



Shri. Shamrao Patil (Yadavkar) Educational & Charitable Trust's
Sharad Institute of Technology College of Engineering
Yadav (Ichalkaranji)-416121, Dist. – Kolhapur
(An Autonomous Institute)

(Approved by AICTE, New Delhi, Recognized by Government of Maharashtra &
Affiliated to BATU University, Lonere)

NBA Accredited Programs, Accredited By NAAC 'A' Grade, ISO 9001:2015 Certified

Syllabus Structure of M.Tech.

(Artificial Intelligence & Data Science)

Department of

Artificial Intelligence & Data Science Engineering

Semester: I & II




Head of Department,
Artificial Intelligence & Data Science
SHARAD INSTITUTE OF TECHNOLOGY
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Department: Department of AIDS Engineering

Rev: Course Structure/01/NEP/2024-25

Class: F.Y. M.Tech

Semester: I

Course Code	Type of Course	Course	Teaching Scheme					Evaluation Scheme				
			L	T	P	Credits	Total Hrs	CA1	CA2	MSE	ESE	Total
24MAD1101	ELC	Research Methodology & IPR	3	1	0	4	4	10	10	30	50	100
24MAD1102	PCC	Digital Image Processing	3	0	0	3	3	10	10	30	50	100
24MAD1103	PCC	Data Analytics & Visualization	3	0	0	3	3	10	10	30	50	100
24MAD1104	PCC	Artificial Intelligence & Machine Learning	3	0	0	3	3	10	10	30	50	100
24MAD1105	PCC	Bridge Course AWS Foundation/Google Cloud Computing Foundations	2	-	-	Audit	2	25	25	--	--	50
24MAD1106	PEC	Elective – I	3	0	0	3	3	10	10	30	50	100
24MAD1107	PCC	Data Analytics & Visualization Laboratory	-	-	2	1	2	15	15	--	20	50
24MAD1108	PCC	Artificial Intelligence & Machine Learning Laboratory	-	-	2	1	2	15	15	--	20	50
24MAD1109	AEC	Effective Communication Skills	0	0	2	1	2	25	25	--	--	50
			17	1	6	19	24	130	130	150	290	700

Elective–I: One subject to be chosen from the following subjects.

Code	Subjects
24MAD1106A	Advanced Computer Networks
24MAD1106B	Advanced Computer Architecture
24MAD1106C	Advanced Database Technologies




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24MAD1101	ELC	Research Methodology & IPR	3-1-0	4 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs /week Tutorial: 1 hr /week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Statistics, Communication Skills

Course Outcomes: At the end of the course, students will be able to:

CO1	Develop and implement appropriate research proposals, including formulating research questions, selecting methodologies, and designing data collection tools.
CO2	Analyze qualitative and quantitative data using relevant statistical tools and interpret the results effectively to support research findings.
CO3	Demonstrate writing skills for articles, manuscripts in the field of engineering.
CO4	Explain the fundamental concepts of intellectual property rights, ethical considerations related to research and IPR, including plagiarism, authorship, and the proper use of intellectual property.
CO5	Explain the fundamental principles of patent law, including the criteria for patentability, types of patents, and the patent application process.
CO6	Describe the key concepts of copyright law, including original works, rights of authors, and the duration and limitations of copyright protection.




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Course Contents:

Unit 1: Introduction to Research Methodology Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics.	[6]
Unit 2: Results and analysis Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artefacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.	[6]
Unit 3: Technical writing Effective technical writing, how to write a manuscript/ response to reviewers' comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee.	[6]
Unit 4: Introduction and the need for intellectual property right (IPR) Types of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design Genetic Resources and Traditional Knowledge – Trade Secrets, IPR in India : Genesis and development, IPR in abroad - Major International Instruments concerning Intellectual, Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.	[6]
Unit 5: Patents Elements of Patentability: Novelty , Non Obviousness (Inventive Steps) Industrial Application - Non - Patentable Subject Matter – Registration. Procedure, Rights and Duties of Patentee, Assignment and license , Restoration of lapsed Patents, Surrender and Revocation of Patents Patent Infringement, Remedies & Penalties – Patent Office and Appellate Board. Patent/Prior art search: Types and tools of patent search, Patent drafting: Elements in patent drafting.	[6]
Unit 6: Copyrights Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings, Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright copyright Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.	[6]





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Reference/Text Book:

1. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004.
2. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students", Juta & Company, 1996.
3. B.L. Wadera, Patents, trademarks, copyright, Designs and Geographical Judications.
4. P. Narayanan (Eastern Law House), Intellectual Property Law.
5. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
6. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
7. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
8. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from <http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf>
9. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf
10. Journal of Intellectual Property Rights (JIPR): NISCAIR




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24MAD1102	PCC	Digital Image Processing	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs /week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Mathematics, Data structure

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the basic principles of digital image processing, including image formation, representation, and transformation.
CO2	Apply various image enhancement techniques to improve the visual quality of images, including histogram equalization, filtering, and contrast adjustment.
CO3	Demonstrate knowledge of image restoration methods to recover degraded images, using techniques such as deblurring and noise reduction.
CO4	Apply image compression algorithms to reduce file sizes while maintaining image quality, including lossy and lossless compression methods.
CO5	Demonstrate image segmentation algorithms to partition images into meaningful regions, using methods like thresholding, clustering, and edge detection.
CO6	Explain the application of machine learning techniques in image processing tasks, such as classification and object detection.




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Course Contents:

Unit 1: Introduction Examples of fields that use digital image processing, fundamental steps in digital image processing, components of image processing system. Digital Image Fundamentals: A simple image formation model, image sampling and quantization, basic relationships between pixels.	[6]
Unit 2: Image enhancement in the spatial domain Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operators, basic spatial filtering, smoothing and sharpening spatial filters, combining the spatial enhancement methods.	[6]
Unit 3: Image restoration A model of the image degradation/restoration process, noise models, and restoration in the presence of noise—only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the Fourier transform and the frequency domain, estimating the degradation function.	[6]
Unit 4: Image Compression Image Compression: Fundamentals, image compression models, error-free compression, lossy predictive coding, image compression standards.	[6]
Unit 5: Image Segmentation Detection of discontinuous, edge linking and boundary detection, thresholding, region— based segmentation.	[6]
Unit 6: Object Recognition Patterns and patterns classes, recognition based on decision—theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods – matching shape numbers, string matching.	[6]
Reference/Text Book: <ol style="list-style-type: none">1. McAndrew A., Introduction to Digital Image Processing with Matlab, Thomson Course Technology (2004)2. Low A., Introductory Computer Vision and Image Processing, McGraw-Hill (1991), 1st ed.3. Gonzalez C. R., Woods E. R., Digital Image Processing, Pearson Education (2008) 3rd ed.4. Sonka M., Hlavac V. and Boyle R., Image Processing, Analysis and Machine Vision, Thomson Learning, (1993) 1st ed.	




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24MAD1103	PCC	Data Analysis and Visualization	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs /week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basics of Programming, DBMS

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate the core concepts and processes involved in data analytics and visualization.
CO2	Illustrate different processes such as collect, clean, and preprocess data from various sources, ensuring data integrity and readiness for analysis.
CO3	summarize exploratory data analysis to data characteristics and identify patterns, trends, and anomalies.
CO4	Apply statistical techniques to analyze data, including descriptive statistics, inferential statistics, and regression analysis.
CO5	Design effective visualizations using various tools and techniques, ensuring clarity and accuracy in representing data insights.
CO6	Analyze real-world datasets to derive actionable insights and communicate findings effectively through ethical implications.




