AR – 26

Course Structure

And

Detailed Syllabus

Applicable for the Batches
Admitted From 2026 –2027

M. Tech

Computer Science and Engineering

ADITYA INSTITUTE OF TECHNOLGY AND MANAGEMENT

(An Autonomous Institution)

Approved by AICTE, Recognized Under 2(f) 12(B) of UGC,
Permanently Affiliated to JNTGV – Vizanagaram.
K. Kotturu, Tekkali, Srikakulam – 532201, Andhra Pradesh.

https://www.adityatekkali.edu.in/

Vision of the Institute

To evolve into a premier engineering institute in the country by continuously enhancing the range of our competencies, expanding the gamut of our activities and extending the frontiers of our operations.

Mission of the Institute

Synergizing knowledge, technology and human resource, we impart the best quality education in Technology and Management. In the process, we make education more objective so that the efficiency for employability increases on a continued basis.

Vision of the Department

To become a pioneer in providing high quality education and research in the area of computer science and engineering.

Mission of the Department

M1: *Enrich society and advance computer science and engineering by preparing graduates with the knowledge, ability, and skill to become innovators and leaders who are able to contribute for the aspirations of the country and society.*

M2: *Benefit humanity through research, creativity, problem solving, and application development.*

M3: *Share knowledge and expertise to benefit the country, the region, and beyond while inspiring people to engage in computing fields.*

The **Programme Educational Objectives (PEOs)** for our Computer Science and Engineering program are to produce graduates who will:

PEO1. *Be employed as a practicing engineer in fields such as design, development, testing and research or undertake higher studies.*
PEO2. *Engage in lifelong self-directed learning, a capacity that is vital for success in today's global and rapidly changing engineering environment.*
PEO3. *Create new methods / processes to meet the society needs with their knowledge.*
PEO4. *Conduct themselves as ethical and responsible professionals with good communication skills and demonstrate leadership skills*

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/Development Of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations Of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-Long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of Computer Science program the student will be able to:

PSO1. *Apply mathematical foundations, algorithmic principles, and theoretical computer science in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.*

PSO2. *Demonstrate understanding of the principles and working of the hardware and software aspects of computer systems.*

PSO3. *Use knowledge in various domains to identify research gaps and hence to provide solution to new ideas and innovations*

Course Structure

Semester – I

Course Code	Course Name	L	T	P	C
26MCS1001	Mathematical Foundation of Computer Science	4	0	0	4
26MCS1002	Advanced Algorithms and Design	4	0	0	4
26MCS1003	Artificial Intelligence and Machine Learning	4	0	0	4
26MCS1E1X	Program Elective – 1	3	0	0	3
26MCS1E2X	Program Elective – 2	3	0	0	3
26MCS1101	Advanced Algorithms Lab	0	0	4	2
26MCS1102	AIML Lab	0	0	4	2
Audit Course		2	0	0	0
26MAC1001	English for Research Paper Writing				
26MAC1002	Disaster Management				
26MAC1003	Constitution of India				
	Total	20	0	8	22

Program Electives

Program Elective – 1			Program Elective – 2	
Course Code	**Course Name**		**Course Code**	**Course Name**
26MCS1E11	Cryptography and Networks Security		26MCS1E21	Internet of Things
26MCS1E12	Distributed Systems		26MCS1E22	Cloud Computing
26MCS1E13	Wireless Sensor Networks		26MCS1E23	Image Processing and Computer Vision

Semester – II

Course Code	Course Name	L	T	P	C
26MCS1004	Deep Learning	4	0	0	4
26MCS1005	Data Science	4	0	0	4
26MCS1006	Global Software Engineering	4	0	0	4
26MCS1E3X	Program Elective – 3	3	0	0	3
26MCS1E4X	Program Elective – 4	3	0	0	3
26MCS1103	Data Science using Python Lab	0	0	4	2
26MCC1001	Research Methodology and IPR / Swayam 12 week MOOC course – RM&IPR	2	0	0	2
	Total	**20**	**0**	**4**	**22**

Program Electives

Program Elective – 3			Program Elective – 4	
Course Code	**Course Name**		**Course Code**	**Course Name**
26MCS1E31	Natural Language Processing		26MCS1E41	Optimization Techniques
26MCS1E32	Generative AI		26MCS1E42	Blockchain Technology
26MCS1E33	Ethical Hacking		26MCS1E43	Quantum Computing

Semester – III

Course Code	Course Name	L	T	P	C
26MCC2101	Internship/Industrial Training (8 Weeks)	-	-	-	3
26MCS2201	Technical Seminar	-	-	4	2
26MCS2202	Comprehensive Viva	-	-	-	2
26MCS2203	Dissertation Phase – 1	0	0	20	10
	Total	**0**	**0**	**24**	**17**

Semester – IV

Category	Course Code	Course Name	L	T	P	C
	26MCS2204	Dissertation Phase – 2	0	0	32	16
		Total	**0**	**0**	**32**	**16**

Mathematical Foundation of Computer Science

Subject Code: 26MCS1001

L	T	P	C
4	0	0	4

Course Objectives

- Provide strong theoretical foundations in mathematical logic, relations, graphs, trees, and combinatory, essential for advanced computer science studies.
- Enable students to analyze and apply discrete mathematical structures for modeling and solving complex computational problems.
- Develop the ability to formally reason, prove correctness, and analyze algorithmic behavior using mathematical techniques.
- Prepare students for advanced research, algorithm design, and system modeling in core areas of computer science.

Course Outcomes

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

1. Analyze and apply principles of propositional and predicate logic, including equivalence laws, normal forms, and inference mechanisms, to formally model and reason about computational problems.
2. Apply rules of inference and proof techniques to validate logical arguments and demonstrate familiarity with automated theorem proving concepts.
3. Analyze relations and functions, including equivalence relations, partial orders, lattices, and POSET structures, and apply them to solve abstract computational problems.
4. Analyze and solve problems related to graph structures, including connectivity, isomorphism, Euler and Hamiltonian properties, using appropriate graph representations.
5. Formulate and solve problems using recurrence relations and generating functions, and apply combinatorial techniques to analyze algorithmic complexity.

Course Contents

Unit – I

Mathematical Logic: Statements and notations, Connectives, Well formed formulas, Truth Tables, tautology, equivalence implication, Normal forms.

Unit – II

Predicates: Predicative logic, Free & Bound variables, Rules of inference, Inference theory of Predicate Calculus, Consistency, proof of contradiction, Automatic Theorem Proving.

Unit – III

Relations: Properties of binary Relations, equivalence, compatibility and partial ordering relations, Hasse diagram, The Principle of Inclusion- Exclusion, Pigeon hole principle and its application, Functions composition of functions, Inverse Functions, Recursive Functions, Lattice and its Properties.

Unit – IV

Graph Theory I: Graph terminology, Types of graphs, Vertex degree and Handshaking property, Matrix representation of graphs: Adjacency Matrices, Incidence Matrices, Connected graphs, Isomorphism of graphs, Subgraphs, Euler graph, Hamiltonian path and circuits.

Planar and Non Planar graphs: Euler's formula, Dual of planar graph, Graph coloring, (Chromatic number),Map coloring.

Trees: Definition and properties, Tree traversing (preorder, inorder, postorder),Graph traversal techniques, Minimum cost spanning trees(Prim's & Kruskal's).

Unit – V

Combinatorics: Binomial Coefficients, The Binomial and Multinomial Theorems, Generating Function of Sequences, Calculating coefficient of Generating function, Partial Fractions, Recurrence relations: Solving Recurrence Relations by Substitution and Generating Functions, The Method of Characteristic roots, Solutions of Inhomogeneous Recurrence Relations.

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Text Books

1. J.P.Tremblay & R. Manohar, "Discrete Mathematical Structure with Applications to Computer Science" Mc.Graw Hill, 1975.
2. Kolman, Busby Ross, "Discrete Matheamatical Structures", Prentice Hall International.
3. D.S.Chandrasekharaiah, "Mathematical Foundation of Computer Science" Prism Publications 2009

Reference Books

1. V. Krishnamurthy, "Combinatories:Theory and Applications", East-West Press.
2. Seymour Lipschutz, M.Lipson, "Discrete Mathemataics" Tata Mc Graw Hill, 2005.
3. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Mc.Graw Hill, 2002.
4. Ronald L. Graham, Donald E. Knuth, Oren Patashnik, *Concrete Mathematics*, **3rd Edition**, Pearson, **2018**.

Advanced Algorithms and Design

Subject Code: 26MCS1002

L	T	P	C
4	0	0	4

Course Objectives

- Identify various memory models to represent static and dynamic Hashed structures.
- Study how to balance a Binary Search tree and 2-3 and so on other Trees
- Distinguishes various graph algorithms and techniques for finding minimum path.
- Understand the mapping of real-world problems to algorithmic solutions.

Course Outcomes

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

1. Demonstrate and outline different types of Hashing and Sorting techniques.
2. Analyze how to optimize various operations on different trees by balancing.
3. Apply different graph algorithms for solving real world problems:
4. Compare different pattern matching algorithms.
5. Develop and implement solutions to problems by applying different design strategies like Greedy and Dynamic programming techniques.

Course Contents

Unit – I

Preliminaries of algorithms, algorithm analysis and complexity; Hashing: Hash tables representation, hash functions, Hashing techniques; Sorting: Review & Analysis of various sorting algorithms; topological sorting;

Unit – II

Representation & efficient operations on Dictionaries, Sets; Trees: Basic concepts, terminology, **Binary Tree representation;** Properties, Insertion and Deletion operations on various Balanced Trees: Binary Search tree, AVL Trees, Splay trees, 2-3 trees.

