

**COURSE STRUCTURE AND
DETAILED SYLLABUS**

CSE (AI)

For

M.Tech. TWO YEAR DEGREE COURSE

(Applicable for the batches admitted from 2025-26)



**VAAGDEVI COLLEGE OF ENGINEERING
(Autonomous)
Bollikunta, Warangal - 506 005
Telangana State, India**



**VAAGDEVI COLLEGE OF ENGINEERING
AUTONOMOUS
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
M.Tech in CSE (AI)**

**COURSE STRUCTURE
Applicable from AY 2025-26 Batch**

I YEAR I – SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1	M25AI01	Artificial Intelligence and Intelligent Systems	3	0	0	3
2	M25AI02	Statistical Foundations for Artificial Intelligence	3	0	0	3
3		Professional Elective – I	3	0	0	3
	M25CS02	1. Advanced Data Structures				
	M25CS03	2. Database Programming with PL/SQL				
	M25CS19	3. Large Language Models				
4		Professional Elective – II	3	0	0	3
	M25AI03	1. Cognitive Systems				
	M25AI04	2. Game Theory and Applications				
	M25AI05	3. Computer Vision and Robotics				
5	M25AI06	Artificial Intelligence and Intelligent Systems Lab	0	0	4	2
6		Professional Elective - I Lab	0	0	4	2
	M25CS10	Advanced Data Structures Lab				
	M25CS11	Database Programming with PL/SQL Lab				
	M25CS27	Large Language Models Lab				
7	M25MC01	Research Methodology & IPR	2	0	0	2
8	M25AC01	Audit Course – I	2	0	0	0
		Total	16	0	8	18



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I YEAR II – SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1	M25AI07	Deep Learning	3	0	0	3
2	M25AI08	Active speech Recognition	3	0	0	3
3		Professional Elective – III	3	0	0	3
	M25AI09	1. Big Data Technologies				
	M25CS16	2. Enterprise Cloud Concepts				
	M25AI10	3. Generative AI				
4		Professional Elective – IV	3	0	0	3
	M25AI11	1. Reinforcement Learning				
	M25AI12	2. Machine Translation				
	M25AI13	3. Federated AI				
5	M25AI14	Deep Learning Lab	0	0	4	2
6		Professional Elective - III Lab	0	0	4	2
	M25AI15	Big Data Technologies Lab				
	M25CS24	Enterprise Cloud Concepts Lab				
	M25AI16	Generative AI Lab				
7	M25AI17	Mini Project with Seminar	0	0	4	2
8	M25AC02	Audit Course- II	2	0	0	0
		Total	14	0	12	18



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II YEAR III – SEMESTER

S.No	Course Code	Course Title	L	T	P	Credits
		Professional Elective - V				
1	M25AI18	1 Block chain Technology	3	0	0	3
	M25AI19	2 Nature Inspired Computing				
	M25AI20	3 Conversational AI				
	M25AI21	4 Prompt Engineering				
2		Open Elective	3	0	0	3
3	M25AI22	Dissertation Work Review - II	0	0	18	6
		Total	6	0	18	12

II YEAR IV – SEMESTER

S.No	Course Code	Course Title	L	T	P	Credits
1	M25AI23	Dissertation Work Review – III	0	0	18	6
2	M25AI24	Dissertation Viva-Voce	0	0	42	14
		Total	0	0	60	20

*For Dissertation Work Review - I, Please refer R25 Academic Regulations.

Audit Course I&II:

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by yoga
8. Personality Development Through Life Enlightenment Skills

Open Electives for other Departments:

1. M25AI25 - Fundamentals of AI
2. M25AI09 - Big data Technologies
3. M25CS19 - Large Language Models

ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS (PC - I)

M.Tech AI I Year I Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: UG level course in Mathematics, Data Structures**Course Outcomes:** After completion of course, students would be able to:

1. Solve basic AI based problems.
2. Define the concept of Artificial Intelligence.
3. Apply AI techniques to real-world problems to develop intelligent systems.
4. Select appropriately from a range of techniques when implementing intelligent systems.
5. Critically evaluate AI approaches for their effectiveness and limitations in complex problem domains.

UNIT - I

Introduction: Overview of AI problems, AI problems as NP, NP-Complete and NP Hard problems. Strong and weak, neat and scruffy, symbolic and sub-symbolic, knowledge-based and data-driven AI.

UNIT -II

Search Strategies: Problem spaces (states, goals and operators), problem solving by search, Heuristics and informed search, Min-max Search, Alpha-beta pruning. Constraint satisfaction (backtracking and local search methods).

UNIT - III

Knowledge representation and reasoning: propositional and predicate logic, Resolution and theorem proving, Temporal and spatial reasoning. Probabilistic reasoning, Bayes theorem. Totally-ordered and partially-ordered Planning. Goal stack planning, Nonlinear planning, Hierarchical planning.

UNIT - IV

Learning: Learning from example, Learning by advice, Explanation based learning, Learning in problem solving, Classification, Inductive learning, Naive Bayesian Classifier, decision trees.

Natural Language Processing: Language models, n-grams, Vector space models, Bag of words, Text classification. Information retrieval.

UNIT - V

Agents: Definition of agents, Agent architectures (e.g., reactive, layered, cognitive), Multi-agent systems- Collaborating agents, Competitive agents, Swarm systems and biologically inspired models.

Intelligent Systems: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.

Key Application Areas: Expert system, decision support systems, Speech and vision, Natural language processing, Information Retrieval, Semantic Web.

TEXT BOOKS:

1. Artificial Intelligence: A Modern Approach by S. Russell and P. Norvig, Prentice Hall

REFERENCE BOOKS:

1. Artificial Intelligence by Elaine Rich, Kevin Knight and Shivashankar B Nair, Tata McGraw Hill.
2. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Pearson Education.

STATISTICAL FOUNDATIONS FOR ARTIFICIAL INTELLIGENCE (PC - II)**M.Tech AI I Year I Sem.**

L	T	P	C
3	0	0	3

Pre-Requisites: UG level course in Mathematics, Probability and Statistics**Course Outcomes:** After completion of course, students would be able to:

1. To model problems using graphical models
2. Design inference algorithms
3. Learn the structure of the graphical model from data.
4. Apply statistical learning methods to solve practical AI problems.
5. Analyze results of statistical models in real-world applications.

