MICROSCOPY TECHNIQUE -1 –SCANNING ELECTRON MICROSCOPY (SEM) (09)

Introduction, Principle, Construction and working principle of Scanning Electron Microscopy, Specimen preparation, Different types of modes used (Secondary Electron and Backscatter Electron), Advantages, limitations and applications of SEM.

UNIT III - MICROSCOPY TECHNIQUE -2 - TRANSMISSION ELECTRON MICROSCOPY (TEM) (09)

Construction and Working principle, Resolving power and Magnification, Bright and dark fields, Diffraction and image formation, Specimen preparation, Selected Area Diffraction, Applications of Transmission Electron Microscopy, Difference between SEM and TEM, Advantage and Limitations of Transmission Electron Microscopy.

UNIT IV - SPECTROSCOPY TECHNIQUES

(09)

Principle, Experimental arrangement, Analysis and advantages of the spectroscopic techniques – (i) UV-Visible spectroscopy (ii) Raman Spectroscopy, (iii) Fourier Transform infrared (FTIR) spectroscopy, (iv) X-ray photoelectron spectroscopy (XPS).

UNIT V - ELECTRICAL & MAGNETIC CHARACTERIZATION TECHNIQUES

(09)

Electrical Properties analysis techniques (DC conductivity, AC conductivity) Activation Energy, Effect of Magnetic field on the electrical properties (Hall Effect). Magnetization measurement by induction method, Vibrating sample Magnetometer (VSM) and SQUID.

TEXTBOOKS

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods – Yang Leng – John Wiley & Sons (Asia) Pvt. Ltd. 2013.
2. Microstructural Characterization of Materials - David Brandon, Wayne D Kalpan, John Wiley & Sons Ltd., 2008

REFERENCE BOOKS

1. Fundamentals of Molecular Spectroscopy – IV Ed. – Colin Neville Banwell and Elaine M. McCash, Tata McGraw-Hill, 2008.
2. Elements of X-ray diffraction – Bernard Dennis Cullity & Stuart R Stocks, Prentice Hall, 2001 – Science.
3. Practical Guide to Materials Characterization: Techniques and Applications - Khalid Sultan – Wiley – 2021.
4. **Materials Characterization Techniques** - Sam Zhang, Lin Li, Ashok Kumar - CRC Press - 2008

NPTEL COURSES LINK

1. <https://nptel.ac.in/courses/115/103/115103030/>
2. https://nptel.ac.in/content/syllabus_pdf/113106034.pdf
3. <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mm08/>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS52T.1	3	3	2	2	1	-	-	-	-	-	-	-	-	-
23AHS52T.2	3	3	2	1	1	-	-	-	-	-	-	-	-	-
23AHS52T.3	3	3	2	1	1	-	-	-	-	-	-	-	-	-
23AHS52T.4	3	2	1	1	-	-	-	-	-	-	-	-	-	-
23AHS52T.5	3	3	1	1	-	-	-	-	-	-	-	-	-	-

III B.TECH I SEM

23AHS53T

CHEMISTRY OF ENERGY SYSTEMS
(OPEN ELECTIVE-I)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To make the student understand basic electrochemical principles such as standard electrode potentials, emf and applications of electrochemical principles in the design of batteries.
2. To understand the basic concepts of processing and limitations of Fuel cells & their applications.
3. To impart knowledge to the students about fundamental concepts of photo chemical cells, reactions and applications.
4. To know the necessity of harnessing alternate energy resources such as solar energy and its basic concepts.
5. To impart knowledge to the students about fundamental concepts of hydrogen storage in different materials and liquification method.

COURSE OUTCOMES

At the end of the course, the student will be able to

1. Understand electrochemical concepts and battery technologies with their practical applications.
2. Apply the principles of fuel cell technology to explain their design, working, classification, efficiency, and applications, including PEM and SOFC types.
3. Apply the concepts of photochemical cells to understand their working, specificity, advantages in photo electrocatalytic conversions, and practical applications.
4. Analyze the principles of solar energy conversion to differentiate between photovoltaic and concentrated solar power technologies and evaluate the performance and applications of solar cells.
5. Analyze hydrogen storage and delivery methods by comparing their mechanisms, advantages, and limitations.

UNIT 1 - ELECTROCHEMICAL SYSTEMS

(09)

Galvanic cell, Nernst equation, standard electrode potential, application of EMF, electrical double layer, polarization, Batteries- Introduction ,Lead-acid ,Nickel- cadmium, Lithium ion batteries and their applications.

UNIT 2 - FUEL CELLS

(09)

Fuel cell- Introduction, Basic design of fuel cell, working principle, Classification of fuel cells, Polymer electrolyte membrane (PEM) fuel cells, Solid-oxide fuel cells (SOFC), Fuel cell efficiency and applications.

UNIT 3 - PHOTO AND PHOTO ELECTROCHEMICAL CONVERSIONS

(09)

Photochemical cells Introduction and applications of photochemical reactions, specificity of photo electrochemical cell, advantage of photoelectron catalytic conversions and their applications.

UNIT 4 - SOLAR ENERGY

(09)

Introduction and prospects, photovoltaic (PV) technology, concentrated solar power (CSP), Solar cells and applications.

UNIT 5 - HYDROGEN STORAGE

(09)

Introduction-Hydrogen fuel, Hydrogen storage and delivery: State-of-the art, Established technologies, Chemical and Physical methods of hydrogen storage, Compressed gas storage, Liquid hydrogen storage, Other storage methods, Hydrogen storage in metal hydrides, metal organic frameworks (MOF), Metal oxide porous structures, hydrogel, and Organic hydrogen carriers.

TEXT BOOKS

1. Ira N. Levine Physical Chemistry, 6th edition, McGraw-Hill Education, 2011
2. Bahl, A., Bahl, B. S., & Tuli, G. D. Essentials of physical chemistry. New Delhi: S. Chand. 2010.

REFERENCE BOOKS

1. Fuel Cell Hand Book, 7th Edition, by US Department of Energy (EG&G technical services and corporation)
2. Arvind, & Shyam. (2018). Handbook of Solar Energy: Theory, Analysis and Applications. Springer.
3. Solar energy fundamental, technology and systems by Klaus Jagar et.al. (2014) Delft University of Technology, Delft.

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS53T.1	3	2	2	1	-	-	2	-	-	-	-	1	-	-
23AHS53T.2	3	2	2	1	-	-	2	-	-	-	-	1	-	-
23AHS53T.3	3	2	2	1	-	-	2	-	-	-	-	1	-	-
23AHS53T.4	3	2	2	1	-	-	2	-	-	-	-	1	-	-
23AHS53T.5	3	2	2	1	-	-	2	-	-	-	-	1	-	-

III B.TECH I SEM

23AHS54T	ENGLISH FOR COMPETITIVE EXAMINATIONS (OPEN ELECTIVE-I) (Common to all branches)	L 3	T 0	P 0	C 3
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COURSE OBJECTIVES

1. To raise awareness of the importance of English for competitive exams
2. To understand the grammatical aspects and identify the errors
3. To enhance verbal ability and identify the errors
4. To enrich vocabulary to face competitive exams and for effective expression
5. To equip learners with the skills and confidence needed to succeed in competitive exams

COURSE OUTCOMES

1. Identify the basics of English grammar and its importance.
2. Explain the use of grammatical structures in sentences.
3. Demonstrate the ability to use various concepts in grammar and vocabulary and their applications in everyday use and in competitive exams.
4. Analyze an unknown passage and reach conclusions about it.
5. Use correct verb forms and improve speed reading and comprehension to excel in competitive exams.

UNIT I - GRAMMAR-1 (09)

Nouns-classification-errors-Pronouns-types-errors-Adjectives-types-errors-Articles-definite-indefinite-Degrees of Comparison-Adverbs-types- errors-Conjunctions-usage.

UNIT II - GRAMMAR-2 (09)

Verbs-tenses- structure-usages- negatives- positives- time adverbs-Sequence of tenses--If Clause-Voice-active voice and passive voice- reported Speech-Agreement- subject and verb-Modals-Spotting Errors-Practices.

UNIT III - VERBAL ABILITY (09)

Sentence completion-Verbal analogies-Word groups-Instructions-Critical reasoning-Verbal deduction-Select appropriate pair-Reading Comprehension-Paragraph-Jumbles.

UNIT IV - READING COMPREHENSION AND VOCUBULARY (09)

Reading Comprehension Skills-Competitive Vocabulary: Word Building – Memory Techniques-Synonyms, Antonyms, Affixes-Prefix & Suffix-One-word substitutes-Compound Words-Phrasal Verbs-Idioms and Phrases-Homophones- Linking Words-Modifiers-Intensifiers.

UNIT V - WRITING FOR COMPETITIVE EXAMINATIONS (09)

Punctuation- Spelling rules- Word Order-Sub Skills of Writing- Paragraph- meaning-salient features-types - Note-making, Note-taking, summarizing-precise writing- Paraphrasing-Expansion of proverbs.

TEXTBOOKS

1. Wren & Martin, English for Competitive Examinations, S.Chand & Co, 2021.
2. Objective English for Competitive Examination, Tata McGraw Hill, New Delhi, 2014.

REFERENCE BOOKS

1. Hari Mohan Prasad, Objective English for Competitive Examination, Tata McGraw Hill, New Delhi, 2014.
2. Philip Sunil Solomon, English for Success in Competitive Exams, Oxford 2016
3. Shalini Verma , Word Power Made Handy, S Chand Publications
4. Neira, Anjana Dev & Co. Creative Writing: A Beginner's Manual. Pearson Education India, 2008.
5. Abhishek Jain, Vocabulary Learning Techniques Vol.I&II,RR Global Publishers 2013.
6. Michel Swan, Practical English Usage, Oxford,2006.

REFERENCES

1. <https://www.grammar.cl/english/parts-of-speech.htm>
2. <https://academicguides.waldenu.edu/writingcenter/grammar/partsofspeech>
3. <https://learnenglish.britishcouncil.org/grammar/english-grammar-reference/active-passive-voice>
4. <https://languagetool.org/insights/post/verb-tenses/>
5. <https://www.britishcouncil.in/blog/best-free-english-learning-resources-british-council>
6. <https://www.careerride.com/post/social-essays-for-competitive-exams-586.aspx>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS54T.1	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS54T.2	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS54T.3	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS54T.4	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS54T.5	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS54T.6	-	-	-	-	-	-	-	-	-	3	-	3	-	-

III B.TECH I SEM

23AHS56T	ENTREPRENEURSHIP AND NEW VENTURE CREATION	L	T	P	C
	(OPEN ELECTIVE-I)	3	0	0	3
	(Common to all branches)				

COURSE OBJECTIVES

1. To foster an entrepreneurial mind-set for venture creation and intrapreneurial leadership.
2. To encourage creativity and innovation.
3. To enable them to learn pitching and presentation skills.
4. To make the students understand MVP development and validation techniques to determine Product-Market fit and Initiate Solution design, Prototype for Proof of Concept.
5. To enhance the ability of analyzing Customer and Market segmentation, estimate.
6. Market size, develop and validate Customer Persona.

COURSE OUTCOMES

1. Develop an entrepreneurial mindset and appreciate the concept of entrepreneurship
2. Comprehend the process of problem-opportunity identification through design thinking, identify market potential and customers while developing a compelling value proposition solution
3. Analyze and refine business models to ensure sustainability and profitability Build Prototype for Proof of Concept and validate MVP of their practice venture Idea
4. Create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture
5. Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

UNIT I - ENTREPRENEURSHIP FUNDAMENTALS AND CONTEXT (09)

Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. An understanding of how to build entrepreneurial mindset, skill sets, attributes and networks while on campus.

Core Teaching Tool: Simulation, Game, Industry Case Studies (Personalized for students – 16 industries to choose from), Venture Activity.

UNIT II - PROBLEM & CUSTOMER IDENTIFICATION (09)

Understanding and analysing the macro-Problem and Industry perspective - technological, socioeconomic and urbanization trends and their implication on new opportunities - Identifying passion - identifying and defining problem using Design thinking principles - Analysing problem and validating with the potential customer - Understanding customer segmentation, creating and validating customer personas.

Core Teaching Tool: Several types of activities including Class, game, Gen AI, ‘Get out of the Building’ and Venture Activity.

UNIT III - SOLUTION DESIGN, PROTOTYPING & OPPORTUNITY ASSESSMENT AND SIZING (09)

Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer's needs and create a strong value proposition - Understanding prototyping and Minimum Viable product (MVP) - Developing a feasibility prototype with differentiating value, features and benefits - Assess relative market position via competition analysis - Sizing the market and assess scope and potential scale of the opportunity.

Core Teaching Tool: Venture Activity, no-code Innovation tools, Class activity.

UNIT IV - BUSINESS & FINANCIAL MODEL, GO-TO-MARKET PLAN (09)

Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach.

Business planning: components of Business plan- Sales plan, People plan and financial plan. Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analysing financial performance.

Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy.

Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Life-cycle to Funding Options.

Core Teaching Tool: Founder Case Studies – Sama and Securely Share; Class activity and discussions; Venture Activities.

UNIT V - SCALE OUTLOOK AND VENTURE PITCH READINESS

(09)

Understand and identify potential and aspiration for scale vis-a-vis your venture idea. Persuasive Storytelling and its key components. Build an Investor ready pitch deck.

Core Teaching Tool: Expert talks; Cases; Class activity and discussions; Venture Activities.

TEXT BOOKS

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha . Entrepreneurship, cGrawHill, 11th Edition.(2020).
2. Ries, E. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business,(2011).
3. Osterwalder, A., & Pigneur, Y. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons. (2010).

REFERENCES

1. Simon Sinek, Start with Why, Penguin Books limited. (2011)
2. Brown Tim, Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business.(2019)
3. Namita Thapar (2022) The Dolphin and the Shark: Stories on Entrepreneurship, Penguin Books Limited
4. Saras D. Sarasvathy, (2008) Effectuation: Elements of Entrepreneurial Expertise, Elgar Publishing Ltd.

E-RESOURCES

- Learning resource- Ignite 5.0 Course Wadhvani platform (Includes 200+ components of custom created modular content + 500+ components of the most relevant curated content)

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS56T.1	2	-	-	-	2	2	-	-	2	2	-	3	2	-
23AHS56T.2	2	2	2	2	3	2	-	-	2	3	-	3	2	-
23AHS56T.3	2	2	3	3	3	2	-	-	2	3	-	3	3	-
23AHS56T.4	2	2	3	3	3	2	-	-	2	3	-	3	3	-
23AHS56T.5	2	3	3	2	3	2	-	-	2	3	-	3	3	-
23AHS56T.6	2	-	-	-	2	-	-	-	3	3	-	2	2	-

III B.TECH I SEMESTER

23A3153L	COMPUTER VISION & NATURAL LANGUAGE PROCESSING LAB (PROFESSIONAL CORE) (Common to CSE(AI))	L 0	T 0	P 3	C 1.5
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COURSE OBJECTIVES

- To provide hands-on experience in implementing image processing and computer vision algorithms.
- To familiarize students with natural language processing techniques using Python libraries.
- To enable the integration of CV and NLP for building intelligent applications.

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- Apply image processing techniques for feature extraction and classification.
- Implement NLP techniques such as tokenization, POS tagging, and sentiment analysis.
- Analyze visual and textual data using open-source tools.
- Develop applications that combine Computer Vision and NLP for real-world tasks.