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Course Contents:

Unit 1: Introduction to Data Analytics Overview of Data Analytics: Definition, importance, and applications. Types of Data: Structured vs. unstructured data, primary vs. secondary data. Data Life Cycle: Collection, processing, analysis, visualization, and interpretation. Introduction to python.	[6]
Unit 2: Data Collection and Preprocessing Data Sources: Primary data collection methods, web scraping, and APIs. Data Cleaning: Handling missing values, outliers, and duplicates. Data Transformation: Normalization, aggregation, and feature engineering. Exploratory Data Analysis (EDA): Techniques for summarizing and visualizing data distributions.	[6]
Unit 3: Statistical Analysis Descriptive Statistics: Measures of central tendency and variability. Inferential Statistics: Hypothesis testing, confidence intervals, and p-values. Correlation and Regression: Understanding relationships between variables. Statistical Software: Python libraries (e.g., Pandas, NumPy, Scikit-learn).	[6]
Unit 4: Data Visualization Principles Visualization Fundamentals: Importance of data visualization and design principles. Types of Visualizations: Bar charts, line graphs, scatter plots, heatmaps, and dashboards. Tools for Visualization: Introduction to tools like Matplotlib, Seaborn. Effective storytelling with data, avoiding common pitfalls in visualization.	[6]
Unit 5: Advanced Data Analytics Techniques Introduction to Predictive Analytics and algorithms. Time Series Analysis: Techniques for analyzing time-dependent data. Text Analytics: Basic natural language processing (NLP) techniques for analyzing textual data.	[6]
Unit 6: Applications and Case Studies Real-World Applications: Exploring case studies from various industries (e.g., finance, healthcare, marketing). Hands-on project to apply concepts learned to analyze a dataset and create visualizations. Ethics in Data Analytics: Understanding ethical considerations and data privacy issues.	[6]
Reference/Text Book: <ol style="list-style-type: none">1. "Python for Data Analysis" by Wes McKinney.2. "Practical Statistics for Data Scientists" by Peter Bruce and Andrew Bruce.3. "Data Mining: Concepts and Techniques" by Jiawei Han, Micheline Kamber, and Jian Pei.4. "Introduction to Data Science: A Python Approach to Concepts, Techniques, and Applications" by Jeffrey Stanton.	





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5. "Data Visualization: A Successful Design Process" by Andrew Abela.
 6. "Data Visualization: A Practical Introduction" by Kieran Healy.
- "Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic.




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24MAD1104	PCC	Artificial Intelligence & Machine Learning	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs /week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Probability and Statistics, Basics of programming

Course Outcomes: At the end of the course, students will be able to:

CO1	Outline fundamental concepts, history, and definitions of Artificial Intelligence (AI) and Machine Learning (ML).
CO2	Implement various supervised learning algorithms and evaluate models using different performance metrics.
CO3	Demonstrate unsupervised learning concepts and apply clustering algorithms.
CO4	Implement feedforward, convolutional (CNN), and recurrent neural networks (RNNs) to solve complex problems classification or prediction.
CO5	Summarize reinforcement learning concepts including agents, environments, rewards, and policies.
CO6	Evaluate ethical concerns related to AI, including bias, fairness, transparency, and privacy in machine learning models.




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Course Contents:

Unit 1: Introduction to Artificial Intelligence and Machine Learning Definitions and history of AI, Differences between AI, Machine Learning, and Deep Learning, Applications of AI, Machine Learning, and Deep Learning, Applications of AI (Healthcare, Finance, Robotics, etc.) Reactive Machines, Limited Memory, Theory of Mind, and Self-Aware AI, what is Machine Learning? Types of ML: Supervised, Unsupervised, and Reinforcement Learning, Data, Labels, Features, Model, Algorithm, Training, Testing, Accuracy.	[6]
Unit 2: Supervised Learning Concept of labeled data, Training and testing phases, Linear Regression, Polynomial Regression, Ridge and Lasso Regression, Logistic Regression, Decision Trees, Support Vector Machines (SVM), k-Nearest Neighbors (k-NN), Accuracy, Precision, Recall, F1-score, ROC curves, AUC.	[6]
Unit 3: Unsupervised Learning Overview of Unsupervised Learning, K-means Clustering, Hierarchical Clustering, DBSCAN (Density-Based Clustering), Principal Component Analysis (PCA), Use of clustering for detecting outliers, Apriori Algorithm.	[6]
Unit 4: Neural Networks and Deep Learning Biological neurons vs. artificial neurons, Structure of a neuron (inputs, weights, activation functions, output), Feedforward networks, Backpropagation and gradient descent, Introduction to Deep Neural Networks, Multi-Layer Perceptron's (MLP) Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM).	[6]
Unit 5: Reinforcement Learning Agents, environments, actions, and rewards, Key differences between RL and other types of learning, States, actions, rewards, transitions, Q-learning, Temporal Difference (TD) Learning, Deep Q-Networks (DQN), Game playing (e.g., AlphaGo) Robotics, self-driving cars.	[6]
Unit 6: Ethics in AI and Machine Learning Bias and fairness in AI models, Ethical implications of AI in society, Data privacy and security, GPT models, Transformers, Large Language Models (LLMs), AI in autonomous systems (self-driving cars, drones), AI in healthcare, finance, and climate science.	[6]




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Reference/Text Book:

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig.
2. "Pattern Recognition and Machine Learning" by Christopher Bishop.
3. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
4. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy.
5. "Understanding Machine Learning: From Theory to Algorithms" by Shai Shalev-Shwartz and Shai Ben-David.
6. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto.
7. "Artificial Intelligence: Foundations of Computational Agents" by David L. Poole and Alan K. Mackworth.





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24MAD1105	PCC	Bridge Course	2-0-0	Audit
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Teaching Scheme	Examination Scheme
Lecture: 2 hrs /week	CA I: 25 Marks CA II: 25 Marks

Pre-Requisites: Cloud Computing

Course Contents:

- The Bridge Course is designed to equip students with fundamental cloud computing skills and hands-on experience.
- Students must create and maintain their own cloud accounts for hands-on labs. Be responsible for managing costs, especially with free-tier limits.
- Ensure all cloud lab exercises are completed as instructed. Follow the steps provided in the tutorials or documentation.
- Use the recommended course materials, AWS/Google documentation, and other official resources. Unauthorized use of third-party services for labs (e.g., copying others' solutions) is not allowed.
- students are encouraged to prepare for an cloud certification exam (e.g., AWS Certified Solutions Architect - Associate) as part of the course's completion.
- Follow the guidelines and ethical practices while using cloud services. Any misuse or violation of cloud policies will lead to penalties.
- Complete all course modules, labs, quizzes, and the final project to receive a course completion certificate.
- Grading will be based on participation, assignments, labs, and quizzes. Achieving a passing score is required to successfully complete the bridge course.




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24MAD1106A	PEC	Advanced Computer Networks	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs /week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Computer Networks

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the classification of network services, routing protocols and architectures.
CO2	Illustrate IPv6 Network.
CO3	Make use of routing protocol to solve the given network situation.
CO4	Demonstrate different Transport Layer Protocols
CO5	Examine the Application layer protocols
CO6	Distinguish wired and wireless networking concept




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Course Contents:

Unit 1: Internetworking Routing Algorithms: Distance Vector Routing, Bellman-ford algorithm, Link State Routing, Path Vector Routing, Congestion Control, Quality of Service, Queue Management, High Speed Networks, Performance Modeling and Estimation.	[6]
Unit 2: IPv6 IPv4 deficiencies, Transition from IPv4 to IPv6: Dual Stack, Tunneling, Header Translation, IPv6 addressing: Representation, address space, address space allocation, Auto configuration, Renumbering, IPv6 Protocol: Packet Format, Extension Header.	[6]
Unit 3: Unicast and Multicast Routing Protocols Introduction: Inter-domain, Intra-domain Routing, Unicast, Multicast and Broadcast, Unicast Routing Protocols: Internet structure, Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol Version 4. Multicast Routing Protocols: Multicast Distance Vector (DVMRP), Multicast Link State (MOSPF), Protocol Independent Multicast (PIM).	[6]
Unit 4: Transport Layer Protocols User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP features, Segment, A TCP Connection, State Transition Diagram, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timer, Options., SCTP: SCTP Services, SCTP features, Packet Format, SCTP association, Flow Control, Error Control.	[6]
Unit 5: Application Layer Protocols World wide web and HTTP, File Transfer: FTP & TFTP, Electronic Mail: Architecture, Web-based mail, Email Security, SMTP, POP, IMAP and MIME, SNMP. DNS: Concept of Domain name space, DNS operation, DHCP: Static and Dynamic Allocation, DHCP Operation, Remote Login: TELNET and SSH.	[6]
Unit 6: Ad Hoc Wireless Networks MAC Protocols for AdHoc Wireless Networks, Routing Protocols for Ad Hoc Wireless Networks, Multicast routing in Ad Hoc Wireless Networks, Transport Layer and Security Protocols for AdHoc Wireless Networks, Quality of Service in Ad Hoc Wireless Networks.	[6]
Reference/Text Book: 1. Behrouz Forouzan, "Data Communication and Networking", McGraw Hill. 2. Andrew Tanenbaum "Computer Networks", Prentice Hall.	