UNIT - I

Fundamentals: Introduction to regression and classification, Formalizing a learning task, experience, reward, Gaussian noise and linear least-square fit, A taste of Bayesian learning, Hypothesis, prior and posterior distributions, Posterior distribution and prediction, Point estimates of posterior e.g. MAP Minimum description length and MAP, Back to regression: linear least-square with square regularizer.

UNIT - II

Linear least square demo, Ridge penalty, Lasso and its quadratic program, Contrast between Ridge and Lasso, model sparsity, From regression to classification, Loss functions for classification and regression

"True loss" and various approximations, Square loss and its limitations, Choice of discriminant functions

Class density and class discrimination, Discriminants for multivariate Gaussian densities

UNIT - III

Eigen-SVD connection, SVD demo with low-rank plus noise matrix, Connection between SVD and (regularized) least square, Principal Component Analysis, Linear discriminants and fitting criteria

Hill-climbing, step size, and Newton method, Derivation of the Perceptron from gradient descent considerations, Kernel regression and kernel density estimation

UNIT - IV

Basic SVM QP for separable problems, scilab, Inseparable problems and hinge loss, Smooth approximations to hinge loss, direct primal optimization, Primal-dual, Gordan's theorem, KKT necessary conditions, Lagrangian saddlepoint, Dual and Lagrangian, dualizing basic SVM

UNIT - V

Dual QP optimization, Using non-linear kernels with the dual formulation, Dual with kernels, scilab demo

Lagrangian support vector machines, Lagrangian and proximal support vector machines, Finite Newton optimization

TEXT BOOKS:

1. The Elements of Statistical Learning, Hastie, Tibshirani, Friedman
2. Pattern Classification, 2nd Edition, Duda, Hart and Stork, Wiley-Interscience

ADVANCED DATA STRUCTURES (PROFESSIONAL ELECTIVE - I)

M.Tech AI I Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites

- A course on “Data Structures”.

Course Outcomes

1. Students will be able to apply various heap structures to solve priority queue and optimization problems efficiently.
2. Students will be able to design efficient hashing techniques for effective data storage and retrieval.
3. Students will be able to construct and analyze balanced search structures for optimized searching.
4. Students will be able to implement digital search structures for efficient string processing and retrieval applications.
5. Apply pattern matching algorithms for efficient text searching.

UNIT - I**Heap Structures**

Introduction, Min-Max Heaps, Leftist trees, Binomial Heaps, Fibonacci heaps.

UNIT - II**Hashing and Collisions**

Introduction, Hash Tables, Hash Functions, different Hash Functions:- Division Method, Multiplication Method, Mid-Square Method, Folding Method, Collisions

UNIT - III**Search Structures**

OBST, AVL trees, Red-Black trees, Splay trees,

Multiway Search Trees

B-trees, 2-3 trees

UNIT - IV**Digital Search Structures**

Digital Search trees, Binary tries and Patricia, Multiway Tries, Suffix trees, Standard Tries, Compressed Tries

UNIT - V**Pattern matching**

Introduction, Brute force, the Boyer –Moore algorithm, Knuth-Morris-Pratt algorithm, Naïve String, Harspool, Rabin Karp

TEXT BOOKS:

1. Fundamentals of data structures in C++ Sahni, Horowitz, Mehatha, Universities Press.
2. Introduction to Algorithms, TH Cormen, PHI

REFERENCES:

1. Design methods and analysis of Algorithms, SK Basu, PHI.
2. Data Structures & Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education.
3. Fundamentals of Computer Algorithms, 2nd Edition, Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Universities Press.

DATABASE PROGRAMMING WITH PL/SQL (PROFESSIONAL ELECTIVE - I)

M.Tech AI I Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites : Data Base Concepts & SQL.**Course Outcomes:**

1. Understand the structure of PL/SQL blocks, variables, data types, control structures, and exception handling.
2. Apply cursors, collections, and bulk operations to process and manage data efficiently.
3. Design and implement functions and procedures with different parameter-passing methods.
4. Develop and manage packages to achieve security, modularity and reusability in PL/SQL applications.
5. Create various types of triggers to enforce business rules and automate database operations.

Unit I**PL/SQL Basics**

Block Structure, Behavior of Variables in Blocks, Basic Scalar and Composite Data Types, Control Structures, Exceptions, Bulk Operations, Functions, Procedures, and Packages, Transaction Scope

Unit II**Language Fundamentals & Control Structures**

Lexical Units, Variables and Data Types, Conditional Statements, Iterative Statements, Cursor Structures, Bulk Statements, Introduction to Collections, Object Types: Varray and Table Collections, Associative Arrays, Oracle Collection API

Unit III**Functions and Procedures**

Function and Procedure Architecture, Transaction Scope, Calling Subroutines, Positional Notation, Named Notation, Mixed Notation, Exclusionary Notation, SQL Call Notation, Functions, Function Model Choices, Creation Options, Pass-by-Value Functions, Pass-by-Reference Functions, Procedures, Pass-by-Value Procedures, Pass-by-Reference Procedures, Supporting Scripts.

Unit IV**Packages**

Package Architecture, Package Specification, Prototype Features, Serially Reusable Precompiler Directive, Variables, Types, Components: Functions and Procedures, Package Body, Prototype Features, Variables, Types, Components: Functions and Procedures, Definer vs. Invoker Rights Mechanics, Managing Packages in the Database Catalog, Finding, Validating, and Describing Packages, Checking Dependencies, Comparing Validation Methods: Timestamp vs. Signature.

Unit V**Triggers**

Introduction to Triggers, Database Trigger Architecture, Data Definition Language Triggers, Event Attribute Functions, Building DDL Triggers, Data Manipulation Language Triggers, Statement-Level Triggers, Row-Level Triggers, Compound Triggers, INSTEAD OF Triggers, System and Database Event Triggers, Trigger Restrictions, Maximum Trigger Size, SQL Statements, LONG and LONG RAW Data Types.

TEXT BOOKS:

1. Oracle Database 12c PL/SQL Programming Michael McLaughlin, McGraw Hill Education.

REFERENCES:

1. Benjamin Rosenzweig, Elena Silvestrova Rakhimov, Oracle PL/SQL by example Fifth Edition.
2. Dr. P. S. Deshpande, SQL & PL / SQL for Oracle 11g Black Book.

LARGE LANGUAGE MODELS (PROFESSIONAL ELECTIVE - I)

M.Tech AI I Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites:

- Machine Learning and Natural Language Processing.