LIST OF EXPERIMENTS

1. Load and display an image using OpenCV and perform basic operations like resizing, cropping, and rotation.
2. Apply edge detection (Sobel, Canny) and thresholding techniques on grayscale and color images.
3. Implement image filtering operations: Gaussian, Median, and Bilateral filters.
4. Perform object detection using contour detection and bounding boxes.
5. Detect faces using Haar Cascade or DNN-based pre-trained models in OpenCV.
6. Implement color-based object tracking using HSV space and CamShift algorithm.
7. Preprocess text data (tokenization, stopword removal, stemming, lemmatization) using NLTK/spaCy.
8. Implement Part-of-Speech (POS) tagging and Named Entity Recognition (NER) using spaCy.
9. Build a simple sentiment analysis classifier using bag-of-words or TF-IDF and Naïve Bayes.
10. Perform topic modeling using Latent Dirichlet Allocation (LDA).
11. Extract text from an image using Optical Character Recognition (OCR) with Tesseract and perform text summarization.
12. Final Mini Project: Integrate CV and NLP (e.g., Read text from signboards or documents and translate/summarize it).

LAB SOFTWARE REQUIREMENTS

- **Languages/Tools:** Python, OpenCV, NLTK, spaCy, Tesseract OCR, scikit-learn, NumPy, Pandas, Matplotlib
- **Platforms:** Jupyter Notebook / Google Colab / PyCharm / VS Code

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A3153L.1	3	2	3	2	3	-	-	-	-	-	-	2	3	3
23A3153L.2	3	2	3	2	3	-	-	-	-	-	-	2	3	3
23A3153L.3	3	3	3	3	3	-	-	-	1	1	1	2	3	3
23A3153L.4	3	3	3	3	3	-	-	1	1	1	1	3	3	3
23A3153L.5	3	2	3	2	3	-	-	-	-	-	-	2	3	3

III B.TECH I SEMESTER

23A3151L

AI & SYSTEM PROGRAMMING LAB
(PROFESSIONAL CORE)
(Common to CSE(AI))

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES

- To provide practical exposure to foundational AI algorithms and system programming.
- To develop skills to write intelligent systems and low-level programs.
- To integrate concepts of AI and system programming for automation and optimization.

COURSE OUTCOMES

- Implement search algorithms and logic programming using AI tools.
- Construct assemblers, macro processors, and shell scripts.
- Develop system utilities using C and integrate them with AI tools.
- Demonstrate real-time intelligent system automation using scripting and AI logic.

LIST OF EXPERIMENTS

1. Write simple programs in Prolog for facts, rules, and queries.
2. Develop a Prolog-based expert system for medical diagnosis or animal identification.
3. Implement Depth-First Search (DFS) and Breadth-First Search (BFS) in Python.
4. Implement A* Search Algorithm using heuristics in Python.
5. Implement the Minimax algorithm for a simple game (e.g., Tic Tac Toe).
6. Design and implement a two-pass assembler in C.
7. Implement a Macro Processor using C for assembly language programs.
8. Develop a simple Linux Shell (command interpreter) using C.
9. Write shell scripts for file operations, process creation, and monitoring.
10. Demonstrate inter-process communication using pipes and signals in Linux.
11. Integrate AI logic (search/expert system) into a shell script or system utility for task automation.
12. **Final Mini Project:** Develop an AI-powered system utility (e.g., Intelligent File Manager, AI Bot for CLI commands).

LAB SOFTWARE REQUIREMENTS

- **Languages:** Python, Prolog, C
- **Tools:** GCC, SWI-Prolog, Linux (Ubuntu/WSL), Shell, Lex/Yacc (optional)
- **IDEs:** Code::Blocks / VS Code / Geany / Terminal-based compilation

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A3151L.1	3	3	2	2	3	-	-	-	-	-	-	2	3	3
23A3151L.2	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A3151L.3	3	3	3	3	3	-	-	1	1	1	1	3	3	3
23A3151L.4	3	3	3	3	3	-	-	1	1	1	1	3	3	3
23A3151L.5	3	3	2	2	3	-	-	-	-	-	-	2	3	3

III B,TECH I SEMESTER

23A0555L

FULL STACK DEVELOPMENT - II
(SKILL ENHANCEMENT COURSE)
(Common to all branches)

L	T	P	C
0	1	2	2

COURSE OBJECTIVES

- To become knowledgeable about the most recent web development technologies.
- Idea for creating two tier and three tier architectural web applications.
- Design and Analyse real time web applications.
- Constructing suitable client and server-side applications.
- To learn core concept of both front end and back-end programming.

COURSE OUTCOMES

- Develop a fully functioning website and deploy on a web server.
- Gain Knowledge about the front end and back-end Tools.
- Find and use code packages based on their documentation to produce working results in a project.
- Create web pages that function using external data.
- Implementation of web application employing efficient database access.

UNIT I - WEB DEVELOPMENT BASICS (09)

Web development Basics - HTML & Web servers Shell - UNIX CLI Version control - Git & Github
HTML, CSS.

UNIT II - FRONTEND DEVELOPMENT (09)

Javascript basics OOPS Aspects of JavaScript Memory usage and Functions in JS AJAX for data exchange with server jQuery Framework jQuery events, UI components etc. JSON data format.

UNIT III - REACT JS (09)

Introduction to React React Router and Single Page Applications React Forms, Flow Architecture and Introduction to Redux More Redux and Client-Server Communication.

UNIT IV - JAVA WEB DEVELOPMENT (09)

JAVA PROGRAMMING BASICS, Model View Controller (MVC) Pattern MVC Architecture using Spring RESTful API using Spring Framework Building an application using Maven.

UNIT V - DATABASES & DEPLOYMENT (09)

Relational schemas and normalization Structured Query Language (SQL) Data persistence using Spring JDBC Agile development principles and deploying application in Cloud.

TEXT BOOKS

1. Web Design with HTML, CSS, JavaScript and JQuery Set Book by Jon Duckett
Professional JavaScript for Web Developers Book by Nicholas C. Zakas
2. Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-by-Step Guide to Creating Dynamic Websites by Robin Nixon
3. Full Stack JavaScript: Learn Backbone.js, Node.js and MongoDB. Copyright © 2015 BY AZAT MARDAN

REFERENCE BOOKS

1. Full-Stack JavaScript Development by Eric Bush
2. Mastering Full Stack React Web Development Paperback – April 28, 2017 by Tomasz Dyl, Kamil Przeorski, Maciej Czarnecki

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A0555L.1	2	2	3	3	3	-	-	-	2	2	-	3	3	3
23A0555L.2	2	3	3	3	3	-	-	-	2	1	-	2	3	3
23A0555L.3	2	2	2	2	3	-	-	-	2	2	-	2	3	3
23A0555L.4	2	2	3	3	3	-	-	-	2	2	-	2	3	3
23A0555L.5	2	2	3	3	3	-	-	-	2	2	-	3	3	3

III B.TECH I SEMESTER

23A0556L

TINKERING LAB FOR COMPUTER ENGINEERS (Common to all branches)

L	T	P	C
0	0	2	1

COURSE OBJECTIVES

- 1 Encourage Innovation and Creativity
- 2 Provide Hands-on Learning and Impart Skill Development
- 3 Foster Collaboration and Teamwork
- 4 Enable Interdisciplinary Learning, Prepare for Industry and Entrepreneurship
- 5 Impart Problem-Solving mind-set

COURSE OUTCOMES

1. These labs bridge the gap between academia and industry, providing students with the practical experience.
2. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers.
3. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

LIST OF EXPERIMENTS

- 1) Make your own parallel and series circuits using breadboard for any application of your choice.
- 2) Demonstrate a traffic light circuit using breadboard.
- 3) Build and demonstrate automatic Street Light using LDR.
- 4) Simulate the Arduino LED blinking activity in Tinkercad.
- 5) Build and demonstrate an Arduino LED blinking activity using Arduino IDE.
- 6) Interfacing IR Sensor and Servo Motor with Arduino.
- 7) Blink LED using ESP32.
- 8) LDR Interfacing with ESP32.
- 9) Control an LED using Mobile App.
- 10) Design and 3D print a Walking Robot
- 11) Design and 3D Print a Rocket.
- 12) Build a live soil moisture monitoring project, and monitor soil moisture levels of a remote plan in your computer dashboard.
- 13) Demonstrate all the steps in design thinking to redesign a motor bike.

Students need to refer to the following links:

1. <https://aim.gov.in/pdf/equipment-manual-pdf.pdf>
2. <https://atl.aim.gov.in/ATL-Equipment-Manual/>
3. <https://aim.gov.in/pdf/Level-1.pdf>
4. <https://aim.gov.in/pdf/Level-2.pdf>
5. <https://aim.gov.in/pdf/Level-3.pdf>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A0556L.1	2	2	3	3	3	-	-	-	2	2	-	3	3	3
23A0556L.2	2	3	3	3	3	-	-	-	2	1	-	2	3	3
23A0556L.3	2	2	2	2	3	-	-	-	2	2	-	2	3	3
23A0556L.4	2	2	3	3	3	-	-	-	2	2	-	2	3	3
23A0556L.5	2	2	3	3	3	-	-	-	2	2	-	3	3	3

III B.TECH II SEMESTER

23A3161T

**AI FOR CLOUD COMPUTING
(PROFESSIONAL CORE)**
(Common to CSE(AI))

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To introduce the concepts, models, and services of cloud computing and its role in AI.
2. To explore the architecture and deployment of AI applications on cloud platforms.
3. To equip students with skills in using cloud-based tools and services for AI/ML workloads.
4. To understand data storage, processing, and security in cloud for AI tasks.
5. To apply cloud computing principles to real-world AI-based solutions.

COURSE OUTCOMES

1. Explain cloud computing architecture, services, and deployment models.
2. Utilize cloud platforms (AWS, GCP, Azure) for training and deploying AI models.
3. Handle large-scale data storage and processing in the cloud environment.
4. Integrate AI workflows using serverless and container-based architectures.
5. Analyze challenges in security, cost, scalability, and performance of cloud-based AI systems.

UNIT I - INTRODUCTION TO CLOUD COMPUTING AND AI INTEGRATION (09)

Basics of Cloud Computing: Characteristics, Models, and Services, Cloud Service Models: IaaS, PaaS, SaaS, Deployment Models: Public, Private, Hybrid, Community, AI and Cloud Convergence: Benefits and Challenges, Use Cases of AI in Cloud: NLP, Vision, Analytics, Overview of Cloud Providers for AI: AWS, Azure, GCP.

UNIT II - STORAGE, COMPUTING, AND DATA PROCESSING IN THE CLOUD (09)

Cloud Storage Services: S3, Blob, BigQuery, Virtualization and Elastic Computing, Distributed Computing with Hadoop and Spark, Data Ingestion and Processing Pipelines, Data Lakes and Warehousing in the Cloud, Cost Optimization for Storage and Compute Resources.

UNIT III - CLOUD-BASED MACHINE LEARNING AND DEEP LEARNING (09)

ML Services on AWS (SageMaker), Azure ML, GCP Vertex AI, Training and Deploying Models on Cloud, AutoML and Custom ML Model Workflows, GPUs/TPUs for Model Training, Experiment Tracking and Model Evaluation, Integration of Notebooks (Jupyter, Colab) with Cloud Storage.

UNIT IV - ADVANCED CLOUD CONCEPTS FOR AI APPLICATIONS (09)

Containers and Docker for AI Applications, Kubernetes and Cloud-native AI Workflows, Serverless Computing: AWS Lambda, Azure Functions, CI/CD Pipelines for AI Models in Cloud, Scaling AI Applications using Load Balancers and Auto-Scaling. Monitoring and Logging in Cloud for AI Workflows.

UNIT V - SECURITY, ETHICS, AND CASE STUDIES IN CLOUD AI (09)

Security and Privacy in Cloud-based AI, Identity and Access Management (IAM) in Cloud, Cost Management and Billing for AI Services, Ethical Issues and Fairness in Cloud AI, Case Study: AI in Healthcare Cloud Solutions, Case Study: Real-Time Analytics in Financial Cloud Services.

TEXTBOOKS

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, McGraw-Hill.
2. Judith Hurwitz et al., Cloud Computing for Dummies, Wiley.
3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly.

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A3161T.1	3	2	2	2	3	-	-	-	-	-	-	2	3	2
23A3161T.2	3	3	3	2	3	-	-	-	-	-	-	3	3	3
23A3161T.3	3	3	3	2	3	-	-	-	-	-	-	3	3	3
23A3161T.4	3	3	3	3	3	-	-	-	1	1	1	3	3	3
23A3161T.5	3	3	2	3	3	1	1	2	1	1	2	3	3	3

III B.TECH II SEMESTER

23A3162T

BIG DATA TECHNOLOGIES
(PROFESSIONAL CORE)
(Common to CSE(AI))

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To introduce the fundamentals of big data and its role in AI-driven applications.
2. To explore big data tools and technologies such as Hadoop, Spark, and NoSQL databases.
3. To enable students to build scalable AI pipelines for data analytics.
4. To apply AI/ML algorithms for real-time and batch processing environments.
5. To demonstrate use cases of big data in domains like healthcare, finance, and IoT using AI.

COURSE OUTCOMES

1. Understand the architecture and ecosystem of big data processing.
2. Analyze and manage large-scale datasets using Hadoop and Spark.
3. Apply AI/ML techniques to extract insights from big data.
4. Design and implement scalable data pipelines using distributed frameworks.
5. Solve real-world domain problems with AI-powered big data solutions.

UNIT I - INTRODUCTION TO BIG DATA AND ANALYTICS ECOSYSTEM (09)

Definition and Characteristics of Big Data – Volume, Velocity, Variety, Veracity, Value, Types of Analytics: Descriptive, Diagnostic, Predictive, Prescriptive, Big Data Challenges and Opportunities, Hadoop Ecosystem Overview: HDFS, MapReduce, YARN, NoSQL Databases: Key-Value, Columnar, Document, Graph Models, Data Lake vs. Data Warehouse.

UNIT II - BIG DATA TOOLS AND FRAMEWORKS (09)

Apache Spark Architecture and RDDs, Spark SQL, DataFrames, and Datasets, Spark Streaming for Real-Time Analytics, Kafka for Data Ingestion and Message Queues, Hive, Pig, and Impala for Big Data Querying, Comparative Analysis of Hadoop vs. Spark.

UNIT III - MACHINE LEARNING ON BIG DATA (09)

Introduction to MLlib and Scikit-learn, Data Preprocessing for Big Data ML Pipelines, Supervised Learning: Classification and Regression on Large Datasets, Unsupervised Learning: Clustering and Dimensionality Reduction, Model Evaluation and Validation Techniques, Distributed Training and Optimization Techniques.

UNIT IV - AI APPLICATIONS ON BIG DATA (09)

Predictive Maintenance using Big Data & AI, Fraud Detection in Banking with Machine Learning, AI in Healthcare: Diagnosis, Genomics, Patient Monitoring, Retail and E-commerce Analytics, AI for Smart Cities and IoT Sensor Data Analysis, Evaluation of Real-Time AI Applications on Streaming Data.

UNIT V - ADVANCED TOPICS AND CASE STUDIES (09)

Deep Learning on Big Data using TensorFlow on Spark, Explainable AI (XAI) in Big Data Environments, Ethical Issues and Data Governance in Big Data AI, Edge Computing and AI for Low Latency Applications, Case Study 1: AI-Powered Big Data in Healthcare, Case Study 2: Big Data AI Solution in Smart Manufacturing.