Unit – III

Basic Concepts, representation of graphs: Adj. Matrices and Adj. Lists; Graph traversals: DFS and BFS; Minimum Cost Spanning Trees- Prim's & Kruskal's Algorithm;

Unit – IV

Text Processing: Pattern matching algorithms-Brute force, the Boyer Moore algorithm, the Knuth-Morris-Pratt algorithm. Tries: Definition and concepts of digital search tree, Binary trie, Patricia , multi-way tree.

Unit – V

Introduction to greedy paradigm: Shortest Path in Graphs: Dijkstra's Algorithm; Dynamic Programming Paradigm: All Pairs Shortest Paths Problem: Floyd’s Algorithm, Wars hall’s Algorithm.

Text Books

1. S.Sahni, , “Data structures, Algorithms and Applications in C++”, University Press (India) Pvt.Ltd, 2nd edition, Universities Press Orient Longman Pvt. Ltd.
2. Aho, Hopcroft, Ullman, "The Design and Analysis of Computer Algorithms", 2009, 4th edition, Pearson Education India.

Reference Books

1. Mark Allen Weiss , “Data structures and Algorithm Analysis in C++” , Pearson Education. Ltd., Second Edition.
2. Adam Drozdek, Thomson , “Data structures and algorithms in C++”, 3rd Edition,

Artificial Intelligence and Machine Learning

Subject Code: 26MCS1003

L	T	P	C
4	0	0	4

Course Objectives

- Understand the fundamental concepts and techniques of AI. Essential AI problem-solving approaches. Explore knowledge representation frameworks, expert system architectures and machine learning paradigms. Emphasis will be placed on data pre-processing and dimensionality reduction techniques. Applying the AIML in real-world applications.

Course Outcomes

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

1. Understand AI Problems and Approaches.
2. Study various heuristic algorithms and Represent the knowledge.
3. Illustrate the architecture of an expert system and Explain Statistics.
4. Applying and demonstrating different ML Algorithms.
5. Analyze case studies in industry-specific applications.

Course Contents

Unit – I

Introduction of Artificial Intelligence: AI, AI Problems, State Space Search: water-jug problem, Production systems: Control strategies: BFS, DFS; Problem characteristics; Production system characteristics, The Turing test approach, The cognitive modeling approach, The laws of thought approach, The rational agent approach.

Unit – II

Heuristic Search Techniques– Generate & Test, Hill Climbing, Best first, A* algorithm, Constraints satisfaction.

Structured Knowledge Representation- Semantic Nets, Frames, Conceptual Dependencies, Forward Vs Backward chaining, matching.

Unit – III

Expert Systems: Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge Heuristics. Typical expert systems – MYCIN, DART, and XOON.

Introduction to Statistics: Central Tendency Measures, Data Visualizations, Different types of Plots, Normalization Techniques.

Unit – IV

Brief Introduction to Machine Learning: Types of ML- Supervised Learning: Decision Tree, Naïve Bayes Classification, K-Nearest Neighbor, Support Vector Machine, Regression- Linear regression, Multiple Linear Regression, Polynomial Regression**,** Performance evaluation metrics of Classifiers.

Unsupervised Learning: Clustering, Partitioned Clustering-K-Means, Hierarchical Clustering- BIRCH, CURE, and Density based Clustering, Performance evaluation metrics of Clustering.

Unit – V

Data Pre-Processing: Data Cleaning-Missing Data, Noisy Data, Binning, Regression, Clustering, Feature Analysis-Feature Selection, Feature Extraction, Dimensionality Reduction, PCA Algorithm.

Applications of AIML: Case Study in Health Care, in Banking, in cyber security, in weather forecasting.

Text Books

1. An Introduction to Artificial Intelligence and Machine Learning, Manikandan Paneerselvam, 2024.
2. Artificial Intelligence and Machine Learning in Business Management: Concepts, Challenges, and Case Studies, Sandeep Kumar Panda, Vaibhav Mishra, R. Balamurali, and Ahmed A. Elngar, 2022.
3. *Artificial Intelligence: A Modern Approach*, Stuart Russell and Peter Norvig Pearson, 2020.
4. *Machine Learning*, McGraw Hill, Tom Mitchell, 1997.

Reference Books

1. Artificial Intelligence and Machine Learning - Principles and Applications, Dr. Shashi Tanwar, 2024.
2. Artificial Intelligence and Machine Learning: An Intelligent Perspective of Emerging Technologies, Rohit Tanwar, Surbhi Bhatia, Varun Sapra, and Neelu Jyoti Ahuja, 2024.
3. Machine Learning: Algorithms, Models, and Applications, Jaydip Sen and colleagues, 2022.
4. AurélienGéron*, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow,* O'Reilly Media, 2019.

Reference Links

- https://onlinecourses.nptel.ac.in/noc24_ge47/preview?
- https://www.coursera.org/learn/machine-learning?
- https://www.coursera.org/specializations/machine-learning-introduction?
- https://www.ibm.com/blogs/ibm-training/jumpstart-your-ai-learning-journey-with-ibm-for-free/
- https://developer.ibm.com/technologies/machine-learning/courses/

Cryptography and Networks Security

Subject Code: 26MCS1E11 (Program Elective – 1)

L	T	P	C
3	0	0	3

Course Objectives

- To clearly recognize the different Security Attacks, Security Services and Security Mechanisms.
- To demonstrate the basic categories of Cryptographic Systems, different Conventional Encryption Algorithms and describe the important public-key cryptosystems.
- To analyze the authentication by studying different authentication applications.
- To describe the security approaches related to Electronic Mail and to express the overall structure of IPSec.

Course Outcomes

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

1. Recall different Security Attacks, Services and Mechanisms.
2. Classify various categories of encryption and decryption techniques.
3. Analyze Identify the authentication algorithms and applications.
4. Illustrate PGP and S/MIME for email security.
5. Understand the importance of IP and Web Security.

Course Contents

Unit – I

Introduction: Security Attacks, Security Services and Security Mechanisms, Network security model. Software Vulnerabilities, Basics of Cryptography: Substitution Techniques, Transposition Techniques, Block and Stream Ciphers.

Unit – II

Conventional Encryption and Message Confidentiality: Conventional Encryption Principles, Algorithms: DES, Triple DES, Blowfish, IDEA and AES, Cipher Block Modes of Operations.

Unit – III

Public-Key Cryptography and Message Authentication: Public Key Cryptography Principles, Algorithms: RSA, Diffie-Hellman Key Exchange, Digital Signatures, Approaches to Message Authentication, Secure Hash Functions (SHA), Kerberos.

Unit – IV

Electronic Mail Security - Pretty Good Privacy: Notation, Operational Description. S/MIME: RFC 822, Limitations of SMTP, MIME Overview, MIME Content Types, MIME Transfer Encodings, S/MIME Functionality.

Unit – V

IP Security: IP Security architecture, Authentication Header, Encapsulating security payload, combining security associations, key management. **Web Security:** Considerations, SSL: Architecture, Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol.

Text Books

1. Network Security Essentials: Applications and Standards, William Stallings, Pearson Education.
2. Cryptography and Network Security: Principles and Practice, William Stallings, Pearson Education.

Reference Books

1. Cryptography and Network Security, 2nd Edition, Behrouz A. Fourouzan and Debdeep Mukhopadhyay, McGraw-Hill, 2010.
2. Principles of Information Security, Whitman, Thomson.
3. Introduction to Cryptography, Buchmann, Springer.

Reference Links

1. https://nptel.ac.in/courses/106105031/
2. https://nptel.ac.in/courses/106105162/

Distributed Systems

Subject Code: 26MCS1E12 (Program Elective – 1)

L	T	P	C
3	0	0	3

Course Objectives

- The objective of the course is to help students understand the fundamental goals of Distributed Systems , Distributed object and process, Operating System issues, Distributed transaction processing and distributed algorithms.

Course Outcomes

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

1. Understand fundamentals, models, and communication in distributed systems
2. Apply distributed object concepts and security mechanisms
3. Analyze coordination, synchronization, and OS-level issues
4. Understand distributed transaction management and consistency
5. Design and analyze distributed algorithms.

Course Contents

Unit – I

Basic Concepts : Definition of a distributed systems, Examples, Resource sharing and the Web, Challenges, System models, Architectural and fundamental models, Networking Interprocess communication, External data representation and marshalling, Client-server and Group communication.

Unit – II

Distributed Objects and Process : Distributed objects and remote invocation, Communication between distributed objects, Remote procedure call, Events and notifications - The operating system layer, Protection, Processes and Threads, Communication and invocation, OS Architecture. Security techniques, Cryptographic algorithms, Access control, Digital signatures, Cryptography pragmatics, Needham-Schroeder, Kerberos, Securing electronics transaction, IEEE 802.11 WiFi.

Unit – III

Operating System Issues: Distributed file systems - Name services, Domain name system, Directory and discovery services, Peer to peer systems, Napster file sharing system, Peer to peer middleware routing overlays – Clocks, Events and process states Clock Synchronization - Logical clocks Global states - Distributed debugging - Distributed mutual exclusion - Elections - Multicast communication.

Unit – IV

Distributed Transaction Processing: Transactions - Nested transactions - Locks - Optimistic concurrency control - Timestamp ordering - Flat and nested distributed transactions - Atomic commit protocols - Concurrency control in distributed transactions - Distributed deadlocks - Transaction recovery - Overview of replication, Distributed shared memory and Web services.

Unit – V

Distributed Algorithms : Synchronous network model - Algorithms: leader election, maximal independent set- Asynchronous system model: I/O automata, operations on automata, fairness - Asynchronous shared memory model - Mutual exclusion: model, the problem, stronger conditions,

lockout-free mutual exclusion algorithms, lower bound on the number of registers - Asynchronous network model - Asynchronous network algorithms: leader election in a ring and an arbitrary network.