Course Outcomes (COs)

- Understand the architecture and inner workings of transformer-based LLMs.
- Apply prompt engineering and fine-tuning techniques for domain-specific tasks.
- Evaluate LLM performance using standard metrics and benchmarks.
- Identify challenges in LLM training, deployment, and scaling.
- Analyze ethical, legal, and societal implications of LLM usage.

UNIT 1 – Foundations of Large Language Models

Introduction to LLMs: Definition, scope, and historical evolution from statistical NLP to transformers. The Transformer architecture: Attention mechanisms, self-attention, multi-head attention. Pretraining objectives: Masked language modeling (MLM), Causal language modeling (CLM). Evolution of LLMs: BERT, GPT series, T5, LLaMA, Mistral.

UNIT 2 – Training and Fine-Tuning LLMs

Pretraining datasets and tokenization: BPE, SentencePiece, WordPiece. Fine-tuning approaches: Full fine-tuning, LoRA, adapters, instruction tuning. Domain adaptation and few-shot/zero-shot learning. Data augmentation for LLMs and prompt-based tuning.

UNIT 3 – Prompt Engineering and Applications

Principles of prompt design: Zero-shot, few-shot, and chain-of-thought prompting. System prompts, role prompting, and context length optimization.

Use cases: Text generation, summarization, code generation, question answering, chatbots. Tools & frameworks: Lang Chain, Llama Index, Hugging Face Transformers.

UNIT 4 – Evaluation and Deployment of LLMs

Evaluation metrics: Perplexity, BLEU, ROUGE, METEOR, human evaluation.

Benchmark datasets: GLUE, SuperGLUE, HELM, BIG-bench.

Deployment strategies: API-based deployment, on-prem deployment, inference optimization.

Scaling and latency considerations; quantization and pruning for LLMs.

UNIT 5 – Ethics, Safety, and Future Directions

Bias, fairness, and toxicity in LLMs. Hallucination problem and mitigation techniques. Legal and regulatory issues: Copyright, data privacy, AI Act. Trends in LLM research: Multimodal LLMs, retrieval-augmented generation (RAG), open-source LLM ecosystems.

TEXT BOOKS:

- Vaswani, A. et al. (2017) *Attention Is All You Need* – NIPS Conference Paper.
- Lewis, P. et al. (2021) *Language Models are Few-Shot Learners* – OpenAI Research Paper.
- Tunstall, L., von Werra, L., & Wolf, T. (2022) *Natural Language Processing with Transformers* – O'Reilly Media.

REFERENCE BOOKS:

- Bommasani, R. et al. (2021) *On the Opportunities and Risks of Foundation Models* – Stanford CRFM.
- Jurafsky, D., & Martin, J. H. (2023) *Speech and Language Processing* (3rd Edition draft) – Pearson.
- Mollick, E., & Mollick, L. (2024) *Co-Intelligence: Living and Working with AI* – Little, Brown Spark.
- Hugging Face Documentation – <https://huggingface.co/docs/>

COGNITIVE SYSTEMS (PROFESSIONAL ELECTIVE - II)

M.Tech AI I Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Probability theory**Course Outcomes:**

1. Understand the basics of cognitive computing and comparisons with traditional approaches.
2. Plan and use the primary tools associated with cognitive computing.
3. Plan and execute a project that leverages cognitive computing.
4. Understand and develop the business implications of cognitive computing.
5. Integrate cognitive computing concepts with AI techniques to design human-centric systems.

UNIT - I

Introduction to Cognitive Science: Understanding Cognition, Design for Human Cognition, Augmented Intelligence, Cognition Modeling Paradigms: Declarative/ logic-based computational cognitive modeling, connectionist models of cognition, Bayesian models of cognition, a dynamical systems approach to cognition

UNIT - II

Cognitive Models of memory and language, computational models of episodic and semantic memory, modeling psycholinguistics

UNIT - III

Cognitive Modeling: modeling the interaction of language, memory and learning, Modeling select aspects of cognition classical models of rationality, symbolic reasoning and decision making

UNIT - IV

Formal models of inductive generalization, causality, categorization and similarity, the role of analogy in problem solving, Cognitive Development Child concept acquisition. Cognition and Artificial cognitive architectures such as ACT-R, SOAR, OpenCog, CopyCat, Memory Networks

UNIT - V

DeepQA Architecture, Unstructured Information Management Architecture (UIMA), Structured Knowledge, Business Implications, Building Cognitive Applications, Application of Cognitive Computing and Systems

Case study: IBM Watson

TEXT BOOKS:

1. The Cambridge Handbook of Computational Psychology by Ron Sun (ed.), Cambridge University Press.
2. Learning IBM Watson Analytics, James D Miller, Packt Publications

REFERENCES:

1. Formal Approaches in Categorization by Emmanuel M. Pothos, Andy J. Wills, Cambridge University Press.
2. Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience by Bernard J. Bears, Nicole M. Gage, Academic Press.
3. Cognitive Computing and Big Data Analytics by Hurwitz, Kaufman, and Bowles, Wiley.

GAME THEORY AND APPLICATIONS (PROFESSIONAL ELECTIVE - II)

M.Tech AI I Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Graph Theory**Course Outcomes:**

1. Solve strategic games between two and more agents in non-cooperative scenario.
2. Analyze and solve both simultaneous-moves and sequential-moves games.
3. Learn different methods to solve games.
4. Apply game theoretic models to decision-making problems.
5. Evaluate applications of game theory in Cryptography and AI.

UNIT - I

Introduction: games and decisions, Games Strategies, Costs and Payoff, Basic Solution Concepts, Finding equilibria and Learning in Games

UNIT - II

Zero-Sum Games: secure strategy, Maximin, Maximax, and Minimax Regret Solvability, value of a game. Normal form games: dominance, iterated dominance, Nash equilibrium. N-player games, mixed strategy nash equilibria.

UNIT - III

Graphical Games: Computing Nash, equilibria in Tree Graphical Games, Graphical Games and correlated Equilibria. Extensive form games: subgame perfection, sequential equilibrium, Stackelberg Model of Duopoly, Buying Votes, Committee Decision-Making. Bargaining: Rubinstein bargaining, Nash bargaining.

UNIT - IV

Repeated Games: Folk theorem and repeated prisoner's dilemma. Tacit collusion. Incomplete information games: Bayesian equilibrium, higher order beliefs.