TEXTBOOKS

1. Big Data: Principles and Paradigms by Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi – Wiley
2. Learning Spark: Lightning-Fast Big Data Analysis by Jules S. Damji et al. – O'Reilly

REFERENCE BOOKS

1. Data Science and Big Data Analytics by EMC Education Services – Wiley
2. Designing Data-Intensive Applications by Martin Kleppmann – O'Reilly
3. Machine Learning with Spark by Rajdeep Dua, Tathagata Das – Packt Publishing
4. Streaming Systems by Tyler Akidau – O'Reilly Media
5. Artificial Intelligence for Big Data by Anand Deshpande – Packt

ONLINE LEARNING RESOURCES

- <https://www.coursera.org/specializations/big-data> – Coursera Big Data Specialization
- <https://spark.apache.org/docs/latest/> – Apache Spark Documentation

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A3162T.1	3	2	2	2	3	-	-	-	-	-	-	2	3	2
23A3162T.2	3	3	3	3	3	-	-	-	-	-	-	3	3	3
23A3162T.3	3	3	3	3	3	-	-	1	-	-	-	3	3	3
23A3162T.4	3	3	3	3	3	-	-	1	1	1	1	3	3	3
23A3162T.5	3	3	3	3	3	1	1	1	1	1	1	3	3	3

III B.TECH II SEMESTER

23A306ET

QUANTUM COMPUTING
(PROFESSIONAL ELECTIVE-III)
(Common to CSE(AI) and AI&ML)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the principles and mathematical foundations of quantum computation.
- To understand quantum gates, circuits, and computation models.
- To explore quantum algorithms and their advantages over classical ones.
- To develop the ability to simulate and write basic quantum programs.
- To understand real-world applications and the future of quantum computing in AI, cryptography, and optimization.

COURSE OUTCOMES

- Explain the fundamental concepts of quantum mechanics used in computing.
- Construct and analyze quantum circuits using standard gates.
- Apply quantum algorithms like Deutsch-Jozsa, Grover's, and Shor's.
- Develop simple quantum programs using Qiskit or similar platforms.
- Analyze applications and challenges of quantum computing in real-world domains.

UNIT I - FUNDAMENTALS OF QUANTUM MECHANICS AND LINEAR ALGEBRA (09)

Classical vs Quantum Computation, Complex Numbers, Vectors, and Matrices, Hilbert Spaces and Dirac Notation, Quantum States and Qubits, Superposition and Measurement, Tensor Products and Multi-Qubit Systems.

UNIT II - QUANTUM GATES AND CIRCUITS (09)

Quantum Logic Gates: Pauli, Hadamard, Phase, Controlled Gates and CNOT, Unitary Operations and Reversibility, Quantum Circuit Representation, Quantum Teleportation, Simulation of Quantum Circuits.

UNIT III - QUANTUM ALGORITHMS AND COMPLEXITY (09)

Quantum Parallelism and Interference, Deutsch and Deutsch-Jozsa Algorithms, Grover's Search Algorithm, Shor's Factoring Algorithm, Quantum Fourier Transform, Complexity Classes: BQP, P, NP, and QMA.

UNIT IV - QUANTUM PROGRAMMING AND SIMULATION PLATFORMS (09)

Introduction to Qiskit and IBM Quantum Experience, Writing Quantum Circuits in Qiskit, Measuring Qubits and Results, Classical-Quantum Hybrid Programs, Noisy Intermediate-Scale Quantum (NISQ) Systems, Limitations and Current State of Quantum Hardware.

UNIT V - APPLICATIONS AND FUTURE OF QUANTUM COMPUTING (09)

Quantum Machine Learning: Basics and Models, Quantum Cryptography and Quantum Key Distribution, Quantum Algorithms in AI and Optimization, Quantum Advantage and Supremacy, Ethical and Societal Impact of Quantum Technologies, Future Trends and Research Directions.

TEXTBOOKS

1. Michael A. Nielsen, Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 10th Anniversary Edition, 2010.
2. Eleanor Rieffel and Wolfgang Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.

REFERENCE BOOKS

1. Chris Bernhardt, *Quantum Computing for Everyone*, MIT Press, 2019.
2. David McMahon, *Quantum Computing Explained*, Wiley, 2008.
3. Phillip Kaye, Raymond Laflamme, Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press, 2007.
4. Scott Aaronson, *Quantum Computing Since Democritus*, Cambridge University Press, 2013.

ONLINE LEARNING RESOURCES

1. IBM Quantum Experience and Qiskit Tutorials
2. Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley
3. edX – The Quantum Internet and Quantum Computers
4. YouTube – Quantum Computing for the Determined by Michael Nielsen
5. Qiskit Textbook – IBM Quantum

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A306ET.1	3	2	-	-	-	-	-	-	-	-	-	2	3	-
23A306ET.2	3	3	2	2	2	-	-	-	-	-	-	2	3	2
23A306ET.3	3	3	3	3	2	-	-	-	-	-	-	3	3	3
23A306ET.4	3	2	3	3	3	-	-	-	-	-	-	3	3	3
23A306ET.5	3	2	3	2	3	2	2	2	2	2	2	3	3	3

III B.TECH II SEMESTER

23A336AT

GRAPH NEURAL NETWORKS
(PROFESSIONAL ELECTIVE-II)
(Common to CSE(AI) and AI&ML)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamentals of graph theory and graph-structured data.
- To explore the concepts of neural networks extended to non-Euclidean domains.
- To understand architectures and algorithms behind various types of GNNs.
- To apply GNN models in real-world applications such as recommendation, social networks, and bioinformatics.
- To enable students to build and evaluate GNN models using frameworks like PyTorch Geometric and DGL.

COURSE OUTCOMES

- Understand the basics of graph structures and their significance in machine learning.
- Learn and implement different types of GNN architectures.
- Apply GNNs to real-world structured data problems.
- Use modern libraries and tools to train and evaluate GNNs.
- Analyze the effectiveness and limitations of GNNs in different domains.

UNIT I - FUNDAMENTALS OF GRAPH THEORY AND MACHINE LEARNING ON GRAPHS

(09)

Introduction to Graphs: Nodes, Edges, Adjacency Matrix, Types of Graphs: Directed, Undirected, Weighted, Bipartite, Graph Traversal Algorithms (BFS, DFS), Graph Representations for ML (Adjacency List, Matrix, Laplacian), Node, Edge, and Graph-level Prediction Problems, Motivation and Challenges for Learning on Graphs.

UNIT II - SPECTRAL AND SPATIAL METHODS FOR GRAPH LEARNING

(09)

Spectral Graph Theory Basics, Graph Convolution via Spectral Methods, Chebyshev and First-order Approximations, Spatial Graph Convolutions, Comparison of Spectral vs Spatial GNNs, Graph Laplacian and Eigenvalue Properties.

UNIT III - GRAPH NEURAL NETWORK ARCHITECTURES

(09)

Graph Convolutional Networks (GCNs), Graph Attention Networks (GATs), GraphSAGE: Sampling and Aggregation, Graph Isomorphism Networks (GIN), Message Passing Neural Networks (MPNNs), Inductive vs Transductive GNN Learning.

UNIT IV - APPLICATIONS OF GNNs

(09)

Node Classification (e.g., Cora, Citeseer), Link Prediction (e.g., Recommender Systems), Graph Classification (e.g., Molecule Property Prediction), Traffic Forecasting and Social Network Modeling, GNNs in Healthcare and Bioinformatics, Explainability and Interpretability in GNNs.

UNIT V - IMPLEMENTATION, OPTIMIZATION, AND RECENT ADVANCES

(09)

Overview of PyTorch Geometric and DGL, Data Loading and Preprocessing for Graph Datasets, Model Training, Loss Functions, and Evaluation Metrics, Hyperparameter Tuning in GNNs, Recent Research Trends and Architectures (e.g., Heterogeneous GNNs, Graph Transformers), Challenges and Future Directions in GNNs.

TEXTBOOKS

1. Zonghan Wu, Shirui Pan, Fengwen Chen, Guodong Long, Chengqi Zhang, Philip S. Yu, *A Comprehensive Survey on Graph Neural Networks*, IEEE Transactions on Neural Networks and Learning Systems, 2021.
2. Yao Ma, Jiliang Tang, *Deep Learning on Graphs*, Cambridge University Press, 2021.

REFERENCE BOOKS

1. William L. Hamilton, *Graph Representation Learning*, Morgan & Claypool Publishers, 2020.
2. Barrett, Jure Leskovec, *Mining of Massive Datasets*, Cambridge University Press.
3. Thomas Kipf, *GCN and related papers and tutorials* (arXiv).
4. Petar Veličković, *Graph Attention Networks* (original paper and slides).
5. Michael Bronstein et al., *Geometric Deep Learning: Grids, Groups, Graphs, Geodesics, and Gauges* (arXiv preprint).

ONLINE LEARNING RESOURCES

1. <https://pytorch-geometric.readthedocs.io/> – PyTorch Geometric Docs
2. <https://cs.stanford.edu/people/jure/> – Stanford GNN Projects
3. <https://www.coursera.org/learn/graph-neural-networks> – Coursera GNN Course by Stanford

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A336AT.1	3	3	-	-	2	-	-	-	-	-	-	2	2	2
23A336AT.2	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A336AT.3	3	2	3	2	3	-	-	-	-	-	-	2	3	3
23A336AT.4	3	2	3	2	3	-	-	-	2	2	-	2	3	3
23A336AT.5	3	3	2	2	3	2	2	-	-	-	2	3	3	3

III B. TECH II SEMESTER

23A336BT

RECOMMENDER SYSTEMS
(PROFESSIONAL ELECTIVE-II)
(Common to CSE(AI) and AI&ML)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the theoretical foundations and practical techniques behind recommender systems.
- To explore collaborative, content-based, and hybrid recommendation methods.
- To apply matrix factorization and deep learning for building intelligent recommenders.
- To analyze system performance using standard evaluation metrics.
- To design and implement recommender systems for real-world applications.

COURSE OUTCOMES

- Explain the core concepts and types of recommender systems.
- Implement basic collaborative and content-based filtering techniques.
- Apply matrix factorization and deep learning models to recommendation problems.
- Evaluate and optimize recommender systems using appropriate metrics.
- Design scalable and context-aware recommender systems for diverse applications.

UNIT I - INTRODUCTION TO RECOMMENDER SYSTEMS (09)

Introduction to Information Filtering Systems, Types of Recommender Systems: Content-based, Collaborative, Hybrid, Data Sources: Explicit vs Implicit Feedback, Applications and Challenges in Recommendation, User and Item Profiling, Popularity, Personalization, and Serendipity Trade-offs.

UNIT II - COLLABORATIVE FILTERING TECHNIQUES (09)

User-based Collaborative Filtering, Item-based Collaborative Filtering, Similarity Measures: Cosine, Pearson, Jaccard, Neighborhood Selection and k-NN, Cold-start and Data Sparsity Issues, Memory-based vs Model-based Collaborative Filtering.

UNIT III - CONTENT-BASED AND HYBRID SYSTEMS (09)

Item Feature Extraction and Vector Representation, TF-IDF and Cosine Similarity in Recommendations, User Profile Learning, Limitations of Content-based Filtering, Hybrid Recommender Architectures, Case Study: Netflix, Amazon Hybrid Systems.

UNIT IV - MATRIX FACTORIZATION AND DEEP LEARNING APPROACHES (09)

Latent Factor Models and SVD, ALS and SGD for Matrix Factorization, Non-negative Matrix Factorization (NMF), Neural Collaborative Filtering (NCF), Deep Learning Models: Autoencoders, CNNs, RNNs for Recommendations, Graph-based and Knowledge Graph Recommenders.

UNIT V - EVALUATION, ETHICS, AND INDUSTRIAL APPLICATIONS (09)

Evaluation Metrics: Precision, Recall, F1, NDCG, MAP, A/B Testing in Recommender Systems, Explainability in Recommendations, Fairness, Bias, and Privacy in Recommenders, Scalability and Real-time Recommendations, Deploying Recommender Systems at Scale (e.g., Spotify, YouTube).

TEXTBOOKS

1. Charu C. Aggarwal, *Recommender Systems: The Textbook*, Springer, 2016.
2. Francesco Ricci, Lior Rokach, and Bracha Shapira, *Recommender Systems Handbook*, Springer, 2nd Ed., 2015.

REFERENCE BOOKS

1. Jannach, Dietmar et al., *Recommender Systems: An Introduction*, Cambridge University Press, 2010.
2. Michael Ekstrand, Joseph A. Konstan, *Collaborative Filtering Recommender Systems*, Now Publishers, 2011.
3. Research papers from *ACM RecSys* Conference proceedings.

ONLINE LEARNING RESOURCES

- <https://www.coursera.org/learn/recommender-systems> – Coursera: University of Minnesota
- <https://www.kaggle.com/learn/recommendation-systems> – Kaggle Course
- <https://developers.google.com/machine-learning/recommendation> – Google Developers

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A336BT.1	3	2	-	-	2	-	-	-	-	-	-	2	2	2
23A336BT.2	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A336BT.3	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A336BT.4	3	2	2	3	3	-	-	-	2	2	-	2	3	3
23A336BT.5	3	3	3	2	3	2	2	-	2	2	2	3	3	3

III B.TECH II SEMESTER

23A306CT

PREDICTIVE ANALYTICS
(PROFESSIONAL ELECTIVE-II)
(Common to CSE(AI) and AI&ML)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamental concepts and techniques of predictive analytics.
- To apply statistical models and machine learning algorithms for prediction.
- To interpret model performance using evaluation metrics.
- To explore feature engineering, model tuning, and cross-validation.
- To implement predictive solutions for real-world business and research problems.

COURSE OUTCOMES

- Understand the principles and importance of predictive analytics.
- Apply regression and classification models for predictive tasks.
- Perform data preprocessing, feature selection, and transformation.
- Evaluate and validate models using standard metrics.
- Design predictive solutions to solve domain-specific challenges.

UNIT I - INTRODUCTION TO PREDICTIVE ANALYTICS (09)

Introduction to Predictive Analytics and Business Intelligence, Types of Predictive Models: Classification, Regression, Time Series, Supervised vs Unsupervised Learning, Predictive Modeling Workflow, Applications in Marketing, Finance, Healthcare, Challenges in Predictive Analytics.

UNIT II - DATA PREPARATION AND FEATURE ENGINEERING (09)

Data Cleaning: Handling Missing, Noisy, and Inconsistent Data, Feature Selection and Dimensionality Reduction (PCA, LDA), Feature Scaling: Normalization, Standardization, Encoding Categorical Variables, Feature Extraction and Construction, Dealing with Imbalanced Datasets.

UNIT III - PREDICTIVE MODELING WITH REGRESSION AND CLASSIFICATION (09)

Linear Regression and Polynomial Regression, Logistic Regression for Binary Classification, Decision Trees and Random Forest, k-Nearest Neighbors (k-NN) and Naïve Bayes, Support Vector Machines (SVM), Model Selection and Comparison.

UNIT IV - MODEL EVALUATION AND VALIDATION (09)

Training, Testing, and Validation Sets, Cross-Validation Techniques (k-Fold, Stratified, LOOCV), Evaluation Metrics: Accuracy, Precision, Recall, F1 Score, ROC-AUC, Confusion Matrix and Classification Report, Bias-Variance Trade-off and Overfitting, Hyperparameter Tuning: Grid Search, Random Search.

UNIT V - ADVANCED TOPICS AND APPLICATIONS (09)

Ensemble Learning: Bagging, Boosting (AdaBoost, XGBoost), Predictive Analytics with Time Series (ARIMA, Prophet), Deep Learning for Predictive Modeling (ANNs, LSTM), Use of Predictive Analytics in IoT, Retail, and Healthcare, Ethics and Privacy in Predictive Analytics, Building and Deploying End-to-End Predictive Systems.

TEXTBOOKS

1. Dean Abbott, Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst, Wiley, 2014.
2. John D. Kelleher, Brendan Tierney, Data Science: Predictive Analytics and Data Mining, MIT Press, 2018.

REFERENCE BOOKS

1. Galit Shmueli et al., Data Mining for Business Analytics: Concepts, Techniques, and Applications in R, Wiley, 2017.
2. Eric Siegel, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, Wiley, 2016.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer, 2009.