Text Books

1. George Coulouris, Jean Dollimore, and Tim Kindberg, " Distributed Systems Concepts and Design", 5th ed., Pearson Education, 2011.
2. 2.Andrew S. Tanenbaum, Maartenvan Steen, "Distributed Systems Principles and Paradigms", 2nd ed., Pearson Education, 2006.
3. Nancy A. Lynch, "Distributed Algorithms", Hardcourt Asia Pvt. Ltd., Morgan Kaufmann, 2000.

Reference Books

4. Pradeep. K. Sinha: " Distributed Operating Systems: Concepts and Design " , PHI, 2007.
5. A. D. Kshemkalyani and M. Singhal "Distributed Computing: Principles, Algorithms, and Systems" , Cambridge 2011.

Wireless Sensor Networks

Subject Code: 26MCS1E13 (Program Elective – 1)

L	T	P	C
3	0	0	3

Course Objectives

- To provide comprehensive knowledge of WSN architecture, protocols, data management, localization, security, and to enable the design of energy-efficient and reliable sensor network solutions for real-world applications.

Course Outcomes

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

1. *Explain* the basic components, node structure, applications, and limitations of Wireless Sensor Networks.
2. *Analyze* different WSN architectures, deployment methods, and energy usage to handle scalability and reliability issues.
3. *Compare* different MAC protocols used in WSNs based on energy efficiency and delay.
4. *Analyze* and choose suitable routing protocols for different Wireless Sensor Network applications.
5. *Apply* data aggregation and transport techniques for efficient data transmission in WSNs.

Course Contents

Unit – I

Introduction to Wireless Sensor Networks Introduction to Wireless Sensor Networks, WSN applications and case studies, Differences between WSN and ad hoc networks, Sensor node architecture: Sensing unit, processing unit, transceiver, power unit; Constraints and challenges in WSN design.

Unit – II

Network Architecture and Design Issues Network architecture of WSN, Data delivery models: Continuous, event-driven, query-driven; Deployment strategies and coverage issues, Energy consumption model, Fault tolerance and reliability, Cross-layer design principles.

Unit – III

Medium Access Control (MAC) Protocols MAC layer requirements for WSN, Energy-efficient MAC design issues, Classification of MAC protocols: Contention-based protocols, Schedule-based protocols; S-MAC, T-MAC, B-MAC; Performance comparison of MAC protocols.

Unit – IV

Routing Protocols in Wireless Sensor Networks Routing challenges and design objectives, Data-centric routing: Flooding and Gossiping, SPIN, Directed Diffusion; Hierarchical routing: LEACH protocol; Location-based routing, Power-aware routing strategies.

Unit – V

Data Management and Transport Layer Data aggregation and data fusion techniques, In-network processing, Query processing in WSN, Transport layer requirements, Reliable data transport protocols, Congestion control mechanisms.

Text Books

1. **Sohraby, K., Minoli, D., and Znati, T.** 2007. *Wireless Sensor Networks: Technology, Protocols, and Applications*. Wiley India, New Delhi, India.

Reference Books

1. Dargie, W. and Poellabauer, C. 2010. *Fundamentals of Wireless Sensor Networks: Theory and Practice*. John Wiley & Sons, Chichester, UK.
2. Akyildiz, I.F. and Vuran, M.C. 2010. *Wireless Sensor Networks*. John Wiley & Sons Ltd., West Sussex, UK.

Reference Links

1. https://nptel.ac.in/courses/106105031/
2. https://nptel.ac.in/courses/106105162/

Internet of Things

Subject Code: 26MCS1E21 (Program Elective – 2)

L	T	P	C
3	0	0	3

Course Objectives.

- Develop a comprehensive understanding of IoT architectures, design principles, and system-level modeling approaches.
- Analyze IoT communication protocols, standards, and network management frameworks for scalable deployments.
- Design and implement IoT systems using embedded platforms and programming frameworks.
- Evaluate cloud-integrated IoT architectures and data management strategies.
- Apply advanced data analytics techniques for real-time and batch IoT data processing

Course Outcomes

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

1. Analyze and design layered IoT architectures and domain-specific IoT solutions.
2. Evaluate and compare IoT communication protocols, SDN/NFV integration, and system management models.
3. Design and implement IoT applications using embedded platforms (e.g., Raspberry Pi) and Python-based frameworks.
4. Understand the development cloud-enabled IoT solutions integrating storage models and web services.
5. Understand big data and real-time analytics frameworks for IoT data streams and evaluate system performance.

Course Contents

Unit – I

IoT Architecture and Design: Introduction to Internet of Things, Definition & Characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels & Deployment Templates, Domain Specific IoTs: Home, Cities, Environment, Energy Systems, Logistics, Agriculture, Health & Lifestyle.

Unit – II

IoT & M2M Communication Frameworks: Introduction to M2M, Difference between IoT and M2M, SDN and NFV for IoT, Need for IoT Systems Management, Simple Network Management Protocol (SNMP), Limitations of SNMP, NETCONF, YANG, IoT Systems Management with NETCONF-YANG, NETOPEER.

Unit – III

IoT Platforms and Programming: IoT Design Methodology, Case Study: IoT System for Weather Monitoring, Motivation for Using Python, Logical Design using Python, Installing Python, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations, Classes, Python Packages of Interest for IoT.

Unit – IV

IoT Devices and Cloud Integration: IoT Physical Devices & Endpoints**,** Raspberry Pi Architecture**,** Linux on Raspberry Pi**,** Raspberry Pi Interfaces**,** Programming Raspberry Pi using Python**,** Other IoT Devices**,** Physical Servers & Cloud Offerings**,** Introduction to Cloud Storage Models**,** Communication APIs**,** WAMP

– AutoBahn for IoT**,** Xively Cloud for IoT**,** Python Web Framework – Django**,** Amazon Web Services (AWS) for IoT.

Unit – V

IoT Data Analytics and Case Studies: Introduction to IoT Data Analytics, Apache Hadoop, Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-Time Data Analysis, Case Studies (Smart Home Automation System, Smart Agriculture Monitoring System, Smart City Traffic Monitoring)

Text Books

1. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education, 2017.
2. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
3. Maciej Kranz, Building the Internet of Things, Wiley India Pvt. Ltd., 2016.

Reference Books

1. Rajkumar Buyya and Amir V. Dastjerdi, Internet of Things: Principles and Paradigms, Morgan Kaufmann, 2016.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley, 2012.
3. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, Wiley, 2014.
4. Thomas Erl, Wajid Khattak, Paul Buhler, Big Data Fundamentals, Prentice Hall, 2016.

Cloud Computing

Subject Code: 26MCS1E22 (Program Elective – 2)

L	T	P	C
3	0	0	3

Course Objectives.

- Understand various basic concepts related to cloud computing technologies
- Understand the various deployment models and concept of different cloud services : IaaS, PaaS, SaaS
- To enable students exploring some important cloud applications
- To gain competence in Virtualization and Cloud platforms
- To understand and be able to cloud environment is collaborating with various databases

Course Outcomes

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

1. Understanding the key computing paradigms and fundamentals of Cloud Computing
2. Assessment of key cloud services requirements and deployment models, for selecting cloud computing for own organization
3. Assessing the financial, technological, and organizational capacity of employer‘s for actively initiating and installing cloud-based applications.
4. Understand various virtualization concepts and cloud platforms: AWS, Microsoft Azure
5. Evaluate various storage classifications and technologies.

Course Contents

Unit – I

Computing Paradigms High-Performance Computing, Parallel Computing, Distributed Computing, Cluster Computing ,Grid Computing Cloud Computing , Bio computing, Mobile Computing, Quantum Computing, Optical Computing , Nano computing, Network Computing,
Cloud Computing Fundamentals: Motivation for Cloud Computing, The Need for Cloud Computing, Defining Cloud Computing: NIST Definition of Cloud Computing

Unit – II

Cloud Computing Is a Service, cloud Computing Is a Platform, Principles of Cloud computing, Five Essential Characteristics, Four Cloud Deployment Models, Three Service Offering Models: SaaS,Paas,IaaS, Cloud Ecosystem, Requirements for Cloud Services , Cloud Application , Benefits and Drawbacks

Unit – III

Using Cloud Services Collaborating on Calendars, Schedules, Task Management, Event Management, Contact Management, Project Management

Unit – IV

Virtualization: Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization various Cloud Platforms in Industry : Amazon Web Services, Microsoft Azure

Unit – V

Storage Systems: Evolution of storage technology, storage models, file systems and database, distributed file systems, Google file system. Apache Hadoop*, NoSQL* Databases.

Text Books

1. K. Chandrasekaran, "Essentials of cloud computing", CRC Press Taylor & Francis Group(unit-1,2)
2. Michael Miller, Cloud Computing: -Web-Based Applications That Change the Way You Work and Collaborate Online**||**,1st Edition, Pearson Education, New Delhi, 2009.(unit-3)
3. Dan C Marinescu Cloud Computing, Theory and Practice, , MK Elsevier.(unit-5)
4 . Arshadeep Bahga, Vijay Madisetti Cloud Computing, A Hands on approach, University Press

Reference Books

5 . Anthony T Velte, Toby J Velte, Robert Cloud Computing, A Practical Approach, Elsenpeter,TMH
6. Raj Kumar Buyya, Christen vecctiola, S Tammarai selvi, "Mastering Cloud Computing, Foundations and Application Programming", TMH(unit-4).

Reference Links

1. https://nptel.ac.in/courses/106/105/106105167/

Image Processing and Computer Vision

Subject Code: 26MCS1E23 (Program Elective – 2)

L	T	P	C
3	0	0	3

Course Objectives.