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3. William Stallings, "Data and Computer Communication", Pearson.
4. Kurose and Ross, "Computer Networking- A Top-Down Approach", Pearson.
5. Peterson and Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann.
6. W. A. Shay, "Understanding Communications and Networks", Cengage Learning.
7. D. Comer, "Computer Networks and Internets", Pearson.
8. Behrouz Forouzan, "TCP/IP Protocol Suite", McGraw Hill.




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24MAD1106B	PEC	Advanced Computer Architecture	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs /week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Computer organization and architecture

Course Outcomes: At the end of the course, students will be able to:

CO1	Summarize different computational models and processing techniques.
CO2	Illustrate the classifications & current trends of Computer Architecture; evaluate & compare System's performance using standard benchmarks.
CO3	Explain memory organization and memory structure of different architectures.
CO4	Identify the advanced RAID Levels, compare SAS vs SATA Disks & understand the implementation of a hierarchical Storage System.
CO5	Explain different software architectures and differences between System Area Networks, Storage Area Networks & analyze the current Networking Technologies for implementing them.
CO6	Outline the advanced microprocessor techniques & the salient features of state-of-the-art processors deployed in current High Performance Computing systems.





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Course Contents:

Unit1: Computational Models Basic computational models, interpretation to the concept of computer architectures at different levels of abstraction. Introduction to parallel Processing: basic concepts, program, process and threads in languages, concepts of parallel concurrency and parallel execution, types and levels of parallelism, classification of parallel architectures, basics parallel techniques, pipelining and replication applications. Pipelined Processors – basic concepts, design space of pipelines, case study: pipelined instruction processing in the Pentium processor and PowerPC 604, VLIW Architectures.	[6]
Unit2: System Architecture Flynn's Classification: SISD, SIMD, MISD, MIMD. Physical Models: PVP, MPP, SMP & Cluster of Workstations (COW). Memory Architectures: Shared, Distributed & Hybrid. UMA, NUMA, CC-NUMA.	[6]
Unit3: Memory organization Basic naming, allocation and accessing techniques, name mapping implementations, name translation before program execution, name translation by an executing program, memory interleaving, memory bandwidth and granularity, memory organizations for array processors, contentions in shared memory architectures, memory structure of SPARC, ALPHA AXP AND MC680*0 architectures.	[6]
Unit 4: Storage Internal/External , Disk Storage, Areal Density ,Seek Time ,Disk Power, Advanced RAID Levels, SATA vs SAS Disks ,Network Attached Storage (NAS) ,Direct Attached Storage (DAS), I/O Performance Benchmarks.	[6]
Unit 5: Software Architecture and System Interconnects Typical HPCC, Software Stack including Cluster Monitoring Tools, Public Domain Software like GANGLIA, CUDA Programming Environment. SAN : System Area Networks, Storage Area Networks including InfiniBand, Gigabit Ethernet, Scalable Coherent Interface (SCI) Standard.	[6]
Unit 6: Advanced Microprocessor Techniques CISC, RISC, EPIC, Superscalar, Superpipelined Architectures, Superscalar/ Superpipelined, In Order Execution /Out of Order Execution (OOO), ILP, TLP, Power Wall, Moore's Law Redefined, Multicore Technologies, Intel's Tick-Talk Model. Study of State-of-the- ART Processors : Intel / AMD X86-64 Bit Series: Intel Xeon Family (Xeon Haswell & Broadwell Architectures), Intel Xeon Phi	[6]





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Coprocessors (MIC Architecture) Intel/IBM Itanium/Power Series (Power 4 - Power 9).

Reference/Text Book:

1. John L. Hennessy and David Patterson, Computer Architecture : A Quantitative Approach, 6th Edition, Elsevier
2. Kai Hwang and Zhiwei Xu, Scalable Parallel Computers, McGraw- Hill, 1998.
3. Data Manuals of respective Processors available at Website
4. Peter S. Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann, Elsevier Series, 2011, ISBN:978-0-12-374260-5.
5. Computer Organization and Design: The hardware/Software Interface (4th edition),
6. By David A.Patterson and John L. Hennessy, Morgan Kaufmann, 2008.




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24MAD1106C	PEC	Advanced Database Technologies	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs /week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Database management system

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate the architecture and design of advanced database systems.
CO2	Apply NoSQL databases and NewSQL databases concepts.
CO3	Apply In-Memory Databases and Graph Databases.
CO4	Demonstrate Cloud-Based Database Technologies.
CO5	Apply skills in managing and analyzing big data.
CO6	Illustrate applications of IOT and edge with database.




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Course Contents:

Unit1: Introduction to Advanced Database Technologies	
Evolution of database systems: From RDBMS to NoSQL and beyond, Overview of modern data challenges: Big Data, real-time processing, and scalability, Introduction to advanced database technologies and their significance.	[6]
Unit2: NoSQL Databases and NewSQL Databases	
Introduction to NoSQL Database, Types-Key-value stores, Document databases, Column-family stores (e.g., Cassandra, HBase), Graph databases, Features of NoSQL, Advantages and disadvantages of NoSQL, Introduction to NewSQL Database, Characteristics of NewSQL databases, Advantages and disadvantages, Google Spanner, VoltDB, CockroachDB comparison between SQL, NoSQL, NewSQL.	[6]
Unit3: In-Memory Databases and Graph Databases	
Architecture and design of in-memory databases, SAP HANA, Redis, Memcached, Performance optimization using in-memory databases, Introduction to graph theory and data modeling, Query languages for graph databases: Cypher, Gremlin, Neo4j, Amazon Neptune, OrientDB, Applications: Social networks, recommendation systems, fraud detection.	[6]
Unit 4: Cloud-Based Database Technologies	
Overview of cloud database services: AWS RDS, Google Cloud Spanner, Azure Cosmos DB, Database as a Service (DBaaS) models, Scalability, availability, and disaster recovery in cloud databases, Security and compliance challenges in cloud-based database management.	[6]
Unit 5: Big Data and Distributed Data Processing	
Introduction to Big Data technologies and the Hadoop ecosystem, Distributed file systems (HDFS) and distributed computing (MapReduce), Real-time data processing with Apache Spark and Flink, Integration of Big Data technologies with modern database systems.	[6]
Unit 6: Emerging Trends and Future Directions	
Blockchain databases and decentralized data storage. Time-series databases (e.g., InfluxDB, TimescaleDB), Multi-model databases: ArangoDB, OrientDB, Database technologies for IoT and edge computing, Future trends in database technology: AI-	[6]





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driven databases, quantum databases.

Reference/Text Book:

1. "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Pramod J. Sadalage and Martin Fowler.
2. "NewSQL: Database Technology for Future-Scale Applications" by Guy Harrison.
3. "Graph Databases" by Ian Robinson, Jim Webber, and Emil Eifrem.
4. "In-Memory Data Management: Technology and Applications" by Hasso Plattner and Alexander Zeier.