ONLINE LEARNING RESOURCES

- <https://www.coursera.org/specializations/predictive-analytics>– Coursera Specialization
- <https://www.edx.org/course/data-science-and-machine-learning-capstone> – edX Predictive Analytics Courses
- <https://www.kaggle.com/learn/intro-to-machine-learning> – Kaggle Tutorials

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A306CT.1	3	2	-	-	2	-	-	-	-	-	-	2	2	1
23A306CT.2	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A306CT.3	3	3	2	3	3	-	-	-	-	-	-	2	3	3
23A306CT.4	3	3	2	3	3	-	-	-	-	-	-	2	3	3
23A306CT.5	3	3	3	3	3	2	1	1	2	2	2	3	3	3

III B.TECH II SEMESTER

23A316BT

BLOCKCHAIN FOR AI
(PROFESSIONAL ELECTIVE-II)
(Common to CSE(AI))

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the foundational concepts of blockchain technology and its architecture.
- To explore smart contracts, consensus algorithms, and distributed ledger technology.
- To investigate the integration of AI with blockchain for secure, decentralized applications.
- To develop blockchain-enabled AI solutions for real-world use cases.
- To understand the ethical, security, and scalability challenges in Blockchain-AI ecosystems.

COURSE OUTCOMES

- Explain the fundamentals of blockchain and its components.
- Analyze the role of consensus mechanisms in maintaining trust and decentralization.
- Apply blockchain for secure data sharing in AI systems.
- Develop and deploy smart contracts using Ethereum/Solidity.
- Evaluate blockchain-based AI applications in healthcare, finance, and supply chains.

UNIT I - BLOCKCHAIN FUNDAMENTALS AND ARCHITECTURE (09)

Introduction to Blockchain Technology, Components: Blocks, Hashing, Merkle Trees, Types of Blockchains: Public, Private, Consortium, Distributed Ledger Technology (DLT) and P2P Networks, Blockchain Structure and Mining, Use Cases and Evolution of Blockchain.

UNIT II - SMART CONTRACTS AND CONSENSUS MECHANISMS (09)

Smart Contracts: Definition, Features, Use Cases, Ethereum and Solidity Basics, Consensus Algorithms: PoW, PoS, DPoS, PBFT, Gas, Transactions, and Events in Ethereum, Hyperledger Fabric: Architecture and Chaincode, Deployment and Testing of Smart Contracts.

UNIT III - INTEGRATION OF BLOCKCHAIN AND AI (09)

Motivation for Integrating Blockchain with AI, Decentralized AI Models and Federated Learning, Secure Model Sharing and Provenance, Blockchain for Data Integrity in AI Systems, AI for Blockchain (e.g., optimizing consensus), Case Study: Decentralized AI Marketplace.

UNIT IV - APPLICATIONS OF BLOCKCHAIN IN AI SYSTEMS (09)

Blockchain for Explainable and Trusted AI, Applications in Healthcare and Genomics, Blockchain for Autonomous Vehicles and IoT, Financial AI Systems with Smart Contracts, Supply Chain and Logistics Intelligence, NFT-based AI Applications (Digital Identity, IP).

UNIT V - SECURITY, PRIVACY AND CHALLENGES IN BLOCKCHAIN-AI (09)

Security Challenges: Sybil Attacks, 51% Attacks, Privacy Preservation and Zero Knowledge Proofs, Scalability and Energy Concerns in Blockchain-AI, Ethical and Legal Concerns in AI with Blockchain, Interoperability of Blockchain Platforms, Future Trends: Quantum-Resistant Blockchain- AI.

TEXTBOOKS

1. Imran Bashir, Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Packt, 2020.
2. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly Media, 2015.

REFERENCE BOOKS

1. Joseph Holbrook, Architecting AI Solutions on Blockchain, Packt Publishing, 2020.
2. Arshdeep Bahga, Vijay Madisetti, Blockchain Applications: A Hands-On Approach, VPT, 2017.
3. Karamjit Singh, Blockchain for AI: Use Cases and Implementation, Springer, 2023.
4. Roger Wattenhofer, The Science of the Blockchain, 2016.

ONLINE LEARNING RESOURCES

- Coursera: Blockchain Specialization – University at Buffalo
- edX: Blockchain Fundamentals – UC Berkeley
- Coursera: AI and Blockchain – IBM

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A316BT.1	3	2	2	2	3	-	-	-	-	-	-	2	3	2
23A316BT.2	3	3	2	3	3	1	1	2	-	-	-	3	3	3
23A316BT.3	3	3	3	3	3	2	-	2	-	-	1	3	3	3
23A316BT.4	3	2	3	2	3	-	-	-	1	1	1	3	3	3
23A316BT.5	3	3	3	3	3	2	1	2	1	1	1	3	3	3

III B.TECH II SEMESTER

23A316CT

AI FOR FINANCE
(PROFESSIONAL ELECTIVE-III)
(Common to CSE(AI))

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the role of Artificial Intelligence (AI) in financial applications and decision-making.
- To understand financial data types, sources, and processing methods.
- To apply machine learning and deep learning models in various finance sectors.
- To analyze risk, fraud detection, credit scoring, and portfolio management using AI.
- To evaluate ethical and regulatory challenges in AI-enabled finance.

COURSE OUTCOMES

- Describe the fundamentals of AI techniques applicable to finance.
- Analyze financial time series data using AI-based models.
- Apply machine learning for fraud detection and credit risk analysis.
- Build predictive models for stock prices, trading, and customer segmentation.
- Evaluate the limitations and ethical implications of AI in financial systems.

UNIT I - INTRODUCTION TO FINANCE AND AI APPLICATIONS (09)

Introduction to Financial Markets and Instruments, Overview of AI Techniques in Finance, Types of Financial Data: Market, Transactional, Customer, Financial Statements and Key Indicators, AI Use Cases in Banking, Insurance, and Investment, FinTech and the Rise of Robo-Advisors.

UNIT II - MACHINE LEARNING IN FINANCE (09)

Supervised Learning for Credit Scoring, Unsupervised Learning for Customer Segmentation, Feature Engineering for Financial Data, Handling Imbalanced Datasets in Fraud Detection, Time Series Forecasting with Regression and ARIMA, Model Validation and Backtesting in Finance.

UNIT III - DEEP LEARNING AND NLP IN FINANCE (09)

Introduction to Deep Learning for Finance, Stock Price Prediction using LSTM and RNNs, Sentiment Analysis from Financial News and Tweets, NLP for Document Classification: Earnings Reports, Chatbots and Virtual Assistants in Banking, Reinforcement Learning for Portfolio Optimization.

UNIT IV - AI-DRIVEN FINANCIAL APPLICATIONS (09)

Fraud Detection Systems using ML and DL, Credit Risk and Loan Default Prediction, AI in Algorithmic and High-Frequency Trading, Robo-Advisors: Architecture and Optimization, Blockchain and AI Integration for Financial Security, Case Studies: AI in Wealth Management & Insurance.

UNIT V - ETHICS, REGULATION, AND FUTURE OF AI IN FINANCE (09)

Regulatory Frameworks in AI-based Finance, Explainability and Interpretability of Financial Models, Ethical Issues: Bias, Fairness, Transparency, Data Privacy and GDPR in Financial AI, Responsible AI Practices in Finance, Emerging Trends: Quantum AI, Decentralized Finance (DeFi).

Textbooks:

1. Yves Hilpisch, Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly, 2020.
2. Yves Hilpisch, Python for Finance: Mastering Data-Driven Finance, O'Reilly, 2018.
3. Markus Loecher, Machine Learning for Finance, Packt Publishing, 2021.

Reference Books:

1. A. W. Lo, The Evolution of Technical Analysis, Wiley Finance, 2010.
2. Tony Guida, Big Data and Machine Learning in Quantitative Investment, Wiley, 2019.
3. Tucker Balch, AI for Trading – Georgia Tech Specialization, Coursera.

Online Learning Resources:

- Coursera: AI for Trading – by NYIF and Google Cloud
- edX: Artificial Intelligence in Finance – NYIF
- Udemy: Machine Learning and AI in Finance
- DataCamp: Financial Trading with Python

YouTube: AI for Finance by Sentdex, Two Minute Papers, and DataProfessor

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A316CT.1	3	2	2	2	3	-	-	-	-	-	2	2	3	2
23A316CT.2	3	3	2	3	3	-	-	-	-	-	2	3	3	3
23A316CT.3	3	3	3	3	3	1	-	1	-	-	2	3	3	3
23A316CT.4	3	3	3	3	3	-	-	1	1	1	2	3	3	3
23A316CT.5	3	2	2	3	3	2	1	3	1	1	1	3	3	3

III B.TECH II SEMESTER

23A316DT

**REINFORCEMENT LEARNING
(PROFESSIONAL ELECTIVE-I)
(Common to CSE(AI) and AI&ML)**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the foundational concepts of Reinforcement Learning (RL) and its mathematical formulations.
- To explore dynamic programming, Monte Carlo methods, and temporal-difference learning.
- To study the advanced function approximation methods using neural networks.
- To apply RL algorithms to real-world decision-making problems.
- To introduce policy gradient methods and deep reinforcement learning techniques.

COURSE OUTCOMES

- Explain the core principles of reinforcement learning and its interaction model.
- Apply tabular and approximate solution methods for prediction and control.
- Evaluate and compare Monte Carlo, TD, and policy gradient methods.
- Design reinforcement learning models for real-world environments.
- Integrate neural networks with reinforcement learning techniques.

UNIT I – INTRODUCTION TO REINFORCEMENT LEARNING (08)

Introduction to Machine Learning and RL, Agent-environment interface, Goals and rewards, Returns: episodic and continuing tasks, Markov Decision Processes (MDP), Value functions: state-value and action-value functions.

UNIT II – DYNAMIC PROGRAMMING AND MONTE CARLO METHODS (08)

Policy evaluation and improvement, Policy iteration and value iteration, Generalized policy iteration, Monte Carlo prediction and control, On-policy and off-policy MC methods.

UNIT III – TEMPORAL-DIFFERENCE LEARNING AND ELIGIBILITY TRACES (08)

TD Prediction (TD(0)), SARSA and Q-Learning, Expected SARSA, n-step returns, Eligibility traces, TD(λ) methods.

UNIT IV – FUNCTION APPROXIMATION AND DEEP RL (08)

Linear and non-linear function approximation, Feature construction, Deep Q Networks (DQN), Experience replay and fixed Q-targets, Double DQN and Dueling DQN, Challenges in deep RL.

UNIT V – POLICY GRADIENT AND ACTOR-CRITIC METHOD (08)

Policy gradient theorem, REINFORCE algorithm, Variance reduction techniques, Actor-Critic architecture, Proximal Policy Optimization (PPO), Applications in Robotics and Games.

TEXTBOOKS

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", 2nd Edition, MIT Press, 2018. (Free online at <http://incompleteideas.net/book/the-book-2nd.html>)

REFERENCE BOOKS

1. Csaba Szepesvári, "Algorithms for Reinforcement Learning", Morgan & Claypool, 2010.
2. Marco Wiering and Martijn van Otterlo, "Reinforcement Learning: State-of-the-Art", Springer, 2012.
3. David Silver, Reinforcement Learning Lecture Series, University College London (UCL).
4. François-Lavet et al., "An Introduction to Deep Reinforcement Learning", Foundations and Trends® in Machine Learning, 2018.

ONLINE LEARNING RESOURCES

1. NPTEL Online Course:
<https://nptel.ac.in/courses/106106143> – Reinforcement Learning by Prof. Balaraman Ravindran, IIT Madras
2. DeepMind & UCL Lectures (David Silver):
<https://www.davidsilver.uk/teaching/>
3. Coursera – Reinforcement Learning Specialization:
<https://www.coursera.org/specializations/reinforcement-learning>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A316DT.1	3	2	1	1	2	-	-	-	-	-	-	2	2	2
23A316DT.2	3	3	2	2	3	-	-	-	-	-	-	2	3	3
23A316DT.3	3	3	2	3	3	-	-	-	-	-	-	2	3	3
23A316DT.4	3	3	3	3	3	-	-	-	-	-	-	2	3	3
23A316DT.5	3	2	3	3	3	-	-	-	-	-	-	3	3	3

III B.TECH II SEMESTER

23A306HT

SOCIAL NETWORK ANALYSIS
(PROFESSIONAL ELECTIVE-III)
(Common to CSE(AI) and AI&ML)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamentals and key concepts of social network theory and graph theory.
- To analyze the structure and properties of large-scale social networks.
- To apply centrality, influence, and community detection measures.
- To model information diffusion and network dynamics.
- To implement real-world social network analysis using tools and datasets.

COURSE OUTCOMES

- Understand basic network models and social network structures.
- Analyze key properties like centrality, clustering, and small-world effect.
- Apply community detection algorithms and influence maximization.
- Interpret diffusion models for viral marketing and information spread.
- Use tools such as Gephi, NetworkX, or SNAP for real-world SNA.

UNIT I - INTRODUCTION TO SOCIAL NETWORKS AND GRAPH THEORY (09)

Basic Concepts: Graphs, Nodes, Edges, Directed/Undirected Graphs, Real-world Examples: Facebook, Twitter, LinkedIn, Adjacency Matrix and Graph Representation, Types of Social Networks: Ego, Bipartite, Multilayer, Degree Distribution, Path Length, and Connectivity, Random Graph Models: Erdős–Rényi and Watts-Strogatz.

UNIT II - STRUCTURAL PROPERTIES OF NETWORKS (09)

Network Centrality Measures: Degree, Closeness, Betweenness, Eigenvector Centrality and PageRank, Network Clustering and Community Detection Basics, Triadic Closure and Clustering Coefficient, Small-world Phenomenon and Milgram's Experiment, Homophily, Influence, and Structural Balance.

UNIT III - COMMUNITY DETECTION AND SUBGROUP ANALYSIS (09)

Girvan–Newman Algorithm and Modularity, Label Propagation and Louvain Method, Clique Detection and k-Core Decomposition, Overlapping Communities and Fuzzy Clustering, Cohesive Subgroups and Structural Equivalence, Evaluation Metrics: NMI, Modularity Score.

UNIT IV - INFORMATION DIFFUSION AND INFLUENCE IN NETWORKS (09)

Models of Diffusion: Linear Threshold and Independent Cascade, Influence Maximization and Viral Marketing, Contagion Models and Epidemic Spreading, Rumor Propagation and Cascade Models, Information Bottlenecks and Bridges, Measuring Influence and Reach.

UNIT V - TOOLS, APPLICATIONS, AND ETHICS IN SNA (09)

SNA Tools: Gephi, Pajek, NetworkX, SNAP, Case Study: Twitter and Hashtag Analysis, LinkedIn Network Mining and Graph Features, Applications in Marketing, Security, and Epidemiology, Ethical Issues in Social Network Data Mining, Building and Visualizing Your Own Social Graph.

TEXTBOOKS

1. Wasserman, S., & Faust, K., *Social Network Analysis: Methods and Applications*, Cambridge University Press, 1994.
2. Easley, D., & Kleinberg, J., *Networks, Crowds, and Markets: Reasoning About a Highly Connected World*, Cambridge University Press, 2010.

REFERENCE BOOKS

1. Newman, M., *Networks: An Introduction*, Oxford University Press, 2010.
2. Borgatti, S. P., Everett, M. G., & Johnson, J. C., *Analyzing Social Networks*, SAGE Publications, 2018.
3. Barabási, A.-L., *Linked: How Everything Is Connected to Everything Else*, Basic Books, 2014.
4. Hansen, D., Shneiderman, B., & Smith, M. A., *Analyzing Social Media Networks with NodeXL*, Elsevier, 2020.

ONLINE LEARNING RESOURCES

- Coursera – Social Network Analysis (University of Michigan)
- YouTube – NetworkX and Gephi Tutorials (freeCodeCamp, TheNetNinja)
- edX – Networks: Friends, Money, and Bytes (University of California, Berkeley)
- Khan Academy – Graph Theory

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A306HT.1	3	2	-	-	-	-	-	-	-	-	-	2	3	1
23A306HT.2	3	3	2	2	-	-	-	-	-	-	-	2	3	2
23A306HT.3	3	3	3	3	2	-	-	-	-	-	-	3	3	2
23A306HT.4	3	3	3	3	3	2	-	-	-	2	2	3	3	2
23A306HT.5	3	2	3	3	3	-	-	2	2	2	2	3	3	3

III B.TECH II SEMESTER

23A316ET

AI IN CYBERSECURITY
(PROFESSIONAL ELECTIVE-IV)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamental concepts of AI and their applications in cybersecurity.
- To understand AI-driven techniques for threat detection, classification, and mitigation.
- To explore machine learning and deep learning methods used for malware and intrusion detection.
- To equip students with skills in building intelligent security systems.
- To examine ethical, legal, and privacy aspects in AI-driven cybersecurity.