- Cover the basic theory and algorithms that are widely used in digital image processing.
- Expose students to current technologies and issues that are specific to image processing systems.
- Give Hands-on experience in using computers to process images.
- Formulate solutions to general image processing problems
- Familiarize with image manipulations and analysis

Course Outcomes

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

1. Explain Basic Concepts in Image Processing.
2. Apply geometric and gray-level transformations for preprocessing and enhancement of digital images.
3. Illustrate different compression models and methods.
4. Explore the meaning, classification and significance of segmentation techniques.
5. Analyze various morphological extraction techniques on digital images.

Course Contents

Unit – I

Digital Image Fundamentals: Examples of fields that Use Image Processing, Fundamental Steps & Components in Digital Image Processing; Image Sampling and Quantization- Spatial and Gray level Resolution - Zooming and Shrinking; Basic Relationship Between Pixels.

Unit – II

Transformations: Basic Geometric Transformations: Translation, Scaling, Rotation; Intensity transformations: Basic Gray-level functions, histogram Processing, fundamentals of Spatial Filtering-Smoothing filters, Sharpening filters.

Unit – III

Image Compression: Redundancy- Coding, Inter Pixel, Psycho-Visual, Fidelity Criteria; Image Compression Models-The Source Encoder and Decoder, The Channel Encoder and Decoder; Variable Length Coding, LZW Coding, Bit-Plane Coding, Image Compression Standard – JPEG

Unit – IV

Image Segmentation: Basics; Detection of discontinuities- point, line, edge detection, edge linking and boundary detection-local processing, global processing via Graph-Theoretic techniques; Thresholding-Basic Global and Basic Adaptive Thresholding; Region- Based Segmentation-Basic Formulation, Region growing, Region Splitting and Merging.

Unit – V

Image Morphology: Preliminaries- Basic Concepts from Set Theory, Logical Operations: Dilation and Erosion, Opening and Closing, Hit or Miss Transformation; Basic Morphological algorithms: Boundary Extraction, Region Filling, Extraction of Connected Components, Thinning, Thickening, Pruning.

Text Books

1. Donald Hearn, Pauline Baker, "Computer Graphics with OPENGL - C Version", 4th Edition, Pearson Education, 2017.
2. Digital Image Processing – R.C. Gonzalez & R.E. Woods, Addison Wesley / Pearson Education, 3rd Edition, 2018.

Reference Books

1. John F. Hughes, Andries Van Dam, Morgan Mc Guire ,David F. Sklar , James D. Foley, Steven K. Feiner and Kurt Akeley, “Computer Graphics: Principles and Practice”, 3rd Edition, AddisonWesley Professional, 2013.
2. Digital Image Processing using MATLAB-Rafael C. Gonzalez, Richard E woods and Steven L. Eddins, Tata McGraw Hill, 2010. 3. Digital Image Processing – S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill.
3. Digital Image Processing – S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill

Reference Links

- http://www.imageprocessingplace.com/root_files_V3/tutorials.htm

Advanced Algorithms Lab

Subject Code: 26MCS1101

L	T	P	C
0	0	4	2

Course Objectives.

- Solve real-world problems by reasoning about data structure choices, choose appropriate implementations, and analyze the costs associated with those choices.
- To make the students write various programs and ADTS for all data structures.
- Think critically for improvement in solutions.

Course Outcomes

After completion of this course, the Students will be able to:

1. Apply critical thinking skills and creativity to solve the problems.
2. Design of hash tables, including collision avoidance and resolution schemes.
3. Demonstrate the use of balanced trees and Paraphrase the underlying organization of the AVL, 2-3 trees.
4. Develop shortest path algorithms like Warshall's, Floyd's, Dijkstra's on graphs
5. Implement searching algorithms on advanced data structures like binary heap and priority queue.

List of Experiments

1. Write a program to implement Multi-way Merge -sort.
2. Write a program to implement functions of Dictionary using Hashing (division method, Multiplication method, Universal hashing).
3. Write a program to implement skip list.
4. Write a program to perform various operations i.e, insertions and deletions on AVL trees
5. Write a program to perform various operations i.e., insertions and deletions on 2-3 trees.
6. Write a program to implement Prim's algorithm to generate a min-cost spanning tree.
7. Write a program to implement Kruskal's algorithm to generate a min-cost spanning tree.
8. Write a program to implement Dijkstra's algorithm.
9. Write a program to implement Floyd's algorithm.
10. Write a program to implement Warshall's algorithm
11. Write a program to implement operations on binary heap (min).
12. Write a program to implement Priority Queues.

Text books

1. S.Sahni, , "Data structures, Algorithms and Applications in C++", University Press (India) pvt.Ltd, 2nd edition, Universities Press Orient Longman Pvt. Ltd.
2. Michael T.Goodrich, R.Tamassia and Mount, "Data structures and Algorithms in C++, Wiley student edition, John Wiley and Sons.

Reference Books

1. Horowitz, Sahni, and Mehta, "Fundamentals of Data Structures in C++".
2. Roberge, J., "Data Structures in C++: A Laboratory Course".

AIML Lab

Subject Code: 26MCS1102

L	T	P	C
0	0	4	2

Course Objectives.

- This lab course aims to provide practical exposure to implementing statistical analysis, data preprocessing, machine learning algorithms and artificial intelligence solutions. The hands-on exercises are designed to reinforce theoretical concepts and real-world problem-solving in AIML.

Course Outcomes

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

1. Preprocess and analyze data using statistical techniques.
2. Implement supervised and unsupervised machine learning algorithms.
3. Explore regularization techniques and evaluate machine learning models.
4. Develop AI-based applications using real-world datasets.
5. Analyze and visualize the outcomes of AIML techniques in various domains.

List of Experiments

1. Given two jugs with capacities X liters and Y liters, and an infinite water supply, develop a program to determine the steps required to obtain Z liters of water in either of the jugs using BFS and DFS.
2. Develop a Chabot that responds to user inputs based on predefined rules. The Chabot should be able to handle basic queries such as greetings, asking for help, and providing predefined responses based on keywords.
3. Develop a program to find the shortest path between a start node and a goal node in a weighted graph using the A algorithm*. The program should consider both the actual cost (g) and the heuristic estimate (h) to determine the best path.
4. Develop a program that simulates Forward Chaining and Backward Chaining inference techniques for knowledge-based systems. The system should use predefined rules to infer conclusions from given facts.
5. Design a simple Expert System that takes a set of symptoms as input and suggests possible diseases based on predefined rules. The system should use IF-THEN rules to infer a diagnosis.
6. Compute central tendency measures and visualize data on plots- Pieplot, Boxplot, Histogram, Scatter plot and Density plot on CSV file.
7. To implement a Decision Tree algorithm for classification, visualize and evaluate its performance evaluation on a dataset.
8. Develop a Multiple Linear Regression to analyze the relationship between multiple independent and a dependent variable. Evaluate its performance using appropriate metrics.
9. To implement the Principal Component Analysis (PCA) algorithm for dimensionality reduction and visualize its effects on a dataset.
10. Create an AI-based virtual assistant for a healthcare domain.

Text Books

1. An Introduction to Artificial Intelligence and Machine Learning, Manikandan Paneerselvam, 2024.
2. Artificial Intelligence and Machine Learning in Business Management: Concepts, Challenges, and Case Studies, Sandeep Kumar Panda, Vaibhav Mishra, R. Balamurali, and Ahmed A. Elngar, 2022.

Reference Books

1. Artificial Intelligence and Machine Learning - Principles and Applications, Dr. Shashi Tanwar, 2024.
2. Artificial Intelligence and Machine Learning: An Intelligent Perspective of Emerging Technologies, Rohit Tanwar, Surbhi Bhatia, Varun Sapra, and Neelu Jyoti Ahuja, 2024.
3. Machine Learning: Algorithms, Models, and Applications, Jaydip Sen and colleagues, 2022.
4. AurélienGéron*, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow,* O'Reilly Media, 2019

English for Research Paper Writing

Subject Code: 26MAC1001 (Audit Course)

L	T	P	C
2	0	0	0

Course Objectives.

- **To develop students' ability to plan and organize academic writing** by mastering word order, sentence structure, paragraph development, conciseness, and techniques for avoiding ambiguity and redundancy.
- **To enable learners to present ideas clearly and responsibly** through skills such as clarifying agency (who did what), highlighting findings, using hedging and criticism appropriately, and avoiding plagiarism through effective paraphrasing.
- **To train students in the structure and components of a research paper** by understanding and producing well-organized abstracts, introductions, literature reviews, methods, results, discussions, and conclusions.
- **To enhance students' competence in writing key academic sections**—including titles, abstracts, introductions, and literature reviews—using appropriate academic style, coherence, and logical progression.
- **To equip learners with practical skills for drafting, revising, and finalizing research papers** by applying section-specific writing strategies and conducting a thorough final check for clarity, accuracy, and academic integrity.

Course Outcomes

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

1. **Students will be able to plan and organize academic texts effectively** by applying correct word order, clear sentence and paragraph structure, and techniques for conciseness while avoiding ambiguity and redundancy.
2. **Students will be able to present information clearly and ethically** by clarifying agency (who did what), highlighting key findings, using appropriate hedging and criticism, and avoiding plagiarism through accurate paraphrasing.
3. **Students will be able to write and evaluate major sections of a research paper** such as literature reviews, methods, results, discussions, conclusions, and perform a final check for coherence and accuracy.
4. **Students will be able to construct effective titles, abstracts, and introductions** and develop logically organized reviews of literature using accepted academic writing conventions.
5. **Students will be able to apply section-specific writing skills** to produce well-structured methods, results, discussion, and conclusion sections that meet academic and research communication standards.

