SANTHIRAM ENGINEERING COLLEGE, NANDYAL

(AUTONOMOUS)

Approved by A.I.C.T.E., New Delhi, Permanently Affiliated to JNT University, Ananthapuramu;
Accredited by NAAC with Grade-A, Accredited by NBA (ECE & CSE);
An ISO 9001:2015 Certified Institution, 2(f) & 12(B) recognition by UGC Act, 1956
NH-40, Nandyal-518501, Nandyal (Dist), A.P.

ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABI

M.TECH (CSE-AI&ML)

REGULAR TWO YEAR PG DEGREE COURSE

(Applicable for the Admitted Batch 2025-26)

REGULATIONS: R-25

Learn - Grow - Empower

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SANTHIRAM ENGINEERING COLLEGE

(AUTONOMOUS)

DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech
I-Semester Course Structure

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. I Sem. - Course Structure

S.No	Subject Code	Course Category	Name of the Subject	Hours/Week			Credits	Marks		
				Lecture	Tutorial	Practical		Internal	External	Total
1	25D13101	PC	ADVANCED ALGORITHMS	3	0	0	3	40	60	100
2	25D13201	PC	AGENTIC AI	3	0	0	3	40	60	100
3	25D13202	PC	CONVERSATIONAL AI	3	0	0	3	40	60	100
4	25D13102	PC	MATHEMATICS FOR AI AND ML	3	0	0	3	40	60	100
5	25D13103A	PE	EVOLUTIONARY COMPUTING (PE-I)	3	0	0	3	40	60	100
6	25D13103B	PE	DEEP LEARNING TRANSFORMERS (PE-I)	3	0	0	3	40	60	100
7	25D13103C	PE	KNOWLEDGE GRAPHS & REASONING (PE-I)	3	0	0	3	40	60	100
8	25D58104A	PE	NATURAL LANGUAGE PROCESSING (PE-III)	3	0	0	3	40	60	100
9	25D13103D	PE	REINFORCEMENT LEARNING (PE-I)	3	0	0	3	40	60	100
10	25D13104A	PE	MEDICAL IMAGING WITH AI (PE-II)	3	0	0	3	40	60	100
11	25D13104B	PE	DRONE TECHNOLOGIES (PE-II)	3	0	0	3	40	60	100
12	25D13104C	PE	AUTONOMOUS VEHICLES (PE-II)	3	0	0	3	40	60	100
13	25D13204D	PE	INTRODUCTION TO LARGE LANGUAGE MODELS (PE-IV)	3	0	0	3	40	60	100
14	25D13104D	PE	MACHINE LEARNING & DEEP LEARNING APPLICATIONS (PE-II)	3	0	0	3	40	60	100
15	25D58105	PC	ADVANCED DATA STRUCTURES & ALGORITHMS LAB	0	0	4	2	40	60	100
16	25D13205	PC	AGENTIC AI LAB	0	0	4	2	40	60	100
17	25D13105	PC	AI AND ML LAB	0	0	4	2	40	60	100
18	25D13206	PC	XAI AND RESPONSIBLE AI LAB (PYTHON FOR BIG DATA)	0	0	4	2	40	60	100
19	25D57107	MC(C)	RESEARCH METHODOLOGY AND IPR	2	0	0	2	40	60	100
20	25D57207	MC(C)	QUANTUM TECHNOLOGIES AND APPLICATIONS	2	0	0	2	40	60	100

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21	25D13106	SC	MLOPS & AI MODEL DEVELOPMENT	0	1	2	2	40	60	100
22	25D57109A	MC(NC)	ENGLISH FOR RESEARCH PAPER WRITING (AC-I)	2	0	0	0	40	0	40
23	25D57109C	MC(NC)	DISASTER MANAGEMENT (AC-I)	2	0	0	0	40	0	40
24	25D57209B	MC(NC)	PEDAGOGY STUDIES (AC-II)	2	0	0	0	40	0	40
25	25D57109D	MC(NC)	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (AC-I)	2	0	0	0	40	0	40

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M.Tech
I -Semester Syllabus

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M.Tech. I Sem.

L	T	P	C
3	0	0	3

(25D13101) ADVANCED ALGORITHMS

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To provide rigorous training in analyzing the time, space, and complexity bounds of advanced algorithms.
2. To study divide & conquer, dynamic programming, greedy, backtracking, and branch & bound techniques with proofs of correctness.
3. To explore network flows, approximation, randomized, and parameterized algorithms in depth
4. To understand the theoretical foundations of NP-Completeness and explore emerging topics like quantum and parallel algorithms.
5. To apply algorithm design paradigms to AI, ML, data science, and optimization problems

UNIT-I ADVANCED COMPLEXITY ANALYSIS

Review of asymptotic notations (Big-O, Ω, Θ, little-o), Amortized analysis: aggregate, accounting, potential methods, Solving recurrences: recursion tree, Master's theorem, Akra–Bazzi method, Average-case analysis (probabilistic methods), Complexity classes: P, NP, co-NP, PSPACE, Polynomial hierarchy and beyond, Lower bounds on algorithmic complexity, Case studies: complexity in large-scale ML training.

UNIT-II ADVANCED DIVIDE AND CONQUER & GEOMETRY ALGORITHMS

Strassen's algorithm & fast matrix multiplication improvements, Closest pair of points problem, Convex hull algorithms (Graham's scan, Divide & Conquer), Voronoi diagrams & Delaunay triangulations, Range searching and segment trees, Parallel divide-and-conquer algorithms, Applications in image processing & computational biology, Case study: fast convolution for deep learning.

UNIT-III GREEDY, DYNAMIC PROGRAMMING & NETWORK OPTIMIZATION

Matroid theory & greedy-choice property, Graph algorithms: MST (Prim's, Kruskal's), shortest paths (Dijkstra, Bellman-Ford), Maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp, Push Relabel), Matching algorithms in bipartite graphs (Hungarian algorithm), Dynamic programming in sequence alignment & edit distance, Optimal binary search trees & matrix chain multiplication, Applications of DP in reinforcement learning. Case study: optimization problems in natural language processing.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

UNIT-IV ADVANCED SEARCH – BACKTRACKING, BRANCH & BOUND, CSPS

Backtracking: general method and complexity analysis, N-Queens, subset sum, graph coloring revisited, Branch & Bound: TSP, knapsack with bounding techniques, Constraint satisfaction problems (CSP) and heuristics, SAT solving and backtracking-based SAT solvers, Exact exponential algorithms (clique, independent set), Integer programming & cutting-plane methods, Applications in scheduling, robotics, and AI planning.

UNIT-V NP-COMPLETENESS, APPROXIMATION & RANDOMIZED ALGORITHMS

Cook-Levin theorem & NP-Complete proofs, Reductions between NP-complete problems, Parameterized complexity & fixed-parameter tractability (FPT), Approximation algorithms: vertex cover, set cover, Polynomial-time approximation schemes (PTAS, FPTAS), Primal-dual method for approximations, Randomized algorithms: Monte Carlo, Las Vegas, Emerging topics: quantum algorithms and complexity.

TEXT BOOKS:

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein – Introduction to Algorithms, MIT Press.
2. E. Horowitz, S. Sahni, S. Rajasekaran – Fundamentals of Computer Algorithms, Galgotia.
3. J. Kleinberg, E. Tardos – Algorithm Design, Pearson.

REFERENCE BOOKS:

1. V. Vazirani ??? Approximation Algorithms, Springer.
2. S. Dasgupta, C.H. Papadimitriou, U.V. Vazirani ??? Algorithms, McGraw Hill.
3. M. Sipser ??? Introduction to the Theory of Computation, Cengage.
4. S. Arora, B. Barak ??? Computational Complexity: A Modern Approach, Cambridge University Press.
5. T. Roughgarden ??? Algorithms Illuminated series (for deeper insights into algorithmic paradigms).
6. Selected research papers from STOC, FOCS, and SODA conferences (for emerging topics like quantum algorithms, streaming algorithms, and AI-related optimizations).

COURSE OUTCOMES:

1. Analyze and evaluate the asymptotic complexity of advanced algorithms.
2. Apply divide-and-conquer, greedy, and dynamic programming methods to design efficient algorithms.
3. Formulate and solve optimization problems in graphs, networks, and sequence alignment using DP and network flow techniques.
4. Develop solutions for constraint satisfaction and NP-Hard problems using backtracking and branch & bound.
5. Classify problems into P, NP, NP-Complete, NP-Hard, and explore approximation and randomized algorithms for intractable problems.

6. Demonstrate ability to connect algorithmic paradigms to AI/ML, bioinformatics, and data driven applications.

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M.Tech. I Sem.

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3	0	0	3

(25D13201) AGENTIC AI

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To introduce the principles and architecture of intelligent autonomous agents.
2. To understand agent-based modeling and simulation frameworks.
3. To explore reasoning, planning, and decision-making in agentic systems.
4. To study coordination, communication, and cooperation in multi-agent systems.
5. To apply agentic AI concepts in real-world domains such as robotics, finance, and smart environments.

UNIT-I INTRODUCTION TO AGENTIC AI

Introduction to intelligent agents – definition, characteristics, Types of agents, PEAS representation of agents, Properties of agent environments, Architectures of intelligent agents – reactive, deliberative, and hybrid models., Rationality, autonomy, and bounded rationality in agent design, Agent lifecycle and perception–action loop. Applications of reactive vs. deliberative agents in real world systems.

UNIT-II KNOWLEDGE REPRESENTATION AND REASONING

Role of knowledge representation (KR) in agent-based systems, Logical reasoning, Rule-based reasoning systems and production rules, Belief-Desire-Intention (BDI) architecture – components and formalization, Epistemic logic and reasoning, Ontologies and semantic models for agent knowledge bases, Probabilistic reasoning and uncertainty handling in agents.

UNIT-III PLANNING AND DECISION-MAKING

Goal formulation and problem-space definition, Search-based planning, Classical planning algorithms – STRIPS, GraphPlan, and partial-order planning, Temporal and hierarchical task planning, Markov Decision Processes (MDPs), Reinforcement learning concepts, Game-theoretic approaches to agent decision-making, Integration of planning and learning in dynamic environments.

UNIT-IV MULTI-AGENT SYSTEMS (MAS)

Introduction to multi-agent systems, Communication protocols – KQML, FIPA-ACL, message structures, Coordination and cooperation strategies among agents, Negotiation, auction, and contract-net protocols, Coalition formation and teamwork in multi-agent environments, Distributed problem solving and consensus algorithms, Emergent behavior and self-organization in MAS, Simulation of MAS using frameworks like JADE and AnyLogic.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

UNIT-V APPLICATIONS OF AGENTIC AI

Agentic AI in robotics, Intelligent digital assistants and conversational agents, Financial trading agents and decision-support systems, Smart cities and energy grid optimization using agent models, Reinforcement-based adaptive learning in dynamic environments, Simulation frameworks for agent based modeling (JADE, AnyLogic, NetLogo), Ethical, legal, and safety issues in deploying autonomous agents.

TEXT BOOKS:

1. Michael Wooldridge – An Introduction to MultiAgent Systems, Wiley.
2. Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach, Pearson.
3. Gerhard Weiss (Ed.) – Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press.

REFERENCE BOOKS:

1. Yoav Shoham & Kevin Leyton-Brown – Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press.
2. Jacques Ferber – Multi-Agent Systems: An Introduction to Distributed Artificial Intelligence, Addison-Wesley.
3. FIPA (Foundation for Intelligent Physical Agents) Standards – https://www.fipa.org

COURSE OUTCOMES:

1. Explain the concept, characteristics, and architecture of intelligent agents.
2. Implement reasoning and planning algorithms for goal-driven autonomous agents.
3. Design collaborative and competitive multi-agent systems.
4. Apply reinforcement and adaptive learning techniques for agentic intelligence.
5. Develop domain-specific agentic AI applications and evaluate their performance.

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M.Tech. I Sem.

L	T	P	C
3	0	0	3

(25D13102) MATHEMATICS FOR AI AND ML

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To strengthen the knowledge of linear algebra, probability, and statistics as a foundation for AI and ML.
2. To study optimization methods (convex, constrained, gradient-based) for ML model training.
3. To apply numerical methods to efficiently solve AI-related mathematical problems.
4. To understand vector calculus tools used in deep learning and advanced ML models.
5. To bridge mathematical theory with practical applications in machine learning, data science, and AI.

UNIT-I LINEAR ALGEBRA FOR ML

Vector spaces, subspaces, basis, dimension, Linear transformations and matrices, Eigenvalues, eigenvectors, diagonalization, Singular Value Decomposition (SVD), Orthogonality and projections, Matrix decompositions: LU, QR, Cholesky, Positive definite matrices and applications in ML, Case study: PCA (Principal Component Analysis).

UNIT-II PROBABILITY & STATISTICS FOR AI

Probability axioms, conditional probability, Bayes' theorem, Random variables and expectations, Common distributions: Bernoulli, Binomial, Gaussian, Exponential, Poisson, Joint, marginal, conditional distributions, Law of large numbers, Central Limit Theorem, Estimation: MLE, MAP, Bayesian inference, Hypothesis testing and confidence intervals, Applications in generative models & Bayesian networks.

UNIT-III OPTIMIZATION FOR ML

Convex sets and convex functions, Gradient Descent and Stochastic Gradient Descent (SGD), Newton's method and Quasi-Newton methods, Constrained optimization (Lagrange multipliers, KKT conditions), Duality in convex optimization, Optimization in neural networks (backpropagation), Regularization methods (L1, L2, dropout interpretation), Case study: Optimization in deep learning frameworks.

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UNIT-IV NUMERICAL METHODS FOR AI

Root-finding methods (Bisection, Newton-Raphson), Fixed-point iteration and convergence analysis, Polynomial interpolation (Lagrange, Newton interpolation), Numerical differentiation, Numerical integration (Trapezoidal, Simpson's rule), Systems of linear equations: Gaussian elimination, iterative methods, Numerical stability and error analysis, Applications in training ML models (approximation techniques).

UNIT-V VECTOR CALCULUS IN ML

Functions of multiple variables, partial derivatives, Gradient, directional derivatives, Jacobian and Hessian matrices, Taylor expansion for multivariate functions, Divergence and curl (applications in optimization), Gradient flow dynamics in ML, Backpropagation using vector calculus, Case study: Application to deep learning (CNNs, RNNs).

TEXT BOOKS:

1. Sheldon Axler – Linear Algebra Done Right, Springer.
2. Christopher Bishop – Pattern Recognition and Machine Learning, Springer.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman – The Elements of Statistical Learning, Springer.