COURSE OUTCOMES

- Understand AI principles and their relevance in cybersecurity.
- Apply machine learning techniques to detect and respond to threats.
- Analyze security incidents using intelligent tools and models.
- Evaluate and implement AI models for malware detection and anomaly analysis.
- Design AI-based cybersecurity frameworks for real-world scenarios.

UNIT I - INTRODUCTION TO AI IN CYBERSECURITY (09)

Role of AI in Modern Cybersecurity, Overview of Cyber Threats and Attack Vectors, Fundamentals of Machine Learning for Security, AI vs Traditional Security Techniques, AI-Based Cyber Defense Lifecycle, Threat Intelligence with AI, Cybersecurity Data Types and Challenges, Case Studies of AI-Driven Attacks and Defenses.

UNIT II - MACHINE LEARNING FOR CYBER THREAT DETECTION (09)

Supervised Learning for Intrusion Detection, Unsupervised Learning for Anomaly Detection, Feature Engineering from Network Traffic, Classification Algorithms: SVM, Decision Trees, Random Forests, Clustering Techniques: K-Means, DBSCAN, Ensemble Models and Model Evaluation Metrics, Real-Time Threat Detection Pipelines, Data Imbalance and Adversarial Sampling.

UNIT III - DEEP LEARNING IN CYBERSECURITY (09)

Neural Networks for Threat Classification, CNNs for Malware Detection from Binary Files, RNNs/LSTMs for Sequential Log Analysis, Autoencoders for Anomaly Detection, GANs in Malware Evasion and Defense, Transfer Learning for Threat Signature Extraction, Deep Learning vs Traditional Models: A Comparative Study, Real-World Use Cases and Limitations.

UNIT IV - AI FOR SPECIFIC SECURITY DOMAINS (09)

AI for Phishing and Spam Detection, AI in Cloud Security and Edge Devices, Botnet and DDoS Attack Detection, AI-Driven Endpoint Security, Natural Language Processing for Threat Intelligence, Behavioral Biometrics and Fraud Detection, AI in Social Engineering Attack Prevention, Security Information and Event Management (SIEM) with AI.

UNIT V - CHALLENGES, ETHICS & FUTURE OF AI IN CYBERSECURITY

(09)

Explainable AI (XAI) in Cybersecurity, Adversarial Attacks and Defenses in AI Systems, Data Privacy and Federated Learning, Legal and Ethical Issues in AI Security Solutions, AI Model Bias and Fairness in Security Decisions, Securing AI Models Against Manipulation, Building Scalable AI-Powered SOC's, Future Trends: Autonomous Security, AI-Augmented Threat Hunting.

TEXTBOOKS

1. Clarence Chio & David Freeman, —Machine Learning and Security, O'Reilly Media.
2. Xiaofeng Chen et al., —Artificial Intelligence and Big Data Analytics for Cybersecurity, Springer.

REFERENCE BOOKS

1. Mark Stamp, —Information Security: Principles and Practice, Wiley.
2. Sumeet Dua & Xian Du, —Data Mining and Machine Learning in Cybersecurity, CRC Press.
3. Shai Shalev-Shwartz & Shai Ben-David, —Understanding Machine Learning, Cambridge University Press.
4. Zhiwei Lin & Yang Xiang, —Cyber Security Intelligence and Analytics, Springer.
5. Bhavani Thuraisingham, —Data Mining for Malware Detection, CRC Press.

ONLINE LEARNING RESOURCES

- Coursera – —AI for Cybersecurity by University of Colorado
- Udemy – —Machine Learning for Cybersecurity
- edX – —Cybersecurity MicroMasters by RIT

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A316ET.1	3	2	2	1	2	2	-	2	-	-	-	2	3	2
23A316ET.2	3	3	3	2	3	1	-	1	-	-	-	2	3	3
23A316ET.3	2	3	3	2	3	2	-	1	-	-	-	2	3	3
23A316ET.4	3	3	2	3	3	2	-	1	-	-	-	2	3	3
23A316ET.5	2	2	3	2	3	3	-	3	-	-	-	2	3	3

III B.TECH II SEMESTER

23A316FT

GAME THEORY
(PROFESSIONAL ELECTIVE-IV)
(Common to CSE(AI))

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamental concepts of game theory and strategic decision-making.
- To analyze different types of games: cooperative, non-cooperative, static, and dynamic.
- To understand solution concepts such as Nash equilibrium, dominant strategies, and backward induction.
- To apply game theory to real-world scenarios in economics, politics, computer science, and engineering.
- To develop mathematical modeling and analytical thinking for interactive decision-making.

COURSE OUTCOMES

- Understand fundamental concepts such as strategies, payoffs, and rationality in games.
- Analyze static games with complete information and identify Nash equilibria.
- Evaluate dynamic games using backward induction and subgame perfection.
- Solve games with incomplete information using Bayesian game models.
- Apply game-theoretic models to real-world scenarios in economics, engineering, and computer science.

UNIT I - INTRODUCTION TO GAME THEORY (09)

Basic Concepts: Players, strategies, payoffs, Classification of games: Cooperative vs. Non-cooperative, Static vs. Dynamic, Complete vs. Incomplete Information, Representing games: Normal form and extensive form, Dominant strategy equilibrium, Rationality and common knowledge.

UNIT II - STATIC GAMES OF COMPLETE INFORMATION (09)

Nash Equilibrium: Definition and examples, Pure vs. mixed strategy Nash equilibrium, Existence of Nash equilibrium (Nash's Theorem - Statement only), Best response functions, Applications in pricing, auctions, and network routing.

UNIT III - DYNAMIC GAMES OF COMPLETE INFORMATION (09)

Extensive form representation of sequential games, Backward induction and Subgame Perfect Nash Equilibrium (SPNE), Stackelberg duopoly, Repeated games: Strategies and equilibrium concepts, Trigger strategies, Grim Trigger, Tit-for-Tat.

UNIT IV - GAMES OF INCOMPLETE INFORMATION (BAYESIAN GAMES) (09)

Bayesian Games: Definitions and modelling, Bayesian Nash Equilibrium, Applications to auctions, contract theory, Mechanism design basics.

UNIT V - APPLICATIONS AND ADVANCED TOPICS (09)

Cooperative Game Theory: Core, Shapley Value, Bargaining, Voting systems and power indices (Banzhaf, Shapley-Shubik), Applications in algorithmic game theory (e.g., algorithmic bidding, traffic networks), Evolutionary Game Theory: Strategies and Evolutionarily Stable Strategies (ESS), Case studies: Game theory in economics, AI, cybersecurity, politics.

TEXTBOOKS

1. Martin J. Osborne, *An Introduction to Game Theory*, Oxford University Press, 2004.
2. Roger B. Myerson, *Game Theory: Analysis of Conflict*, Harvard University Press, 1991.

REFERENCE BOOKS

1. Kevin Leyton-Brown and Yoav Shoham, *Essentials of Game Theory*, Morgan & Claypool, 2008.
2. Eric Rasmusen, *Games and Information*, Wiley-Blackwell, 2007.
3. Fudenberg & Tirole, *Game Theory*, MIT Press, 1991.
4. Vijay Krishna, *Auction Theory*, Academic Press, 2010.

ONLINE LEARNING RESOURCES

- NPTEL - Game Theory
- MIT OpenCourseWare – Game Theory
- [Coursera – Game Theory by Stanford and The University of British Columbia](#)

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A316FT.1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
23A316FT.2	3	3	2	2		-	-	-	-	-	-	1	2	2
23A316FT.3	3	3	2	2	1	-	-	-	-	-	-	1	3	2
23A316FT.4	3	3	2	2	1	-	-	-	-	-	-	1	2	3
23A316FT.5	3	3	3	3	2	1	1	1	1	2	-	2	3	3

III B.TECH II SEMESTER

23A016GT

DISASTER MANAGEMENT
(OPEN ELECTIVE-I)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To understand the fundamental concepts of natural disasters, their occurrence, and disaster risk reduction strategies.
2. To analyze the impact of cyclones on structures and explore retrofitting techniques for adaptive reconstruction.
3. To apply wind engineering principles and computational techniques in designing wind-resistant structures.
4. To evaluate earthquake effects on buildings and develop strategies for seismic retrofitting.
5. To assess seismic safety planning, design considerations, and innovative construction materials for disaster-resistant structures.

COURSE OUTCOMES

1. Understand the fundamental concepts of natural disasters, their occurrence, and disaster risk reduction strategies.
2. Analyze the impact of cyclones on structures and explore retrofitting techniques for adaptive reconstruction.
3. Apply wind engineering principles and computational techniques in designing wind-resistant structures.
4. Evaluate earthquake effects on buildings and develop strategies for seismic retrofitting.
5. Assess seismic safety planning, design considerations, and innovative construction materials for disaster-resistant structures.

UNIT I - INTRODUCTION TO NATURAL DISASTERS

(09)

Introduction to Natural Disasters– Brief Introduction to Different Types of Natural Disasters, Occurrence of Disasters in Different Climatic and Geographical Regions, Hazard Maps (Earthquake and Cyclone) of The World and India, Regulations for Disaster Risk Reduction, Post-Disaster Recovery and Rehabilitation (Socioeconomic Consequences).

UNIT II - CYCLONES AND THEIR IMPACT

(09)

Cyclones and Their Impact– Climate Change and Its Impact On Tropical Cyclones, Nature of Cyclonic Wind, Velocities and Pressure, Cyclone Effects, Storm Surges, Floods, and Landslides. Behavior of Structures in Past Cyclones and Windstorms, Case Studies. Cyclonic Retrofitting, Strengthening of Structures, and Adaptive Sustainable Reconstruction. Life-Line Structures Such as Temporary Cyclone Shelters.

UNIT III - WIND ENGINEERING AND STRUCTURAL RESPONSE (09)

Wind Engineering and Structural Response– Basic Wind Engineering, Aerodynamics of Bluff Bodies, Vortex Shedding, and Associated Unsteadiness Along and Across Wind forces. Lab: Wind Tunnel Testing and Its Salient Features. Introduction to Computational Fluid Dynamics (CFD). General Planning and Design Considerations Under Windstorms and Cyclones. Wind Effects On Buildings, towers, Glass Panels, Etc., and Wind-Resistant Features in Design. Codal Provisions, Design Wind Speed, Pressure Coefficients. Coastal Zoning Regulations for Construction and Reconstruction in Coastal Areas. Innovative Construction Materials and Techniques, Traditional Construction Techniques in Coastal Areas.

UNIT IV - SEISMOLOGY AND EARTHQUAKE EFFECTS (09)

Seismology and Earthquake Effects– Causes of Earthquakes, Plate Tectonics, Faults, Seismic Waves; Magnitude, Intensity, Epicenter, Energy Release, and Ground Motions. Earthquake Effects– On Ground, Soil Rupture, Liquefaction, Landslides. Performance of Ground and Buildings in Past Earthquakes– Behavior of Various Types of Buildings and Structures, Collapse Patterns; Behavior of Non-Structural Elements Such as Services, Fixtures, and Mountings – Case Studies. Seismic Retrofitting– Weakness in Existing Buildings, Aging, Concepts in Repair, Restoration, and Seismic Strengthening.

UNIT V - PLANNING AND DESIGN CONSIDERATIONS FOR SEISMIC SAFETY (09)

Planning and Design Considerations for Seismic Safety– General Planning and Design Considerations; Building forms, Horizontal and Vertical Eccentricities, Mass and Stiffness Distribution, Soft Storey Effects, Etc.; Seismic Effects Related to Building Configuration. Plan and Vertical Irregularities, Redundancy, and Setbacks. Construction Details– Various Types of Foundations, Soil Stabilization, Retaining Walls, Plinth Fill, Flooring, Walls, Openings, Roofs, Terraces, Parapets, Boundary Walls, Underground and Overhead Tanks, Staircases, and Isolation of Structures. Innovative Construction Materials and Techniques. Local Practices– Traditional Regional Responses. Computational Investigation Techniques.

TEXT BOOKS

1. David Alexander, Natural Disasters, 1st Edition, CRC Press, 2017.
2. Edward A. Keller and Duane E. DeVecchio, Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes, 5th Edition, Routledge, 2019.

REFERENCE BOOKS

1. Ben Wisner, J.C. Gaillard, and Ilan Kelman (Editors), Handbook of Hazards and Disaster Risk Reduction and Management, 2nd Edition, Routledge, 2012.
2. Damon P. Coppola, Introduction to International Disaster Management, 4th Edition, Butterworth-Heinemann, 2020.
3. Bimal Kanti Paul, Environmental Hazards and Disasters: Contexts, Perspectives and Management, 2nd Edition, Wiley-Blackwell, 2020.

ONLINE LEARNING RESOURCES

- <https://nptel.ac.in/courses/124107010>
- https://onlinecourses.swayam2.ac.in/cec19_hs20/preview

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A016GT.1	3	-	-	-	-	2	-	2	2	-	-	-	3	3
23A016GT.2	-	3	-	-	2	-	-	-	-	-	-	2	3	-
23A016GT.3	3	-	-	3	-	-	3	-	-	2	-	-	-	3
23A016GT.4	-	-	3	-	3	-	-	2	-	-	-	-	3	-
23A016GT.5	-	-	-	3	-	3	3	3	2	-	-	-	-	3

III B.TECH II SEMESTER

	SUSTAINABILITY IN ENGINEERING PRACTICES	L	T	P	C
23A016HT	(OPEN ELECTIVE-II)	3	0	0	3
	<i>(Common to all branches)</i>				

COURSE OBJECTIVES

1. To understand the fundamentals of sustainability, the carbon cycle, and the environmental impact of construction materials.
2. To analyze sustainable construction materials, their durability, and life cycle assessment.
3. To apply energy calculations in construction materials and assess their embodied energy.
4. To evaluate green building standards, energy codes, and performance ratings.
To assess the environmental effects of energy use, climate change, and global warming.

COURSE OUTCOMES

1. Understand the fundamentals of sustainability, the carbon cycle, and the environmental impact of construction materials.
2. Analyze sustainable construction materials, their durability, and life cycle assessment.
3. Apply energy calculations in construction materials and assess their embodied energy.
4. Evaluate green building standards, energy codes, and performance ratings.
5. Assess the environmental effects of energy use, climate change, and global warming.

UNIT I – INTRODUCTION (09)

Introduction and Definition of Sustainability - Carbon Cycle - Role of Construction Material: Concrete and Steel, Etc. - CO₂ Contribution From Cement and Other Construction Materials

UNIT II - MATERIALS USED in SUSTAINABLE CONSTRUCTION (09)

Construction Materials and Indoor Air Quality - No/Low Cement Concrete - Recycled and Manufactured Aggregate - Role of QC and Durability - Life Cycle and Sustainability.

UNIT III - ENERGY CALCULATIONS (09)

Components of Embodied Energy - Calculation of Embodied Energy for Construction Materials - Energy Concept and Primary Energy - Embodied Energy Via-A-Vis Operational Energy in Conditioned Building - Life Cycle Energy Use.

UNIT IV - GREEN BUILDINGS (09)

Control of Energy Use in Building - ECBC Code, Codes in Neighboring Tropical Countries - OTTV Concepts and Calculations – Features of LEED and TERI – GRIHA Ratings - Role of Insulation and Thermal Properties of Construction Materials - Influence of Moisture Content and Modeling - Performance Ratings of Green Buildings - Zero Energy Building.