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24MAD1107	PCC	Data Analytics & Visualization Laboratory	0-0-2	1 Credit
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Teaching Scheme	Examination Scheme
Practical: 2 hrs /week	CA I: 15 Marks CA II: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Basics of Programming, DBMS

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate the core concepts and processes involved in data analytics and visualization.
CO2	Illustrate different processes such as collect, clean, and preprocess data from various sources, ensuring data integrity and readiness for analysis.
CO3	summarize exploratory data analysis to data characteristics and identify patterns, trends, and anomalies.
CO4	Apply statistical techniques to analyze data, including descriptive statistics, inferential statistics, and regression analysis.
CO5	Design effective visualizations using various tools and techniques, ensuring clarity and accuracy in representing data insights.
CO6	Analyze real-world datasets to derive actionable insights and communicate findings effectively through ethical implications.




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Experiment List:

Minimum 7 experiments should be performed from the following list.

1. Import a dataset from CSV, Excel, or an online source (e.g., API or web scraping), Handle missing values (imputation, deletion), Perform data normalization, standardization, and data encoding (for categorical variables), Identify and remove outliers using statistical methods.
2. Generate descriptive statistics (mean, median, mode, variance), Visualize data distributions (histograms, box plots). Plot pairwise relationships (scatterplots, heatmaps) to analyze correlations. Detect patterns and trends in time-series data.
3. Plot bar charts, line charts, and pie charts for categorical and numerical data. Use advanced visualizations like violin plots, swarm plots, and pair plots. Customize visualizations (color palettes, legends, titles, labels).
4. Create interactive charts (bar, line, pie, maps). Use filters, slicers, and parameters to make the dashboard dynamic. Implement drill-down functionalities for deeper insights. Share or publish the dashboard.
5. Preprocess text data (tokenization, stemming, lemmatization). Perform sentiment analysis using TextBlob or VADER. Visualize the results using word clouds, bar charts, and pie charts for sentiment distribution. Perform basic text classification to categorize positive and negative reviews.
6. Apply the Apriori algorithm to a dataset (e.g., supermarket transactions). Generate frequent itemsets and association rules. Visualize the results using bar charts and network graphs.
7. Plot and analyze time-series data (e.g., stock prices, sales data). Decompose the time series into trend, seasonality, and noise. Apply time series forecasting models (ARIMA, Exponential Smoothing). Visualize forecasted values and evaluate the model performance.
8. Create and populate a database with sample data. Write SQL queries to extract, aggregate, and analyze data (e.g., GROUP BY, JOIN, HAVING). Perform advanced operations like window functions for data analytics. Visualize query results using Python.
9. Load and plot geospatial data (e.g., city locations, customer distributions). Create maps and visualize data points on geographic regions. Perform spatial analysis (e.g., distance calculations, clustering based on location). Use heatmaps or choropleth maps to visualize density or distribution.





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24MAD1108	PCC	Artificial Intelligence & Machine Learning Laboratory	0-0-2	1 Credit
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Teaching Scheme	Examination Scheme
Practical: 2 hrs /week	CA I: 15 Marks CA II: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Probability and Statistics, Basics of programming

Course Outcomes: At the end of the course, students will be able to:

CO1	Outline fundamental concepts, history, and definitions of Artificial Intelligence (AI) and Machine Learning (ML).
CO2	Implement various supervised learning algorithms and evaluate models using different performance metrics.
CO3	Demonstrate unsupervised learning concepts and apply clustering algorithms.
CO4	Implement feedforward, convolutional (CNN), and recurrent neural networks (RNNs) to solve complex problems classification or prediction.
CO5	Summarize reinforcement learning concepts including agents, environments, rewards, and policies.
CO6	Evaluate ethical concerns related to AI, including bias, fairness, transparency, and privacy in machine learning models.





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Experiment List:

Minimum 7 experiments should be performed from the following list.

1. Implement Depth-First Search (DFS) and Breadth-First Search (BFS) for solving problems like a maze or a puzzle. Implement A* Search Algorithm and compare it with DFS and BFS. Analyze the performance and complexity of each algorithm.
2. Use a binary classification dataset (e.g., Titanic dataset). Implement logistic regression using Scikit-learn. Visualize the decision boundary. Evaluate the model using accuracy, confusion matrix, and ROC-AUC curve.
3. Implement KNN algorithm from scratch or use Scikit-learn. Test the model on datasets like Iris or Breast Cancer. Tune hyperparameters such as k-value (number of neighbors) and distance metrics. Evaluate the model performance using confusion matrix and cross-validation.
4. Train a decision tree classifier on a dataset (e.g., Wine dataset). Visualize the decision tree. Perform pruning to avoid overfitting. Evaluate model performance using metrics like accuracy and confusion matrix.
5. Implement SVM using the Scikit-learn library. Train the SVM on datasets such as Iris or Breast Cancer. Experiment with different kernels (linear, polynomial, RBF) and tune hyperparameters. Visualize the decision boundary and evaluate the model performance.
6. Implement K-Means algorithm to cluster a dataset (e.g., Iris or Mall Customers dataset). Determine the optimal number of clusters using the elbow method. Visualize the clusters and centroids.
7. Apply PCA on a high-dimensional dataset (e.g., Wine dataset). Visualize the explained variance for each principal component. Reduce the dataset to two or three dimensions and visualize the clusters. Use the reduced dataset for further classification tasks.
8. Load and preprocess an image dataset (e.g., CIFAR-10 or MNIST). Build a simple CNN with convolutional and pooling layers. Train the CNN and evaluate its performance using accuracy and loss. Visualize the training process and model predictions on test images.
9. Implement the Q-Learning algorithm. Apply it to simple environments like the Frozen Lake or CartPole problem from OpenAI Gym. Visualize the agent's performance as it learns over time. Tune hyperparameters like learning rate and discount factor to optimize the agent's behavior.





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24MAD1109	AEC	Effective Communication Skills	0-0-2	1 Credit
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Teaching Scheme	Examination Scheme
Practical: 2 hrs /week	CA I: 25 Marks CA II: 25 Marks

Pre-Requisites: Basics of communication skills, Ethics

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate the ability to communicate effectively in verbal and non-verbal forms.
CO2	Examine proficiency in written communication across different formats.
CO3	Demonstrate presentation and public speaking skills with confidence and clarity.
CO4	Apply interpersonal communication skills to effectively manage and resolve conflicts.
CO5	Develop the ability to communicate in group discussions, debates, and team settings.
CO6	Adapt the ability of various communication style and techniques to diverse audiences.




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Experiment List:

Minimum 7 experiments should be performed from the following list.

1. Self-Introduction Practice- Each student prepares a 1–2-minute self-introduction covering their background, interests, and goals. Practice in front of peers, focusing on tone, clarity, and confidence. Receive feedback on body language, eye contact, and speaking style.
2. Group Discussion on Current Topics- Form small groups to discuss current events or topics relevant to the field of study (e.g., AI advancements, climate change). Each group member is encouraged to express their thoughts clearly and contribute to the discussion. Evaluate participation based on coherence, confidence, listening skills, and respect for differing opinions.
3. Presentation Skills Development- Each student prepares a short presentation (3-5 minutes) on a chosen topic. Focus on structure (introduction, body, conclusion), use of visuals (PowerPoint), voice modulation, and engagement with the audience. Peers and instructors give constructive feedback on clarity, body language, and interaction with the audience.
4. Email Writing and Professional Communication- Students draft emails for different situations: job applications, customer service inquiries, internal team communication, etc. Focus on professionalism, tone, clarity, and structure (subject line, salutation, body, closing). Provide feedback on grammar, tone, conciseness, and whether the message meets its intended purpose.
5. Debate on Controversial Topics- Organize a formal debate on a controversial or thought-provoking topic (e.g., "Social Media is a Blessing or a Curse"). Students are divided into teams to present arguments for and against the topic. Focus on structured arguments, use of evidence, rebuttals, and persuasive language. Evaluate based on clarity, coherence, logical reasoning, and emotional appeal.
6. Negotiation Skills Simulation- Simulate real-world negotiation scenarios (e.g., salary negotiation, resolving a workplace conflict). Practice negotiation techniques such as establishing common ground, assertiveness, compromise, and maintaining a calm demeanor. Evaluate based on the ability to communicate needs clearly, listen actively, and reach a mutually beneficial agreement.
7. Mock Job Interview- Conduct mock interviews where students take on the role of





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interviewees for different job roles. Focus on answering common interview questions (e.g., "Tell me about yourself", "What are your strengths and weaknesses?"). Provide feedback on verbal responses, body language, professionalism, and ability to handle challenging questions. Students learn to communicate their qualifications and personality confidently.