REFERENCE BOOKS:

1. 1. Gilbert Strang – Linear Algebra and Its Applications, Cengage
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville – Deep Learning, MIT Press
3. Stephen Boyd, Lieven Vandenberghe – Convex Optimization, Cambridge University Press
4. Dimitri Bertsekas – Nonlinear Programming, Athena Scientific
5. Marc Peter Deisenroth, A. Faisal, C. Ong – Mathematics for Machine Learning, Cambridge.
6. Morris H. DeGroot, Mark J. Schervish – Probability and Statistics, Pearson.

COURSE OUTCOMES:

1. Apply concepts of linear algebra (vector spaces, eigenvalues, SVD) to machine learning.
2. Use probability and statistics for data modeling, inference, and Bayesian reasoning in AI.
3. Formulate and solve optimization problems in ML training using gradient descent and convex optimization.
4. Apply vector calculus (gradients, Jacobians, Hessians) in deep learning model design.
5. Implement numerical methods for root finding, interpolation, and integration in AI problem-solving.
6. Integrate mathematical foundations to evaluate, analyze, and improve ML algorithms.

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M.Tech. I Sem.

L	T	P	C
3	0	0	3

(25D13202) CONVERSATIONAL AI

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To introduce the foundations and architectures of dialogue systems and conversational design.
2. To explore NLP pipelines for intent detection, slot filling, and entity recognition.
3. To study and apply generative transformer-based models such as GPT, BERT, and T5 for dialogue generation.
4. To design context-aware, multimodal, and personalized conversational agents.
5. To evaluate ethical considerations, safety, and performance metrics in conversational AI systems.

UNIT-I INTRODUCTION TO CONVERSATIONAL AI

Introduction to dialogue systems and chatbots, Types of conversational AI, Components of conversational systems, Conversation design principles, History and evolution of conversational AI, Frameworks and platforms, Multimodal and voice-based conversational agents.

UNIT-II NLP FOR CONVERSATION

Text preprocessing, Word embeddings, Intent detection using classification models, Entity recognition (NER) and slot filling for dialogue systems, Sentiment analysis and emotion detection in conversations, Context modeling in dialogue ??? dialogue state tracking and context windows, Multilingual and cross-lingual NLP for global conversational systems.

UNIT-III GENERATIVE MODELS FOR CONVERSATION

Sequence-to-sequence (Seq2Seq) models, Attention mechanisms and context vector modelling, Transformer, Large Language Models (LLMs), Fine-tuning and prompt engineering, Transfer learning and few-shot learning in conversational AI, Dialogue data curation and preprocessing.

UNIT-IV DIALOGUE MANAGEMENT AND CONTEXT MODELING

Dialogue management, Reinforcement learning, Contextual dialogue management with memory networks and transformers, Hybrid models: retrieval-based and generative dialogue systems, Personalization and adaptive user profiling in conversation, Handling interruptions, context switching, and multi-turn conversations, Integration with external APIs and databases for task completion.

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UNIT-V EVALUATION, SAFETY, AND ETHICS IN CONVERSATIONAL AI

Evaluation metrics for conversational AI ??? BLEU, ROUGE, METEOR, perplexity, Human evaluation: coherence, engagement, empathy, and naturalness, Bias, fairness, and safety in generative dialogue systems, Ethical considerations, Explainability and transparency in conversational models, Human-AI collaboration and co-creation in dialogue systems.

TEXT BOOKS:

1. Alan Nichol & Greg Nichols – Conversational AI with Rasa, O'Reilly Media.
2. Palash Goyal, Sumit Pandey, Karan Jain – Deep Learning for Natural Language Processing, Springer.
3. Tom B. Brown et al. – Language Models are Few-Shot Learners (GPT-3 Paper), OpenAI, 2020.

REFERENCE BOOKS:

1. Daniel Jurafsky & James H. Martin ??? Speech and Language Processing, Pearson.
2. Sudharsan Ravichandiran ??? Hands-On Transformers and NLP with PyTorch and Hugging Face.
3. Thomas Wolf et al. ??? Transformers: State-of-the-Art Natural Language Processing, ACL 2020.

COURSE OUTCOMES:

1. Understand the structure, components, and working of conversational agents.
2. Implement NLP-based intent recognition, sentiment analysis, and dialogue flow.
3. Design and fine-tune transformer-based generative dialogue models.
4. Integrate contextual understanding and user personalization into chat systems.
5. Evaluate conversational systems for performance, safety, and ethical compliance.

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M.Tech. I Sem.

L	T	P	C
3	0	0	3

(25D13103A) EVOLUTIONARY COMPUTING (PE-I)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. 1. To introduce the theory and biological inspiration behind evolutionary algorithms.
2. To understand genetic algorithms, genetic programming, and swarm intelligence techniques in depth.
3. To apply evolutionary computing for single-objective and multi-objective optimization problems.
4. To explore hybrid approaches combining evolutionary and machine learning algorithms.
5. To develop evolutionary computing solutions for AI/ML applications such as feature selection, hyperparameter tuning, and neural architecture search.

UNIT-I INTRODUCTION TO EVOLUTIONARY COMPUTING

Biological inspiration: Darwin's theory, natural selection, survival of the fittest, General evolutionary algorithm framework, Representation schemes: binary, real-valued, permutation encoding, Fitness evaluation functions, Selection methods: roulette wheel, tournament, rank-based, Schema theorem and building block hypothesis, Exploration vs exploitation in evolutionary algorithms, Applications in search, optimization, and learning.

UNIT-II GENETIC ALGORITHMS (GA)

Canonical GA: initialization, selection, crossover, mutation, Advanced operators: adaptive mutation, elitism, steady-state GA, Parameter tuning and convergence analysis, Hybrid GA with local search (memetic algorithms), Applications in combinatorial optimization (scheduling, routing), Feature selection in machine learning using GA, Case study: GA for function optimization, Case study: GA for ML hyperparameter tuning.

UNIT-III GENETIC PROGRAMMING (GP)

Basics of GP and evolutionary computation models, Tree-based representation of programs, Genetic operators in GP: crossover, mutation, reproduction, Fitness measures in GP (error-based, complexity-based), Symbolic regression and classification using GP, Automatic program generation and symbolic AI, Applications in neural architecture search and reinforcement learning, Case study: GP for automated ML pipeline design.

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UNIT-IV SWARM INTELLIGENCE TECHNIQUES

Particle Swarm Optimization (PSO): velocity update, global/local best, Ant Colony Optimization (ACO): pheromone model, path construction, Artificial Bee Colony (ABC) optimization, Firefly Algorithm and Cuckoo Search, Comparative study of SI techniques with GA/GP, Applications in clustering and routing problems, Neural network training using SI algorithms, Case study: PSO/ACO for AI optimization problems.

UNIT-V MULTI-OBJECTIVE & ADVANCED APPLICATIONS

Multi-objective optimization: Pareto optimality and dominance, Evolutionary algorithms for multi objective optimization (NSGA-II, SPEA2), Differential Evolution (DE) and Evolution Strategies (ES), Hybrid evolutionary algorithms with ML/DL, Ensemble methods using evolutionary optimization, Neural architecture search using evolutionary algorithms, Applications in robotics, computer vision, and data mining, Case study: Multi-objective optimization for deep learning hyperparameter tuning.

TEXT BOOKS:

1. 1. David E. Goldberg – Genetic Algorithms in Search, Optimization, and Machine Learning, Pearson.
2. Melanie Mitchell – An Introduction to Genetic Algorithms, MIT Press.
3. A.E. Eiben, J.E. Smith – Introduction to Evolutionary Computing, Springer.

REFERENCE BOOKS:

1. Kalyanmoy Deb – Multi-Objective Optimization Using Evolutionary Algorithms, Wiley.
2. James Kennedy, Russell Eberhart, Y. Shi – Swarm Intelligence, Morgan Kaufmann.
3. Riccardo Poli, William B. Langdon, Nicholas McPhee – A Field Guide to Genetic Programming.
4. Simon D. – Evolutionary Optimization Algorithms, Wiley.
5. Yaochu Jin – Knowledge Incorporation in Evolutionary Computation, Springer.

COURSE OUTCOMES:

1. Explain the working principles and biological basis of evolutionary algorithms.
2. Apply genetic algorithms and genetic programming to solve optimization and search problems.
3. Implement swarm intelligence algorithms for AI/ML applications.
4. Analyze and solve multi-objective optimization problems using Pareto-based evolutionary techniques.
5. Develop evolutionary computing solutions for AI/ML tasks such as feature selection, model optimization, and neural architecture design.
6. Compare and evaluate different evolutionary and swarm-based techniques for computational intelligence tasks.

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M.Tech. I Sem. L T P C

(25D13203A) AI ENHANCED DATA SCIENCE (PE-III)

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

COURSE OUTCOMES:

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L	T	P	C
3	0	0	3

(25D13103B) DEEP LEARNING TRANSFORMERS (PE-I)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Introduce the fundamentals of attention mechanisms and transformer architectures.
2. Understand the principles of encoder–decoder models in sequence learning.
3. Explore state-of-the-art models such as BERT, GPT, and Vision Transformers
4. Study transfer learning and fine-tuning techniques for transformers.
5. Apply transformers to Natural Language Processing (NLP), Computer Vision (CV), and multimodal AI tasks.

UNIT-I INTRODUCTION & ATTENTION MECHANISMS

Sequence modeling challenges in RNNs and LSTMs, Additive vs. multiplicative attention, Self attention and multi-head attention, Positional encoding and its significance, Applications of attention in NLP and computer vision, Comparative study: RNN/LSTM vs. Transformers, Practical use cases of attention mechanisms, Limitations and scalability issues in attention-based models.

UNIT-II TRANSFORMER ARCHITECTURE

Encoder–decoder structure and working, Scaled dot-product attention, Multi-head attention mechanism, Feed-forward layers and residual connections, Layer normalization and dropout in transformers, Training transformers: optimization and parallelization, Handling long sequences (efficient transformer variants), Challenges in training large-scale transformer models.

UNIT-III BERT AND GPT MODELS

BERT: bidirectional encoding and masked language modelling, Pre-training and fine-tuning strategies for BERT, GPT family: autoregressive modeling and generative capabilities, Applications: text classification, summarization, translation, and dialogue systems, Comparative study: BERT vs. GPT architectures, Case studies in real-world NLP tasks, Transfer learning with large pre-trained models, Deployment issues and challenges with large models.

UNIT-IV VISION TRANSFORMERS & MULTIMODAL MODELS

Vision Transformer (ViT) architecture and patch embeddings, Image classification using ViT, Multimodal transformers: CLIP, ALIGN, Flamingo, Applications in image captioning, cross-modal retrieval, and video understanding, Transformers in healthcare imaging and robotics, Case studies in autonomous driving and surveillance, Comparison with CNN-based approaches, Future scope of transformers in multimodal AI.

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UNIT-V FINE-TUNING & ADVANCED TOPICS

Transfer learning strategies in transformers, Domain adaptation and low-resource fine-tuning, Prompt engineering techniques, Parameter-efficient fine-tuning (LoRA, adapters), Challenges: computational cost, model bias, interpretability, and ethical concerns, Emerging trends: Large Language Models (LLMs) and foundation models, Transformers in scientific discovery and industrial applications, Future research directions in transformer-based AI.

TEXT BOOKS:

1. Vaswani et al. – Attention is All You Need, NeurIPS 2017 (Original Transformer Paper).
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf – Natural Language Processing with Transformers, O'Reilly.
3. Hugging Face Team – Transformers Library Documentation.

REFERENCE BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville – Deep Learning, MIT Press.
2. Denis Rothman – Transformers for Natural Language Processing, Packt Publishing
3. Jay Alammar – The Illustrated Transformer (Online Resource).
4. Dosovitskiy et al. – An Image is Worth 16x16 Words: Transformers for Image Recognition at Scale (ViT), ICLR 2021.
5. Devlin et al. – BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding.
6. Radford et al. – GPT Series Papers (GPT-2, GPT-3), OpenAI.
7. Radford et al. – Learning Transferable Visual Models from Natural Language Supervision (CLIP), ICML 2021.

COURSE OUTCOMES:

1. Explain the working of attention mechanisms and their significance in deep learning.
2. Analyze transformer architectures and their components.
3. Implement BERT, GPT, and Vision Transformers for real-world AI problems.
4. Apply fine-tuning and transfer learning strategies for domain-specific applications.
5. Evaluate transformer-based models in NLP, CV, and multimodal tasks, considering efficiency, scalability, and interpretability.

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(25D13203B) DEEP REINFORCEMENT LEARNING (PE-III)

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

COURSE OUTCOMES:

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(25D13103C) KNOWLEDGE GRAPHS & REASONING (PE-I)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Introduce the fundamentals of knowledge representation using graphs.
2. Understand RDF, ontologies, and graph databases for semantic data modeling.
3. Study reasoning techniques and inference mechanisms.
4. Learn to query and manipulate knowledge graphs using SPARQL and Cypher.
5. Apply knowledge graphs in AI applications like NLP, recommendation systems, and question answering.

UNIT-I INTRODUCTION TO KNOWLEDGE GRAPHS

Basics of knowledge representation and semantic web concepts, Graph structures: nodes, edges, labels, properties, Difference between relational databases and graph databases, Labeled property graphs vs RDF graphs, Applications of knowledge graphs in AI and data integration, Case study: Google Knowledge Graph, Knowledge graph lifecycle: construction and storage, Tools and platforms: Neo4j, GraphDB (overview).

UNIT-II RDF AND SEMANTIC DATA MODELING

RDF basics: triples, subjects, predicates, objects, RDF Schema (RDFS): defining vocabularies, Web Ontology Language (OWL) – introduction, Ontology design principles,Linked Data principles, Schema alignment and integration, Example datasets: DBpedia, Wikidata, Tools for RDF modeling: Protégé, RDFLib.

UNIT-III ONTOLOGIES AND REASONING

Ontology concepts and examples, Building ontologies using Protégé, Types of reasoning: deductive, inductive, abductive (overview), Description logics – basics, Reasoning tasks: classification, consistency checking, Reasoning engines: Pellet, HermiT (introductory use), Rule-based reasoning: SWRL, Case study: ontology-driven applications in healthcare.