UNIT V - ENVIRONMENTAL EFFECTS (09)

Non-Renewable Sources of Energy and Environmental Impact– Energy Norm, Coal, Oil, Natural Gas - Nuclear Energy - Global Temperature, Green House Effects, Global Warming - Acid Rain: Causes, Effects and Control Methods - Regional Impacts of Temperature Change.

TEXT BOOKS

1. Charles J Kibert, Sustainable Construction: Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.

REFERENCE BOOKS

1. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
2. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2012.

ONLINE LEARNING RESOURCES

- <https://archive.nptel.ac.in/courses/105/105/105105157/>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A016HT.1	3	-	-	-	-	2	3	2	-	-	-	-	3	3
23A016HT.2	-	3	-	-	2	-	3	-	-	-	-	2	3	3
23A016HT.3	-	-	3	3	3	-	2	-	-	2	-	-	3	3
23A016HT.4	-	-	3	3	3	-	3	2	-	-	-	-	3	3
23A016HT.5	-	-	-	-	-	3	3	3	-	-	-	-	-	3

III B.TECH II SEMESTER

23A026IT

RENEWABLE ENERGY SOURCES
(OPEN ELECTIVE-II)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To introduce the fundamental principles and working mechanisms of various renewable energy sources such as solar, wind, geothermal, ocean, biomass, and fuel cells.
2. To develop an understanding of the energy conversion processes and technologies involved in harvesting renewable energy.
3. To enable students to analyze and evaluate the performance, efficiency, and site selection criteria of renewable energy systems.
4. To familiarize students with the design and application aspects of solar PV modules, wind turbines, and biomass energy systems.
5. To promote awareness of the environmental, economic, and sustainability aspects of using renewable energy for power generation.

COURSE OUTCOMES

1. Understand principle operation of various renewable energy sources.
2. Identify site selection of various renewable energy sources.
3. Analyze various factors affecting on solar energy measurements, wind energy conversion techniques, Geothermal, Biomass, Tidal Wave and Fuel cell energies
4. Design of Solar PV modules and considerations of horizontal and vertical axis Wind energy systems.
5. Apply the concepts of Geo Thermal Energy, Ocean Energy, Bio mass and Fuel Cells for generation of power.

UNIT I - SOLAR ENERGY

(09)

Solar radiation - beam and diffuse radiation, solar constant, Sun at Zenith, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, storage of solar energy-thermal storage.

UNIT II - PV ENERGY SYSTEMS

(09)

Introduction, The PV effect in crystalline silicon basic principles, the film PV, Other PV technologies, Solar PV modules from solar cells, mismatch in series and parallel connections design and structure of PV modules, Electrical characteristics of silicon PV cells and modules, Stand-alone PV system configuration, Grid connected PV systems.

UNIT III - WIND ENERGY

(09)

Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades; wind data and energy estimation and site selection considerations.

UNIT IV - GEOTHERMAL ENERGY

(09)

Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geopressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

UNIT – V - MISCELLANEOUS ENERGY TECHNOLOGIES

(09)

Ocean Energy: Tidal Energy-Principle of working, Operation methods, advantages and limitations. Wave Energy-Principle of working, energy and power from waves, wave energy conversion devices, advantages and limitations.

Bio mass Energy: Biomass conversion technologies, Biogas generation plants, Classification, advantages and disadvantages, constructional details, site selection, digester design consideration
 Fuel cell: Principle of working of various types of fuel cells and their working, performance and limitations.

TEXTBOOKS

1. G. D. Rai, —Non-Conventional Energy Sources, 4th Edition, Khanna Publishers, 2000.
2. Chetan Singh Solanki —Solar Photovoltaics fundamentals, technologies and applications, 2nd Edition PHI Learning Private Limited. 2012.

REFERENCE BOOKS

1. Stephen Peake, —Renewable Energy Power for a Sustainable Future, Oxford International Edition, 2018.
2. S. P. Sukhatme, —Solar Energy, 3rd Edition, Tata Mc Graw Hill Education Pvt. Ltd, 2008.
3. B H Khan — Non-Conventional Energy Resources, 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011.
4. S. Hasan Saeed and D.K.Sharma,—Non-Conventional Energy Resources, 3rd Edition, S.K.Kataria & Sons, 2012.
5. G. N. Tiwari and M.K.Ghosal, —Renewable Energy Resource: Basic Principles and Applications, Narosa Publishing House, 2004.

ONLINE LEARNING RESOURCES

- <https://nptel.ac.in/courses/103103206>
- <https://nptel.ac.in/courses/108108078>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A026IT.1	3	2	-	-	-	2	-	-	-	-	-	-	2	-
23A026IT.2	3	2	2	-	2	2	-	-	-	-	-	-	2	1
23A026IT.3	3	3	3	-	2	-	-	-	-	-	-	2	3	2
23A026IT.4	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A026IT.5	3	3	2	2	2	2	2	-	-	-	-	2	3	2

III B.TECH II SEMESTER

23A036KT

AUTOMATION AND ROBOTICS
(OPEN ELECTIVE-II)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- 1 Fundamentals of industrial automation, production types, automation strategies, and hardware elements used in modern manufacturing processes.
- 2 Understanding of automated manufacturing systems, and strategies for improving productivity And flexibility in industrial automation.
- 3 Knowledge of industrial automation and robotics, sensors, and end-effector design for modern manufacturing environments.
- 4 Explain industrial automation and robotics, and trajectory planning for intelligent and efficient manufacturing applications.
- 5 Familiarity of industrial automation and robotics, and practical applications in manufacturing processes.

COURSE OUTCOMES

1. Understand and analyze the structure and functions of automated manufacturing systems, and evaluate hardware components for efficient production.
2. Analyze and design automated flow lines with or without buffer storage, perform quantitative evaluations, apply assembly line balancing techniques.
3. Classify robot configurations, select suitable actuators and sensors, analyze and apply automation and robotics principles to optimize production efficiency and flexibility.
4. Simply kinematic and dynamic modeling using D-H notation and select appropriate hardware and control strategies for real-world industrial scenario to analyze and design automated and robotic systems.
5. Design, program, and implement robotic systems, understand and apply robotics technology to manufacturing tasks.

UNIT I - INTRODUCTION TO AUTOMATION

(09)

Introduction to Automation, Need, Types, Basic elements of an automated system, Manufacturing Industries, Types of production, Functions in manufacturing, Organization and information processing in manufacturing, Automation strategies and levels of automation, Hardware components for automation and process control, mechanical feeders, hoppers, orienters, high speed automatic insertion devices.

UNIT II - AUTOMATED FLOW LINES

(09)

Automated flow lines, Part transfer methods and mechanisms, types of Flow lines, flow line with/without buffer storage, Quantitative analysis of flow lines. Assembly line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

UNIT III - INTRODUCTION TO INDUSTRIAL ROBOTICS

(09)

Introduction to Industrial Robotics, Classification of Robot Configurations, functional line diagram, degrees of freedom. Components common types of arms, joints grippers, factors to be considered in the design of grippers.

Robot actuators and Feedback components: Actuators, Pneumatic, Hydraulic actuators,

Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders
- velocity sensors, Tactile sensors, Proximity sensors.

UNIT IV - MANIPULATOR KINEMATICS

(09)

Manipulator Kinematics, Homogenous transformations as applicable to rotation and transition - D-H notation, Forward inverse kinematics.

Manipulator Dynamics: Differential transformations, Jacobians, Lagrange - Euler and Newton – Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.

UNIT V - ROBOT PROGRAMMING

(09)

Robot Programming, Methods of programming - requirements and features of programming languages, software packages. Problems with programming languages.

Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading - Process - spot and continuous arc welding & spray painting - Assembly and Inspection.

TEXT BOOKS

1. Automation, Production systems and CIM, M.P. Groover /Pearson Edu.
2. Industrial Robotics - M.P. Groover, TMH.

REFERENCES

1. Robotics, Fu K S, McGraw Hill, 4th edition, 2010.
2. An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3. Robotic Engineering, Richard D. Klafter, Prentice Hall
4. Robotics, Fundamental Concepts and analysis – Ashitave Ghosal, Oxford Press, 1/e, 2006
5. Robotics and Control, Mittal R K &Nagrath I J , TMH.

ONLINE LEARNING RESOURCES

- <https://www.youtube.com/watch?v=yxZm9WQJUA0&list=PLRLB5WCqU54UJG45UnazSYmnmhl-gt76o>
- <https://www.youtube.com/watch?v=6f3bvIhSWyM&list=PLRLB5WCqU54X5Vy4DwjfSODT3 ZJgwEjyE>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A036KT.1	3	2	2	2	3	-	-	-	-	-	-	2	3	2
23A036KT.2	2	3	3	3	3	-	-	-	-	-	-	2	3	2
23A036KT.3	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A036KT.4	3	3	3	3	3	-	-	-	-	-	-	3	3	3
23A036KT.5	2	3	3	2	3	-	-	-	-	-	-	3	3	3

III B.TECH II SEMESTER

23A046GT

DIGITAL ELECTRONICS
(OPEN ELECTIVE-II)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To Learn Boolean algebra, logic simplification techniques, and combinational circuit design.
2. To analyze combinational circuits like adders, subtractors, and code converters.
3. To explore combinational logic circuits and their applications in digital design.
4. To understand sequential logic circuits, including latches, flip-flops, counters, and shift registers.
5. To gain knowledge about programmable logic devices and digital IC's.

COURSE OUTCOMES

1. Learn Boolean algebra, logic simplification techniques, and combinational circuit design.
2. Analyze combinational circuits like adders, subtractors, and code converters.
3. Explore combinational logic circuits and their applications in digital design.
4. Understand sequential logic circuits, including latches, flip-flops, counters, and shift registers.
5. Gain knowledge about programmable logic devices and digital IC's.

UNIT I - LOGIC SIMPLIFICATION AND COMBINATIONAL LOGIC DESIGN (09)

Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Introduction to Logic Gates, Ex-OR, Ex- NOR operations, Minimization of Switching Functions: Karnaugh map method, Logic function realization: AND-OR, OR-AND and NAND/NOR realizations.

UNIT II - INTRODUCTION TO COMBINATIONAL DESIGN 1 (09)

Binary Adders, Subtractors and BCD adder, Code converters - Binary to Gray, Gray to Binary, BCD to excess3, BCD to Seven Segment display.

UNIT III – COMBINATIONAL LOGIC DESIGN 2 (09)

Decoders, Encoders, Priority Encoder, Multiplexers, Demultiplexers, Comparators, Implementations of Logic Functions using Decoders and Multiplexers.

UNIT IV - SEQUENTIAL LOGIC DESIGN (09)

Latches, Flip-flops, S-R, D, T, JK and Master-Slave JK FF, Edge triggered FF, set up and hold times, Ripple counters, Shift registers.

UNIT V - PROGRAMMABLE LOGIC DEVICES (09)

ROM, Programmable Logic Devices (PLA and PAL).

Digital IC's:Decoder (74x138), Priority Encoder (74x148), multiplexer (74x151) and de-multiplexer (74x155), comparator (74x85).

TEXT BOOKS

1. Digital Design, M.Morris Mano & Michel D. Ciletti, 5th Edition, Pearson Education, 1999.
2. Switching theory and Finite Automata Theory, ZviKohavi and NirahK.Jha, 2nd Edition, Tata McGraw Hill, 2005.

REFERENCE BOOKS

1. Fundamentals of Logic Design, Charles H Roth,Jr., 5th Edition, Brooks/cole Cengage Learning, 2004.

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A046GT.1	3	2	2	-	2	-	-	-	-	-	-	2	3	2
23A046GT.2	3	3	3	2	2	-	-	-	-	-	-	-	3	2
23A046GT.3	3	3	3	2	3	-	-	-	-	-	-	2	3	3
23A046GT.4	3	3	3	3	3	-	-	-	-	-	-	2	3	3
23A046GT.5	3	2	3	2	3	-	-	-	-	-	-	2	3	3

III B.TECH II SEMESTER

23AHS61T

OPTIMIZATION TECHNIQUES FOR ENGINEERS
(OPEN ELECTIVE-II)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To formulate and solve optimization problems using various techniques.
2. To apply optimization algorithms to real-world problems.
3. To analyze and interpret the results of optimization models.
4. To use optimization software tools to solve problems.

COURSE OUTCOMES

1. Understand the meaning, purpose, tools of Operations Research and linear programming in solving practical problems in industry.
2. Interpret the transportation models' solutions and infer solutions to the real-world problems.
3. Develop mathematical skills to analyze and solve nonlinear programming models arising from a wide range of applications.
4. Apply the concept of non-linear programming for solving the problems involving non-linear constraints and objectives
5. Apply the concept of unconstrained geometric programming for solving the problems involving non-linear constraints and objectives.

UNIT I - LINEAR PROGRAMMING I

(08)

Introduction, Applications of Linear Programming, Standard form of a Linear Programming Problem, Geometry of Linear Programming Problems, Basic Definitions in Linear Programming. Simplex Method, Simplex Algorithm and Two phase Simplex Method, Big-M method.

UNIT II - LINEAR PROGRAMMING II: DUALITY IN LINEAR PROGRAMMING

(08)

Symmetric Primal-Dual Relations, General Primal-Dual Relations, Duality Theorem, Dual Simplex Method, Transportation Problem and assignment problem, Complementary slackness Theorem.

UNIT III - NON-LINEAR PROGRAMMING: UNCONSTRAINED OPTIMIZATION TECHNIQUES

(08)

Introduction: Classification of Unconstrained minimization methods.

Direct Search Methods: Random Search Methods: Descent Method and Fletcher Powell Method, Grid Search Method.

UNIT IV - NON-LINEAR PROGRAMMING: CONSTRAINED OPTIMIZATION TECHNIQUES

(08)

Introduction, Characteristics of a constrained problem, Random Search Methods, complex method, Sequential linear programming, Basic approach in methods of Feasible directions, Zoutendijk's method of feasible directions: direction finding problem, determination of step length, Termination criteria.

UNIT V - GEOMETRIC PROGRAMMING

(08)

Unconstrained Minimization Problems: solution of unconstrained geometric programming using differential calculus and arithmetic-geometric inequality.

Constrained minimization Problems: Solution of a constrained geometric programming problem, primal-dual programming in case of less-than inequalities, geometric programming with mixed inequality constraints.

TEXT BOOK

1. Singiresu S Rao., Engineering Optimization: Theory and Practices, New Age Int. (P) Ltd. Publishers, New Delhi.
2. J. C. Panth, Introduction to Optimization Techniques, (7-e) Jain Brothers, New Delhi.

REFERENCES

1. Harvey M. Wagner, Principles of Operation Research, Printice-Hall of India Pvt. Ltd. New Delhi.
2. Peressimi A.L., Sullivan F.E., Vhl, J. J. Mathematics of Non-linear Programming, Springer – Verlag.

WEB REFERENCE

- https://onlinecourses.nptel.ac.in/noc24_ee122/preview
- <https://archive.nptel.ac.in/courses/111/105/111105039/>
- https://onlinecourses.nptel.ac.in/noc21_ce60/preview

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS61T.1	3	3	2	2	-	-	-	-	-	-	-	1	-	-
23AHS61T.2	3	2	2	2	-	-	-	-	-	-	-	1	-	-
23AHS61T.3	3	2	2	1	-	-	-	-	-	-	-	1	-	-
23AHS61T.4	2	2	2	1	-	-	-	-	-	-	-	1	-	-
23AHS61T.5	3	3	2	1	-	-	-	-	-	-	-	1	-	-

III B.TECH II SEMESTER

23AHS66T

MATHEMATICAL FOUNDATION OF QUANTUM TECHNOLOGIES

Open Elective – II
(Common to all branches)

L T P C

3 0 0 3

COURSE OBJECTIVES

1. To provide students with essential linear algebra foundations including vector spaces, inner products, and operators for quantum mechanical applications.
2. To develop understanding of the transition from finite-dimensional systems to infinite-dimensional function spaces and Hilbert space concepts.
3. To establish quantum mechanical formalism including measurement theory, uncertainty relations, and time evolution principles.
4. To enable students to apply quantum mechanical principles to solve problems in simple quantum systems and understand statistical interpretation.
5. To introduce advanced concepts in composite systems, measurement processes, and modern perspectives in quantum mechanics.