Course Contents

Unit – I

Planning and preparation, Word order, breaking up long sentences, and structuring paragraphs and sentences. Being concise and removing redundancy, avoiding ambiguity, and vagueness.

Unit – II

Clarifying who did what, highlighting findings. Hedging and criticizing. Paraphrasing and plagiarism, Sections of a paper, Abstracts, Introduction

Unit – III

Review of the Literature. Methods, Results, Discussion, Conclusions, Final check

Unit – IV

Key skills needed when writing a title. An abstract, an introduction, and a review of the Literature

Unit – V

Skills needed when writing Methods, Results, Discussions, and Conclusion

Text Books

1. Goldbort R (2006). Writing for Science. Yale University Press.
2. Day R (2006). How to Write and Publish a Scientific Paper. Cambridge University Press.
3. Highman N (1998). Handbook of Writing for the Mathematical Sciences. SIAM. Highman's book.

Disaster Management

Subject Code: 26MAC1002 (Audit Course)

L	T	P	C
2	0	0	0

Course Objectives.

- To provide basic concepts and terminologies related to hazards and disasters.
- To highlight the critical importance and role of disaster management in the contemporary world.
- To enhance awareness of institutional processes, policies, and management strategies used to mitigate disaster impacts.
- To analyze the various dimensions of vulnerability and their contribution to disaster risk.
- To equip knowledge regarding emergency management for manmade and technological threats.

Course Outcomes

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

1. Define and classify different types of disasters and distinguish them from hazards.
2. Evaluate the nature of vulnerability and assess the impacts of disasters on different communities.
3. Explain the components of the Disaster Management Cycle, including mitigation, preparedness, response, and recovery.
4. Discuss the institutional frameworks and legislations available for disaster risk management at national and international level.
5. Identify specific threats related to industrial accidents and security, and understand the necessary emergency response mechanisms.

Course Contents

Unit – I

Introduction and Basic Concepts: Understanding Fundamental Concepts: Definitions of Hazards and Disasters. Classification: Disaster types and causes, including Geophysical, Hydrological, Meteorological, Biological, Atmospheric, and Human-made. Distinguishing between natural hazards and manmade disasters.

Unit – II

Dimensions of Disasters and Vulnerability: Global Trends: Analysis of global trends in disasters. Impact analysis: Physical, Social, Economic, Political, Environmental, and Psychosocial impacts of disasters. Understanding Vulnerability: Defining and analyzing Physical Vulnerability, Economic Vulnerability, and Social Vulnerability.

Unit – III

The Disaster Management Cycle and Risk Reduction: Detailed study of the components of DM Cycle: Response and recovery, Risk assessment, Mitigation and prevention, Preparedness planning, Prediction and warning. Disaster Risk Reduction (DRR): Concepts of DRR and Community-based Disaster Risk Reduction Strategies.

Unit – IV

Institutional Frameworks and Initiatives: National Context: Disaster Risk Management in India; related policies, plans, programs, and legislation. Global Context: International strategies for disaster reduction and other global initiatives. Agencies: Role of agencies NIDM, NDRF.

Unit – V

Emergency Management and Emerging Threats: Technological and Industrial Disasters: Explosions, Industrial accidents, Nuclear, Transport, and Mining accidents. Environmental Emergencies: Spills (Oil and Hazardous material). Security Threats: Bomb threats, terrorist attacks, stampedes, and conflict situations.

Text Books

1. Sharma, S.C., Disaster Management, Khanna Book Publishing. Latest Edition
2. Singh, R. B. (ed.), Natural Hazards and Disaster Management: Vulnerability and Mitigation, Rawat Publications, New Delhi. Latest Edition
3. Modh, S., Managing Natural Disaster: Hydrological, Marine and Geological Disasters, Macmillan, Delhi. Latest Edition.

Reference Books

1. Carter, N., Disaster Management: A Disaster Management Handbook, Asian Development Bank, Manila. Latest Edition
2. Clements, B. W., Disasters and Public Health: Planning and Response, Elsevier Inc. Latest Edition
3. Dunkan, K., and Brebbia, C. A. (Eds.), Disaster Management and Human Health Risk: Reducing Risk, Improving Outcomes, WIT Press, UK. Latest Edition
4. Ramkumar, Mu, Geological Hazards: Causes, Consequences and Methods of Containment, New India Publishing Agency, New Delhi. Latest Edition

Constitution of INDIA

Subject Code: 26MAC1003 (Audit Course)

L	T	P	C
2	0	0	0

Course Objectives.

- To provide students with a comprehensive understanding of the historical background and salient features of the Indian Constitution, including Fundamental Rights, Duties, and Directive Principles of State Policy.
- To familiarize learners with the structure and functioning of local self-government institutions and the importance of grassroots democracy in India.
- To develop awareness of the parliamentary system of government in India, including the roles and powers of the President, Prime Minister, Cabinet, and Judiciary.
- To explain the nature of Indian federalism and the legislative procedures and privileges of Union and State legislatures.
- To enable students to understand the role and functioning of constitutional and statutory bodies such as parliamentary committees, the Election Commission, CAG, Finance Commission, NITI Aayog, and political parties.

Course Outcomes

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

1. Students will be able to explain the origin, structure, and key features of the Indian Constitution, including Fundamental Rights, Fundamental Duties, and Directive Principles.
2. Students will be able to describe the organization and functions of local administration, including Panchayati Raj Institutions and municipal bodies, and appreciate the value of participatory democracy.
3. Students will be able to analyze the working of the parliamentary system and the emergency provisions, and understand the relationship between the executive, legislature, and judiciary.
4. Students will be able to interpret the principles of Indian federalism and explain Union–State relations and the legislative process in Parliament and State Legislatures.
5. Students will be able to evaluate the role of constitutional and non-constitutional bodies and recognize their contribution to democratic governance and accountability in India.

Course Contents

Unit – I

Introduction: Historical perspective of the constitution of India -Salient features of The Indian Constitution-Features: Fundamental Rights (Article 12 to 35), Duties (31 A-1976 emergency) and Directive principles (Article 30 to 51) of State Policy - Articles 14 to 18 Articles 19-Article 21-Amendment Procedure of The Indian Constitution: 42nd amendment (Mini Constitution)-44th amendment (1978-Janatha Govt.).

Unit – II

Local Administration: District's administration head: Role and Importance, Municipalities Introduction, Mayer and role of elected representative, CEO of municipal corporation, Pachayati raj: Introduction, PRI: Zilla Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of elected and appointed officials, Importance of grass root democracy.

Unit – III

Parliamentary form of Govt. In India: President of India- Emergency provisions- National Emergency Article 352 President Rules- Article 356 Financial Emergency- Article 360 Prime Minister and Cabinet- Supreme Court of India (Indian Judiciary)

Unit – IV

Indian Federalism: Union-State relations, Legislative, Administrative, and Financial relations. Lok Sabha, Rajya Sabha, Vidhan Sabha & Vidhan Parishad-Composition, Speaker, Chairman, Privileges, Legislative procedure.

Unit – V

Parliamentary Committees: Public Accounts Committee- Estimates Committee- Committee on Public Undertakings- Election Commission of India (Article 324) -Comptroller and Auditor General (CAG) of India (Article 148 to 150) Finance Commission (Article-280)-Niti Aayog (Planning Commission) and Political Parties.

Text Books

1. DD Basu-Indian Constitution
2. Dr. D. Surannaida - Indian Politica ISystem.
3. Madhav Khosla- The Indian Constitution.

Reference Books

1. The Constitution of India. 1950 (Bare Act), Government Publication
2. M. P. Jain, Indian Constitution Law, 7th Edn, Lexis Nexis, 2014

Deep Learning

Subject Code: 26MCS1004

L	T	P	C
4	0	0	4

Course Objectives

- Understanding of deep learning, emphasizing theoretical foundations, advanced architectures, optimization techniques, and state-of-the-art applications. By integrating hands-on projects and exposure to cutting-edge research, students will develop the expertise required for innovation in AI-driven domains like vision, language processing, and autonomous systems.

Course Outcomes

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

1. Understand deep learning fundamentals, including neural network optimization and regularization techniques.
2. Build and analyze advanced architectures like CNNs, RNNs, GANs, and transformers for various tasks.
3. Develop solutions for computer vision and NLP challenges using state-of-the-art tools and frameworks.
4. Analyze Generative Models and Explainable AI (XAI) techniques.
5. Explore and evaluate emerging trends in federated learning, quantum AI, and ethical implications of AI.

Course Contents

Unit – I

Foundations of Deep Learning: Introduction to Deep Learning: Historical context and motivation, Relationship with machine learning and AI, Real-world applications in vision, Challenges and Future Directions in Deep Learning

Optimization and Regularization: Loss functions (Cross-Entropy, MSE), Optimization algorithms: SGD, Adam, RMSProp, Learning Rate Scheduling, Regularization techniques: Dropout, Batch Normalization

Unit – II

Convolutional and Advanced Neural Networks Convolutional Neural Networks (CNNs): Convolution operations, pooling, padding, Advanced techniques: Dilated convolutions, Depth-wise separable convolutions, Activation Functions in CNNs,

Advanced CNN Architectures: ResNet: Skip connections and residual blocks, DenseNet: Feature reuse, MobileNet and EfficientNet: Optimization for mobile devices, Inception Architecture

Unit – III

Sequence Modeling and NLP with Deep Learning Sequence Models: Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), and Gated Recurrent Units (GRU), Self-attention, **Bidirectional RNNs:** Both forward and backward directions. Applications in sequence-to-sequence tasks, **NLP Applications:** Sentiment analysis, language translation, text summarization

Unit – IV

Generative and Explainable AI Generative Models: Autoencoders: Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs): DCGAN, CycleGAN.

Explainable AI (XAI): Techniques: LIME, SHAP, and challenges in interpretability.