UNIT-IV QUERYING KNOWLEDGE GRAPHS

SPARQL basics: triple patterns and graph matching, SPARQL queries with filters and optional patterns, SPARQL updates, Querying linked datasets (e.g., DBpedia), Introduction to Cypher query language (Neo4j), Path queries and shortest path problems, Query optimization basics, Hands-on exercise: small KG query using SPARQL and Neo4j.

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UNIT-V APPLICATIONS OF KNOWLEDGE GRAPHS

Knowledge graphs in search engines, Knowledge graphs in recommendation systems, Question answering with knowledge graphs, Integration with NLP: entity linking, Relation extraction for knowledge graph construction, Explainable AI using knowledge graphs, Industrial case studies: e commerce, social networks, Research challenges and open problems in KG.

TEXT BOOKS:

1. Dean Allemang & James Hendler – Semantic Web for the Working Ontologist, Morgan Kaufmann.
2. Ian Robinson, Jim Webber, Emil Eifrem – Graph Databases, O'Reilly.
3. Tom Heath & Christian Bizer – Linked Data: Evolving the Web into a Global Data Space, Morgan & Claypool.

REFERENCE BOOKS:

1. Franz Baader et al. – The Description Logic Handbook: Theory, Implementation and Applications.
2. Pascal Hitzler et al. – Foundations of Semantic Web Technologies.
3. Neo4j Documentation (online).
4. Protégé tutorials (Stanford).
5. RDFLib Python library documentation.

COURSE OUTCOMES:

1. Explain graph-based knowledge representation and semantic modeling.
2. Use RDF and ontologies for structured knowledge representation.
3. Apply reasoning techniques using engines and description logics.
4. Query knowledge graphs using SPARQL and graph databases.
5. Implement real-world AI applications using knowledge graphs.

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(25D13203C) ADVANCED PROMPT DESIGN AND ENGINEERING (PE-III)

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

COURSE OUTCOMES:

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(25D13103D) REINFORCEMENT LEARNING (PE-I)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Understand the fundamentals of Reinforcement Learning (RL) and its elements.
2. Analyze and solve multi-armed bandit problems using exploration vs. exploitation strategies.
3. Master Markov Decision Processes (MDPs) and dynamic programming techniques for RL.
4. Apply Monte Carlo and Temporal Difference methods for prediction and control in RL.
5. Utilize eligibility traces and function approximation methods for advanced RL algorithms.

UNIT-I INTRODUCTION

:

Introduction to Reinforcement Learning (RL) – Difference between RL and Supervised Learning, RL and Unsupervised Learning. Elements of RL, Markov property, Markov chains, Markov reward process (MRP).

UNIT-II EVALUATIVE FEEDBACK - MULTI-ARM BANDIT PROBLEM

:

An n-Armed Bandit Problem, Exploration vs Exploitation principles, Action value methods, Incremental Implementation, tracking a non- stationary problem, optimistic initial values, upper-confidence-bound action selection, Gradient Bandits. Introduction to and proof of Bellman equations for MRPs

UNIT-III INTRODUCTION TO MARKOV DECISION PROCESS (MDP)

state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

Dynamic Programming (DP): Overview of dynamic programming for MDP, principle of optimality, Policy Evaluation, Policy Improvement, policy iteration, value iteration, asynchronous DP , Generalized Policy Iteration.

UNIT-IV MONTE CARLO METHODS FOR PREDICTION AND CONTROL

:

Overview of Monte Carlo methods for model free RL, Monte Carlo Prediction, Monte Carlo estimation of action values, Monto Carlo Control, On policy and off policy learning, Importance sampling. Temporal Difference Methods: TD Prediction, Optimality of TD(0), TD Control methods - SARSA, Q-Learning and their variants.

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UNIT-V ELIGIBILITY TRACES

:

n-Step TD Prediction, Forward and Backward view of TD(??), Equivalence of forward and backward view, Sarsa(??),, Watkins???s Q(??), Off policy eligibility traces using importance of sampling. Function Approximation Methods: Value prediction with function approximation, gradient descent methods, Linear methods, control with function approximation.

TEXT BOOKS:

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction", 2nd Edition, The MIT Press.
2. CsabaSzepesvari – Algorithms for Reinforcement Learning – Morgan & Claypool, 2010.

REFERENCE BOOKS:

1. Reinforcement Learning By Richard S. (University Of Alberta) Sutton,Andrew G. (Co-Director Autonomous Learning Laboratory) Barto

COURSE OUTCOMES:

1. Explain and apply core RL concepts and elements.
2. Solve multi-armed bandit problems using action value methods.
3. Implement and evaluate MDPs and dynamic programming techniques.
4. Apply Monte Carlo and TD methods to RL problems.
5. Use eligibility traces and function approximation for complex RL scenarios.
6. Design and implement RL algorithms for practical and complex decision making problems.

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(25D58104A) NATURAL LANGUAGE PROCESSING (PE-III)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

UNIT-I INTRODUCTION TO NATURAL LANGUAGE PROCESSING

Introduction to Natural Language, Study of Language, Applications of NLP, Challenges in NLP, Evaluating Language Understanding Systems, Levels of Language Analysis, Text Preprocessing, Tokenization, Normalization, Stemming and Lemmatization, Spelling Correction Techniques, Language Modeling, N-grams and Smoothing Methods, Corpus and Annotation, Organization of NLP Systems, Outline of English Syntax.

UNIT-II SEQUENCE MODELING AND TAGGING

Part-of-Speech Tagging, Rule-Based Tagging, Statistical Tagging Methods, Hidden Markov Models for Tagging, Feature-Based Tagging, Maximum Entropy Models, Conditional Random Fields (CRF), Sequence Labeling Techniques, Named Entity Tagging Basics, Training and Inference in Sequence Models, Evaluation Measures for Tagging.

UNIT-III SYNTACTIC PROCESSING AND PARSING

Constituency Grammar, Phrase Structure Rules, Context-Free Grammars, Parse Tree Representation, CKY Parsing, Shift–Reduce Parsing, Dependency Grammar, Dependency Parsing Algorithms, Universal Dependencies, Syntactic Ambiguity Resolution, Treebanks and Annotation Schemes, Grammatical Relations.

UNIT-IV SEMANTIC ANALYSIS AND TOPIC MODELING

Distributional Semantics, Vector Space Models, Word Embeddings (Word2Vec, GloVe), Word Similarity and Relatedness, Lexical Semantics, Word Senses, Synonymy, Antonymy, Polysemy, Semantic Networks, WordNet, Semantic Role Labeling, Topic Models, Latent Dirichlet Allocation (LDA), Document Similarity and Clustering.

UNIT-V INFORMATION EXTRACTION, TEXT MINING AND SENTIMENT ANALYSIS

Named Entity Recognition, Entity Linking, Relation Extraction, Information Extraction Pipelines, Coreference Resolution, Text Summarization (Extractive & Abstractive), Text Classification Approaches, Document Categorization, Sentiment Analysis Techniques, Opinion Mining, Polarity Detection, Evaluation of Text Mining Systems, Applications in Social Media and Web Analytics.

TEXT BOOKS:

1. "Speech and Language Processing" – Daniel Jurafsky & James H. Martin A comprehensive textbook covering NLP fundamentals, syntax, semantics, probabilistic models, sequence tagging, parsing, information extraction, and modern applications.
2. "Foundations of Statistical Natural Language Processing" – Christopher D. Manning & Hinrich Schütze-A classic book focusing on statistical NLP methods including language modeling, tagging, parsing, semantics, and text mining techniques.

e-Resources and Digital Material:

1. https://onlinecourses.nptel.ac.in/noc26_cs45/preview
2. https://www.classcentral.com/course/swayam-natural-language processing-7950
3. https://www.classcentral.com/course/nlpintro-3332

COURSE OUTCOMES:

1. Understand the fundamental concepts, applications, and linguistic foundations of Natural Language Processing.
2. Apply sequence modeling techniques such as POS tagging, MaxEnt, and CRF for effective text labeling.
3. Analyze sentence structure using constituency and dependency parsing methods.
4. Apply semantic models and topic modeling techniques to extract meaning and themes from text.
5. Implement information extraction, text classification, and sentiment analysis techniques in real-world NLP tasks.

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(25D13104A) MEDICAL IMAGING WITH AI (PE-II)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Introduce the fundamentals of medical imaging modalities such as MRI, CT, Ultrasound, X ray, and PET.
2. Understand preprocessing, enhancement, and feature extraction techniques in medical imaging.
3. Apply segmentation and detection algorithms, including AI-based approaches.
4. Implement deep learning models for classification, detection, and analysis of medical images.
5. Explore ethical, legal, and regulatory issues in AI-driven healthcare applications.

UNIT-I INTRODUCTION TO MEDICAL IMAGING

Overview of imaging modalities: MRI, CT, X-ray, Ultrasound, PET, Basic principles of image acquisition and reconstruction, Characteristics of medical images: resolution, contrast, artifacts, and noise, Clinical importance of imaging in diagnosis and treatment, File formats in medical imaging (DICOM, NIfTI), Limitations and challenges in medical image analysis, Role of AI in clinical decision support and imaging workflows.

UNIT-II PREPROCESSING AND FEATURE EXTRACTION

Image enhancement: filtering, denoising, histogram equalization, Noise reduction techniques: Gaussian, median, and non-local means filtering, Normalization and standardization of medical image datasets, Feature extraction: shape, texture, intensity, and edge-based features, Dimensionality reduction: PCA, LDA, t-SNE (overview), Data augmentation strategies for medical imaging datasets, Introduction to medical imaging datasets: BraTS, CheXpert, LIDC-IDRI, ISLES, Hands-on: preprocessing pipeline for MRI/CT images.

UNIT-III SEGMENTATION AND DETECTION

Traditional segmentation methods: thresholding, region growing, clustering, Watershed algorithm and morphological segmentation, AI-based segmentation: U-Net, Mask R-CNN, DeepLab, Tumor and lesion detection techniques in MRI/CT images, Object detection in medical images using Faster R-CNN, YOLO, Evaluation metrics: Dice coefficient, Jaccard index, sensitivity/specificity, Case study: brain tumor segmentation (BraTS challenge), Hands-on: segmentation workflow for lung X rays or MRI scans.

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UNIT-IV DEEP LEARNING IN MEDICAL IMAGING

CNN architectures for classification: VGG, ResNet, DenseNet, Transfer learning and fine-tuning on medical datasets, Multi-modal deep learning: combining imaging with clinical data, Generative models (GANs, VAEs) for synthetic medical image generation, Applications: cancer detection, organ segmentation, COVID-19 diagnosis, Explainability in deep learning models for medical imaging, Deployment of AI models in clinical settings, Case study: deep learning for chest X-ray anomaly detection

UNIT-V ETHICS, REGULATIONS & ADVANCED TOPICS

Ethical issues in AI for healthcare: bias, transparency, and fairness, Data privacy and patient confidentiality challenges, Regulatory frameworks: HIPAA, GDPR, and FDA guidelines, Explainable AI and interpretability in medical decision-making, Federated learning for privacy preserving medical AI, Emerging trends: digital twins, precision medicine, personalized AI diagnosis, Role of AI in treatment planning and prognosis prediction, Research challenges and future directions in AI for healthcare imaging.

TEXT BOOKS:

1. S. Kevin Zhou, Hayit Greenspan, Dinggang Shen – Deep Learning for Medical Image Analysis, Academic Press.
2. Ayman El-Baz, Jasjit S. Suri – Big Data in Multimodal Medical Imaging, CRC Press.
3. Klaus D. Toennies – Guide to Medical Image Analysis, Springer.

REFERENCE BOOKS:

1. Geert Litjens et al. – A Survey on Deep Learning in Medical Image Analysis, Medical Image Analysis, 2017.
2. Ronneberger et al. – U-Net: Convolutional Networks for Biomedical Image Segmentation.
3. Esteva et al. – A Guide to Deep Learning in Healthcare, Nature Medicine.
4. Kaggle datasets and grand challenges: BraTS, ISLES, CheXpert.
5. Online resources: Medical Imaging with Deep Learning (MIDL) conference papers

COURSE OUTCOMES:

1. Explain medical imaging modalities and their fundamental characteristics.
2. Apply preprocessing and feature extraction techniques to medical images.
3. Implement deep learning architectures for classification, segmentation, and anomaly detection.
4. Evaluate AI methods for medical imaging tasks such as cancer detection, brain analysis, and organ segmentation.
5. Analyze ethical, privacy, and regulatory challenges in deploying AI for healthcare.

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(25D13204A) VISUAL TRANSFORMERS (PE-IV)

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

COURSE OUTCOMES:

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(25D13104B) DRONE TECHNOLOGIES (PE-II)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Introduce the fundamentals of drone design, aerodynamics, and system integration.
2. Explore navigation techniques, positioning systems, and autonomous flight mechanisms.
3. Understand the role of sensors, communication protocols, and payloads in drones.
4. Apply AI and machine learning techniques for drone control, perception, and decision making.
5. Study swarm drone concepts and their applications in defense, agriculture, logistics, and disaster management.
6. Analyze regulatory, ethical, and safety considerations in drone deployment.

UNIT-I FUNDAMENTALS OF DRONE DESIGN

Introduction to UAVs and types of drones (fixed-wing, rotary-wing, hybrid), Drone aerodynamics and flight principles, Structural design and material selection, Propulsion systems: motors, propellers, batteries, fuel cells, Flight dynamics and stability considerations, Drone system architecture: hardware and software components, Case studies: consumer drones vs. industrial drones

UNIT-II NAVIGATION, GUIDANCE, AND CONTROL

Basics of UAV navigation and guidance systems, GPS, GNSS, and alternative localization methods, Inertial Navigation Systems (INS) and sensor fusion, Path planning algorithms (Dijkstra, A*, RRT), Control strategies: PID, LQR, MPC for UAVs, Autonomous flight modes and autopilot systems (PX4, Ardupilot), Obstacle avoidance and collision detection methods

UNIT-III SENSORS, PAYLOADS, AND COMMUNICATION

Onboard sensors: IMU, gyroscope, accelerometer, magnetometer, Vision-based sensors: RGB, thermal, LiDAR, depth cameras, Environmental sensing (gas, weather, multispectral sensors), Payload integration: cameras, delivery mechanisms, agricultural sprayers, Communication systems: RF, Wi-Fi, 4G/5G, LoRaWAN, Drone-to-drone and drone-to-ground communication protocols, Power management and endurance enhancement techniques

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UNIT-IV AI AND AUTONOMOUS DRONE CONTROL

Role of AI in UAV autonomy and perception, Computer vision for drones (object detection, SLAM, mapping), Deep learning for aerial image classification and tracking, Reinforcement Learning (RL) for UAV path optimization, Swarm intelligence and AI-based coordination, Edge computing and onboard AI processing, Applications: surveillance, precision agriculture, disaster response, delivery services

UNIT-V SWARM DRONES, REGULATIONS, AND FUTURE TRENDS

Swarm drone architectures and coordination mechanisms, Multi-agent systems and communication in swarms, Applications of swarm drones (defense, search & rescue, smart cities), Cybersecurity threats and countermeasures in UAV networks, Regulatory frameworks: FAA, DGCA, EASA guidelines, Ethical and legal challenges in drone deployment, Future trends: drone taxis, autonomous cargo, military UAVs, AI-powered UAV swarms

TEXT BOOKS:

1. Randal W. Beard & Timothy W. McLain – Small Unmanned Aircraft: Theory and Practice, Princeton University Press.
2. Kimon P. Valavanis & George J. Vachtsevanos – Handbook of Unmanned Aerial Vehicles, Springer.
3. B.L. Stevens & F.L. Lewis – Aircraft Control and Simulation, Wiley.