UNIT - V

Auctions and Mechanism Design: Basic auctions, voting, Vickrey-Clarke-Groves Auction. Cryptography and Game theory: cryptographic influence on game theory and Game theoretic influence on cryptography

TEXT BOOKS:

1. A Course in Game Theory by M. J. Osborne & A. Rubinstein, MIT Press.

REFERENCES:

1. Algorithmic Game Theory by N. Nisan, T. Rougharden, E. Tardos and V. V. Vazirani, Cambridge University Press.
2. Game Theory and Applications by Tatsurolchiishi, Abraham Neyman and Yair Tauman, Elsevier.
3. Essentials of Game Theory: A Concise, Multidisciplinary Introduction by K. Leyton-Brown and Y. Shoham, Morgan & Claypool Publishers.

COMPUTER VISION AND ROBOTICS (PROFESSIONAL ELECTIVE - II)**M.Tech AI I Year I Sem.**

L	T	P	C
3	0	0	3

Pre-Requisites: UG level Course in Linear Algebra and Probability.**Course Outcomes:**

1. Implement fundamental image processing techniques required for computer vision
2. Implement boundary tracking techniques
3. Apply chain codes and other region descriptors, Hough Transform for line, circle, and ellipse detections.
4. Apply 3D vision techniques and Implement motion related techniques.
5. Develop applications using computer vision techniques.

UNIT -I**CAMERAS:** Pinhole Cameras**Radiometry – Measuring Light:** Light in Space, Light Surfaces, Important Special Cases**Sources, Shadows, And Shading:** Qualitative Radiometry, Sources and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models**Color:** The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.**UNIT-II****Linear Filters:** Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency and Fourier Transforms, Sampling and Aliasing, Filters as Templates,**Edge Detection:** Noise, Estimating Derivatives, Detecting Edges**Texture:** Representing Texture, Analysis (and Synthesis) Using Oriented Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture.**UNIT-III****The Geometry of Multiple Views:** Two Views**Stereopsis:** Reconstruction, Human Stereopsis, Binocular Fusion, Using More Cameras**Segmentation by Clustering:** What Is Segmentation?, Human Vision: Grouping and Gestalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering,**UNIT-IV****Segmentation by Fitting a Model:** The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness**Segmentation and Fitting Using Probabilistic Methods:** Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice,**Tracking With Linear Dynamic Models:** Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications and Examples**UNIT- V****Geometric Camera Models:** Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations**Geometric Camera Calibration:** Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, Case study: Mobile Robot Localization**Model- Based Vision:** Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Case study: Registration In Medical Imaging Systems, Curved Surfaces and Alignment.**TEXT BOOKS:**

1. David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning

(Indian Edition), 2009.

REFERENCES:

1. E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.
2. R. C. Gonzalez and R. E. Woods “Digital Image Processing” Addison Wesley 2008.
3. Richard Szeliski “Computer Vision: Algorithms and Applications” Springer-Verlag London Limited 2011.

ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS LAB (LAB - I)**M.Tech AI I Year I Sem.**

L	T	P	C
0	0	4	2

Prerequisites: UG level course in Mathematics, Data Structures, Programming, and AI**Course Outcomes:**

1. Elicit, analyze and specify software requirements.
2. Simulate a given problem scenario and analyze its performance.
3. Develop programming solutions for given problem scenario.
4. Simulate a given problem implementation with appropriate tools.

List of Programs

1. Installation and working on various AI tools viz. Python, R tool, GATE, NLTK, MATLAB, etc.
2. Data preprocessing and annotation and creation of datasets.
3. Learn existing datasets and Treebanks
4. Implementation of searching techniques in AI.
5. Implementation of Knowledge representation schemes.
6. Natural language processing tool development.
7. Application of Machine learning algorithms.
8. Application of Classification and clustering problem.
9. Working on parallel algorithms.
10. Scientific distributions used in python for Data Science - Numpy, scifi, pandas, scikit learn, statsmodels, nltk.

ADVANCED DATA STRUCTURES LAB (LAB - II)

M.Tech AI I Year I Sem.

L	T	P	C
0	0	4	2

Prerequisites: A course on Computer Programming & Data Structures**Course Outcomes:**

1. Ability to select the data structures that efficiently model the information in a problem.
2. Ability to assess efficiency trade-offs among different data structure implementations or combinations.
3. Implement and know the application of algorithms for sorting and pattern matching.
4. Design programs using a variety of data structures, including hash tables, binary and general tree structures, search trees, tries, heaps, graphs, and B-trees.

List of Programs

1. Write a program to perform the following operations:
 - a) Insert an element into a binary search tree.
 - b) Delete an element from a binary search tree.
 - c) Search for a key element in a binary search tree.
2. Write a program for implementing the following sorting methods:
 - a) Merge sort b) Heap sort c) Quick sort
3. Write a program to perform the following operations:
 - a) Insert an element into a B- tree.
 - b) Delete an element from a B- tree.
 - c) Search for a key element in a B- tree.
4. Write a program to perform the following operations:
 - a) Insert an element into a Min-Max heap
 - b) Delete an element from a Min-Max heap
 - c) Search for a key element in a Min-Max heap
5. Write a program to perform the following operations:
 - a) Insert an element into a Leftist tree
 - b) Delete an element from a Leftist tree
 - c) Search for a key element in a Leftist tree
6. Write a program to perform the following operations:
 - a) Insert an element into a binomial heap
 - b) Delete an element from a binomial heap.
 - c) Search for a key element in a binomial heap
7. Write a program to perform the following operations:
 - a) Insert an element into a AVL tree.
 - b) Delete an element from a AVL search tree.
 - c) Search for a key element in a AVL search tree.
8. Write a program to perform the following operations:
 - a) Insert an element into a Red-Black tree.
 - b) Delete an element from a Red-Black tree.
 - c) Search for a key element in a Red-Black tree.
9. Write a program to implement all the functions of a dictionary using hashing.

10. Write a program for implementing Knuth-Morris-Pratt pattern matching algorithm.
11. Write a program for implementing Brute Force pattern matching algorithm.
12. Write a program for implementing Boyer pattern matching algorithm.

TEXT BOOKS:

1. Fundamentals of Data structures in C, E. Horowitz, S. Sahni and Susan Anderson Freed, 2nd Edition, Universities Press
2. Data Structures Using C – A.S. Tanenbaum, Y. Langsam, and M.J. Augenstein, PHI/Pearson education.
3. Introduction to Data Structures in C, Ashok Kamthane, 1st Edition, Pearson.