8. Understanding Non-Verbal Communication- Analyze non-verbal cues in different videos or role-play activities. Have students practice using appropriate gestures, posture, and eye contact in various communication scenarios. Provide feedback on how non-verbal communication aligns with their verbal message.
9. Team Communication and Collaboration- Organize a group task (e.g., solving a case study, creating a presentation, or brainstorming ideas). Assign roles within the team (leader, presenter, researcher) and encourage collaboration. Assess communication within the team, leadership, listening skills, and how ideas are shared effectively.





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Department: AIDS

Rev: Course Structure/01/NEP/2024-25

Class: F.Y. M.Tech

Semester: II

Course Code	Type of Course	Course	Teaching Scheme					Evaluation Scheme				
			L	T	P	Credits	Total Hrs	CA1	CA2	MSE	ESE	Total
24MAD1201	PCC	Algorithm & Complexity Theory	3	-	-	3	3	10	10	30	50	100
24MAD1202	PCC	Deep Learning & Generative AI	3	-	-	3	3	10	10	30	50	100
24MAD1203	PCC	Reinforcement Learning	3	-	-	3	3	10	10	30	50	100
24MAD1204	ESC	Cyber Security and Computing	3	-	-	3	3	10	10	30	50	100
24MAD1205	PEC	Elective – II	3	-	-	3	3	10	10	30	50	100
24MAD1206	HSSM	Project Management	1	-	-	Audit	1	25	25	--	--	50
24MAD1207	PCC	Deep Learning & Generative AI Laboratory	-	-	2	1	2	15	15	--	20	50
24MAD1208	VSEC	Cyber Security and Computing Laboratory	-	-	2	1	2	15	15	--	20	50
24MAD1209	AEC	Presentation skills	-	-	2	1	2	25	25	--	--	50
			16	-	6	18	22	130	130	150	310	700

Elective – II: One subject to be chosen from the following subjects.

Code	Subjects
24MAD1205A	High Performance Computing
24MAD1205B	Computer Vision
24MAD1205C	Natural Language Processing




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24MAD1201	PCC	Algorithm & Complexity Theory	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture:3hrs/week	CA I:10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Design Analysis of Algorithms, Data Structure.

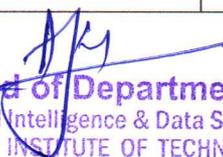
Course Outcomes: At the end of the course, students will be able to:

CO1	Relate basics of algorithm for performance of different types of algorithms using Divide and conquer.
CO2	Illustrate greedy Approach and Analyze the performance by taking different examples.
CO3	Analyze dynamic approach and the performance by taking different examples.
CO4	Design algorithm by applying backtracking technique.
CO5	Design NP Hard and NP Complete Problems.
CO6	Solve problems of branch and bound by comparing performance with backtracking.

Course Contents:

Unit 1: Divide and Conquer What is algorithm, Algorithm Specification, Divide and Conquer-The general method, Binary search, finding the maximum and minimum, Merge sort, Quick sort, Selection sort and analysis of these algorithms. Strassen's matrix multiplication Advantages and Disadvantages of divide and conquer.	[6]
Unit 2: The Greedy method The general method, General method, Coin Change Problem, Activity Selection Problem, Huffman Coding Knapsack problem, Job sequencing with deadlines, Minimum-cost spanning trees – Prim's and Kruskal's Algorithms, Single source shortest paths. Transform and Conquer Approach:Heaps and Heap Sort.	[6]
Unit 3: Dynamic Programming Introduction, Characteristics of Dynamic Programming All Pairs Shortest Paths: Floyd's Algorithm, Optimal Binary Search Trees, Knapsack problem Bellman-Ford Algorithm Travelling Sales Person problem, Reliability design.	[6]




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Unit 4: Basic Traversal and Search Techniques and Backtracking	
Techniques for Binary Trees, Techniques for Graphs – Breadth First Search & Traversal, Depth First Search & Traversal, AND/OR graphs; Backtracking Concept, N-Queens Problem, four-Queens Problem, eight-Queen Problem, Hamiltonian Cycle, Sum of Subsets Problem, Graph Coloring Problem.	[6]
Unit 5: NP Hard and NP Complete Problems	
Basic concepts, non-deterministic algorithms, P, NP, NP-Complete, and NP-Hard classes.	[6]
Unit 6: Branch and Bound	
Introduction, Traveling Salesperson Problem, 15-Puzzle Problem, Comparisons between Backtracking and Branch and Bound.	[6]
Text Books:	
<ol style="list-style-type: none">1. Fundamentals of Computer Algorithms - Ellis Horowitz, Satraj Sahani, Saguthevar Rajasejaram, Universities Press, Second Edition.2. Cormen, Introduction to Algorithms, PHI Publication, 2nd Edition, 2002.3. Sara Base, Computer algorithms: Introduction to Design and Analysis, Addison-Wesley Publication, 2nd Edition.	
Reference Books:	
<ol style="list-style-type: none">1. Fundamentals of Algorithmic – Gilles Brassard, Paul Bratley (Pearson Education).2. Mastering Algorithms with C – Kyle Loudon (SPD O'Reilly).3. Computer Algorithms- Introduction to Design and Analysis – Sara Baase, Allen Van Gelder (Pearson Education).4. Michel Goodrich, Roberto Tamassia, Algorithm Design – Foundation, Analysis & Internet Examples, Wiley Publication, 2nd Edition, 2006	




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24MAD1202	PCC	Deep Learning & Generative AI	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA I:10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Engineering Mathematics I & II, Machine Learning.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall the foundational concepts of Deep Learning.
CO2	Demonstrate the architecture of Deep Neural Network.
CO3	Apply the regularization techniques and Autoencoders.
CO4	Construct the architectures of neural networks including CNN.
CO5	Analyze sequence modeling using RNN.
CO6	Develop the ability to apply deep learning and generative models to real-world problems.

Course Contents:

Unit 1: Introduction to Deep Learning Overview of AI, Machine Learning, and Deep Learning, Bias-Variations trade-off, History and milestones in deep learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron, Perceptron Learning Algorithm	[6]
Unit 2: Deep Neural Networks Feedforward neural networks, Multilayer Perceptron (MLPs), Backpropagation algorithm, Activation functions, Gradient descent and its variants (SGD, Adam, RMSprop)	[6]
Unit 3: Autoencoders and Regularization Autoencoder: Use of Autoencoders, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders. Regularization: Bias-Variance Trade-off, Overfitting and regularization techniques, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise, Dropout.	[6]



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Unit 4: Convolutional Neural Networks (CNNs) Convolution, pooling, and architecture, Convolution Algorithm, Popular CNN architectures (LeNet, AlexNet, VGG, ResNet), Unsupervised Features, and Neuroscientific for convolution Network.	[6]
Unit 5: Sequence Modelling Recurrent Neural Networks (RNNs), Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks and Echo State Networks.	[6]
Unit 6: Generative Deep Learning Introduction to GANs: Concept and architecture, Training GANs: Generator and Discriminator dynamics, Introduction to transformers for generative tasks, Generative Pre-trained Transformers (GPT) and variants. Evaluating and Deploying Generative Models: valuation metrics: Inception Score, Fréchet Inception Distance (FID), Ethical implications of deep learning and generative AI: Addressing bias and fairness in AI models, Deepfakes, misinformation, and societal impacts.	[6]
Text Books: <ol style="list-style-type: none">1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, “Deep Learning”2. David Foster, “Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play”, O’Reilly Publications	
Reference Books: <ol style="list-style-type: none">1. François Chollet, “Deep Learning with Python”, Manning Publications Co.2. Charu C. Aggarwal “Neural Networks and Deep Learning”, Springer.	