REFERENCE BOOKS:

1. Paul G. Fahlstrom & Thomas J. Gleason – Introduction to UAV Systems, Wiley.
2. Michael S. Lewis – Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles, Springer.
3. Hussein A. Abbass et al. – Foundations of Trusted Autonomy, Springer (for AI and swarm aspects).
4. Research papers from IEEE Transactions on Robotics, Journal of Field Robotics, and Unmanned Systems.
5. Online resources: PX4 and Ardupilot documentation, Dronecode Consortium, FAA & DGCA guidelines.

COURSE OUTCOMES:

1. Explain drone design principles, aerodynamics, and system architecture.
2. Apply navigation, guidance, and control techniques for UAVs.
3. Evaluate and integrate sensors, payloads, and communication systems in drones.
4. Implement AI and machine learning algorithms for drone autonomy and decision making.
5. Analyze swarm drone coordination strategies and real-world applications.
6. Assess regulatory, safety, and ethical issues in drone technologies.

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(25D13204B) AI FOR SMART CITIES (PE-IV)

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

COURSE OUTCOMES:

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(25D13104C) AUTONOMOUS VEHICLES (PE-II)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Introduce the fundamentals of autonomous driving systems and their architecture.
2. Study perception methods using sensors and computer vision for environment understanding.
3. Explore localization, mapping, and state estimation techniques.
4. Apply path planning and control algorithms for autonomous navigation.
5. Integrate deep reinforcement learning for decision-making and vehicle control.
6. Analyze safety, ethical, and regulatory issues in autonomous vehicle deployment.

UNIT-I FUNDAMENTALS OF AUTONOMOUS VEHICLES

Introduction to autonomous driving: Levels of autonomy (SAE L0–L5), System architecture: perception, planning, control, and actuation layers, Vehicle dynamics and motion models (bicycle, kinematic, dynamic models), Drive-by-wire systems and electronic control units (ECUs), Autonomous driving platforms (Apollo, Autoware, CARLA simulator), Real-world applications: self-driving taxis, delivery vehicles, smart mobility, Challenges in autonomous driving (weather, infrastructure, safety)

UNIT-II PERCEPTION SYSTEMS

Sensors for AVs: LiDAR, radar, ultrasonic, cameras, Sensor calibration, synchronization, and fusion techniques, Environment perception: object detection and tracking, Semantic segmentation for road and lane detection, SLAM (Simultaneous Localization and Mapping) basics, Computer vision applications: traffic sign recognition, pedestrian detection, Datasets for AV perception (KITTI, Waymo, nuScenes)

UNIT-III LOCALIZATION AND MAPPING

Global Navigation Satellite Systems (GNSS) and limitations, Inertial Measurement Units (IMUs) and odometry, Kalman filters and Extended Kalman Filter (EKF) for state estimation, Particle filters and Monte Carlo Localization (MCL), Visual SLAM and LiDAR-based SLAM methods, High definition (HD) maps and map-based localization, Sensor fusion for robust localization under challenging conditions

UNIT-IV PATH PLANNING AND CONTROL

Motion planning problem formulation in AVs, Graph-based planning: Dijkstra, A*, RRT, PRM, Optimal control methods for trajectory generation, Local vs. global planning approaches, Control algorithms: PID, LQR, MPC for vehicle control, Obstacle avoidance strategies in dynamic environments, Simulation platforms for testing planning and control (CARLA, SUMO, Gazebo)

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UNIT-V DEEP REINFORCEMENT LEARNING, SAFETY & ETHICS

Introduction to Reinforcement Learning (RL) in autonomous driving, Deep RL architectures for control (DQN, DDPG, PPO, SAC), Imitation learning and behavior cloning for driving policy learning, Safe RL for collision-free navigation, Ethical challenges: decision-making in safety critical scenarios, Legal and regulatory issues in autonomous vehicle deployment, Future trends: V2X communication, cooperative AVs, AI-powered traffic systems

TEXT BOOKS:

1. Rajesh Rajamani – Vehicle Dynamics and Control, Springer.
2. Shaoshan Liu, Liyun Li, Jie Tang – Deep Learning for Autonomous Vehicle Control, Springer.
3. Umit Ozguner, Tankut Acarman, Keith Redmill – Autonomous Ground Vehicles, Artech House.

REFERENCE BOOKS:

1. Steven Waslander et al. – Autonomous Driving: Technical, Legal and Social Aspects, Springer.
2. Sebastian Thrun et al. – Probabilistic Robotics, MIT Press.
3. Recent papers from IEEE Transactions on Intelligent Transportation Systems and IEEE Robotics and Automation Letters.
4. Datasets & open platforms: KITTI, Waymo, nuScenes, Apollo, Autoware, CARLA simulator.

COURSE OUTCOMES:

1. Explain the system architecture and components of autonomous vehicles.
2. Apply perception techniques using LiDAR, radar, and vision-based systems.
3. Implement localization and mapping algorithms for autonomous navigation.
4. Develop path planning and motion control strategies.
5. Apply deep reinforcement learning techniques for autonomous driving tasks.
6. Analyze safety, ethical, and regulatory issues in autonomous vehicle systems.

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(25D13204C) AI FOR EDGE COMPUTING (PE-IV)

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

COURSE OUTCOMES:

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(25D13104D) MACHINE LEARNING & DEEP LEARNING APPLICATIONS (PE-II)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To learn basic machine learning and probabilistic decision concepts.
2. To study various classification and estimation techniques in machine learning.
3. To understand ensemble techniques, dimensionality reduction, and clustering methods in machine learning.
4. Understand clustering methods and neural network models for pattern analysis.
5. Understand deep learning architectures and their applications in complex data analysis.

UNIT-I UNIT-I

Introduction to ML, Performance Measures, Bias-Variance Trade off, Linear Regression. Bayes Decision Theory, Normal Density and Discriminant Function, Bayes Decision Theory – Binary Features, Bayesian Belief Network.

UNIT-II UNIT-II

Parametric and Non- Parametric Density Estimation – ML and Bayesian Estimation, Parzen Window and KNN, Perceptron Criteria, Discriminative models, Support Vector Machines (SVM), Logistic Regression, Decision trees, Hidden Markov Model (HMM).

UNIT-III UNIT-III

Ensemble methods: Ensemble strategies, boosting and bagging, Random Forest Dimensionality Problem, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Concept of mixture model, Gaussian mixture model, Expectation Maximization Algorithm, K- means clustering.

UNIT-IV UNIT-IV

Clustering - Fuzzy K-means clustering, Hierarchical Agglomerative Clustering, Mean-shift clustering. Neural network: Perceptron, multilayer network, backpropagation, RBF Neural Network, Applications

UNIT-V UNIT-V

Introduction to Deep Learning, Convolutional Neural Networks (CNN), Vanishing and Exploding Gradients in Deep Neural Networks, LeNet - 5, AlexNet, VGGNet, GoogleNet, and ResNet. Generative Adversarial Networks (GAN), Auto Encoders and Relation to PCA, Recurrent Neural Networks, U-Net, Applications and Case studies.

TEXT BOOKS:

1. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, 4th Edition, 2020.
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical

REFERENCE BOOKS:

1. Learning: Data Mining, Inference, and Prediction, Springer, 2nd Edition, 2009.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.

COURSE OUTCOMES:

1. Able to apply machine learning and Bayesian methods for prediction and analysis.
2. Able to apply parametric, non-parametric, and discriminative models for pattern recognition.
3. Able to implement ensemble, dimensionality reduction, and clustering algorithms for data analysis.
4. Apply clustering and neural network techniques for data classification and prediction.
5. Utilize deep neural network models for image, sequence, and generative tasks.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

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(25D13204D) INTRODUCTION TO LARGE LANGUAGE MODELS (PE-IV)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To introduce the fundamentals of Large Language Models (LLMs), their characteristics, working mechanisms, and evolution.
2. To provide an overview of Natural Language Processing (NLP) and Neural Networks as foundational technologies for LLMs.
3. To explore various language models, including statistical and neural approaches, along with their limitations.
4. To understand different prompting strategies used in LLMs and their impact on performance.
5. To examine advanced topics such as reasoning, handling long contexts, model editing, and hallucination in LLMs.

UNIT-I INTRODUCTION

Definition of LLMs, Key Characteristics of LLMs, How LLMs work, Evolution of Language Modelling Technologies, Evolution of LLMs, Applications of LLMs.

UNIT-II AN OVERVIEW OF NLP AND NEURAL NETWORKS

NLP: NLP Pipeline, Morphology, Tokenization. Neural Networks: The Perceptron, Multi layer Perceptron, Training Neural Networks.

UNIT-III LANGUAGE MODELS

Statistical Language Model, Smoothing, Evaluation of Language Model, Limitations of Statistical Language Models. Neural Language Models: Convolutional Neural Networks, Recurrent Neural Networks, Limitations of Neural Language Models.

UNIT-IV PROMPTING STRATEGIES IN LLMS

Prompt Engineering: Prompt shape, Manual Template Engineering, Automated Template Learning, Continuous Prompts, Prompt Application, Chain-of-Thoughts, Tree-of-Thoughts, Graph-of-Thoughts.

UNIT-V ADVANCED TOPICS IN LARGE LANGUAGE MODELS

Reasoning with LLMs, Handling long context in LLMs, Model Editing, Hallucination in LLMs, Self-Evolving LLMs.

TEXT BOOKS:

1. Tanmoy Chakraborty, Introduction to Large Language Models, Wiley India, 1st Edition, 2025. ISBN : 9789363864740.

2. Dan Jurafsky and James H. Martin, Speech and Language Processing, 2nd edition, Pearson Press, 2008.

REFERENCE BOOKS:

1. Jacob Eisenstein, Natural Language Processing, First edition,The MIT Press, 2019.
2. Research papers published in conferences/journals likeAssociation for Computational Linguistics (ACL).

COURSE OUTCOMES:

1. Define Large Language Models (LLMs) and describe their key characteristics.
2. Explain the working principles of LLMs, including training and inference processes.
3. Analyze the evolution of language modeling technologies and their transition to modern LLMs.
4. Evaluate different applications of LLMs across various domains.
5. Compare different LLM architectures based on their capabilities and limitations.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. I Sem. L T P C

(25D13204E) HIGH PERFORMANCE SCIENTIFIC COMPUTING (PE-IV)

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

COURSE OUTCOMES:

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L	T	P	C
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(25D58105) ADVANCED DATA STRUCTURES & ALGORITHMS LAB

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Provide hands-on experience with advanced data structures and algorithms.
2. Implement graph algorithms, trees, heaps, and hashing techniques.
3. Explore AI-based data structures and their applications.
4. Develop problem-solving and optimization skills for AI and ML applications.
5. Enhance programming proficiency in implementing efficient algorithms.

1. Implementation of Min Heap and Max Heap – insertion, deletion, heapify.

2. Priority Queue using Heaps – scheduling applications.

3. B-Trees and B+ Trees – insertion and search operations.

4. Hash Tables – linear probing, quadratic probing, chaining.

5. Disjoint Set (Union-Find) – applications in network connectivity.

6. Graph Traversals – BFS, DFS, applications in AI search.

7. Shortest Path Algorithms – Dijkstra, Bellman-Ford, A*.

8. Minimum Spanning Trees – Kruskal’s and Prim’s algorithms.

9. Tries (Prefix Trees) – autocomplete and spell-check applications.

10. KD-Trees for Nearest Neighbor Search – AI and ML use cases.

11. R-Trees for Spatial Data Indexing – GIS and computer vision applications.

12. AI-based Experiment – Implement Graph Neural Network (GNN) basics or Reinforcement Learning search using advanced data structures.

TEXT BOOKS:

1. Thomas H. Cormen et al. – Introduction to Algorithms, MIT Press.
2. Sartaj Sahni – Data Structures, Algorithms and Applications in C++, Universities Press.

3. Narasimha Karumanchi – Data Structures and Algorithms Made Easy.

REFERENCE BOOKS:

1. Steven Skiena – The Algorithm Design Manual, Springer.
2. Goodrich & Tamassia – Algorithm Design and Applications.
3. Research papers on AI-based data structures (Trie, KD-Tree, GNN).
4. Online resources: GeeksforGeeks, LeetCode, Kaggle (for AI applications).

COURSE OUTCOMES:

1. Implement and analyze advanced data structures (heaps, B-trees, hashing).
2. Apply graph algorithms to solve real-world AI-related problems.
3. Design and implement AI-based data structures (Trie, KD-Tree, R-Tree).
4. Evaluate performance and complexity of implemented algorithms.
5. Use modern tools and libraries to implement and visualize algorithms.

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(25D13105) AI AND ML LAB

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Provide hands-on experience with machine learning and deep learning techniques.
2. Implement supervised and unsupervised learning algorithms on real-world datasets.
3. Explore deep learning frameworks (TensorFlow, PyTorch) for AI applications.
4. Apply AI/ML methods to natural language processing (NLP) and computer vision (CV) tasks.
5. Develop problem-solving and model evaluation skills using modern AI tools.