REFERENCES:

1. The C Programming Language, B.W. Kernighan, Dennis M.Ritchie, PHI/Pearson Education
2. C Programming with problem solving, J.A. Jones & K. Harrow, Dreamtech Press
3. Data structures: A Pseudocode Approach with C, R.F. Gilberg And B.A. Forouzan, 2nd Edition, Cengage Learning

DATABASE PROGRAMMING WITH PL/SQL LAB (LAB - II)**M.Tech AI I Year I Sem.****L T P C**
0 0 4 2**Prerequisites:** C Programming, Database Management systems concepts ,**Course Outcomes:**

1. Understand the structure of PL/SQL blocks, variables, control structures, and exception handling.
2. Apply cursors, functions, and procedures to manage and manipulate database information effectively.
3. Develop modular and reusable code using PL/SQL packages and bulk operations.
4. Design and implement triggers to enforce business rules and automate database processes.

List of Experiments:

1. Write a PL/SQL program using FOR loop to insert ten rows into a database table.
2. Given the table EMPLOYEE (EmpNo, Name, Salary, Designation, DeptID), write a cursor to select the five highest paid employees from the table.
3. Illustrate how you can embed PL/SQL in a high-level host language such as C/Java And demonstrates how a banking debit transaction might be done.
4. Given an integer i, write a PL/SQL procedure to insert the tuple (i, 'xxx') into a given relation.
5. Write a PL/SQL program to demonstrate Exceptions.
6. Write a PL/SQL program to demonstrate Cursors.
7. Write a PL/SQL program to demonstrate Functions.
8. Write a PL/SQL program to demonstrate Packages.
9. Write PL/SQL queries to create Procedures.
10. Write PL/SQL queries to create Triggers.

RESEARCH METHODOLOGY & IPR

M.Tech AI I Year I Sem.

L	T	P	C
0	0	4	2

Prerequisite: None**Course Outcomes:** At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

UNIT-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II

Effective literature studies approaches, analysis, Plagiarism, Research ethics

UNIT-III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. C.R. Kothari, Research Methodology, methods & techniques, 2nd edition, New age International publishers

REFERENCES:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.

4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

DEEP LEARNING (PC - III)

M.Tech AI I Year II Sem.

L	T	P	C
3	0	0	3

Prerequisite: Machine Learning, AI.**Course Outcomes:**

1. Implement deep learning algorithms, understand neural networks and traverse the layers of data
2. Learn topics such as convolutional neural networks, recurrent neural networks, training deep networks and high-level interfaces
3. Understand applications of Deep Learning to Computer Vision
4. Understand and analyze Applications of Deep Learning to NLP.
5. Analyze the sentence and dialogue generation using CNN and LSTMs.

UNIT - I

Introduction: Feed forward Neural networks, Gradient descent and the back propagation algorithm, Unit saturation, the vanishing gradient problem, and ways to mitigate it. ReLU Heuristics for avoiding bad local minima, Heuristics for faster training, Nestors accelerated gradient descent, Regularization, Dropout

UNIT - II

Convolutional Neural Networks: Architectures, convolution/pooling layers, Recurrent Neural Networks: LSTM, GRU, Encoder Decoder architectures. Deep Unsupervised Learning: Auto encoders, Variational Auto-encoders, Adversarial Generative Networks, Auto-encoder and DBM Attention and memory models, Dynamic Memory Models

UNIT - III

Applications of Deep Learning to Computer Vision: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models, Attention Models for computer vision tasks

UNIT -IV

Applications of Deep Learning to NLP: Introduction to NLP and Vector Space Model of Semantics, Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of-Words model (CBOW), Glove, Evaluations and Applications in word similarity

UNIT -V

Analogy reasoning: Named Entity Recognition, Opinion Mining using Recurrent Neural Networks: Parsing and Sentiment Analysis using Recursive Neural Networks: Sentence Classification using Convolutional Neural Networks, Dialogue Generation with LSTMs

TEXT BOOKS:

1. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
2. The Elements of Statistical Learning by T. Hastie, R. Tibshirani, and J. Friedman, Springer.
3. Probabilistic Graphical Models. Koller, and N. Friedman, MIT Press.

REFERENCES:

1. Bishop, C, M., Pattern Recognition and Machine Learning, Springer, 2006.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Golub, G.,H., and Van Loan, C.,F., Matrix Computations, JHU Press,2013.
4. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Extensive Reading:

1. <http://www.deeplearning.net>
2. <https://www.deeplearningbook.org/>
3. <https://developers.google.com/machine-learning/crash-course/ml-intro>
4. www.cs.toronto.edu/~fritz/absps/imagenet.pdf
5. <http://neuralnetworksanddeeplearning.com/>

BIG DATA TECHNOLOGIES (PROFESSIONAL ELECTIVE - III)

M.Tech AI I Year II Sem.

L	T	P	C
3	0	0	3

Prerequisite: Data Warehousing, Data Mining.**Courses Outcomes**

1. Ability to explain the foundations, definitions, and challenges of Big Data and various Analytical tools.
2. Ability to program using HADOOP and Map reduce, NOSQL
3. Ability to understand the importance of Big Data in Social Media and Mining.
4. Ability to gain knowledge on data analysis tools like Hive,Pig.
5. Ability to analyze the role of coordination services zookeeper

Unit I**Getting an Overview of Big Data**

Big Data, History of Data Management – Evolution of Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics, Careers in Big Data, Future of Big Data

Technologies for Handling Big Data

Distributed and Parallel Computing for Big Data, Introducing Hadoop, Cloud Computing and Big Data, In-Memory Computing Technology for Big Data.