COURSE OUTCOMES

1. Understand vector spaces, inner products, and linear operators with applications to quantum systems.
2. Apply linear algebra concepts to function spaces and analyze the transition from finite to infinite dimensional systems.
3. Analyze quantum mechanical formalism including measurement theory, uncertainty relations, and time evolution.
4. Apply quantum mechanical principles to solve problems in simple quantum systems and evaluate statistical interpretations.
5. Evaluate advanced concepts in composite systems and synthesize understanding of measurement processes and modern quantum theory.

UNIT I - LINEAR ALGEBRA FOUNDATION FOR QUANTUM MECHANICS

(10)

Vector spaces definition and examples ($\mathbb{R}^2$, $\mathbb{R}^3$, function spaces), Inner products (dot product, orthogonality, normalization), Linear operators (matrices, eigenvalues, eigenvectors), Finite-dimensional examples (2×2 matrices, spin-1/2 systems), Dirac notation introduction ($|\psi\rangle$, $\langle\phi|$, $\langle\phi|\psi\rangle$), Change of basis (transformations, unitary matrices).

UNIT II - FROM FINITE TO INFINITE DIMENSIONS

(08)

Function spaces (L^2 space, square-integrable functions), Inner products for functions ($\int \psi^* \phi dx$), Orthogonal function sets (Fourier series, basis functions), Introduction to Hilbert space concept (complete inner product spaces), Position and momentum representations (wave functions), Operators on functions (d/dx , multiplication by x).

UNIT III - QUANTUM MECHANICAL FORMALISM

(08)

Mathematical formulation (states as vectors, observables as operators), Measurement theory (Born rule, expectation values, probabilities), Uncertainty relations (mathematical derivation from commutators), Time evolution (Schrödinger equation, unitary evolution).

UNIT IV - APPLICATIONS AND STATISTICAL INTERPRETATION

(06)

Simple applications (infinite square well, harmonic oscillator), Statistical interpretation (ensembles, pure vs mixed states), Measurement process (von Neumann measurement scheme).

UNIT V - ADVANCED TOPICS

(08)

Composite systems (tensor products basic introduction), Reversibility and irreversibility (unitary evolution vs measurement), Thermodynamic connections (equilibrium states, entropy), Modern perspectives (decoherence, measurement problem conceptual).

TEXTBOOKS

1. David J. Griffiths, Darrell F. Schroeter, —Introduction to Quantum Mechanics, 3rd Edition, Cambridge University Press (2018).
2. R. Shankar, Principles of Quantum Mechanics, 2nd Edition, Kluwer Academy/Plenum Publishers (1994).

REFERENCE BOOKS

1. George. F. Simmons, —Introduction to Topology and Modern Analysis, MedTech Science Press.
2. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition, Cengage Learning (2006).
3. John von Neumann and Robert T Beyer, Mathematical Foundations of Quantum Mechanics, Princeton Univ. Press (1996).

WEB RESOURCES

1. <https://eclass.uoa.gr/modules/document/file.php/CHEM248/Griffiths%20-%20Introduction%20to%20Quantum%20Mechanics%203rd%20ed%202018.pdf>
2. <https://fisica.net/mecanica-quantica/Shankar%20-%20Principles%20of%20quantum%20mechanics.pdf>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS66T.1	3	3	2	2	1	-	-	-	-	-	-	2	-	-
23AHS66T.2	3	3	2	3	2	-	-	-	-	-	-	2	-	-
23AHS66T.3	3	3	3	3	2	-	-	-	-	-	-	2	-	-
23AHS66T.4	3	3	3	3	2	-	-	-	-	-	-	2	-	-
23AHS66T.5	3	3	3	3	2	1	-	-	-	-	-	3	-	-

III B.TECH II SEMESTER

23AHS62T	PHYSICS OF ELECTRONIC MATERIALS AND DEVICES (OPEN ELECTIVE-II) (Common to all branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To provide exposure to different characterization techniques.
2. To explain the basic principles and analysis of different spectroscopic techniques.
3. To elucidate the working of Scanning electron microscope - Principle, limitations and applications.
4. To illustrate the working of the Transmission electron microscope (TEM) - SAED patterns and its applications.
5. To educate the uses of advanced electric and magnetic instruments for characterization.

COURSE OUTCOMES

1. Analyze the crystal structure and crystallite size by various methods
2. Analyze the morphology of the sample by using a Scanning Electron Microscope
3. Analyze the morphology and crystal structure of the sample by using Transmission Electron Microscope
4. Explain the principle and experimental arrangement of various spectroscopic techniques
5. Identify the construction and working principle of various Electrical & Magnetic Characterization technique

UNIT I - FUNDAMENTALS OF MATERIALS SCIENCE (09)

Introduction, Phase rule, Phase Diagram, Elementary idea of Nucleation and Growth, Methods of crystal growth. The basic idea of point, line, and planar defects. Concept of thin films, preparation of thin films, Deposition of thin film using sputtering methods (RF and glow discharge).

UNIT II - SEMICONDUCTORS (09)

Introduction, charge carriers in semiconductors, effective mass, Diffusion and drift, Diffusion and recombination, Diffusion length. The Fermi level & Fermi-Dirac distribution, Electron and Hole in quantum well, Change of electron-hole concentration- Qualitative analysis, Temperature dependency of carrier concentration, Conductivity and mobility, Effects of temperature and doping on mobility, High field effects.

UNIT III - PHYSICS OF SEMICONDUCTOR DEVICES (09)

Introduction, Band structure, PN junctions and their typical characteristics under equilibrium and under bias, Heterojunctions, Transistors, MOSFETs.

UNIT IV - EXCITONS AND LUMINESCENCE (09)

Luminescence: Different types of luminescence, basic definitions, Light emission in solids, Inter- band luminescence, Direct and indirect gap materials. Photoluminescence: General Principles of photoluminescence, Excitation and relaxation, OLED, Quantum-dot. Electro-luminescence: General Principles of electroluminescence, light emitting diode, diode laser.

UNIT V - DISPLAY DEVICES

(09)

LCD, three-dimensional display: Holographic display, light-field displays: Head-mounted display, MOEMS (Micro-Opto-Electro-Mechanical Systems) and MEMS displays.

TEXTBOOKS

1. Principles of Electronic Materials and Devices-S.O. Kasap, McGraw-Hill Education (India) Pvt. Ltd., 4th edition, 2021.
2. Semiconductor physics & devices: basic principles, 4th Edition, McGraw-Hill, 2012.

REFERENCE BOOKS

1. Solid State Electronic Devices -B.G. Streetman and S. Banerjee, PHI Learning, 6th edition
2. Electronic Materials Science- Eugene A. Irene, Wiley, 2005
3. Electronic Components and Materials, Grover and Jamwal, Dhanpat Rai and Co., New Delhi., 2012.
4. An Introduction to Electronic Materials for Engineers-Wei Gao, Zhengwei Li, Nigel Sammes, World Scientific Publishing Co. Pvt. Ltd. 2nd Edition, 2011

NPTEL COURSE LINKS

- <https://nptel.ac.in/courses/113/106/113106062/>
- https://onlinecourses.nptel.ac.in/noc20_ph24/preview

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS62T.1	3	3	2	2	1	-	-	-	-	-	-	-	-	-
23AHS62T.2	3	3	2	1	1	-	-	-	-	-	-	-	-	-
23AHS62T.3	3	3	2	1	1	-	-	-	-	-	-	-	-	-
23AHS62T.4	3	2	1	1	-	-	-	-	-	-	-	-	-	-
23AHS62T.5	3	3	1	1	-	-	-	-	-	-	-	-	-	-

III B.TECH II SEMESTER

23AHS63T

CHEMISTRY OF POLYMERS AND APPLICATIONS
(OPEN ELECTIVE-II)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To understand the basic principles of polymers
2. To understand natural polymers and their applications.
3. To impart knowledge to the students about synthetic polymers, their preparation and importance.
4. To enumerate the applications of hydrogel polymers.
5. To enumerate applications of conducting and degradable polymers in engineering.

COURSE OUTCOMES

1. Explain polymerization mechanism and measurement of molecular weight of polymer.
2. Describe the physical, chemical properties and applications of natural polymers and modified Cellulosics.
3. Explain types of polymerizations, types of polymers and applications.
4. Understand polymer networks, hydrogels, and their applications.
5. Explain classification and mechanism of conducting and degradable polymers.

UNIT I - POLYMERS-BASICS AND CHARACTERIZATION

(09)

Basic concepts: monomers, repeating units, degree of polymerization, linear, branched and network polymers, classification of polymers, Polymerization: addition, condensation, copolymerization and coordination polymerization. Average molecular weight concepts: number, weight and viscosity average molecular weights, polydispersity and molecular weight distribution. Measurement of molecular weight: End group, viscosity, light scattering, osmotic and ultracentrifugation methods, analysis and testing of polymers.

UNIT II - NATURAL POLYMERS & MODIFIED CELLULOSICS

(09)

Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins.

Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals, Liquid crystalline polymers; specialty plastics- PES, PAES, PEEK, PEA.

UNIT III - SYNTHETIC POLYMERS

(09)

Addition and condensation polymerization processes– Bulk, Solution, Suspension and Emulsion polymerization. Preparation and significance, classification of polymers based on physical properties. Thermoplastics, Thermosetting plastics, Fibers and elastomers, General Applications. Preparation of Polymers based on different types of monomers, Olefin polymers(PE,PVC), Butadiene polymers(BUNA-S,BUNA-N), nylons, Urea-formaldehyde, phenol – formaldehyde, Melamine Epoxy and Ion exchange resins.

UNIT IV- HYDROGELS OF POLYMER NETWORKS

(09)

Definitions of Hydrogel, polymer networks, Types of polymer networks, Methods involved in hydrogel preparation, Classification, Properties of hydrogels, Applications of hydrogels in drug delivery.

UNIT V- CONDUCTING AND DEGRADABLE POLYMERS

(09)

Conducting polymers: Introduction, Classification, Mechanism of conduction in Poly Acetylene, Poly Aniline, Poly Thiophene, Doping, Applications.

Degradable polymers: Introduction, Classifications, Examples, Mechanism of degradation, poly lactic acid, Nylon-6, Polyesters, applications.

TEXT BOOKS

1. Fred W. Billmeyer, Jr. is: Billmeyer F. W. A Textbook of Polymer Science, Textbook of Polymer Science (3rd ed.). Wiley-Interscience, 1984.
2. Introduction to polymer chemistry, G.S. Mishra, Wiley Eastern Ltd., New Delhi. Newage publishers

REFERENCES BOOKS

1. Polymer science- V.R Gowrikar, N V Viswanathan, Jayaadev Sreedhar-New age International Publishers. 1986
2. Organic polymer Chemistry, K.J. Saunders, Chapman and Hall
3. Advanced Organic Chemistry, B. Miller, Prentice Hall
4. Polymer Science and Technology by Premamoy Ghosh, 3rd edition, McGraw-Hill, 2010

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS63T.1	3	3	2	2	-	-	2	-	-	-	-	1	-	-
23AHS63T.2	2	2	1	1	-	-	2	-	-	-	-	1	-	-
23AHS63T.3	2	2	1	1	-	-	2	-	-	-	-	1	-	-
23AHS63T.4	2	2	1	1	-	-	2	-	-	-	-	1	-	-
23AHS63T.5	2	2	1	1	-	-	2	-	-	-	-	1	-	-

III B.TECH II SEMESTER

23AHS64T

ACADEMIC WRITING AND PUBLIC SPEAKING
(OPEN ELECTIVE-II)
(Common to all branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To encourage all-round development of the students by focusing on writing skills
2. To make the students aware of non-verbal skills
3. To enhance analytical skills in academic writing for deeper knowledge enhancement
4. To cultivate proficiency in delivering clear and engaging public speeches

COURSE OUTCOMES

1. Understand various elements of Academic Writing
2. Identify sources and avoid plagiarism
3. Demonstrate the knowledge in writing a Research paper
4. Analyze different types of essays
5. Assess the strengths of other speakers and build confidence in delivering impactful presentations to an audience.

UNIT I - INTRODUCTION TO ACADEMIC WRITING (09)

Introduction to Academic Writing – Essential Features of Academic Writing – Courtesy – Clarity – Conciseness – Correctness – Coherence – Completeness – Types – Descriptive, Analytical, Persuasive, Critical writing

UNIT II - ACADEMIC JOURNAL ARTICLE (09)

Art of condensation- summarizing and paraphrasing - Abstract Writing, writing Project Proposal, writing application for internship, Technical/Research/Journal Paper Writing – Conference Paper writing - Editing, Proof Reading – Plagiarism

UNIT III - ESSAY & WRITING REVIEWS (09)

Compare and Contrast – Argumentative Essay – Exploratory Essay – Features and Analysis of Sample Essays – Writing Book Report, Summarizing, Book/film Review- SoP

UNIT IV - PUBLIC SPEAKING (09)

Introduction, Nature, characteristics, significance of Public Speaking – Presentation – 4 Ps of Presentation – Stage Dynamics – Answering Strategies – Analysis of Impactful Speeches- Speeches for Academic events

UNIT V - PUBLIC SPEAKING AND NON-VERBAL DELIVERY (09)

Body Language – Facial Expressions-Kinesics – Oculistics – Proxemics – Haptics – Chronemics – Paralanguage - Signs

TEXT BOOKS

1. Critical Thinking, Academic Writing and Presentation Skills: MG University Edition Paperback – 1 January 2010 Pearson Education; First edition (1 January 2010).
2. Pease, Allan & Barbara. The Definitive Book of Body Language RHUS Publishers, 2016.

REFERENCES BOOKS

1. Alice Savage, Masoud Shafiei Effective Academic Writing, 2Ed., 2014. ssrP ytisrevinU drofxO
2. Shalini Verma, Body Language, S Chand Publications 2011.
3. Sanjay Kumar and Pushpalata, Communication Skills 2E 2015, Oxford.
4. Sharon Gerson, Steven Gerson, Technical Communication Process and Product, Pearson, New Delhi, 2014.
5. Elbow, Peter. Writing with Power. OUP USA, 1998.

ONLINE LEARNING RESOURCES

1. <https://youtu.be/NNhTIT81nH8>
2. <https://www.youtube.com/watch?v=478ccrWKY-A>
3. <https://www.youtube.com/watch?v=nzGo5ZC1gMw>
4. <https://www.youtube.com/watch?v=Qve0ZBmJMh4>
5. <https://courses.lumenlearning.com/publicspeakingprinciples/chapter/chapter-12-nonverbal-aspects-of-delivery/>
6. https://onlinecourses.nptel.ac.in/noc21_hs76/preview
7. <https://archive.nptel.ac.in/courses/109/107/109107172/#>
8. <https://archive.nptel.ac.in/courses/109/104/109104107/>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS64T.1	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS64T.2	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS64T.3	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS64T.4	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS64T.5	-	-	-	-	-	-	-	-	-	3	-	3	-	-

III B.TECH II SEMESTER

23A3163L BIG DATA TECHNOLOGIES & CLOUD COMPUTING LAB	L	T	P	C
(PROFESSIONAL CORE)				
<i>(Common to CSE(AI))</i>	0	0	3	1.5

COURSE OBJECTIVES

- To provide hands-on experience in working with big data tools and cloud computing environments.
- To equip students with practical skills in data ingestion, transformation, analysis, and visualization using Hadoop and Spark ecosystems.
- To enable deployment and management of cloud services using AWS, Azure, or GCP.
- To expose students to cloud-native storage, computing, and container orchestration techniques.
- To integrate big data workflows with cloud infrastructure for scalable, distributed data processing.