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24MAD1203	PCC	Reinforcement Learning	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Probability and Statistics, Python Programming, Machine Learning.

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand fundamental concepts of Reinforcement Learning.
CO2	Demonstrate Bandit Algorithms and Policy Gradient methods to solve decision-making problems.
CO3	Summarize various algorithms of RL and the role of Bellman Optimality.
CO4	Analyze the role of Dynamic Programming, and TD Methods in RL.
CO5	Develop function approximation techniques and least squares methods for RL.
CO6	Elaborate advanced RL techniques such as DQN, Hierarchical RL, and POMDPs.

Course Contents:

Unit 1: Introduction to Reinforcement Learning Definition of RL, comparison with supervised and unsupervised learning Elements of RL: Agent, Environment, State, Actions, Rewards, Policy, Value Function Markov Decision Processes (MDP): States, Actions, Transition Probabilities, Rewards Bellman Equation and Optimality Principle Applications of RL in Robotics, Finance, Healthcare, and Gaming	[6]
Unit 2: Bandit Algorithms – UCB, PAC Multi-Armed Bandit (MAB) problem, Exploration vs. Exploitation trade-off, Upper Confidence Bound (UCB) algorithm, Probably Approximately Correct (PAC) framework, Regret minimization, Median Elimination for MABs, Sample complexity analysis, Introduction to Policy Gradient methods, Monte Carlo Policy Gradient (REINFORCE algorithm), Advantages of Policy Gradient methods	[6]
Unit 3: Full RL & MDPs, Bellman Optimality Markov Decision Processes (MDPs), State transition probabilities and reward	[6]

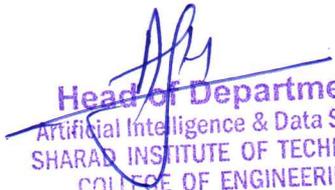


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function, Discount factor and return, Value functions (state-value and action-value functions) Bellman Equations, Bellman Expectation Equations, Bellman Optimality Equations, Policy Evaluation and Policy Improvement, Value Iteration and Policy Iteration Convergence of Bellman Equations	
Unit 4: Dynamic Programming & TD Methods, Eligibility Traces Dynamic Programming (DP) for MDPs, Monte Carlo vs. Temporal Difference (TD) Learning, TD (0) and TD(λ) methods, Off-policy vs On-policy learning Q-learning and SARSA algorithms, Definition of eligibility traces, Forward and backward view of TD(λ), Relationship between TD and Monte Carlo methods Implementing eligibility traces in RL algorithms, Lambda-return estimation	[6]
Unit 5: Function Approximation & Least Squares Methods Need for function approximation in RL, Linear function approximation, Nonlinear function approximation using Neural Networks, Trade-offs: Bias-variance, Stability, Convergence, Stochastic Gradient Descent (SGD) in RL, Least Squares Temporal Difference (LSTD) learning, Least Squares Policy Iteration (LSPI), Least Squares Q-learning (LSQ), Importance sampling and function approximation, Stability and convergence properties	[6]
Unit 6: Hierarchical RL & POMDPs (Partially Observable MDPs) Full RL, Motivation for Hierarchical RL, Options Framework, Semi-Markov Decision Processes (SMDPs), Temporal Abstraction in RL, Hierarchical DQN (h-DQN) Introduction to POMDPs, Belief States and Filtering, Planning in POMDPs, Approximate methods for solving POMDPs, Applications of POMDPs in real-world RL problems	[6]
Text Books: <ol style="list-style-type: none">1. Reinforcement Learning: An Introduction – Richard S. Sutton & Andrew G. Barto2. Dynamic Programming and Optimal Control – Dimitri P. Bertsekas3. Reinforcement Learning and Optimal Control – Dimitri P. Bertsekas.	
Reference Books: <ol style="list-style-type: none">1. Reinforcement Learning: State-of-the-Art – Marco Wiering & Martijn van Otterlo2. Approximate Dynamic Programming – Warren B. Powell	




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24MAD1204	PCC	Cyber Security and Computing	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA I:10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Engineering Mathematics I & II, Machine Learning.

Course Outcomes: At the end of the course, students will be able to:

CO1	Illustrate the principles of Control hijacking, Software architecture.
CO2	Explain the principles cold-boot attacks, defence.
CO3	Demonstrate Malware - Viruses and worms, spyware, key loggers, and bot nets.
CO4	Analyse concepts of Host and Application security.
CO5	Explain various techniques like Mobile, GSM.
CO6	Explain principles of various modern Wireless LAN security techniques.

Course Contents:

Unit 1: Critical characteristics of Information NSTISSC Security Model -Components of information System –SDLC – Information assurance - Security Threats and vulnerabilities - Overview of Security threats— Security Standards.	[6]
Unit 2: Classical Cryptography Symmetric Cryptography- Asymmetric Cryptography - Modern Cryptography – Access Control - DRM – Steganography – Biometrics. Network security - Intrusion Prevention, detection and Management - Firewall – Ecommerce Security - Computer Forensics - Security for VPN and Next Generation Networks paths.	[6]
Unit 3: Host and Application security Control hijacking, Software architecture and a simple buffer overflow - Common exploitable application bugs, shell code - Buffer Overflow - Side-channel attacks - Timing attacks, power analysis, cold-boot attacks, defences – Malware - Viruses and worms, spyware, key loggers, and bot nets; defences auditing, policy - Defending weak applications - Isolation, sandboxing, virtual machines.	[6]

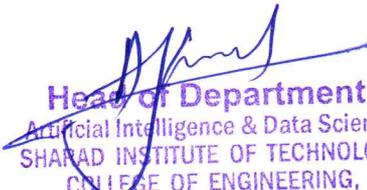


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Unit 4: Mobile, GSM and Wireless LAN security	
Protection measures - Business risk analysis – Information Warfare and Surveillance – Case study on Attack prevention, detection and response.	[6]
Unit 5: Cloud Computing	
Cloud Concepts, Architecture and Design, Cloud Data Security, Cloud Platform & Infrastructure Security, Cloud Application Security, Cloud Security Operations, Legal, Risk and Compliance.	[6]
Unit 6: Security	
Access Controls, Security Operations and Administration, Risk Identification, Monitoring, and Analysis Incident Response and Recovery, Cryptography, Network and Communications Security Systems and Application Security.	[6]
Text Books:	
1. William Stallings, “Cryptography and Network Security: Principles and Practice”, 6 th Edition, PHI, 2014.	
2. Michael E. Whitman and Herbert J Mattord, "Principles of Information Security", 6 th edition, Vikas Publishing House, 2017.	
Reference Books:	
1. Bill Nelson, Amelia Phillips, F.Enfinger and Christopher Stuart, “Guide to Computer Forensics and Investigations, 4 th ed., Thomson Course Technology, 2010.	
2. Matt Bishop, “Computer Security: Art and Science”, 1 st edition, Addison-Wesley Professional, 2015.	




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24MAD1205A	PEC	High Performance Computing	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA I:10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basics of Programming, Computer Architecture

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the fundamentals of High-Performance Computing.
CO2	Demonstrate parallel programming solutions using OpenMP and MPI.
CO3	Analyze GPU-based applications using CUDA/OpenCL for high-performance computing.
CO4	Elaborate scientific computing libraries (BLAS, LAPACK, PETSc) for numerical computations.