Unit II**Understanding Hadoop Ecosystem**

Hadoop Ecosystem, Hadoop Distributed File System, MapReduce, Hadoop YARN, Hbase, Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, Oozie

Understanding MapReduce Fundamentals and HBase

The MapReduce Framework, Techniques to Optimize MapReduce Jobs, Uses of MapReduce, Role of HBase in Big Data Processing

Unit III**Exploring Hive**

Introducing Hive, Getting Started with Hive, Data Types in Hive, Built-In Functions in Hive, Hive DDL, Data Manipulation in Hive, Data Retrieval Queries, Using JOINS in Hive

Analyzing Data with Pig

Introducing Pig, Running Pig, Getting Started with Pig Latin, Working with Operators in Pig, Working with Functions in Pig

Unit IV**Using Oozie**

Introducing Oozie, Installing and Configuring Oozie, Understanding the Oozie Workflow, Oozie Coordinator, Oozie Bundle, Oozie Parameterization with EL, Oozie Job Execution Model, Accessing Oozie, Oozie SLA

NoSQL Data Management

Introduction to NoSQL, Aggregate Data Models, Key Value Data Model, Document Databases, Relationships, Graph Databases, Schema-Less Databases, Materialized Views, Distribution Models, Sharding, MapReduce Partitioning and Combining, Composing MapReduce Calculations

Unit V

Zookeeper: Installing and Running ZooKeeper, An Example, Group Membership in ZooKeeper, Creating the Group, Joining a Group, Listing Members in a Group, The ZooKeeper Service, Data Model, Operations, Implementation, Consistency, Sessions, Building Applications with ZooKeeper, A Configuration, Service, The Resilient ZooKeeper Application, A Lock Service, More Distributed Data Structures and Protocols, ZooKeeper in Production

Sqoop: Getting Sqoop, Sqoop Connectors, A Sample Import, Generated Code, Imports: A Deeper Look, Working with Imported Data, Importing Large Objects, Performing an Export, Exports: A Deeper Look

TEXT BOOKS: Big data, blackbook, Dream Tech Press, 2015

1. Hadoop: The Definitive Guide, Tom White, 3rd Edition, O'Reilly Media, 2012.

REFERENCES:

1. Big Data Analytics, Seema Acharya, Subhashini Chellappan, Wiley 2015.
2. Simon Walkowiak, Big Data Analytics with R, Packt Publishing, ISBN: 9781786466457
3. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business, Michael Minelli, Michehe Chambers, 1st Edition, Ambiga Dhiraj, Wiley CIO Series, 2013.
4. Big Data Analytics: Disruptive Technologies for Changing the Game, Arvind Sathi, 1st Edition, IBM Corporation, 2012.

ENTERPRISE CLOUD CONCEPTS (PROFESSIONAL ELECTIVE - III)

M.Tech AI I Year II Sem.

L	T	P	C
3	0	0	3

Prerequisite: Computer Networks, Os, DBMS, Programming.**Course Outcomes:**

1. Understand importance of cloud architecture
2. Illustrating the fundamental concepts of cloud security
3. Analyze various cloud computing mechanisms
4. Understanding the architecture and working of cloud computing.
5. Apply cloud concepts to design enterprise solutions and evaluate their impact on business transformation.

Unit - I**Understanding Cloud Computing:**

Origins and influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges.

Fundamental Concepts and Models:

Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Cloud Deployment Models.

Unit - II**Cloud-Enabling Technology:**

Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology

CLOUD COMPUTING MECHANISMS:**Cloud Infrastructure Mechanisms:** Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud Usage Monitor, Resource Replication**Unit - III****Cloud Management Mechanisms:** Remote Administration System, Resource Management System, SLA Management System, Billing Management System, Case Study Example**Cloud Computing Architecture****Fundamental Cloud Architectures:** **Workload** Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture, Case Study Example**Unit - IV****Cloud-Enabled Smart Enterprises**

Introduction, Revisiting the Enterprise Journey, Service-Oriented Enterprises, Cloud Enterprises, Smart Enterprises, The Enabling Mechanisms of Smart Enterprises

Cloud-Inspired Enterprise Transformations

Introduction, The Cloud Scheme for Enterprise Success, Elucidating the Evolving Cloud Idea, Implications of the Cloud on Enterprise Strategy, Establishing a Cloud-Incorporated Business Strategy

UNIT-V Transitioning to Cloud-Centric Enterprises

The Tuning Methodology, Contract Management in the Cloud

Cloud-Instigated IT Transformations

Introduction, Explaining Cloud Infrastructures, A Briefing on Next-Generation Services, Service Infrastructures, Cloud Infrastructures, Cloud Infrastructure Solutions, Clouds for Business Continuity, The Relevance of Private Clouds, The Emergence of Enterprise Clouds

TEXT BOOKS:

1. Erl Thomas, Puttini Ricardo, Mahmood Zaigham, Cloud Computing: Concepts, Technology & Architecture 1st Edition,
2. Pethuru Raj, Cloud Enterprise Architecture, CRC Press

REFERENCE:

1. James Bond, The Enterprise Cloud, O'Reilly Media, Inc.

GENERATIVE AI (PROFESSIONAL ELECTIVE - III)

M.Tech AI I Year II Sem.

L	T	P	C
3	0	0	3

Prerequisite: AI, Machine Learning.**Course Outcomes**

1. Demonstrate knowledge of AI foundations, generative models, and advanced neural architectures.
2. Apply generative AI techniques to create solutions for text, image, video, and multimodal tasks.
3. Design, fine-tune, and optimize Large Language Models for specific applications.
4. Evaluate ethical, social, and legal implications of Generative AI deployments and propose mitigation strategies.
5. Gain practical experience with state-of-the-art framework and tools.

UNIT 1**Foundations of AI and Generative Models**

Introduction and historical evolution to Artificial Intelligence (AI), Machine Learning (ML), Natural Language Processing (NLP) and Deep Learning (DL), Structure of Artificial Neural Networks (ANNs), Mathematical and computational foundations of generative modeling, Overview of generative models and their applications across various domains; Importance of Generative AI in modern applications, Transfer learning and in advancing Generative AI

UNIT 2**Advanced Neural Architectures for Generative AI**

Variational Autoencoders (VAEs): principles and applications, Generative Adversarial Networks (GANs): architecture and working principles; Transformer architecture and attention mechanisms (in detail); Long Short-Term Memory Networks (LSTMs) and the limitations of traditional RNNs/LSTMs, Advanced Transformer architectures and techniques, Pre-training and transfer learning strategies for generative models

UNIT 3**Large Language Models and Prompt Engineering**

Overview of Large Language Models (LLMs), GPT architecture, variants, and working principles, Pre-training and fine-tuning GPT models for applications (e.g., chatbots, text generation), Case study: GPT-based customer support chatbot, BERT architecture, pre-training objectives, and fine-tuning, Prompt Engineering: Designing effective prompts, controlling model behavior, and improving output quality, Fine-tuning language models for creative writing and chatbot development