1. Linear Regression & Polynomial Regression – predicting continuous values.

2. Logistic Regression & SVM – binary/multi-class classification.

3. Decision Trees and Random Forests – classification on real-world datasets.

4. K-Means and Hierarchical Clustering – unsupervised learning applications.

5. Principal Component Analysis (PCA) – dimensionality reduction & visualization.

6. Artificial Neural Networks (ANNs) – basic feedforward and backpropagation.

7. Convolutional Neural Networks (CNNs) – image classification (MNIST/CIFAR-10).

8. Transfer Learning with Pretrained Models – ResNet, VGG, or MobileNet.

9. Recurrent Neural Networks (RNNs) & LSTMs – text sequence modeling.

10. NLP Experiment – text classification / sentiment analysis using embeddings (Word2Vec, BERT).

11. Computer Vision Experiment – object detection using YOLO/Faster R-CNN.

12. Capstone AI Experiment – integrate ML/DL for a real-world dataset (healthcare, finance, or social media analytics).

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COURSE OUTCOMES:

1. Implement classical ML algorithms for regression, classification, and clustering.
2. Apply neural networks and deep learning models using TensorFlow/PyTorch.
3. Solve NLP tasks using text processing and deep learning approaches.
4. Apply computer vision models for image classification and detection tasks.
5. Evaluate AI/ML models with appropriate metrics and optimize performance.

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(25D13205) AGENTIC AI LAB

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To implement single and multi-agent systems using simulation frameworks.
2. To analyze agent communication, coordination, and decision-making strategies.
3. To design reactive and deliberative agents using BDI and reinforcement learning models.
4. To apply agent-based modeling for solving real-world problems.

1. Reactive Agent Implementation – Develop a simple reflex agent that responds to environmental changes.

2. Goal-Based Agent Simulation – Design a goal-driven agent capable of achieving defined objectives.

3. BDI Agent Model Implementation – Build a Belief–Desire–Intention agent using a rule based reasoning framework.

4. Multi-Agent Coordination – Implement task-sharing or resource allocation among multiple agents.

5. Agent Communication – Simulate interaction using message passing (ACL in JADE).

6. Negotiation and Game-Theoretic Decision Making – Model cooperative and competitive negotiation scenarios.

7. Reinforcement Learning Agent – Train an agent to adapt to dynamic environments using RL techniques.

8. Swarm Intelligence-Based Agents – Implement ant colony or particle swarm behaviors in a simulated environment.

9. Agent-Based Traffic Simulation – Simulate intelligent traffic systems with autonomous decision-making agents.

10. Agentic Simulation Mini-Project – Develop a collaborative multi-agent system using JADE or AnyLogic for a real-world problem (e.g., disaster response, supply chain optimization).

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

COURSE OUTCOMES:

1. Implement single and multi-agent systems with environmental interaction.
2. Model agent communication, coordination, and negotiation.
3. Apply BDI and learning-based models to agent design.
4. Simulate intelligent agent behavior in real-world applications.

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M.Tech. I Sem.

L	T	P	C
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(25D13206) XAI AND RESPONSIBLE AI LAB (PYTHON FOR BIG DATA)

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To implement explainable AI models and visualization tools.
2. To apply interpretable ML methods for large-scale data analysis.
3. To understand ethical and responsible AI practices through case studies.
4. To use big data frameworks like PySpark for explainable model deployment.

1. Introduction to XAI Tools ??? Implement SHAP and LIME explainers for classification models.

2. Decision Tree Interpretability ??? Train and visualize interpretable decision tree models using Scikit-learn.

3. RuleFit and Explainable Boosting Machines (EBM) ??? Build transparent models and analyze decision rules.

4. Feature Importance Analysis ??? Compare global and local feature importance using SHAP values.

5. Counterfactual Explanations ??? Generate counterfactual examples to interpret model predictions

. 6. Fairness and Bias Detection ??? Evaluate ML models for gender or group bias using AIF360 or Fairlearn.

7. Big Data Preprocessing using PySpark ??? Clean, transform, and prepare large datasets for ML training.

8. Explainable Model Deployment ??? Integrate SHAP/LIME explanations in Flask or Streamlit dashboards for transparency.

9. Visualization Dashboards for Model Interpretability ??? Build interactive dashboards using Plotly/Dash or Streamlit.

10. Case Study on Responsible AI ??? Analyze a real-world AI ethics case (healthcare, finance, or hiring) and prepare an interpretability report.

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COURSE OUTCOMES:

1. Apply explainable AI frameworks for model interpretation.
2. Implement interpretable ML models for large-scale data
3. Evaluate fairness, bias, and transparency in AI models.
4. Design interactive visualization dashboards for responsible AI.

Remarks:

Software Tools ???

Programming & ML: Python (Scikit-learn, PyTorch, SHAP, LIME, Fairlearn, AIF360) ??? Big Data: PySpark ??? Visualization & Dashboards: Streamlit, Plotly Dash, Jupyter Notebooks

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2	0	0	2

(25D57107) RESEARCH METHODOLOGY AND IPR

Course Category	**Mandatory Course (credit)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To understand the research design process and data collection methods.
2. To develop skills in data analysis and reporting
3. To familiarize students with intellectual property rights (IPR) and patents.
4. To apply research skills in real-world contexts.

UNIT-I UNIT-I

Overview of research process and design - Types of Research - Approaches to Research (Qualitative vs Quantitative) - Observation studies, Experiments and Surveys - Use of Secondary and exploratory data to answer the research question - Importance of Reasoning in Research and Research ethics - Documentation Styles (APA/IEEE etc.) - Plagiarism and its consequences

Learning Outcomes ● Recall key concepts of the research process, including different types and approaches to research, and the importance of ethics.

● Differentiate between qualitative and quantitative research approaches and the various uses of secondary data.

● Identify the core principles of research design and ethics, including plagiarism and documentation styles.

● Explain the significance of reasoning and ethical conduct in all stages of the research process.

● Apply knowledge of different documentation styles, such as APA and IEEE, to properly cite sources and avoid plagiarism.

UNIT-II UNIT-II

Importance of Data Collection - Types of Data - Data Collection Methods - Data Sources - primary, secondary and Big Data sources - Data Quality & Ethics - Tools and Technology for Data Collection

Learning Outcomes

● Identify different types of data and the various methods for collecting both primary and secondary data.

● Explain the importance of data quality and ethical considerations in data collection.

● Differentiate between primary, secondary, and Big Data sources.

● Describe the various tools and technologies used for effective data collection. Analyze the ethical implications of data collection and ensure data quality in a research study.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

UNIT-III UNIT-III

Overview of Multivariate analysis - Experimental research, cause-effect relationship, and development of hypotheses- Measurement systems analysis, error propagation, and validity of experiments - Guidelines for writing abstracts, introductions, methodologies, results, and discussions - Writing Research Papers & proposals

Learning Outcomes

● Apply knowledge of multivariate analysis and experimental research to develop hypotheses and analyze data.

● Explain the process of measurement systems analysis and error propagation in experimental design.

● Formulate clear and concise abstracts, introductions, and methodologies for research papers.

● Write effective results and discussion sections based on data analysis. Develop comprehensive research papers and proposals based on proper data analysis and reporting guidelines.

UNIT-IV UNIT-IV

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

Learning Outcomes ● Recall the fundamental concepts of Intellectual Property (IP) and its evolution.

● Describe the roles of organizations like **WIPO** and **WTO** in the establishment of IPR.

● Differentiate between various types of IPR, including trade secrets and trademarks.

● Explain the common rules and features of IPR agreements and the role of UNESCO.

● Analyze the relationship between IPR and biodiversity, and its broader impact.

UNIT-V UNIT-V

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification - Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents

Learning Outcomes

● Explain the objectives, benefits, and key features of a patent, including the concept of an inventive step.

● Differentiate between the various types of patent applications and the e-filing process.

● Describe the process of patent examination, grant, and revocation.

● Identify the roles of patent agents and the process for their registration. Analyze the concepts of equitable assignments, licenses, and licensing of related patents.

TEXT BOOKS:

1. 1.Stuart Melville and Wayne Goddard, Research Methodology: An introduction for Science & Engineering students, Juta and Company Ltd, 2004
2. 2.Catherine J. Holland, Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, Entrepreneur Press, 2007.

3. 1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education 11e (2012).
4. Ranjit Kumar , Research Methodology: A Step-by-Step Guide for Beginners. . David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
5. Deborah E. Bouchoux , Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets, 6th Edition, Cengage 2024.
6. Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, The Craft of Research, 5th Edition, University of Chicago Press, 2024

REFERENCE BOOKS:

1. Coursera / edX – Research Methodology and Data Analysis courses
2. Springer Link & ScienceDirect – Latest journals on research design and statistics
3. Google Scholar – Free access to research papers
4. NCBI Bookshelf – Open-access research methodology resources
5. Khan Academy (Statistics & Probability) – For fundamentals of hypothesis testing, regression, and ANOVA.

COURSE OUTCOMES:

1. Recall key concepts and terminology related to research design, data collection, and intellectual property rights.
2. Explain the importance of research design and data analysis in research studies, and describe the concept of intellectual property rights.
3. Design a research study, including data collection and analysis methods, and apply intellectual property rights principles to protect research findings.
4. Analyze research studies to identify strengths and limitations, and evaluate the effectiveness of data collection and analysis methods.
5. Assess the impact of intellectual property rights on research and innovation, and evaluate the effectiveness of research designs and methods.
6. Develop a comprehensive research plan, including a detailed research design, data collection and analysis methods, and a plan for protecting intellectual property.

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0	1	2	2

(25D13106) MLOPS & AI MODEL DEVELOPMENT

Course Category	**Skill Oriented Course (SC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To provide hands-on exposure to building and deploying AI/ML models.
2. To introduce MLOps practices for scalable and reproducible AI systems.
3. To integrate data pipelines, CI/CD, and monitoring for ML workflows.
4. To develop industry-ready skills for AI application deployment.

Unit I:

Fundamentals of MLOps & Workflow Automation Introduction to MLOps: Need & Benefits, ML Lifecycle: Data → Model → Deployment → Monitoring, Experiment tracking (MLflow, Weights & Biases), Data versioning (DVC, Delta Lake), Workflow orchestration basics (Airflow, Kubeflow), Reproducibility & automation challenges, Case study: End-to-end ML workflow, Hands-on: Setting up ML pipeline with MLflow

Unit II:

Data Engineering for AI Pipelines: Data ingestion & preprocessing pipelines, Handling structured & unstructured data, Batch vs. real time data processing, Streaming data in ML (Kafka, Spark Streaming), Feature engineering & feature stores, Data quality monitoring, Scalable storage systems for ML, Hands-on: Building a data pipeline with Kafka/Spark

Unit III:

Model Development & Deployment: Model training best practices, Hyperparameter tuning & AutoML, Model compression & optimization, Containerization with Docker, Deployment strategies: REST APIs, microservices, Model serving frameworks (TensorFlow Serving, TorchServe, FastAPI), CI/CD for ML models (GitHub Actions, Jenkins), Hands-on: Deploying a model as REST API using Docker + FastAPI

Unit IV:

Monitoring, Maintenance & Responsible AI Model monitoring: drift detection, performance tracking, Logging & error handling, Continuous monitoring frameworks (Prometheus, Grafana, EvidentlyAI), Retraining pipelines for adaptive learning, A/B testing & shadow deployment in ML, Bias, fairness, and explainability in AI models,

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Ethical AI practices in deployment, Hands-on: Monitoring drift in deployed model

Unit V:

Industrial Applications & Case Studies

MLOps in healthcare (diagnosis, patient monitoring), MLOps in finance (fraud detection, risk analytics), AI in manufacturing (predictive maintenance, anomaly detection), Cloud platforms for MLOps (AWS Sagemaker, Azure ML, GCP AI Platform), Blockchain integration for AI model security, Scaling MLOps in large enterprises, Case study: End-to-end MLOp

TEXT BOOKS:

1. Mark Treveil, Alok Shukla ??? Introducing MLOps: How to Scale Machine Learning in the Enterprise. O???Reilly.
2. Emmanuel Raj ??? Engineering MLOps: Rapidly build, test, and manage production-ready machine learning life cycles. Packt.

REFERENCE BOOKS:

1. Hannes Hapke, Catherine Nelson – Machine Learning in Production: Developing and Operating AI Models. O'Reilly.
2. Munn, Deep – Practical MLOps. Manning.

COURSE OUTCOMES:

1. Explain MLOps concepts and lifecycle for ML/AI model development.
2. Apply pipeline automation for training, validation, deployment, and monitoring.
3. Use containerization and orchestration for scalable AI services.
4. Evaluate ML models in production with monitoring and drift detection.
5. Analyze challenges in governance, reproducibility, and ethical deployment of AI systems.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. I Sem.

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2	0	0	2

(25D57207) QUANTUM TECHNOLOGIES AND APPLICATIONS

Course Category	**Mandatory Course (credit)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Present core quantum principles such as superposition and entanglement without mathematical formalism.
2. Develop conceptual clarity on qubits, quantum states, and information frameworks.
3. Examine the theoretical challenges in realizing scalable quantum systems.
4. Introduce foundational ideas in quantum communication and computing.
5. Highlight applications, industrial adoption, and future research directions in quantum technologies.

UNIT-I FOUNDATIONS OF QUANTUM THEORY AND TECHNOLOGIES

Transition from classical to quantum physics. Key conceptual principles: Superposition, Entanglement, Uncertainty, Wave-particle duality. Quantum states and measurement; the role of the observer. Representative quantum systems: electrons, photons, atoms. Concept of quantization and discrete energy levels. Strategic relevance of quantum technologies. Overview of major domains: Computing, Communication, Sensing. Global quantum initiatives: India’s National Quantum Mission, EU Quantum Flagship, USA, China.

UNIT-II CONCEPTUAL STRUCTURE OF QUANTUM INFORMATION

Qubits: qualitative understanding using spin and polarization. Classical bits vs quantum bits: distinctions and implications. Quantum systems (non-engineering perspective): trapped ions, superconducting qubits, photonics. Coherence and decoherence mechanisms. Abstract notions: quantum states, measurement operators, Hilbert space???interpretation without mathematics. Entanglement and non-locality as foundational resources. Quantum vs classical information principles; philosophical considerations.

UNIT-III BUILDING A QUANTUM COMPUTER – CHALLENGES AND REQUIREMENTS

Conceptual prerequisites for functional quantum hardware. Fragility of quantum states: decoherence, noise, stability issues. Requirements: isolation, error resilience, scalability, control. Why maintaining entanglement is difficult; theoretical necessity of quantum error correction. Comparative overview of hardware platforms (superconducting circuits, trapped ions, photonics).Current progress vs scientific constraints; conceptual view of quantum software’s role.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

UNIT-IV QUANTUM COMMUNICATION AND COMPUTING

(Redundant explanations removed, retaining only unique themes.)Quantum vs classical communication paradigms. Essentials of Quantum Key Distribution (QKD) and its security rationale. Entanglement-enabled communication protocols. Concept of the Quantum Internet and secure global networking. Introduction to quantum computing and quantum parallelism. Conceptual comparison of classical and quantum gate operations. Challenges: decoherence, noise, and the necessity of error correction frameworks.