Unit – V

Case Studies and Emerging Trends: AI in agriculture (GANs for synthetic data), AI-Based Precision Irrigation and Crop Water Stress Monitoring

Federated Learning: Decentralized AI models, Split Learning models.

Text Books

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, MIT Press, 2016.
2. Francois Chollet, *Deep Learning with Python*, Manning Publications, 2021.

Reference Books

1. Jeremy Howard and Sylvain Gugger, *Deep Learning for Coders with fastai and PyTorch*, O'Reilly Media, 2020.
2. Rajiv Chopra, *Deep Learning: A Practitioner's Approach*, Apress, 2021.
3. Andreas C. Müller and Sarah Guido, *Introduction to Machine Learning with Python*, O'Reilly Media, 2016.

Reference Links

1. https://www.coursera.org/learn/illinois-tech-deep-learning
2. https://online.stanford.edu/courses/cs230-deep-learning
3. https://onlinecourses.nptel.ac.in/noc22_cs22/preview

Data Science

Subject Code: 26MCS1005

L	T	P	C
4	0	0	4

Course Objectives

- Be ready with a wide range of expertise in Data Science for Industrial Problems through Python, including data collection, data pre-processing, modelling, and visualization of data sets.

Course Outcomes

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

1. Explore the Data Science lifecycle and roles of Data Science
2. Compute data manipulation with NumPy arrays and basic statistical tools.
3. Apply data manipulation with Pandas Series and Pandas DataFrames.
4. Develop data transformations and cleaning with Pandas and apply data wrangling with join, combine, and reshape.
5. Exemplify data visualization with Matplotlib.

Course Contents

Unit – I

Introduction to Data Science: Introduction to Data Science, Data Science Applications, Comparison between AI, ML, and DS, Various roles within Data Science, Essential Stages of Data Science Life Cycle, Organizational challenges while building Data Science projects.

Unit – II

NumPy Basics: Arrays and Vectorized Computation: The NumPy ndarray: A Multidimensional Array Object, Universal Functions: Fast Element-Wise Array Functions, Array-Oriented Programming with Arrays, File Input and Output with Arrays, Linear Algebra, Pseudorandom Number Generation

Unit – III

GETTING STARTED WITH PANDAS: Introduction to Pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics. Reading and Writing Data in Text Format

Unit – IV

DATA CLEANING AND PREPARATION: Handling Missing Data, Data Transformation, String Manipulation, DATA WRANGLING: Hierarchical Indexing, Combining and Merging Datasets, Reshaping and Pivoting

Unit – V

PLOTTING AND VISUALIZATION: Visualization with Matplotlib: A brief Matplotlib API primer, Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots

Text Books

1. Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython”, O’Reilly, 2nd Edition, 2018.

Reference Books

1. Dr. Ossama Embarak, “Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems”, Apress, 2018.
2. Jake VanderPlas, “Python Data Science Handbook: Essential Tools for Working with Data”, O’Reilly, 2017.
3. Python Data Analytics-Data Analysis and Science Using Pandas, matplotlib, and the Python Programming Language, Fabio Nelli, 2015.

Reference Links

1. https://onlinecourses.nptel.ac.in/noc22_cs08/preview
2. https://onlinecourses.nptel.ac.in/noc22_cs32/preview
3. https://www.edx.org/course/analyzing-data-with-python

Global Software Engineering

Subject Code: 26MCS1006

L	T	P	C
4	0	0	4

Course Objectives

- To understand principles and models of Global Software Development (GSD).
- To analyze coordination, cultural, and communication challenges in distributed teams.
- To evaluate agile and DevOps practices in global contexts.
- To assess risk, quality, governance, and security in global projects.
- To explore emerging research trends in global software ecosystems.

Course Outcomes

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

1. Explain global software development models and structures.
2. Analyze cultural and coordination challenges in distributed projects.
3. Apply agile and DevOps practices in global environments.
4. Evaluate risk, quality, and governance strategies.
5. Design effective collaboration frameworks for global teams.

Course Contents

Unit – I

Foundations of Global Software Engineering: Evolution of software engineering in a global context, Globalization of the software industry, Offshore, Nearshore, and Onshore models, Distributed Software Development Life Cycle, Benefits and challenges of GSD, Case studies of multinational IT organizations.

Unit – II

Communication, Coordination & Culture: Organizational structures in distributed projects, Time zone and geographical separation issues, Hofstede's cultural dimensions, Trust building and communication management, Knowledge sharing and collaboration mechanisms, Virtual team management strategies.

Unit – III

Agile & DevOps in Distributed Development: Agile methodologies in global settings, Distributed Scrum practices, Scaling Agile frameworks (SAFe, LeSS overview), DevOps culture and automation pipelines, Continuous Integration & Continuous Delivery (CI/CD), Collaboration tools (Git, Jira, Slack, Azure DevOps).

Unit – IV

Risk, Quality & Governance in GSD: Risk identification and mitigation in distributed projects, Effort and cost estimation models, Quality assurance in global development, Metrics and performance measurement, Intellectual Property (IP) and data security issues, Legal and compliance aspects.

Unit – V

Emerging Trends & Research Issues: Cloud-based global collaboration, Open source global communities, AI-assisted software engineering, Blockchain for distributed trust, Global software ecosystems, Research challenges and future directions.

Text Books

1. Carmel, E. 1999. Global Software Teams: Collaborating Across Borders and Time Zones. Prentice Hall, Upper Saddle River, NJ.
2. Audy, J. L. N., and E. Prikladnicki. 2016. Distributed Software Development: Practices and Challenges. Springer, Cham, Switzerland.

Reference Books

1. Bass, J. M., I. Weber, and L. Zhu. 2015. DevOps: A Software Architect's Perspective. Addison-Wesley, Boston.
2. Pressman, R. S., and B. R. Maxim. 2020. Software Engineering: A Practitioner's Approach. 9th ed. McGraw-Hill, New York.
3. Sommerville, I. 2016. Software Engineering. 10th ed. Pearson, Boston.

Natural Language Processing

Subject Code: 26MCS1E31 (Program Elective – 3)

L	T	P	C
3	0	0	3

Course Objectives

- Learn the introduction to classical and modern techniques in NLP.
- Understand Word-level analysis.
- Learn how to employ literary-historical NLP-based analytic techniques, named entity recognition.
- Understand sentiment analysis and topic modelling.
- Introduction to text visualisation techniques and clustering the documents.
- Understand the use of Cross-Lingual Information Retrieval (CLIR).

Course Outcomes

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

1. Understand the fundamental concepts and techniques of natural language processing.
2. Demonstrate N-Grams, TF-IDF, and POS.
3. Illustrate how to collect data from social media, web, and other sources using APIs and web scraping.
4. Analyze text using sentiment analysis and topic modelling methods.
5. Classify the text and visualisation.

Course Contents

Unit – I

Introduction to NLP: Origins and challenges of NLP – Language Modelling: Grammar-based LM, Statistical LM, Tokenization, Morphology fundamentals, Morphology Paradigms.

Unit – II

Word Level Analysis: Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation, and Backoff -Word Classes, TF-IDF, Features, Word Vectors, Part-of-Speech Tagging, Rule-based, stochastic, and Transformation-based tagging.

Unit – III

Data Collection and Software tools: Data Collection using API, social media, Web scraping; Software tools such as NLTK; Named Entity Recognition.

Unit – IV

Fundamentals of sentimental analysis and topic modelling: Sentiment Analysis; Block diagram of sentiment analysis, Applications, Topic Modelling, Goals of topic modelling; Stylometry.

Unit – V

Introduction to text classification and visualisation: Text classification, Text Visualisation; Dendrograms, PCA, Plotting the Text; Document Clustering;

Machine Translation: Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross-Lingual Information Retrieval (CLIR).

Text Books

1. Dan Jurafsky and James H. Martin. Speech and Language Processing (3rd ed. draft)
2. Jacob Eisenstein. Natural Language Processing

3. Delip Rao and Brian McMahan. Natural Language Processing with PyTorch

Reference Books

1.Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Deep Learning

Reference Links

- https://nptel.ac.in/courses/106/105/106105158/ A course on Natural Language Processing, by Prof. Pawan Agrawal, IIT Kharagpur.
- https://nptel.ac.in/courses/106/106/106106211/ A course on Applied Natural Language Processing, Prof. Rameseshan Ramchandran, IIT Madras.

Generative AI

Subject Code: 26MCS1E32 (Program Elective – 3)

L	T	P	C
3	0	0	3

Course Objectives

- This course covers Neural Networks fundamentals, Generative AI models like GANs, VAEs, Transformers, traditional RNNs and LSTM limitations, data visualization using Python and TensorFlow, and current trends in Generative AI research.

Course Outcomes

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

1. Understand the evolution of AI and the significance of Deep Learning.
2. Apply various Neural Network architectures for tasks like image recognition and sequence modeling.
3. Analyse data preprocessing and training techniques for neural networks.
4. Create various Visualizations on data distributions and patterns using different tools.
5. Design practical solutions using advanced neural networks for diverse applications.

Course Contents

Unit – I

Foundations of AI and Neural Networks: History and evolution of AI/ML, Deep learning revolution, Transfer learning, History of Neural Natural Language Processing, Structure of Artificial Neural Networks, Steps in Training an Artificial Neural Network, Parameters and Hyperparameters, Backpropagation.

Unit – II

Advanced Neural Network Architectures: Introduction to advanced architectures, Introduction to Generative AI Models: Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), Transformers, Attention Mechanism, Long Short-Term Memory Networks (LSTMs).

Unit – III

Data Preprocessing: Probability and Statistics, Data Preprocessing Techniques, Model Training Techniques.