UNIT 4**Multi-Agent Systems and Generative AI Applications**

Introduction to Multi-Agent Systems (MAS), Types of agents: reactive, deliberative, hybrid, and learning agents, Multi-agent collaboration and orchestration for generative tasks, Use cases: autonomous research assistants, cooperative creative generation, distributed problem-solving, Frameworks and tools: AutoGen, CrewAI, Hugging GPT for LLM-powered multi-agent systems, Generative AI applications: Art, Creativity, Image/Video generation, Music composition, Healthcare, Finance, Real-world case studies and deployment challenges

UNIT 5**Frameworks, Multimodal Applications, and Ethics**

LangChain framework: components and LLM application development, Retrieval-Augmented Generation (RAG), Embeddings, Indexing networks, and Vector databases, Generative AI across modalities: Text, Code, Image, and Video generation, Image and Video generation using GANs and VAEs, Multimodal Generative AI: integration and training strategies, Ethical considerations: bias,

fairness, trust, and responsible AI deployment, Social and legal implications of Generative AI, Risk mitigation strategies and real-world ethical case studies

TEXT BOOKS

1. Altaf Rehmani, Generative AI for Everyone: Understanding the Essentials and Applications of This Breakthrough Technology.
2. Charu C. Aggarwal, Neural Networks and Deep Learning: A Textbook. Joseph Babcock, Raghav Bali, Generative AI with Python and TensorFlow 2, 2024.

REFERENCE BOOKS

1. Josh Kalin, Generative Adversarial Networks Cookbook.
2. Jesse Sprinter, Generative AI in Software Development: Beyond the Limitations of Traditional Coding, 2024.

ONLINE REFERENCES

1. Fabian Gloeckle et al., Better & Faster Large Language Models via Multi-token Prediction, arXiv:2404.19737v1, 2024. Vaswani et al., Attention Is All You Need, NeurIPS 2017.

REINFORCEMENT LEARNING (PROFESSIONAL ELECTIVE - IV)

M.Tech AI I Year II Sem.

L T P C

Prerequisite: Machine Learning**Course Outcomes**

1. Understand basics of RL
2. Understand RL Framework and Markov Decision Process
3. Analyzing through the use of Dynamic Programming and Monte Carlo
4. Understand TD(0) algorithm, Model-free control.
5. Understand TD(λ) algorithm and tile coding

Unit I

Basics of probability and linear algebra, Definition of a stochastic multi-armed bandit, Definition of regret, Achieving sublinear regret, UCB algorithm, KL-UCB, Thompson Sampling.

Unit II

Markov Decision Problem, policy, and value function, Reward models (infinite discounted, total, finite horizon, and average), Episodic & continuing tasks, Bellman's optimality operator, and Value iteration & policy iteration

Unit III

The Reinforcement Learning problem, prediction and control problems, Model-based algorithm, Monte Carlo methods for prediction, and Online implementation of Monte Carlo policy evaluation

Unit IV

Bootstrapping; TD(0) algorithm; Convergence of Monte Carlo and batch TD(0) algorithms; Model-free control: Q-learning, Sarsa, Expected Sarsa.

Unit V

n-step returns; TD(λ) algorithm; Need for generalization in practice; Linear function approximation and geometric view; Linear TD(λ). Tile coding; Control with function approximation; Policy search; Policy gradient methods; Experience replay; Fitted Q Iteration; Case studies.

TEXT BOOKS:

1. "Reinforcement learning: An introduction," First Edition, Sutton, Richard S., and Andrew G. Barto, MIT press 2020
2. "Statistical reinforcement learning: modern machine learning approaches," First Edition, Sugiyama, Masashi. CRC Press 2015

REFERENCES:

1. "Bandit algorithms," First Edition, Lattimore, T. and C. Szepesvári. Cambridge University Press. 2020
2. "Reinforcement Learning Algorithms: Analysis and Applications," Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters First Edition, Springer 2021
3. Alexander Zai and Brandon Brown "Deep Reinforcement Learning in Action," First Edition, Manning Publications 2020

MACHINE TRANSLATION (PROFESSIONAL ELECTIVE - IV)

M.Tech AI I Year II Sem.

L	T	P	C
3	0	0	3

Prerequisite: Machine Learning**Course Outcomes:** Upon the Successful Completion of the Course, the Students would be able to:

1. Understand machine translation approaches.
2. Apply and assess manual and automatic evaluation methods for machine translation.
3. Build machine translation model using existing tools for machine translation.
4. Ability to understand rule based machine translation and its types.
5. Understand steps, working on example based machine translation.

Unit I

Introduction to Machine Translation, MT Approaches: vauquois Triangle, Three major paradigms of Machine Translation, MT Evaluation

Unit II Learning Bilingual word Mappings

A Combinatorial Argument, Deeper look at one- one alignment, Heuristic based Computation of the $V_E * V_F$ Table, Iterative Computation of the $V_E * V_F$ Table, EM: Study of progress in Parameter values

Unit III Phrase based Machine Translation

Need for phrase alignment, An example to illustrate phrase alignment technique, Phrase table, Mathematics of Phrase based SMT, Decoding, Moses.

Unit IV Rule based Machine Translation (RBMT)

Two kinds of RBMT: Interlingua and Transfer, Universal networking Language (UNL), UNL expressions as binary predicates, Interlingua and Word Knowledge, Translation using Interlingua, Details of english to UNL Conversion: with illustration, Transfer based MT.

Unit V Example based Machine Translation

Essential steps of EBMT, EBMTs working, EBMT and case-based reasoning, Text similarity computation, EBMT and Translation Memory, EBMT and SMT.

TEXT BOOKS:

1. Pushpak Bhattacharyya, Machine Translation, CRC Press.

REFERENCES:

1. Statistical Machine Translation by Philipp Koehn, Cambridge University Press.
2. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
3. Linguistic Fundamentals for Natural Language Processing by Emily Bender, Morgan & Claypool.

FEDERATED AI (PROFESSIONAL ELECTIVE - IV)

M.Tech AI I Year II Sem.

L	T	P	C
3	0	0	3

Prerequisite: Machine Learning, AI**Course Outcomes:**

1. To understand the fundamental concepts, architecture, and workflow of Federated AI and distributed machine learning systems.
2. To analyze and implement core algorithms and privacy-preserving techniques used in Federated Learning.
3. To evaluate various applications of Federated AI across industries such as healthcare, finance, IoT, and mobile devices.
4. To identify and address security, privacy, and ethical challenges associated with federated systems, including compliance with regulatory frameworks.
5. To explore emerging trends, tools, and real-world case studies to assess future directions and industry practices in Federated AI.