UNIT-V APPLICATIONS, INDUSTRY, AND FUTURE DIRECTIONS

Application domains: Healthcare and drug discovery, Material science and chemistry, Optimization and logistics, Quantum sensing and precision timing. Case studies: IBM, Google, Microsoft, PsiQuantum. Ethical, societal, and policy considerations. Barriers to adoption: cost, skilled workforce, standards. Emerging research and career landscapes; India???s strategic opportunity in the global quantum ecosystem.

TEXT BOOKS:

1. Nielsen & Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2010.
2. Rieffel & Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2011.
3. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019.

REFERENCE BOOKS:

1. David McMahon, Quantum Computing Explained, Wiley, 2008.
2. Kaye, Laflamme, Mosca, An Introduction to Quantum Computing, OUP, 2007.
3. Scott Aaronson, Quantum Computing Since Democritus, CUP, 2013.
4. Susskind & Friedman, Quantum Mechanics: The Theoretical Minimum, Basic Books, 2014.
5. Rosenblum & Kuttner, Quantum Enigma, OUP, 2011.
6. Benenti et al., Principles of Quantum Computation and Information, World Scientific, 2004.
7. DST India and MeitY: Official Quantum Mission Reports, 2020 onwards. Quantum Flagship EU: Roadmaps and Strategy Documents.

e-Resources and Digital Material:

1. IBM Quantum Experience & Qiskit Textbook Coursera ??? Quantum Mechanics and Quantum Computation (UC Berkeley) edX ??? Quantum Internet & Quantum Computers YouTube ??? Quantum Computing for the Determined (Michael Nielsen)

COURSE OUTCOMES:

1. Explain fundamental quantum concepts conceptually.
2. Distinguish classical information systems from quantum information frameworks.
3. Identify the principal theoretical limitations in building quantum computers.

4. Describe the conceptual basis of quantum communication and computation.
5. Discuss current applications, technological trajectories, and career opportunities in the quantum domain.

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M.Tech. I Sem. L T P C

(25D13207) COMPREHENSIVE VIVA VOCE

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

Application domains: Healthcare and drug discovery, Material science and chemistry, Optimization and logistics, Quantum sensing and precision timing. Case studies: IBM, Google, Microsoft, PsiQuantum. Ethical, societal, and policy considerations. Barriers to adoption: cost, skilled workforce, standards. Emerging research and career landscapes; India???s strategic opportunity in the global quantum ecosystem.

COURSE OUTCOMES:

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M.Tech. I Sem.

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(25D57109A) ENGLISH FOR RESEARCH PAPER WRITING (AC-I)

Course Category	**Mandatory Course (Non-credit)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To equip students with the fundamentals of academic English for research paper writing.
2. To develop students' advanced reading skills for analyzing and evaluating research articles.
3. To refine students' grammar and language skills for clarity and precision in research writing.
4. To master the skills of revising, editing, and proofreading research papers.
5. To familiarize students with the role of technology and AI in research writing, including digital literacy and ethical considerations.

UNIT-I UNIT-I

:

Academic English - MAP (Message-Audience-Purpose) - Language Proficiency for Writing - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References - Word order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Structuring Paragraphs - Paraphrasing Skills – Framing Title and Sub headings

UNIT-II UNIT-II

Reading Academic Texts - Critical Reading Strategies - Skimming and Scanning - Primary Research Article vs. Review Article - Reading an Abstract - Analyzing Research Articles - Identifying Arguments - Classifying Methodologies - Evaluating Findings - Making Notes

UNIT-III UNIT-III

Advanced Punctuation Usage - Grammar for Clarity - Complex Sentence Structures - Active- Passive Voice - Subject-Verb Agreement - Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences

UNIT-IV UNIT-IV

Effective Revisions - Restructuring Paragraph - Editing vs Proofreading, Editing for Clarity and Coherence - Rectifying Sentence Structure Issues - Proofreading for Grammatical Precision – Spellings - Tips for Correspondence with Editors - Critical and Creative Phases of Writing

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UNIT-V UNIT-V

Digital Literacy and Critical Evaluation of Online Content - Technology and Role of AI in Research Writing – Assistance in Generating Citations and References - Plagiarism and Ethical Considerations – Tools and Awareness – Fair Practices

TEXT BOOKS:

1. Bailey. S. Academic Writing: A Handbook for International Students. London and New York: Routledge,2015.
2. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

REFERENCE BOOKS:

1. Craswell, G. Writing for Academic Success, Sage Publications, 2004.
2. Peter Elbow, Writing With Power, E-book, Oxford University Press, 2007
3. Oshima, A. & Hogue, A. Writing Academic English, Addison-Wesley, New York, 2005
4. Swales, J. & C. Feak, Academic Writing for Graduate Students: Essential Skills and Tasks. Michigan University Press, 2012.
5. Goldbort R.Writing for Science, Yale University Press (available on Google Books), 2006
6. Day R.How to Write and Publish a Scientific Paper, Cambridge University Press, 2006

COURSE OUTCOMES:

1. Recall the key language aspects and structural elements of academic writing in research papers.
2. Explain the importance of clarity, precision, and objectivity in research writing.
3. Apply critical reading strategies and advanced grammar skills to analyze and write research papers.
4. Analyze research articles and identify the strengths and limitations of different methodologies.
5. Evaluate research papers to check for plagiarism, structure, clarity, and language accuracy.
6. Develop a well-structured research paper that effectively communicates complex ideas.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. I Sem.

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2	0	0	0

(25D57109C) DISASTER MANAGEMENT (AC-I)

Course Category	**Mandatory Course (Non-credit)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To enable the students to understand the fundamental concepts of disasters, hazards, their factors, and significance with special reference to India.
2. To prepare them to classify and analyze different types of natural and man-made disasters, their causes, magnitude, and impacts.
3. To foster them develop understanding of disaster preparedness, monitoring systems, and the role of government, community, and media.
4. To equip them in learning risk assessment techniques, disaster risk reduction strategies, and the importance of global and national cooperation.
5. To foster their ability to think critically and respond to disasters and design effective mitigation measures (structural and non-structural) with a focus on emerging trends and Indian disaster management programs.

UNIT-I UNIT-I

Disaster - Definition, Factors and Significance - Difference Between Hazard and Disaster - Natural and Man-made Disasters - Difference, Nature, Types and Magnitude - Disaster Prone Areas in India - Study of Seismic Zones - Areas Prone to Floods and Droughts, Landslides and Avalanches - Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami - Post-Disaster Diseases and Epidemics.

UNIT-II UNIT-II

Economic Damage - Loss of Human and Animal Life - Destruction of Ecosystem - Natural Disasters - Earthquakes, Volcanism, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster - Nuclear Reactor Meltdown - Industrial Accidents - Oil Slick sand Spills - Outbreaks of Disease and Epidemics War and Conflicts

UNIT-III UNIT-III

Preparedness - Monitoring of Phenomena - Triggering a Disasteror Hazard - Evaluation of RiskApplication of Remote Sensing - Data from Meteorological and Other Agencies - Media ReportsGovernmental and Community Preparedness

UNIT-IV UNIT-IV

Disaster Risk -Concept and Elements, Disaster Risk Reduction - Global and National Disaster Risk Situation -Techniques of Risk Assessment – Global Co-Operation in Risk Assessment and Warning - People’s participation in Risk Assessment – Strategies for Survival

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UNIT-V UNIT-V

Meaning, Concept and Strategies of Disaster Mitigation - EmergingTrends in Mitigation - Structural Mitigation and Non- Structural Mitigation - Programs of Disaster Mitigation in India.

TEXT BOOKS:

1. Gupta, H. K. Disaster Management. Universities Press, 2003
2. Singh, R. B. Natural Hazards and Disaster Management. Rawat Publications, 2006.

REFERENCE BOOKS:

1. Coppola, D. P. (2020). Introduction to International Disaster Management (4th ed.). Elsevier.
2. Shaw, R., & Izumi, T. (2022). Science and Technology in Disaster Risk Reduction in Asia. Springer.
3. Wisner, B., Gaillard, J. C., & Kelman, I. (2021). Handbook of Hazards and Disaster Risk Reduction and Management (2nd ed.). Routledge.
4. Saini, V. K. (2021). Disaster Management in India: Policy, Issues and Perspectives. Sage India.
5. Kelman, I. Disaster by Choice: How Our Actions Turn Natural Hazards into Catastrophes, Oxford University Press, 2022
6. Sahni, P. & Dhameja, A. Disaster Mitigation: Experiences and Reflections. Prentice Hall of India, 2004.

COURSE OUTCOMES:

1. Define and distinguish between hazards and disasters, and explain their types, nature, and impacts.
2. Identify and map disaster-prone areas in India and understand the epidemiological consequences of disasters.
3. Assess the economic, social, and ecological repercussions of major natural and man-made disasters.
4. Demonstrate knowledge of disaster preparedness tools such as remote sensing, meteorological data, risk evaluation, and community awareness.
5. Apply risk assessment methods and propose disaster risk reduction strategies at local, national, and global levels.
6. Formulate and evaluate structural and non-structural disaster mitigation strategies, with emphasis on Indian programs and emerging trends.

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L	T	P	C
2	0	0	0

(25D57209B) PEDAGOGY STUDIES (AC-II)

Course Category	**Mandatory Course (Non-credit)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To enable the students to understand the aims, rationale, policy background, and conceptual frameworks in pedagogy, curriculum, and teacher education research.
2. To develop an understanding of diverse pedagogical practices
3. To make them learn the methodologies for assessing the effectiveness of pedagogical practices and teacher education models.
4. To enable them to learn professional development strategies, including peer support, community engagement, and alignment with curriculum and assessment.

UNIT-I FOUNDATIONS OF PEDAGOGY

Introduction to pedagogy and its importance in education - Historical and philosophical foundations of pedagogy - Theories of learning and teaching (behaviorist, cognitive, constructivist) - Role of pedagogy in shaping educational practices - Role of technology in modern pedagogy (ICT, e-learning, blended learning)

UNIT-II TEACHING-LEARNING PROCESSES

Understanding the teaching-learning process - Lesson planning and curriculum design - Strategies for effective teaching and learning (expository, collaborative, experiential) - Use of technology to enhance teaching-learning processes (multimedia, simulations, gamification)

UNIT-III TECHNOLOGY INTEGRATION IN EDUCATION

Educational technology and system design - Instructional design models (ADDIE, ASSURE, Dick and Carey Model) - Emerging trends in e-learning (social learning, MOOCs, mobile learning) - ICT tools for teaching and learning (Learning Management Systems, online resources)

UNIT-IV PEDAGOGY AND ASSESSMENT

Pedagogy, pedagogical analysis, and assessment - Types of assessment (placement, formative, diagnostic, summative) - Technology-based assessment tools (online quizzes, polls, discussions) - Rubrics for self and peer evaluation- Reflective Practices

UNIT-V CONTEMPORARY ISSUES AND TRENDS

Inclusive education and technology (assistive technology, accessibility) - Change management and innovation in education - Quality assurance and evaluation in education (TQM, Six Sigma) - Future trends in pedagogy and technology (AI, AR, VR in education) - Personalized learning and adaptive teaching

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TEXT BOOKS:

1. Alexander, R. J. Essays on Pedagogy. Routledge, 2008.
2. Shulman, L. S. The Wisdom of Practice: Essays on Teaching, Learning, and Learning to Teach. Jossey-Bass, 2004

COURSE OUTCOMES:

1. Define and explain key concepts, frameworks, and methodologies in pedagogy and teacher education research.
2. Critically analyze pedagogical practices used in diverse classroom settings, with reference to teacher education and curriculum design.
3. Evaluate the effectiveness of pedagogical approaches using quality assessment tools and theory of change models.
4. Apply evidence-based strategies to improve classroom practices, curriculum alignment, and teacher professional development.
5. Identify and address barriers to learning through innovative pedagogical strategies.
6. Design and propose research studies that contribute to filling gaps in pedagogy, curriculum, and teacher education, with focus on dissemination and impact.

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M.Tech. I Sem.

L	T	P	C
2	0	0	0

(25D57109D) ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (AC-I)

Course Category	**Mandatory Course (Non-credit)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
2. To make them understand the need for protecting traditional knowledge and its significance in the global economy.
3. To make them understand the legal frame work and policies related to traditional knowledge protection.
4. To enable them to understand the relationship between traditional knowledge and intellectual property rights.
5. To make them explore the applications of traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology

UNIT-I UNIT-I

Introduction to traditional knowledge - Definition, Nature and characteristics, scope and importance - Kinds of traditional knowledge - Physical and social contexts in which traditional knowledge develop - Historical impact of social change on traditional knowledge systems - Indigenous Knowledge (IK) – Characteristics - traditional knowledge vis-à-vis indigenous knowledge -Traditional knowledge Vs western knowledge, traditional knowledge vis-à-vis formal knowledge.

Learning Outcomes: At the end of the unit the student will able to:

> Understand the concept of traditional knowledge.
> Contrast and compare characteristics, importance& kinds of traditional knowledge.
> Analyze physical and social contexts of traditional knowledge.
> Evaluate social change on traditional knowledge.

UNIT-II UNIT-II

Protection of traditional knowledge- Need for protecting traditional knowledge - Significance of TK Protection - Value of TK in global economy - Role of Government to harness TK.

Learning Outcomes: At the end of the unit the student will able to:

> Know the need of protecting traditional knowledge.
>Apply significance of TK protection.
>Analyze the value of TK in global economy.
> Evaluate role of government

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UNIT-III UNIT-III

Legal frame work and TK - A)The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 - Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act) – B)The Biological Diversity Act 2002 and Rules 2004 - the protection of traditional knowledge bill, 2016 - Geographical Indicators Act 2003.

Learning Outcomes: At the end of the unit the student will able to:

>Understand legal frame work of TK.

> Contrast and compare the ST and other traditional forest dwellers

> Analyze plant variant protections

> Understand the rights of farmers forest dwellers

UNIT-IV UNIT-IV

Traditional knowledge and Intellectual property - Systems of traditional knowledge protection - Legal concepts for the protection of traditional knowledge - Certain non-IPR mechanisms of traditional knowledge protection - Patents and traditional knowledge - Strategies to increase protection of traditional knowledge -Global legal FORA for increasing protection of Indian Traditional Knowledge.