Unit – IV

Python and TensorFlow 2 in Generative AI: Overview of Python and TensorFlow 2, Preprocessing and cleaning data for Generative AI applications. Visualizing data distributions and patterns in Generative AI datasets. Introduction to TensorFlow's computation graph and eager execution.

Unit-V

Generative AI Applications: Applications in Various Fields: Art and Creativity, Image and Video Generation, Text Generation, Music Composition, and Healthcare Finance.Real-world use cases and challenges in deploying generative AI models.

Text Books

1. “Generative AI for everyone: Understanding the essentials and applications of this breakthrough technology". Altaf Rehmani .
2. "Introduction to Generative AI”, Numa Dhamani, Kindle Edition, 2024.

Reference Books

1. "Generative Adversarial Networks Cookbook: Over 100 recipes to build generative models using Python, TensorFlow, and Keras" by Josh Kalin.
2. “Generative AI in Software Development: Beyond the Limitations of Traditional Coding” Jesse Sprinter, 2024.

Reference Links

1. https://elearn.nptel.ac.in/shop/iit-workshops/completed/leveraging-generative-ai-for-teaching-programming-courses/?v=c86ee0d9d7ed

2. https://elearn.nptel.ac.in/shop/iit-workshops/completed/introduction-to-language-models/?v=c86ee0d9d7ed

Ethical Hacking

Subject Code: 26MCS1E33 (Program Elective – 3)

L	T	P	C
3	0	0	3

Course Objectives

- Define ethical hacking concepts, security principles, and the security–functionality–usability triangle.
- Explain different types of hackers and phases of hacking.
- Identify legal and ethical considerations in cybersecurity practices.
- Describe cyber ethics, hacking laws, and regulations.
- Examine reconnaissance, scanning, and access phases in hacking processes.

Course Outcomes

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

1. Understand ethical hacking fundamentals and security principles.
2. Differentiate types of hackers and their roles in cybersecurity.
3. Analyze various phases of hacking and the attack lifecycle.
4. Apply ethical and legal guidelines in cybersecurity practices.
5. Evaluate ethical implications of hacking activities.

Course Contents

Unit – I

Introduction to Ethical Hacking Ethical Hacking Overview, Security, Functionality, and Usability Triangle, Types of Hackers, White Hat Hackers, Black Hat Hackers, Grey Hat Hackers, Phases of Hacking, Reconnaissance, Scanning, Gaining Access, Maintaining Access, Clearing Tracks, Legal and Ethical Considerations, Cybernetics, Hacking Laws and Regulations

Unit – II

Foot printing & Reconnaissance Information Gathering, Passive Information Gathering, Active Information Gathering, Foot printing Techniques, Advanced Google Searching, WHOIS Lookup, DNS Enumeration, Network Scanning Tools, NMAP, Nessus, Enumeration Techniques, User and service enumeration

Unit – III

System Hacking, Password Cracking Techniques, Dictionary Attack, Brute Force Attack, Rainbow Tables, Privilege Escalation, Gaining higher-level access, Application Execution, Malware Analysis, Viruses, Worms, Trojans, Rootkits, and Backdoors

Unit – IV

Web Application & Network Hacking Web Application Hacking, Web application vulnerabilities, OWASP Top 10 Vulnerabilities, SQL Injection, Cross-Site Scripting (XSS), Sniffing Techniques, Wireshark, BurpSuite, Denial of Service Attacks, DoS and DDoS attacks, Prevention methods

Unit – V

Wireless & Advanced Hacking Wireless Network Hacking, WEP, WPA, WPA2 Cracking, IoT Hacking, Cloud Security Models, Cryptography, Public Key Encryption, Private Key Encryption, Digital Signatures, Social Engineering Attacks

Text Books

1. Michael T. Simpson, Kent Backman, and James E. Corley, Hands-On Ethical Hacking and Network Defense, Course Technology, Delmar Cengage Learning, 2010.
2. The Basics of Hacking and Penetration Testing - Patrick Engebretson, SYNGRESS, Elsevier, 2013.

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Reference Books

1. MattWalker
https://www.oreilly.com/library/view/certified-ethical-hacker/9781098174767/
2. Black Hat Python: Python Programming for Hackers and Pentesters, Justin Seitz, 2014.

Optimization Techniques

Subject Code: 26MCS1E41 (Program Elective – 4)

L	T	P	C
3	0	0	3

Course Objectives

- To introduce various optimization techniques, i.e., classical, linear programming,
- Transportation problem, simplex algorithm, dynamic programming
- Constrained and unconstrained optimization techniques for solving and optimizing electrical and electronic engineering circuits design problems in real-world situations.
- To explain the concept of Dynamic programming and its applications to project implementation.

Course Outcomes

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

1. Explain the need for optimization of engineering systems.
2. Understand optimization of electrical and electronics engineering problems.
3. Apply classical optimization techniques, linear programming, the simplex algorithm, transportation problem.
4. Apply unconstrained optimization, constrained non-linear programming, and dynamic programming.
5. Formulate optimization problems.

Course Contents

Unit – I

Introduction and Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surface - classification of optimization problems.

Linear Programming: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation for the simplex method – simplex algorithm.

Unit – II

Transportation Problem: Finding an initial basic feasible solution by the north–west corner rule, the least cost method, and Vogel's approximation method – testing for optimality of balanced transportation problems. Degeneracy. Assignment problem – Formulation – Optimal solution - Variants of the Assignment Problem; Traveling Salesman problem.

Unit – III

Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints: Solution by method of Lagrange multipliers – Multivariable Optimization with inequality

constraints: Kuhn – Tucker conditions. Single Variable Nonlinear Unconstrained Optimization: Elimination methods: Uni Model function-its importance, Fibonacci method & Golden section method.

Unit – IV

Multi-variable nonlinear unconstrained optimization: Direct search methods – Univariate method, Pattern search methods – Powell's, Hooke - Jeeves, Rosenbrock's search methods. Gradient methods:

Gradient of function & its importance, Steepest descent method, Conjugate direction methods: Fletcher-Reeves method & variable metric method.

Unit – V

Dynamic Programming: Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Text Books

1. Optimization Techniques & Applications by S.S.Rao, New Age International.
2. Optimization for Engineering Design by Kalyanmoy Deb, PHI

Reference Books

1. George Bernard Dantzig, Mukund Narain Thapa, “Linear programming”, Springer series in Operations Research, 3rd edition, 2003.
2. H. A. Taha, “Operations Research: An Introduction”, 8th Edition, Pearson/Prentice Hall, 2007.
3. Optimization Techniques by Belegundu & Chandrupatla, Pearson Asia.
4. Optimization Techniques: Theory and Practice by M.C. Joshi, K.M. Moudgalya, Narosa Publications

Blockchain Techniques

Subject Code: 26MCS1E42 (Program Elective – 4)

L	T	P	C
3	0	0	3

Course Objectives

- Understand the fundamentals of blockchain technology and its components.
- Explore different blockchain subjects, platforms, and their unique features.
- Learn how to develop and deploy smart contracts.
- Analyze the impact of blockchain on various industries.
- Gain hands-on experience with blockchain development tools and frameworks.

Course Outcomes

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

1. Explain the fundamental concepts of blockchain technology, distributed ledger architecture, cryptographic techniques, consensus mechanisms, and blockchain networks.
2. Apply blockchain principles and cryptographic methods to design and implement secure distributed applications and blockchain-based solutions.
3. Analyze the performance, security, privacy, and scalability characteristics of various blockchain platforms, protocols, and consensus algorithms.
4. Evaluate different blockchain frameworks, smart contract models, and decentralized architectures to select appropriate solutions for specific application requirements.
5. Design, develop, and deploy smart contracts and decentralized applications (DApps) to address real-world challenges in domains such as finance, healthcare, supply chain, and IoT.

Course Contents

Unit – I

Introduction to Blockchain Technology, History and evolution of blockchain, Basic concepts: decentralization, consensus mechanisms, cryptography. **Key components**: blocks, chains, nodes, miners**. Types of blockchains**: public, private, consortium.

Unit – II

Cryptographic Foundations: Cryptographic hash functions, Public and private keys, Digital signatures, Merkle trees. **Blockchain Platforms and Ecosystems**: Overview of major blockchain platforms: Bitcoin, Ethereum, Hyperledger, Corda, Comparative analysis of platform features, Blockchain as a Service **(BaaS).**

Unit – III

Blockchain Architecture and Use Cases: Design Methodology for Blockchain Applications. Smart Contracts and Decentralized Applications **(DApps):** Definition and characteristics of smart contracts, Ethereum Virtual Machine **(EVM).** Writing and deploying smart contracts using Solidity. Introduction to DApps and their architecture.

Unit – IV

Advanced topics: Byzantine fault tolerance, proof-of-work vs proof-of-stake, Security and Privacy of Blockchain, smart contract vulnerabilities, and scalability of Blockchain.

Unit – V

Blockchain for real-world applications: Manufacturing and production, supply chain management, logistics and transportation, Internet of Things, e-voting, healthcare, product life cycle, knowledge and innovation management, new business models and applications.

Text Books

1. Blockchain applications: a hands-on approach, Bahga A., Madisetti V., VPT, 2017.
2. Mastering Blockchain – Imran Bashir, 2024.
3. Blockchain Technology and Applications – Manoj Kumar M. V, Annappa B et al., CRC Press, 2023.

Reference Books

1. S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, 'Blockchain Technology: Crypto Currency and Applications', Oxford University Press, 2019.
2. Josh Thompson, 'Blockchain: The Blockchain for Beginners, Guide to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.
3. Vikram Dhillon, David Metcalf, Max Hooper, 'Blockchain Enabled Applications', Apress, 2017.
4. William Mougayar, 'The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology', Wiley, 2016.
5. Roger Wattenhofer, 'Blockchain Science: Distributed Ledger Technology', Inverted Forest Publishing, 3rd Edition, 2019.