Course Contents:

Unit 1: Introduction to High Performance Computing Overview of High-Performance Computing (HPC) and Scientific Computing, Importance of HPC in scientific and engineering applications, Evolution of computing: From single-core to multi-core to distributed computing, Supercomputers and clusters: Architecture and applications, Basics of processor architecture and performance metrics, Understanding Memory Hierarchy (Registers, Cache, RAM, Disk), Multi-core processors: Challenges and benefits, Introduction to Vector Processing and SIMD (Single Instruction Multiple Data), Overview of hardware accelerators (FPGAs, GPUs, TPUs).	[6]
Unit 2: Parallel Programming & Algorithms The limits of serial computing, Models of parallel computing: Shared memory, Distributed memory, Hybrid models, Flynn's taxonomy: SISD, SIMD, MISD, MIMD, Parallel programming paradigms: Task parallelism vs. Data parallelism, Speedup and efficiency: Amdahl's Law and Gustafson's Law, Introduction to parallel algorithms: Sorting, Matrix Multiplication, Graph Algorithms, Understanding OpenMP: API, compilation, and execution, Thread creation, parallel regions, and synchronization, Fork-Join model in OpenMP, Parallel loops and workload distribution.	[6]
Unit 3: OpenMP Programming OpenMP task-based parallelism, Data locality and memory optimizations, Thread synchronization: Mutex, Critical sections, Barriers, Dynamic vs. Static scheduling,	[6]

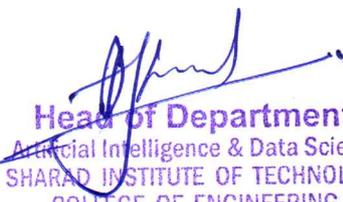


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Nested parallelism and performance tuning, Debugging OpenMP programs, Message Passing Interface (MPI): Overview and need, Distributed memory programming model, Basic MPI functions: MPI_Init, MPI_Comm_size, MPI_Comm_rank, MPI_Finalize, Point-to-point communication: MPI_Send and MPI_Recv, Blocking vs. Non-blocking communication.	
Unit 4: Advanced MPI Collective Communication: Broadcast, Scatter, Gather, Reduce, Communicators and groups in MPI, MPI derived data types and data distribution strategies, Performance considerations in MPI applications, Hybrid MPI+OpenMP programming, Debugging MPI programs with tools like TotalView, mpiP.	[6]
Unit 5: Introduction to GPGPU / Vector Programming Introduction to General-Purpose GPU (GPGPU) computing, GPU architecture: CUDA cores, Memory hierarchy, Threads and Warps, Difference between CPU vs. GPU computing, Introduction to CUDA programming: Memory management, thread synchronization, Introduction to OpenCL, Debugging challenges in parallel computing, Debugging tools: GDB, Valgrind, TotalView, DDT, Intel Inspector, Deadlock detection and race conditions, Profiling parallel programs using gprof, perf, and Intel VTune.	[6]
Unit 6: Performance Analysis of Parallel Programming Performance metrics: Speedup, Efficiency, Scalability, Load Balance, Profiling tools: TAU, PAPI, HPCToolkit, Bottleneck analysis in parallel applications, Performance optimization in real-world HPC applications, Introduction to BLAS (Basic Linear Algebra Subprograms), LAPACK (Linear Algebra Package), PETSc (Portable, Extensible Toolkit for Scientific Computation)	[6]
Reference Books/Text Books: 1. The Sourcebook of Parallel Computing (Dongarra et. al.) Publisher: Morgan Kaufmann; 1 edition (November 25, 2002). 2. Parallel programming with MPI (Peter Pacheco) 3. An Introduction to Parallel Programming with OpenMP, PThreads and MPI (Cook's Books) by Robert Cook	




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24MAD1205B	PEC	Computer Vision	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA I:10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Calculus, Linear algebra, Probability, Programming knowledge.

Course Outcomes: At the end of the course, students will be able to:

CO1	Outline the Fundamentals of Image Formation and Transformation Techniques.
CO2	Summarize Geometric Concepts in Image Processing and 3D Reconstruction.
CO3	Apply Feature Detection and Extraction Techniques in Images.
CO4	Analyze Image Segmentation and Object Detection Techniques.
CO5	Explain Clustering, Classification, and Dimensionality Reduction Techniques in Image Analysis.
CO6	Elaborate Motion Analysis and Surface Modeling Techniques in Computer Vision.

Course Contents:

Unit 1: Digital Image Formation and low-level processing Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.	[6]
Unit 2: Depth estimation and Multi-camera views Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.	[6]
Unit 3: Feature Extraction Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.	[6]
Unit 4: Image Segmentation Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.	[6]




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Unit 5: Pattern Analysis	
Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.	[6]
Unit 6: Motion Analysis & Shape from X	
Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.	[6]
Reference Books/Text Books:	
<ol style="list-style-type: none">1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 20065. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.6. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.	




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24MAD1205C	PEC	Natural Language Processing	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Python, probability & statistics, linear algebra.

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain fundamental concepts of Natural Language Processing and text processing.
CO2	Illustrate various language modelling and POS tagging techniques.
CO3	Construct syntactic structures using parsing algorithms.
CO4	Experiment with word representations using distributional semantics.
CO5	Analyze entity linking solutions using knowledge graphs and NER-based techniques.
CO6	Elaborate text summarization and classification models.

Course Contents:

Unit 1: Introduction to NLP and Basic Text Processing Overview of Natural Language Processing (NLP) and its applications, Text preprocessing techniques: Tokenization (Word and Sentence Tokenization), Stopword removal, Stemming, and Lemmatization, Regular expressions for text processing, Text normalization (lowercasing, handling punctuation, spelling correction), Spelling Correction: Edit Distance (Levenshtein, Damerau-Levenshtein), Noisy Channel Model, Probabilistic spelling correction (Bayesian approach), Language Modeling: Unigram, Bigram, Trigram models, Probability estimation using Maximum Likelihood Estimation (MLE), Applications in speech recognition, machine translation.	[6]
Unit 2: Language Modeling and POS Tagging Smoothing techniques: Additive (Laplace) smoothing, Good-Turing smoothing, Kneser-Ney smoothing Part-of-Speech (POS) Tagging: Rule-based, statistical, and neural POS tagging approaches, Hidden Markov Model (HMM) for POS tagging, POS tagging with NLTK, spaCy, and Stanza Maximum Entropy Markov Models (MEMM): Concept and training, Applications in	[6]




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sequence tagging (NER, Chunking) Conditional Random Fields (CRF): Advantages over HMM and MEMM, Feature engineering for CRF models.	
Unit 3: Parsing Syntactic structures in language, Context-Free Grammars (CFG), Probabilistic Context-Free Grammars (PCFG), CKY Parsing algorithm, Applications of syntactic parsing (e.g., Grammar Checking), Introduction to Dependency Grammar, Projective and non-projective parsing, Transition-based vs. Graph-based dependency parsing, Neural dependency parsing (BiLSTM, Transformer-based parsers).	[6]
Unit 4: Distributional Semantics Vector Space Models for Words: Word Similarity: Cosine similarity, Jaccard similarity Word Embeddings: Word2Vec (CBOW & Skip-gram), GloVe, FastText Dimensionality Reduction: PCA, t-SNE for visualization. Word Sense Disambiguation (WSD): Knowledge-based WSD (Lesk Algorithm, WordNet-based approaches), Supervised and Unsupervised WSD methods, Semantic Similarity and Textual Entailment, Named Entity Recognition (NER) using word embeddings and deep learning.	[6]
Unit 5: Entity Linking and Information Extraction Latent Semantic Analysis (LSA), Latent Dirichlet Allocation (LDA): Understanding document-topic-word distributions, Gibbs Sampling for LDA. Neural topic modeling (e.g., Neural Variational Inference for Topic Modeling), Entity Linking: Named entity recognition (NER) vs. entity linking, Knowledge Graph-based entity linking, Information Extraction (IE): Relation extraction, Coreference resolution.	[6]
Unit 6: Text Summarization and Sentiment Analysis Text Summarization: Extractive summarization (TextRank, LexRank), Abstractive summarization using Transformers. Text Classification: Naïve Bayes, Logistic Regression, and SVM for text classification, Deep learning for text classification (RNNs, CNNs, Transformers), Introduction to Sentiment Analysis, Lexicon-based vs. Machine Learning-based approaches, Sentiment classification using Naïve Bayes, LSTMs, and Transformers (BERT, RoBERTa), Aspect-based sentiment analysis.	[6]
Reference Books/Text Books: 1. Dan Jurafsky and James Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Prentice Hall, Second Edition, 2009. 2. Chris Manning and Hinrich Schütze. Foundations of Statistical Natural Language Processing. MIT Press, Cambridge, MA: May 1999.	