Learning Outcomes: At the end of the unit the student will able to:

> Understand TK and IPR

> Apply systems of TK protection.

> Analyze legal concepts for the protection of TK.

>Evaluate strategies to increase the protection of TK.

UNIT-V UNIT-V

Traditional knowledge in different sectors - Traditional knowledge and Engineering - Traditional medicine system - TK and Biotechnology - TK in Agriculture - Traditional societies depend on it for their food and healthcare needs - Importance of conservation and sustainable development of environment - Management of biodiversity, Food security of the country and protection of TK

Learning Outcomes: At the end of the unit the student will be able to:

> Know TK in different sectors.

> Apply TK in Engineering.

>Analyze TK in various sectors.

> Evaluate food security and protection of TK in the country.

TEXT BOOKS:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. Introduction to Indian Knowledge System: Concepts and Applications, PHI Learning Pvt.Ltd. Delhi, 2022.
2. Basanta Kumar Mohanta and Vipin Kumar Singh,Traditional Knowledge System and Technology in India, PratibhaPrakashan 2012.

REFERENCE BOOKS:

1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.

2. Kak, S.C. “On Astronomy in Ancient India”, Indian Journal of History of Science, 22(3), 1987
3. Subbarayappa, B.V. and Sarma, K.V. Indian Astronomy: A Source Book, Nehru Centre, Mumbai, 1985.
4. Bag, A.K. History of Technology in India, Vol. I, Indian National Science Academy, New Delhi, 1997.
5. Acarya, P.K. Indian Architecture, Munshiram Manoharlal Publishers, New Delhi, 1996.
6. Banerjea, P. Public Administration in Ancient India, Macmillan, London, 1961.
7. Kapoor Kapil, Singh Avadhesh,Indian Knowledge Systems Vol – I & II, Indian Institute of Advanced Study, Shimla, H.P., 2022

COURSE OUTCOMES:

1. Define and explain the concept of traditional knowledge, its nature, characteristics, and scope
2. Understand the need for protecting traditional knowledge and its significance in the global economy
3. Explain the legal framework and policies related to traditional knowledge protection
4. Apply traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology
5. Analyze the importance of traditional knowledge in various contexts, including its historical impact and social change
6. Analyze the relationship between traditional knowledge and intellectual property rights, including patents and non-IPR mechanisms

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I

M.Tech
II-Semester Course Structure

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. II Sem. - Course Structure

S.No	Subject Code	Course Category	Name of the Subject	Hours/Week				Marks		
				Lecture	Tutorial	Practical	Credits	Internal	External	Total
1	25D13201	PC	AGENTIC AI	3	0	0	3	40	60	100
2	25D13202	PC	CONVERSATIONAL AI	3	0	0	3	40	60	100
3	25D58104A	PE	NATURAL LANGUAGE PROCESSING (PE-III)	3	0	0	3	40	60	100
4	25D13204D	PE	INTRODUCTION TO LARGE LANGUAGE MODELS (PE-IV)	3	0	0	3	40	60	100
5	25D13205	PC	AGENTIC AI LAB	0	0	4	2	40	60	100
6	25D13206	PC	XAI AND RESPONSIBLE AI LAB (PYTHON FOR BIG DATA)	0	0	4	2	40	60	100
7	25D57207	MC(C)	QUANTUM TECHNOLOGIES AND APPLICATIONS	2	0	0	2	40	60	100
8	25D57209B	MC(NC)	PEDAGOGY STUDIES (AC-II)	2	0	0	0	40	0	40

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M.Tech
II -Semester Syllabus

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M.Tech. II Sem.

L	T	P	C
3	0	0	3

(25D13201) AGENTIC AI

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To introduce the principles and architecture of intelligent autonomous agents.
2. To understand agent-based modeling and simulation frameworks.
3. To explore reasoning, planning, and decision-making in agentic systems.
4. To study coordination, communication, and cooperation in multi-agent systems.
5. To apply agentic AI concepts in real-world domains such as robotics, finance, and smart environments.

UNIT-I INTRODUCTION TO AGENTIC AI

Introduction to intelligent agents – definition, characteristics, Types of agents, PEAS representation of agents, Properties of agent environments, Architectures of intelligent agents – reactive, deliberative, and hybrid models., Rationality, autonomy, and bounded rationality in agent design, Agent lifecycle and perception–action loop. Applications of reactive vs. deliberative agents in real world systems.

UNIT-II KNOWLEDGE REPRESENTATION AND REASONING

Role of knowledge representation (KR) in agent-based systems, Logical reasoning, Rule-based reasoning systems and production rules, Belief-Desire-Intention (BDI) architecture – components and formalization, Epistemic logic and reasoning, Ontologies and semantic models for agent knowledge bases, Probabilistic reasoning and uncertainty handling in agents.

UNIT-III PLANNING AND DECISION-MAKING

Goal formulation and problem-space definition, Search-based planning, Classical planning algorithms – STRIPS, GraphPlan, and partial-order planning, Temporal and hierarchical task planning, Markov Decision Processes (MDPs), Reinforcement learning concepts, Game-theoretic approaches to agent decision-making, Integration of planning and learning in dynamic environments.

UNIT-IV MULTI-AGENT SYSTEMS (MAS)

Introduction to multi-agent systems, Communication protocols – KQML, FIPA-ACL, message structures, Coordination and cooperation strategies among agents, Negotiation, auction, and contract-net protocols, Coalition formation and teamwork in multi-agent environments, Distributed problem solving and consensus algorithms, Emergent behavior and self-organization in MAS, Simulation of MAS using frameworks like JADE and AnyLogic.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

UNIT-V APPLICATIONS OF AGENTIC AI

Agentic AI in robotics, Intelligent digital assistants and conversational agents, Financial trading agents and decision-support systems, Smart cities and energy grid optimization using agent models, Reinforcement-based adaptive learning in dynamic environments, Simulation frameworks for agent based modeling (JADE, AnyLogic, NetLogo), Ethical, legal, and safety issues in deploying autonomous agents.

TEXT BOOKS:

1. Michael Wooldridge – An Introduction to MultiAgent Systems, Wiley.
2. Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach, Pearson.
3. Gerhard Weiss (Ed.) – Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press.

REFERENCE BOOKS:

1. Yoav Shoham & Kevin Leyton-Brown – Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press.
2. Jacques Ferber – Multi-Agent Systems: An Introduction to Distributed Artificial Intelligence, Addison-Wesley.
3. FIPA (Foundation for Intelligent Physical Agents) Standards – https://www.fipa.org

COURSE OUTCOMES:

1. Explain the concept, characteristics, and architecture of intelligent agents.
2. Implement reasoning and planning algorithms for goal-driven autonomous agents.
3. Design collaborative and competitive multi-agent systems.
4. Apply reinforcement and adaptive learning techniques for agentic intelligence.
5. Develop domain-specific agentic AI applications and evaluate their performance.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. II Sem.

L	T	P	C
3	0	0	3

(25D13202) CONVERSATIONAL AI

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To introduce the foundations and architectures of dialogue systems and conversational design.
2. To explore NLP pipelines for intent detection, slot filling, and entity recognition.
3. To study and apply generative transformer-based models such as GPT, BERT, and T5 for dialogue generation.
4. To design context-aware, multimodal, and personalized conversational agents.
5. To evaluate ethical considerations, safety, and performance metrics in conversational AI systems.

UNIT-I INTRODUCTION TO CONVERSATIONAL AI

Introduction to dialogue systems and chatbots, Types of conversational AI, Components of conversational systems, Conversation design principles, History and evolution of conversational AI, Frameworks and platforms, Multimodal and voice-based conversational agents.

UNIT-II NLP FOR CONVERSATION

Text preprocessing, Word embeddings, Intent detection using classification models, Entity recognition (NER) and slot filling for dialogue systems, Sentiment analysis and emotion detection in conversations, Context modeling in dialogue ??? dialogue state tracking and context windows, Multilingual and cross-lingual NLP for global conversational systems.

UNIT-III GENERATIVE MODELS FOR CONVERSATION

Sequence-to-sequence (Seq2Seq) models, Attention mechanisms and context vector modelling, Transformer, Large Language Models (LLMs), Fine-tuning and prompt engineering, Transfer learning and few-shot learning in conversational AI, Dialogue data curation and preprocessing.

UNIT-IV DIALOGUE MANAGEMENT AND CONTEXT MODELING

Dialogue management, Reinforcement learning, Contextual dialogue management with memory networks and transformers, Hybrid models: retrieval-based and generative dialogue systems, Personalization and adaptive user profiling in conversation, Handling interruptions, context switching, and multi-turn conversations, Integration with external APIs and databases for task completion.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

UNIT-V EVALUATION, SAFETY, AND ETHICS IN CONVERSATIONAL AI

Evaluation metrics for conversational AI ??? BLEU, ROUGE, METEOR, perplexity, Human evaluation: coherence, engagement, empathy, and naturalness, Bias, fairness, and safety in generative dialogue systems, Ethical considerations, Explainability and transparency in conversational models, Human-AI collaboration and co-creation in dialogue systems.

TEXT BOOKS:

1. Alan Nichol & Greg Nichols – Conversational AI with Rasa, O'Reilly Media.
2. Palash Goyal, Sumit Pandey, Karan Jain – Deep Learning for Natural Language Processing, Springer.
3. Tom B. Brown et al. – Language Models are Few-Shot Learners (GPT-3 Paper), OpenAI, 2020.

REFERENCE BOOKS:

1. Daniel Jurafsky & James H. Martin ??? Speech and Language Processing, Pearson.
2. Sudharsan Ravichandiran ??? Hands-On Transformers and NLP with PyTorch and Hugging Face.
3. Thomas Wolf et al. ??? Transformers: State-of-the-Art Natural Language Processing, ACL 2020.

COURSE OUTCOMES:

1. Understand the structure, components, and working of conversational agents.
2. Implement NLP-based intent recognition, sentiment analysis, and dialogue flow.
3. Design and fine-tune transformer-based generative dialogue models.
4. Integrate contextual understanding and user personalization into chat systems.
5. Evaluate conversational systems for performance, safety, and ethical compliance.

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M.Tech. II Sem.

L	T	P	C
3	0	0	3

(25D58104A) NATURAL LANGUAGE PROCESSING (PE-III)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

UNIT-I INTRODUCTION TO NATURAL LANGUAGE PROCESSING

Introduction to Natural Language, Study of Language, Applications of NLP, Challenges in NLP, Evaluating Language Understanding Systems, Levels of Language Analysis, Text Preprocessing, Tokenization, Normalization, Stemming and Lemmatization, Spelling Correction Techniques, Language Modeling, N-grams and Smoothing Methods, Corpus and Annotation, Organization of NLP Systems, Outline of English Syntax.

UNIT-II SEQUENCE MODELING AND TAGGING

Part-of-Speech Tagging, Rule-Based Tagging, Statistical Tagging Methods, Hidden Markov Models for Tagging, Feature-Based Tagging, Maximum Entropy Models, Conditional Random Fields (CRF), Sequence Labeling Techniques, Named Entity Tagging Basics, Training and Inference in Sequence Models, Evaluation Measures for Tagging.

UNIT-III SYNTACTIC PROCESSING AND PARSING

Constituency Grammar, Phrase Structure Rules, Context-Free Grammars, Parse Tree Representation, CKY Parsing, Shift–Reduce Parsing, Dependency Grammar, Dependency Parsing Algorithms, Universal Dependencies, Syntactic Ambiguity Resolution, Treebanks and Annotation Schemes, Grammatical Relations.

UNIT-IV SEMANTIC ANALYSIS AND TOPIC MODELING

Distributional Semantics, Vector Space Models, Word Embeddings (Word2Vec, GloVe), Word Similarity and Relatedness, Lexical Semantics, Word Senses, Synonymy, Antonymy, Polysemy, Semantic Networks, WordNet, Semantic Role Labeling, Topic Models, Latent Dirichlet Allocation (LDA), Document Similarity and Clustering.

UNIT-V INFORMATION EXTRACTION, TEXT MINING AND SENTIMENT ANALYSIS

Named Entity Recognition, Entity Linking, Relation Extraction, Information Extraction Pipelines, Coreference Resolution, Text Summarization (Extractive & Abstractive), Text Classification Approaches, Document Categorization, Sentiment Analysis Techniques, Opinion Mining, Polarity Detection, Evaluation of Text Mining Systems, Applications in Social Media and Web Analytics.

TEXT BOOKS:

1. "Speech and Language Processing" – Daniel Jurafsky & James H. Martin A comprehensive textbook covering NLP fundamentals, syntax, semantics, probabilistic models, sequence tagging, parsing, information extraction, and modern applications.
2. "Foundations of Statistical Natural Language Processing" – Christopher D. Manning & Hinrich Schütze-A classic book focusing on statistical NLP methods including language modeling, tagging, parsing, semantics, and text mining techniques.

e-Resources and Digital Material:

1. https://onlinecourses.nptel.ac.in/noc26_cs45/preview
2. https://www.classcentral.com/course/swayam-natural-language processing-7950
3. https://www.classcentral.com/course/nlpintro-3332

COURSE OUTCOMES:

1. Understand the fundamental concepts, applications, and linguistic foundations of Natural Language Processing.
2. Apply sequence modeling techniques such as POS tagging, MaxEnt, and CRF for effective text labeling.
3. Analyze sentence structure using constituency and dependency parsing methods.
4. Apply semantic models and topic modeling techniques to extract meaning and themes from text.
5. Implement information extraction, text classification, and sentiment analysis techniques in real-world NLP tasks.

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M.Tech. II Sem.

L	T	P	C
3	0	0	3

(25D13204D) INTRODUCTION TO LARGE LANGUAGE MODELS (PE-IV)

Course Category	**Professional Elective (PE)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To introduce the fundamentals of Large Language Models (LLMs), their characteristics, working mechanisms, and evolution.
2. To provide an overview of Natural Language Processing (NLP) and Neural Networks as foundational technologies for LLMs.
3. To explore various language models, including statistical and neural approaches, along with their limitations.
4. To understand different prompting strategies used in LLMs and their impact on performance.
5. To examine advanced topics such as reasoning, handling long contexts, model editing, and hallucination in LLMs.