COURSE OUTCOMES

- Students will be able to implement big data pipelines and cloud-based solutions using tools like Hadoop, Spark, and cloud platforms such as AWS, Azure, or GCP.
- Students gain proficiency in managing distributed data processing, scalable storage, cloud service provisioning, and deploying applications using containers and orchestration platforms.
- Students will understand the synergy between big data technologies and cloud computing to solve real-world problems efficiently.

LIST OF LAB EXPERIMENTS

1. Installation and Configuration of Hadoop Cluster (Single Node & Multi-node)
Hadoop HDFS setup, NameNode & DataNode configuration
2. Working with HDFS: File Operations
Upload, read, delete, and replicate files in HDFS
3. MapReduce Programming Basics
Word count, sorting, and filtering examples in Java/Python
4. Apache Hive & Pig for Querying Large Datasets
Creation of tables, data loading, and running queries
5. Apache Spark Basics: RDDs and DataFrames
Implement Spark transformations and actions
6. Data Preprocessing and Machine Learning using PySpark MLlib
Classification or regression using MLlib pipelines
7. Introduction to Cloud Computing and AWS/Azure/GCP Console
Creating virtual machines, basic compute and storage services
8. Cloud Storage and Database Services
Using S3 (AWS), Blob (Azure), or GCP buckets and Cloud SQL/NoSQL
9. Deploying Big Data Workloads on Cloud (EMR, HDInsight, Dataproc)
Running Hadoop/Spark jobs in cloud-managed services
10. Cloud Function/Serverless Deployment
11. Building and deploying a serverless function (e.g., AWS Lambda)
Containerization with Docker
12. Building, running, and managing Docker containers
Orchestration with Kubernetes in the Cloud
Deploy and manage a containerized application using GKE/EKS/AKS

TEXT BOOKS

1. Tom White, Hadoop: The Definitive Guide, O'Reilly Media.
2. Rajkumar Buyya et al., Mastering Cloud Computing, McGraw-Hill Education.

REFERENCE BOOKS

1. Holden Karau et al., Learning Spark: Lightning-Fast Big Data Analysis, O'Reilly Media.
2. Vignesh Prajapati, Big Data Analytics with R and Hadoop, Packt Publishing.
3. Benjamin Bengfort, Data Analytics with Hadoop, O'Reilly.
4. Srinivasan & J.Shrinivasan, Cloud Computing – A Hands-on Approach, Wiley India.

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A3163L.1	3	2	3	2	3	–	–	–	–	–	–	2	3	3
23A3163L.2	3	2	2	2	3	–	–	–	–	–	–	2	3	3
23A3163L.3	3	3	3	3	3	–	–	–	2	–	1	2	3	3
23A3163L.4	3	3	3	3	3	–	–	–	2	–	1	2	3	3
23A3163L.5	3	3	3	3	3	–	–	1	2	–	1	3	3	3

III B.TECH II SEMESTER

23A306EL	QUANTUM COMPUTING LAB (PROFESSIONAL CORE) (Common to CSE(AI))	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To provide practical understanding of quantum states, qubits, and gates using simulation platforms.
- To enable students to design and test basic quantum algorithms (e.g., Grover's, Deutsch-Jozsa).
- To apply Qiskit/IBM Quantum to create and test quantum circuits.
- To analyze results from quantum measurement and quantum entanglement.
- To introduce quantum error modeling and classical-quantum hybrid circuits.

COURSE OUTCOMES

- Implement quantum gates and circuits using Qiskit and visualize outputs.
- Design basic quantum programs to demonstrate superposition and entanglement.
- Execute and analyze quantum algorithms like Grover's, Deutsch-Jozsa, and Bell State circuits.
- Apply quantum measurement and interpret probabilistic outcomes.
- Evaluate quantum circuits with noise simulation and hybrid integration (classical + quantum).

LIST OF LAB EXPERIMENTS

- 1 Introduction to Qiskit and setting up IBM Quantum Lab
- 2 Implementation of single-qubit gates: X, Y, Z, H, S, T
- 3 Implementation of multi-qubit gates: CNOT, SWAP, Toffoli
- 4 Building Bell State circuit and verifying entanglement
- 5 Quantum superposition and measurement simulation
- 6 Deutsch Algorithm implementation and verification
- 7 Deutsch-Jozsa Algorithm for constant vs balanced functions
- 8 Grover's Search Algorithm for a 2/3-bit database
- 9 Quantum Teleportation using Qiskit
- 10 Quantum Fourier Transform circuit design
- 11 Simulation of noisy quantum circuits using Aer simulator
- 12 Classical-Quantum Hybrid Program: Using Python + Qiskit

TEXT BOOKS

1. Michael A. Nielsen & Isaac L. Chuang Quantum Computation and Quantum Information, Cambridge University Press, 10th Anniversary Edition, 2010. Standard reference for theory, quantum gates, algorithms.

2. Eleanor Rieffel & Wolfgang Polak Quantum Computing: A Gentle Introduction, MIT Press, 2011. Beginner-friendly, includes practical insights.

REFERENCE BOOKS

1. David McMahon Quantum Computing Explained, Wiley, 2008. Focuses on quantum principles and circuit design.
2. Chris Bernhardt Quantum Computing for Everyone, MIT Press, 2019. Accessible to students with basic math background.
3. Phillip Kaye, Raymond Laflamme & Michele Mosca An Introduction to Quantum Computing, Oxford University Press, 2007. Compact and algorithm-focused.
4. Thomas G. Draper et al. Programming Quantum Computers: Essential Algorithms and Code Samples, O'Reilly Media, 2020. Hands-on programming examples using Qiskit and other frameworks.

ONLINE RESOURCES

- IBM Quantum Lab – <https://quantum-computing.ibm.com>
Interactive simulator and quantum device access.
- Qiskit Documentation – <https://qiskit.org/documentation>
- Qiskit YouTube Channel – Tutorials and Live Coding: [Qiskit YouTube](#)
- MIT OpenCourseWare – Quantum Computation (6.845)
<https://ocw.mit.edu>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23A306EL.1	3	2	3	3	3	–	–	–	–	–	–	2	3	2
23A306EL.2	3	3	2	3	3	–	–	–	–	–	–	2	3	2
23A306EL.3	3	3	3	3	3	–	–	–	–	–	–	3	3	3
23A306EL.4	2	3	2	3	2	–	–	–	–	–	–	2	2	3
23A306EL.5	2	2	3	3	2	–	–	–	–	–	–	3	3	3

III B.TECH II SEMESTER

23AHS65L

SOFT SKILLS
(SKILL ENHANCEMENT COURSE)
(Common to all branches)

L	T	P	C
0	1	2	2

COURSE OBJECTIVES

1. To encourage all round development of the students by focusing on soft skills
2. To develop Inter and Intrapersonal skills of the students to enhance leadership qualities
3. To make the students aware of critical thinking and problem-solving skills
4. To enhance healthy relationships and understanding within and outside an organization
5. To function effectively with heterogeneous teams.

COURSE OUTCOMES

1. List out various elements of soft skills.
2. Describe methods for building professional image.
3. Apply critical thinking skills through listening skills in problem solving
4. Analyze the needs of an individual and team for well-being
5. Make informed decisions and foster a positive workplace using social and work-life skills for personal and emotional well-being

UNIT I - SOFT SKILLS & COMMUNICATION SKILLS

(12)

Soft Skills - Introduction, Need - Mastering Techniques of Soft Skills – Communication Skills - Significance, process, types - Barriers of communication - Improving techniques.

Activities:

(Interpersonal Skills& Intra-personal skills- Group Discussion - Group leader presenting views (non-controversial and secular) on contemporary issues or on a given topic.)

Verbal Communication- Oral Presentations-planning, preparation, and practice - Extempore- brief addresses and speeches- convincing- negotiating- agreeing and disagreeing with professional grace.

Non-verbal communication –Interview Skills-Mock interviews – presentations with an objective to identify non- verbal clues and remedy the lapses on observation.

UNIT II - CRITICAL THINKING

(09)

Active Listening – Observation – Curiosity – Introspection – Analytical Thinking – Open-mindedness – Creative Thinking - Positive thinking – Reflection.

Activities:

Gathering information and statistics on a topic - sequencing – assorting – reasoning – critiquing issues – placing the problem – finding the root cause - seeking viable solution – judging with rationale – evaluating the views of others - Case Study, Story Analysis.

UNIT III - PROBLEM SOLVING & DECISION MAKING

(09)

Meaning & features of Problem Solving – Managing Conflict – Conflict resolution – Team building - Effective decision making in teams – Methods & Styles- Group Discussions.

Activities: Placing a problem which involves conflict of interests, choice and views – formulating the problem – exploring solutions by proper reasoning – Discussion on important professional, career and organizational decisions and initiate debate on the appropriateness of the decision.

UNIT IV - EMOTIONAL INTELLIGENCE & STRESS MANAGEMENT

(12)

Managing Emotions – Thinking before Reacting – Empathy for Others – Self-awareness – Self-Regulation – Stress factors – Controlling Stress – Tips (oral presentation, Organizing Debates).

Activities: Providing situations for the participants to express emotions such as happiness, enthusiasm, gratitude, sympathy, and confidence, compassion in the form of written or oral presentations. Providing opportunities for the participants to narrate certain crisis and stress –ridden situations caused by failure, anger, jealousy, resentment and frustration in the form of written and oral presentation, Organizing Debates.

UNIT V - CORPORATE ETIQUETTE

(06)

Etiquette- Introduction, concept, significance - Corporate etiquette - meaning, modern etiquette, benefits - Global and local culture sensitivity - Gender Sensitivity - Etiquette in interaction- Cell phone etiquette - Dining etiquette - Netiquette - Job interview etiquette -Corporate grooming tips - Overcoming challenges.

Activities: Providing situations to take part in the Role Plays where the students will learn about bad and good manners and etiquette - Group Activities to showcase gender sensitivity, dining etiquette etc. - Conducting mock job interviews - Case Study - Business Etiquette Games.

PRESCRIBED BOOKS

1. Mitra Barun K, Personality Development and Soft Skills, Oxford University Press, Pap/Cdr edition 2012
2. Dr Shikha Kapoor, Personality Development and Soft Skills: Preparing for Tomorrow, I K International Publishing House, 2018

REFERENCE BOOKS

1. Sharma, Prashant, Soft Skills: Personality Development for Life Success, BPB Publications 2018
2. Alex K, Soft Skills S. Chand & Co, 2012 (Revised edition)
3. Gajendra Singh Chauhan & Sangeetha Sharma, Soft Skills: An Integrated Approach to Maximise Personality Published by Wiley, 2013
4. Pillai, Sabina & Fernandez Agna, Soft Skills and Employability Skills, Cambridge University Press, 2018
5. Dr. Rajiv Kumar Jain, Dr. Usha Jain, Life Skills (Paperback English) Publisher: Vayu Education of India, 2014
6. Sharma, Prashant, Soft Skills: Personality Development for Life Success, BPB Publications 2018

ONLINE LEARNING RESOURCES

1. https://youtu.be/DUlsNJtg2L8?list=PLLy_2iUCG87CQhELCYtvXh0E_y-bOO1_q
2. https://youtu.be/xBaLgJZ0t6A?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7_KIJ
3. <https://youtu.be/-Y-R9hDI7IU>
4. <https://youtu.be/gkLsn4ddmTs>
5. <https://youtu.be/2bf9K2rRWwo>
6. <https://youtu.be/FchfE3c2jzc>
7. <https://www.businesstrainingworks.com/training-resource/five-free-business-etiquette-training-games/>
8. https://onlinecourses.nptel.ac.in/noc24_hs15/preview
9. https://onlinecourses.nptel.ac.in/noc21_hs76/preview
10. https://youtu.be/DUlsNJtg2L8?list=PLLy_2iUCG87CQhELCYtvXh0E_y-bOO1_q
11. https://youtu.be/xBaLgJZ0t6A?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7_KIJ
12. <https://youtu.be/-Y-R9hDI7IU>

CO-PO MAPPING

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	PSO1	PSO2
23AHS65L.1	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS65L.2	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS65L.3	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS65L.4	-	-	-	-	-	-	-	-	-	3	-	3	-	-
23AHS65L.5	-	-	-	-	-	-	-	-	-	3	-	3	-	-

III B.TECH II SEMESTER

23AHS67T

TECHNICAL PAPER WRITING & IPR

L	T	P	C
2	0	0	0

(Common to all branches)

COURSE OBJECTIVES

1. To enable the students to practice the basic skills of research paper writing
2. To make the students understand the importance of IP and to educate them on the basic concepts of Intellectual Property Rights.
3. To practice the basic skills of performing quality literature review
4. To help them in knowing the significance of real life practice and procedure of Patents.
5. To enable them learn the procedure of obtaining Patents, Copyrights, & Trade Marks

COURSE OUTCOMES

1. Identify key secondary literature related to their proposed technical paper writing
2. Explain various principles and styles in technical writing
3. Use the acquired knowledge in writing a research/technical paper
4. Analyse rights and responsibilities of holder of Patent, Copyright, Trademark, International Trademark etc.
5. Evaluate different forms of IPR available at national & international level
6. Develop skill of making search of various forms of IPR by using modern tools and techniques.

UNIT I - PRINCIPLES OF TECHNICAL WRITING (09)

styles in technical writing; clarity, precision, coherence and logical sequence in writing-avoiding ambiguity- repetition, and vague language -highlighting your findings-discussing your limitations - hedging and criticizing -plagiarism and paraphrasing.

UNIT II - TECHNICAL RESEARCH PAPER WRITING (09)

Abstract- Objectives-Limitations-Review of Literature- Problems and Framing Research Questions- Synopsis.

UNIT III - PROCESS OF RESEARCH (09)

Publication mechanism types of journals- indexing-seminars- conferences- proof reading –plagiarism style; seminar & conference paper writing; Methodology- discussion-results- citation rules.

UNIT IV - INTRODUCTION TO INTELLECTUAL PROPERTY (09)

Introduction, types of intellectual property, International organizations, agencies and treaties, importance of intellectual property rights.

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

UNIT V - LAW OF COPY RIGHTS (09)

Fundamentals of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer. Patent law, intellectual property audits.

TEXTBOOKS

1. Deborah. E. Bouchoux, Intellectual Property Rights, Cengage Learning India, 2013
2. Meenakshi Raman, Sangeeta Sharma. Technical Communication: Principles and practices. Oxford.

REFERENCE BOOKS

1. R.Myneni, Law of Intellectual Property, 9th Ed, Asia law House, 2019.
2. Prabuddha Ganguli, Intellectual Property Rights Tata McGraw Hill, 2001.
3. P.Naryan, Intellectual Property Law, 3rd Ed, Eastern Law House, 2007.
4. Adrian Wallwork. English for Writing Research Papers Second Edition. Springer Cham Heidelberg New York, 2016.
5. Dan Jones, Sam Dragga, Technical Writing Style.

ONLINE RESOURCES

1. <https://theconceptwriters.com.pk/principles-of-technical-writing/>
2. <https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/TechPaperWriting.html>
3. <https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/TechPaperWriting.html>
4. <https://www.manuscriptedit.com/scholar-hangout/process-publishing-research-paper-journal/>
5. <https://www.icsi.edu/media/website/IntellectualPropertyRightLaws&Practice.pdf>
6. <https://lawbhoomi.com/intellectual-property-rights-notes/>
7. <https://www.extension.purdue.edu/extmedia/ec/ec-723.pdf>

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23AHS67T.2	3	3	3	3	2	-	-	-	-	-	-	2	2	3
23AHS67T.3	2	3	3	3	3	-	-	-	-	-	-	2	3	3
23AHS67T.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23AHS67T.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-