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24MAD1206	HSSM	Project Management	1-0-0	Audit
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Teaching Scheme	Examination Scheme
Lecture: 1 hr/week	CA I:25 Marks CA II: 25 Marks

Pre-Requisites: Nil.

Course Outcomes: At the end of the course, students will be able to:

CO1	Outline fundamental concepts of project management and its lifecycle.
CO2	Summarize human resource management and contracting in projects.
CO3	Apply project management tools and techniques for scheduling and tracking.
CO4	Examine project feasibility, cost estimation, and performance measures.
CO5	Determine risk analysis and risk management strategies.
CO6	Recommend financing strategies for projects.

Course Contents:

Unit 1: Introduction to Project Management	
Concepts of projects, characteristics of project, Phases of project life cycle, Tools and techniques for project management, Computer based project management.	[2]
Unit 2: Organizing Human Resources and Contracting	
Delegation, Skills / abilities required for project manager, Authorities and responsibilities of project manager, Project organization, Contracts, Tendering and Selection of contractors.	[2]
Unit 3: Tools and techniques of project management	
Bar (GANTT) chart, Networks – PERT and CPM, Applications, Basic steps in PERT/CPM, Rules for drawing network diagram, Labelling, Time estimates, Critical Path Method, Project Evaluation and Review Technique (PERT).	[2]
Unit 4: Project planning, estimating and Performance measures	
Feasibility report, Preparation of cost estimation, Evaluation of the project profitability. Performance indicators, Performance Improvement, Project management and environment.	[2]




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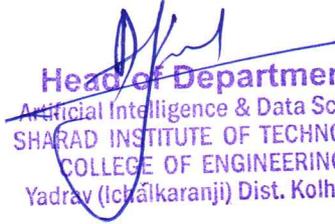


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Unit 5: Risk Analysis	
Sources, measures and perspectives on risk, sensitivity analysis, scenario analysis, breakeven analysis, Hiller model, simulation analysis, decision tree analysis, managing risk, project selection under risk.	[2]
Unit 6: Financing of Projects	
Capital structure, menu of financing, equity capital, internal accruals, term loans, debentures, working capital advance, miscellaneous sources, raising of venture capital, raising capital in international markets.	[2]
Reference Books/Text Books:	
<ol style="list-style-type: none">1. A Guide to the Project Management Body of knowledge PMBOK Guide 6th Edition, Project Management Institute 2017.2. Project management a system approach to planning scheduling and controlling- Harold Kerzner, CBS Publisher and distributors, 2002.3. Project Management: Choudhry S., Tata McGraw-Hill,2010.4. Projects: Planning, Analysis, Financing, Implementation, and Review-Prasanna Chandra, 5th edition, Tata McGraw-Hill publishing company limited,2005.	




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24MAD1207	PCC	Deep Learning & Generative AI Laboratory	0-0-2	1 Credit
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Teaching Scheme	Examination Scheme
Practical: 2 hrs/week	CA I: 15 Marks CA II: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Python, Data Science, Machine Learning.

Course Outcomes: At the end of the course, students will be able to:

CO1	Construct deep learning models using popular frameworks.
CO2	Apply key concepts in neural networks, including backpropagation and gradient descent.
CO3	Design, train, and evaluate deep learning models for tasks such as image classification, natural language processing, and more.
CO4	Experiment with advanced topics like transfer learning, GANs.
CO5	Demonstrates deep learning techniques for real-world problems.
CO6	Construct deep learning models using popular frameworks.

Practical List:

1. Set up a deep learning environment and run a basic neural network on a simple dataset.
2. Implement single layer neural network.
3. Implement and train a simple feedforward neural network for a classification task.
4. Explore overfitting in neural networks and apply regularization.
5. Build and train a CNN for image classification (e.g., CIFAR-10 dataset).
6. Implement an RNN model for text generation or sentiment analysis.
7. Apply transfer learning to a new dataset using a pre-trained model (e.g., ResNet, Inception).
8. Design a model for Text generation using LSTM
9. Implement and train a GAN to generate synthetic images.
10. Experiment with Transformer models for text processing (e.g., BERT, GPT).




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24MAD1208	VSEC	Cyber Security and Computing Laboratory	0-0-2	1 Credit
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Teaching Scheme	Examination Scheme
Practical: 2 hrs/week	CA I:15 Marks CA II: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Engineering Mathematics I & II, Machine Learning.

Course Outcomes: At the end of the course, students will be able to:

CO1	Apply fundamental cryptographic techniques, including substitution and transposition ciphers, to encrypt and decrypt messages, ensuring data confidentiality.
CO2	Analyze various encryption algorithms such as DES, RSA, Diffie-Hellman, MD5, and SHA-1 to evaluate their effectiveness in securing communication and data integrity.
CO3	Evaluate security mechanisms such as digital signatures, intrusion detection systems, and honeypots to assess their role in protecting networks and detecting threats.
CO4	Create secure data storage and transmission methods using cryptographic techniques, and demonstrate ethical hacking practices such as wireless auditing and rootkit analysis.

Practical List:

1. Important commands for data and network security.
2. Program in C++ to generate pseudo-Random numbers in a range.
3. Program in C++ for XOR Encryption and Decryption.
4 A. Implement the following substitution & transposition techniques concepts: a) Caesar Cipher b) Playfair Cipher c) Hill Cipher d) Vigenere Cipher e) Rail fence – row & Column Transformation
4 B. Implement the following algorithms: a) DES b) RSA Algorithm c) Diffiee-Hellman d) MD5 e) SHA-1
5. Implement the Signature Scheme - Digital Signature Standard.
6. Demonstrate how to provide secure data storage, secure data transmission and for creating digital signatures.



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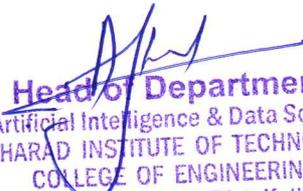


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7. Setup a honey pot and monitor the honeypot on network.
8. Installation of rootkits and study about the variety of options.
9. Perform wireless audit on an access point or a router and decrypt WEP and WPA.
10. Demonstrate intrusion detection system using any tool.
11. Study of Cryptool in security.




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24MAD1209	AEC	Presentation Skills	0-0-2	1 Credit
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Teaching Scheme	Examination Scheme
Practical: 2 hrs/week	CA I: 25 Marks CA II: 25 Marks

Pre-Requisites: Communication Skills.

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate the ability to comprehend and explain complex technical topics effectively.
CO2	Develop critical thinking and analytical skills to evaluate research and technical content.
CO3	Apply professional communication strategies, including storytelling and debate techniques, for effective knowledge sharing.
CO4	Demonstrate proficiency in delivering structured presentations using modern digital tools and engaging in live discussions.

Practical List:

1. Choose a recent research topic (e.g., AI, edge computing, blockchain) and present it within 10 minutes.
2. Select a random technical topic and speak about it for 5 minutes without preparation.
3. Summarize any research problem, methodology, and expected results in 15 minutes.
4. Create a research poster on a published paper and present it in 5 minutes.
5. Choose a complex AI topic (e.g., neural networks, distributed systems) and teach it to peers in 10 minutes.
6. Present a piece of code (e.g., ML model, data structure) and explain its working, challenges, and optimizations.
7. Conduct a debate on recent topics.
8. Choose a research paper, present its strengths and weaknesses, and suggest improvements.
9. Use storytelling techniques to explain a technical topic (e.g., using an analogy to explain deep learning).
10. Deliver a 5-minute presentation on a technical topic via an online platform (e.g., Zoom) with live Q&A.




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