Reference Links

https://skillsbuild.org/students/course-catalog/blockchain

Quantum Computing

Subject Code: 26MCS1E43 (Program Elective – 4)

L	T	P	C
3	0	0	3

Course Objectives

- To provide a fundamental understanding of quantum computing principles, including qubits, superposition, entanglement, and quantum circuits.
- To develop strong mathematical foundations required for quantum computation, such as linear algebra, Hilbert spaces, and unitary transformations.
- To introduce various quantum hardware platforms and architectures, including superconducting qubits and trapped ions.
- To explain quantum noise models and error correction techniques for reliable quantum computation.
- To enable practical implementation of quantum algorithms using Python and Qiskit frameworks.

Course Outcomes

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

1. Analyze and differentiate between classical and quantum computation models and represent quantum states using Dirac notation and the Bloch sphere.
2. Apply linear algebra concepts such as tensor products, eigenvalues, and unitary matrices in quantum state transformations.
3. Evaluate different quantum hardware technologies and understand the working principles of NISQ devices.
4. Design basic quantum error-correcting codes and analyze the impact of noise and decoherence in quantum systems.
5. Develop and execute quantum circuits using Python and Qiskit, including simulation and quantum random number generation.

Course Contents

Unit – I

Introduction To Quantum Computing

- Classical Vs Quantum Computation
- Qubits, Superposition, Entanglement
- Quantum Circuits and Measurement
- Quantum Teleportation and Superdense Coding
- Bloch Sphere and Dirac Notation

Unit–II

Mathematical Foundations for Quantum Computing

- Linear Algebra, Probability, And Complex Numbers
- Tensor Products and Matrices
- Eigenvalues/eigenvectors, Unitary Transformations
- Vector Spaces and Hilbert Space
- Quantum State Transformations

Unit–III

Quantum Hardware And Implementations

- **Superconducting Qubits, Trapped Ions, Photonics**
- **Quantum Control Systems**
- **NISQ Devices**
- **IBM, Google, And IonQ Architectures**

Unit–IV

Quantum Error Correction and Noise

- **Quantum Noise Models**
- **Quantum Error-correcting Codes (Shor, Steane)**
- **Stabilizer Formalism and Fault-tolerant Computation**
- **Density Matrices and Decoherence**

Unit–V

Programming For Quantum Systems (Python + Qiskit)

- **Python For Scientific Computing**
- **Qiskit Basics, Simulators, And Visualization**
- **Building And Running Circuits**
- **Quantum Random Number Generation**.

Text Books

1. Michael Nielsen & Isaac Chuang — Quantum Computation And Quantum Information
2. Eleanor Rieffel & Wolfgang Polak — Quantum Computing: A Gentle Introduction
3. Jack D. Hidary — Quantum Computing: An Applied Approach
4. Peter Shor, Lov Grover, David Deutsch — Research Papers
5. IBM Qiskit Textbook (free Online)

Reference Books

1. Quantum computation and quantum information, Michael A. Nielsen and Isaac L. Chuang, Cambridge University Press, 2010.
2. Introduction to Quantum Mechanics, 2nd Edition, David J. Griffiths, Prentice Hall, New Jersey, 1995.

Reference Links

- https://r.search.yahoo.com/_ylt=Awr1UVMSAY9pGQIA0gu7HAx.;_ylu=Y29sbwNzZzMEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=1772189202/RO=10/RU=https%3a%2f%2fonlinecourses.nptel.ac.in%2fnoc25_cs95%2fpreview/RK=2/RS=HlGwhJhqQ6.yguksMRFEahjQ5z4-

Data Science using Python Lab

Subject Code: 26MCS1103

L	T	P	C
0	0	4	2

Course Outcomes

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

1. Explore numerical operations using NumPy for Data Science
2. Apply data manipulation with Pandas Series and Pandas Data Frames.
3. Develop data transformations and cleaning with Pandas.
4. Demonstrate data wrangling with join, combine, and reshape.
5. Illustrate data visualization with Matplotlib.

List of Experiments

I. NumPy Arrays and Vectorized Computation

a) Create NumPy arrays from Python Data Structures, Intrinsic NumPy objects, and Random Functions.
b) Manipulation of NumPy arrays- Indexing, Slicing, Reshaping, Joining, and Splitting.
c) Computation on NumPy arrays using Universal Functions.
d) Import data to NumPy arrays and compute Statistical and Mathematical methods and comparison operations on rows/columns.
e) Computation on NumPy arrays using sorting, unique, and set operations.
f) Load an image file and do a crop and flip operation using NumPy Indexing.

II. Data Manipulation with Pandas

a) Create Panda Series from a Python List, Numpy Array, and Dictionary
b) Data manipulation with Pandas Series- Indexing, Selection, and Filtering, Arithmetic Operations, Ranking and Sorting, Checking Null Values, and concatenating.
c) Creating a DataFrame from a list and a dictionary
d) Import various file formats to Pandas DataFrame and perform the following:

i). Display the top five rows and the bottom five rows. Get the shape, data type, null values, index, and column details.
ii). Select/Delete the records(rows)/columns based on conditions. Perform Sorting and Ranking operations in the DataFrame. Do required statistical operations on DataFrames.
iii). Find the count and uniqueness of the given categorical values.
iv). Rename single/multiple columns.

III. Data Cleaning and Preparation

Import any CSV file into a Pandas Data Frame and perform the following:

a. Handle missing data by detecting, dropping, and replacing/filling missing values.
b. Transform data using apply() and map() method.
c. Detect and filter outliers.
d. Perform Vectorized String operations on Pandas Series.

IV. Plotting and Visualization

Data visualization on any sample dataset using matplotlib for the following:

a. Line Plot
b. Bar Plot
c. Histogram
d. Density Plot
e. Scatter Plot

Research Methodology and IPR

Subject Code: 26MCC1001 (Program Elective – 4)

L	T	P	C
2	0	0	2

Course Objectives

- Formulate research problems with clarity and develop strong analytical skills.
- Apply structured research methodology, literature review techniques, and ethical practices to academic work.
- Interpret research data effectively and master the mechanics of technical report writing.
- Gain a comprehensive understanding of Intellectual Property Rights (IPR) and the legalities of the patenting process.
- Understand the global landscape of patent rights, technology transfer, and emerging trends in IP.

Course Outcomes

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

1. Summarize the fundamental concepts, types, and systematic processes of scientific research.
2. Formulate a well-defined research problem by applying systematic selection techniques
3. Construct a comprehensive literature review and theoretical framework while maintaining high ethical standards.
4. Execute data interpretation and produce high-quality technical reports and oral presentations.
5. Navigate the legalities of Intellectual Property Rights, including patent filing, licensing, and emerging IP trends.

Course Contents

Unit – I

Introduction to Research Methodology: Meaning, objectives, and motivation in research. Research Taxonomy: Types of research (Descriptive vs. Analytical, Applied vs. Fundamental, and Quantitative vs. Qualitative). Methodology: Research approaches, significance of research, and the distinction between Research Methods vs. Methodology. Scientific Rigor: Research and the scientific method; Importance of understanding the research process from inception to completion.

Unit–II

Defining the Research Problem Quality Standards: Criteria of good research; Common problems encountered by researchers in India. Problem Formulation: The art of defining the research problem; the necessity and importance of a well-defined problem. Techniques: Step-by-step process of identifying and selecting a research problem. Application: Practical illustrations and the logic of narrowing down a broad area into a researchable topic.

Unit–III

Literature Review and Research Ethics Strategic Review: Place of literature review in research; Bringing clarity and focus to the problem; improving methodology and broadening knowledge base. Execution: Searching existing literature, reviewing selected literature, and contextualizing findings. Frameworks: Developing theoretical and conceptual frameworks for the study. **Integrity**: Writing about the literature reviewed; Analysis of Plagiarism and adherence to Research Ethics.

Unit–IV

Interpretation and Report Writing Data Synthesis: Meaning and techniques of interpretation; Precautions to take during data interpretation. Technical Communication: Significance of report

writing; Different steps and layout of a formal research report. Formatting & Mechanics: Types of reports, oral presentation skills, and the mechanics of writing a research report. **Quality Control:** Precautions for writing effective and accurate research reports.

Unit–V

Nature of Intellectual Property and Patenting IP Fundamentals: Nature of Intellectual Property: Patents, Designs, Trademarks, and Copyrights. The Patent Lifecycle: From technological research and innovation to development; Procedure for grant of patents. Global Framework: International cooperation on IP; Patenting under the Patent Cooperation Treaty (PCT). Rights & Trends: Scope of patent rights; Licensing and transfer of technology; Patent databases. Emerging Areas: Geographical Indications (GI), Traditional knowledge case studies.

Text Books

1. Kothari, C. R(1990). Research methodology, 2nd edition, New Age International Publishers.
2. Kothari, C. R., & Garg, G. (2024). Research methodology: Methods and techniques (5th ed.). New Age International Publishers.
3. Ramappa, T. (2021). Intellectual property rights under WTO (3rd ed.). S. Chand Publishing.

Reference Books

1. Chawla, D., & Sondhi, N. (2016). Research methodology: Concepts and cases (2nd ed.). Vikas Publishing House.
2. Cornish, W., Llewelyn, D., & Aplin, J. (2025). Intellectual property: Patents, copyright, trade marks and allied rights (10th South Asian ed.). Sweet & Maxwell. Available at Bharat Law House.
3. Controller General of Patents, Designs and Trade Marks. (2024). Manual of patent practice and procedure. IP India Official Website.
4. World Intellectual Property Organization. (2024). PCT – The International Patent System. WIPO.