UNIT-I INTRODUCTION

Definition of LLMs, Key Characteristics of LLMs, How LLMs work, Evolution of Language Modelling Technologies, Evolution of LLMs, Applications of LLMs.

UNIT-II AN OVERVIEW OF NLP AND NEURAL NETWORKS

NLP: NLP Pipeline, Morphology, Tokenization. Neural Networks: The Perceptron, Multi layer Perceptron, Training Neural Networks.

UNIT-III LANGUAGE MODELS

Statistical Language Model, Smoothing, Evaluation of Language Model, Limitations of Statistical Language Models. Neural Language Models: Convolutional Neural Networks, Recurrent Neural Networks, Limitations of Neural Language Models.

UNIT-IV PROMPTING STRATEGIES IN LLMS

Prompt Engineering: Prompt shape, Manual Template Engineering, Automated Template Learning, Continuous Prompts, Prompt Application, Chain-of-Thoughts, Tree-of-Thoughts, Graph-of-Thoughts.

UNIT-V ADVANCED TOPICS IN LARGE LANGUAGE MODELS

Reasoning with LLMs, Handling long context in LLMs, Model Editing, Hallucination in LLMs, Self-Evolving LLMs.

TEXT BOOKS:

1. Tanmoy Chakraborty, Introduction to Large Language Models, Wiley India, 1st Edition, 2025. ISBN : 9789363864740.

2. Dan Jurafsky and James H. Martin, Speech and Language Processing, 2nd edition, Pearson Press, 2008.

REFERENCE BOOKS:

1. Jacob Eisenstein, Natural Language Processing, First edition,The MIT Press, 2019.
2. Research papers published in conferences/journals likeAssociation for Computational Linguistics (ACL).

COURSE OUTCOMES:

1. Define Large Language Models (LLMs) and describe their key characteristics.
2. Explain the working principles of LLMs, including training and inference processes.
3. Analyze the evolution of language modeling technologies and their transition to modern LLMs.
4. Evaluate different applications of LLMs across various domains.
5. Compare different LLM architectures based on their capabilities and limitations.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. II Sem.

L	T	P	C
0	0	4	2

(25D13205) AGENTIC AI LAB

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To implement single and multi-agent systems using simulation frameworks.
2. To analyze agent communication, coordination, and decision-making strategies.
3. To design reactive and deliberative agents using BDI and reinforcement learning models.
4. To apply agent-based modeling for solving real-world problems.

1. Reactive Agent Implementation – Develop a simple reflex agent that responds to environmental changes.

2. Goal-Based Agent Simulation – Design a goal-driven agent capable of achieving defined objectives.

3. BDI Agent Model Implementation – Build a Belief–Desire–Intention agent using a rule based reasoning framework.

4. Multi-Agent Coordination – Implement task-sharing or resource allocation among multiple agents.

5. Agent Communication – Simulate interaction using message passing (ACL in JADE).

6. Negotiation and Game-Theoretic Decision Making – Model cooperative and competitive negotiation scenarios.

7. Reinforcement Learning Agent – Train an agent to adapt to dynamic environments using RL techniques.

8. Swarm Intelligence-Based Agents – Implement ant colony or particle swarm behaviors in a simulated environment.

9. Agent-Based Traffic Simulation – Simulate intelligent traffic systems with autonomous decision-making agents.

10. Agentic Simulation Mini-Project – Develop a collaborative multi-agent system using JADE or AnyLogic for a real-world problem (e.g., disaster response, supply chain optimization).

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

COURSE OUTCOMES:

1. Implement single and multi-agent systems with environmental interaction.
2. Model agent communication, coordination, and negotiation.
3. Apply BDI and learning-based models to agent design.
4. Simulate intelligent agent behavior in real-world applications.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. II Sem.

L	T	P	C
0	0	4	2

(25D13206) XAI AND RESPONSIBLE AI LAB (PYTHON FOR BIG DATA)

Course Category	**Professional Core course (PC)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To implement explainable AI models and visualization tools.
2. To apply interpretable ML methods for large-scale data analysis.
3. To understand ethical and responsible AI practices through case studies.
4. To use big data frameworks like PySpark for explainable model deployment.

1. Introduction to XAI Tools ??? Implement SHAP and LIME explainers for classification models.

2. Decision Tree Interpretability ??? Train and visualize interpretable decision tree models using Scikit-learn.

3. RuleFit and Explainable Boosting Machines (EBM) ??? Build transparent models and analyze decision rules.

4. Feature Importance Analysis ??? Compare global and local feature importance using SHAP values.

5. Counterfactual Explanations ??? Generate counterfactual examples to interpret model predictions

. 6. Fairness and Bias Detection ??? Evaluate ML models for gender or group bias using AIF360 or Fairlearn.

7. Big Data Preprocessing using PySpark ??? Clean, transform, and prepare large datasets for ML training.

8. Explainable Model Deployment ??? Integrate SHAP/LIME explanations in Flask or Streamlit dashboards for transparency.

9. Visualization Dashboards for Model Interpretability ??? Build interactive dashboards using Plotly/Dash or Streamlit.

10. Case Study on Responsible AI ??? Analyze a real-world AI ethics case (healthcare, finance, or hiring) and prepare an interpretability report.

SANTHIRAM ENGINEERING COLLEGE

(AUTONOMOUS)

DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

COURSE OUTCOMES:

1. Apply explainable AI frameworks for model interpretation.
2. Implement interpretable ML models for large-scale data
3. Evaluate fairness, bias, and transparency in AI models.
4. Design interactive visualization dashboards for responsible AI.

Remarks:

Software Tools ???

Programming & ML: Python (Scikit-learn, PyTorch, SHAP, LIME, Fairlearn, AIF360) ??? Big Data: PySpark ??? Visualization & Dashboards: Streamlit, Plotly Dash, Jupyter Notebooks

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. II Sem.

L	T	P	C
2	0	0	2

(25D57207) QUANTUM TECHNOLOGIES AND APPLICATIONS

Course Category	**Mandatory Course (credit)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. Present core quantum principles such as superposition and entanglement without mathematical formalism.
2. Develop conceptual clarity on qubits, quantum states, and information frameworks.
3. Examine the theoretical challenges in realizing scalable quantum systems.
4. Introduce foundational ideas in quantum communication and computing.
5. Highlight applications, industrial adoption, and future research directions in quantum technologies.

UNIT-I FOUNDATIONS OF QUANTUM THEORY AND TECHNOLOGIES

Transition from classical to quantum physics. Key conceptual principles: Superposition, Entanglement, Uncertainty, Wave-particle duality. Quantum states and measurement; the role of the observer. Representative quantum systems: electrons, photons, atoms. Concept of quantization and discrete energy levels. Strategic relevance of quantum technologies. Overview of major domains: Computing, Communication, Sensing. Global quantum initiatives: India’s National Quantum Mission, EU Quantum Flagship, USA, China.

UNIT-II CONCEPTUAL STRUCTURE OF QUANTUM INFORMATION

Qubits: qualitative understanding using spin and polarization. Classical bits vs quantum bits: distinctions and implications. Quantum systems (non-engineering perspective): trapped ions, superconducting qubits, photonics. Coherence and decoherence mechanisms. Abstract notions: quantum states, measurement operators, Hilbert space???interpretation without mathematics. Entanglement and non-locality as foundational resources. Quantum vs classical information principles; philosophical considerations.

UNIT-III BUILDING A QUANTUM COMPUTER – CHALLENGES AND REQUIREMENTS

Conceptual prerequisites for functional quantum hardware. Fragility of quantum states: decoherence, noise, stability issues. Requirements: isolation, error resilience, scalability, control. Why maintaining entanglement is difficult; theoretical necessity of quantum error correction. Comparative overview of hardware platforms (superconducting circuits, trapped ions, photonics).Current progress vs scientific constraints; conceptual view of quantum software’s role.

SANTHIRAM ENGINEERING COLLEGE

(AUTONOMOUS)

DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

UNIT-IV QUANTUM COMMUNICATION AND COMPUTING

(Redundant explanations removed, retaining only unique themes.)Quantum vs classical communication paradigms. Essentials of Quantum Key Distribution (QKD) and its security rationale. Entanglement-enabled communication protocols. Concept of the Quantum Internet and secure global networking. Introduction to quantum computing and quantum parallelism. Conceptual comparison of classical and quantum gate operations. Challenges: decoherence, noise, and the necessity of error correction frameworks.

UNIT-V APPLICATIONS, INDUSTRY, AND FUTURE DIRECTIONS

Application domains: Healthcare and drug discovery, Material science and chemistry, Optimization and logistics, Quantum sensing and precision timing. Case studies: IBM, Google, Microsoft, PsiQuantum. Ethical, societal, and policy considerations. Barriers to adoption: cost, skilled workforce, standards. Emerging research and career landscapes; India???s strategic opportunity in the global quantum ecosystem.

TEXT BOOKS:

1. Nielsen & Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2010.
2. Rieffel & Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2011.
3. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019.

REFERENCE BOOKS:

1. David McMahon, Quantum Computing Explained, Wiley, 2008.
2. Kaye, Laflamme, Mosca, An Introduction to Quantum Computing, OUP, 2007.
3. Scott Aaronson, Quantum Computing Since Democritus, CUP, 2013.
4. Susskind & Friedman, Quantum Mechanics: The Theoretical Minimum, Basic Books, 2014.
5. Rosenblum & Kuttner, Quantum Enigma, OUP, 2011.
6. Benenti et al., Principles of Quantum Computation and Information, World Scientific, 2004.
7. DST India and MeitY: Official Quantum Mission Reports, 2020 onwards. Quantum Flagship EU: Roadmaps and Strategy Documents.

e-Resources and Digital Material:

1. IBM Quantum Experience & Qiskit Textbook Coursera ??? Quantum Mechanics and Quantum Computation (UC Berkeley) edX ??? Quantum Internet & Quantum Computers YouTube ??? Quantum Computing for the Determined (Michael Nielsen)

COURSE OUTCOMES:

1. Explain fundamental quantum concepts conceptually.
2. Distinguish classical information systems from quantum information frameworks.
3. Identify the principal theoretical limitations in building quantum computers.

4. Describe the conceptual basis of quantum communication and computation.
5. Discuss current applications, technological trajectories, and career opportunities in the quantum domain.

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. II Sem. L T P C

(25D13207) COMPREHENSIVE VIVA VOCE

Course Category	
Course Enrichment Relevance	

COURSE OBJECTIVES:

Application domains: Healthcare and drug discovery, Material science and chemistry, Optimization and logistics, Quantum sensing and precision timing. Case studies: IBM, Google, Microsoft, PsiQuantum. Ethical, societal, and policy considerations. Barriers to adoption: cost, skilled workforce, standards. Emerging research and career landscapes; India???s strategic opportunity in the global quantum ecosystem.

COURSE OUTCOMES:

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

M.Tech. II Sem.

L	T	P	C
2	0	0	0

(25D57209B) PEDAGOGY STUDIES (AC-II)

Course Category	**Mandatory Course (Non-credit)**
Course Enrichment Relevance	**Employability**

COURSE OBJECTIVES:

1. To enable the students to understand the aims, rationale, policy background, and conceptual frameworks in pedagogy, curriculum, and teacher education research.
2. To develop an understanding of diverse pedagogical practices
3. To make them learn the methodologies for assessing the effectiveness of pedagogical practices and teacher education models.
4. To enable them to learn professional development strategies, including peer support, community engagement, and alignment with curriculum and assessment.

UNIT-I FOUNDATIONS OF PEDAGOGY

Introduction to pedagogy and its importance in education - Historical and philosophical foundations of pedagogy - Theories of learning and teaching (behaviorist, cognitive, constructivist) - Role of pedagogy in shaping educational practices - Role of technology in modern pedagogy (ICT, e-learning, blended learning)

UNIT-II TEACHING-LEARNING PROCESSES

Understanding the teaching-learning process - Lesson planning and curriculum design - Strategies for effective teaching and learning (expository, collaborative, experiential) - Use of technology to enhance teaching-learning processes (multimedia, simulations, gamification)

UNIT-III TECHNOLOGY INTEGRATION IN EDUCATION

Educational technology and system design - Instructional design models (ADDIE, ASSURE, Dick and Carey Model) - Emerging trends in e-learning (social learning, MOOCs, mobile learning) - ICT tools for teaching and learning (Learning Management Systems, online resources)

UNIT-IV PEDAGOGY AND ASSESSMENT

Pedagogy, pedagogical analysis, and assessment - Types of assessment (placement, formative, diagnostic, summative) - Technology-based assessment tools (online quizzes, polls, discussions) - Rubrics for self and peer evaluation- Reflective Practices

UNIT-V CONTEMPORARY ISSUES AND TRENDS

Inclusive education and technology (assistive technology, accessibility) - Change management and innovation in education - Quality assurance and evaluation in education (TQM, Six Sigma) - Future trends in pedagogy and technology (AI, AR, VR in education) - Personalized learning and adaptive teaching

SANTHIRAM ENGINEERING COLLEGE

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DEPARTMENT OF CSE - COMPUTER SCIENCE ENGINEERING (AI&ML)

TEXT BOOKS:

1. Alexander, R. J. Essays on Pedagogy. Routledge, 2008.
2. Shulman, L. S. The Wisdom of Practice: Essays on Teaching, Learning, and Learning to Teach. Jossey-Bass, 2004

COURSE OUTCOMES:

1. Define and explain key concepts, frameworks, and methodologies in pedagogy and teacher education research.
2. Critically analyze pedagogical practices used in diverse classroom settings, with reference to teacher education and curriculum design.
3. Evaluate the effectiveness of pedagogical approaches using quality assessment tools and theory of change models.
4. Apply evidence-based strategies to improve classroom practices, curriculum alignment, and teacher professional development.
5. Identify and address barriers to learning through innovative pedagogical strategies.
6. Design and propose research studies that contribute to filling gaps in pedagogy, curriculum, and teacher education, with focus on dissemination and impact.

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R-25

M.TECH (CSE-AI & ML)

VISION

- To become a nucleus for pursuing technical education and pool industrial research and developmental activities with social-conscious and global standards.

MISSION

M1: To provide Advanced Educational Programs and prepare students to achieve success and take leading roles in their chosen fields of specialization by arising a self-sustained University.

M2: To establish postgraduate programs in the current and Advanced Technologies.

M3: To establish an R&D Consultancy through developing Industry Institute Interaction, building up exceptional infrastructure.

M4: To propel every individual, realize and act for the technical development of the society.

MOTTO

- Education for Peace and Progress

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