Unit I

Introduction to Federated AI and Distributed Machine Learning Overview of Federated AI, Need and Motivation for Federated Learning, Differences between Centralized, Distributed, and Federated Learning.

Types of Federated Learning: Horizontal, Vertical, and Federated Transfer Learning, Architecture and Workflow of Federated AI Systems, Challenges: Data Privacy, Communication Efficiency, System Heterogeneity.

Unit II: Foundations and Algorithms of Federated Learning

Mathematical Foundations of Federated Learning, Federated Averaging (FedAvg) Algorithm, Privacy-preserving Techniques: Differential Privacy, Secure Multiparty Computation, Homomorphic Encryption, Model Personalization and Fine-tuning in Federated Settings, Handling Non-IID Data and Stragglers.

Unit III: Applications of Federated AI

Healthcare: Privacy-sensitive Medical Data Analysis, IoT and Edge Devices: Smart Devices, Autonomous Vehicles.

Finance: Privacy-preserving Fraud Detection, Mobile Devices: Personal Assistants, Keyboard Suggestions, Ethical and Legal Considerations in Federated AI Deployments

Unit IV: Security, Privacy, and Ethical Challenges

Privacy Leakage Risks, Data Poisoning and Model Poisoning Attacks, Robust Federated Learning Approaches

Ethical Implications: Consent, Bias, Fairness, Regulatory Frameworks and Compliance (GDPR, CCPA)

Unit V: Future Trends, Tools, and Case Studies

Federated Learning Frameworks: TensorFlow Federated, PySyft, Flower, Multi-modal Federated AI, Federated Learning in Privacy-Preserving AI Ecosystems,

Industry Case Studies: Google Gboard, Apple, Medical Research

Future Directions: Federated Meta-Learning, Cross-silo Federated Learning

TEXT BOOKS:

1. Peter Kairouz, H. Brendan McMahan, et al., "Advances and Open Problems in Federated Learning," Foundations and Trends® in Machine Learning, 2021.
2. Yoshua Bengio, Ian Goodfellow, Aaron Courville, Deep Learning, MIT Press, 2016. (for foundational ML concepts)
3. Qiang Yang, Yang Liu, Tianjian Chen, et al., Federated Learning: Challenges, Methods, and Future Directions, Springer, 2020.

REFERENCE BOOKS:

1. Peter Kairouz, et al., Federated Learning: Fundamentals and Applications, CRC Press, 2023.
2. H. Brendan McMahan, Daniel Ramage, et al., Practical Federated Learning, Google AI Blog Publications.
3. Yiheng Wang, & Jun Liu, Privacy-Preserving Machine Learning: Threats and Defense Mechanisms, Springer, 2022.

DEEP LEARNING LAB (Lab - III)

M.Tech AI I Year II Sem.

L	T	P	C
0	0	4	2

Prerequisite: Machine Learning, AI, Programming.

Course Outcomes:

1. Upon the Successful Completion of the Course, the Students would be able to:
2. Learn the Fundamental Principles of Deep Learning.
3. Identify the Deep Learning Algorithms for Various Types of Learning Tasks in various domains.
4. Implement Deep Learning Algorithms and Solve Real-world problems.
5. Analyze the performance of Deep Learning models and optimize them for accuracy, efficiency, and generalization.

LIST OF EXPERIMENTS:

1. Setting up the Spyder IDE Environment and Executing a Python Program
2. Installing Keras, Tensorflow and Pytorch libraries and making use of them
3. Applying the Convolution Neural Network on computer vision problems
4. Image classification on MNIST dataset (CNN model with Fully connected layer)
5. Applying the Deep Learning Models in the field of Natural Language Processing
6. Train a sentiment analysis model on IMDB dataset, use RNN layers with LSTM/GRU notes
7. Applying the Autoencoder algorithms for encoding the real-world data
8. Applying Generative Adversial Networks for image generation and unsupervised tasks.

TEXT BOOKS:

1. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
2. The Elements of Statistical Learning by T. Hastie, R. Tibshirani, and J. Friedman, Springer.
3. Probabilistic Graphical Models. Koller, and N. Friedman, MIT Press.

REFERENCES:

1. Bishop, C, M., Pattern Recognition and Machine Learning, Springer, 2006.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Golub, G.,H., and Van Loan, C.,F., Matrix Computations, JHU Press,2013.
4. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Extensive Reading:

1. <http://www.deeplearning.net>
2. <https://www.deeplearningbook.org/>
3. <https://developers.google.com/machine-learning/crash-course/ml-intro>
4. www.cs.toronto.edu/~fritz/absps/imagenet.pdf
5. <http://neuralnetworksanddeeplearning.com/>

BIG DATA TECHNOLOGIES LAB (LAB - IV)

M.Tech AI I Year II Sem.

L	T	P	C
0	0	4	2

Prerequisite: Data Mining, Data Warehousing, R programming.

Course Outcomes

1. Use Excel as an Analytical tool and visualization tool.
2. program using HADOOP and Map reduce
3. perform data analytics using ML in R.
4. Use cassandra to perform social media analytics
5. Design and implement big data storage and retrieval solutions using HBase and Pig for efficient data management.

List of Experiments

1. Implement a simple map-reduce job that builds an inverted index on the set of input documents (Hadoop)
2. Process big data in HBase
3. Store and retrieve data in Pig
4. Perform Social media analysis using cassandra
5. Buyer event analytics using Cassandra on suitable product sales data.
6. Using Power Pivot (Excel) Perform the following on any dataset
 - a. Big Data Analytics
 - b. Big Data Charting
7. Use R-Project to carry out statistical analysis of big data
8. Use R-Project for data visualization of social media data

Textbooks:

1. Big Data Analytics, SeemaAcharya, Subhashini Chellappan, Wiley 2015.
2. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business, Michael Minelli, Michehe Chambers, 1st Edition, AmbigaDhiraj, Wiely CIO Series, 2013.
3. Hadoop: The Definitive Guide, Tom White, 3rd Edition, Oⁿ Reilly Media, 2012.
4. Big Data Analytics: Disruptive Technologies for Changing the Game, Arvind Sathi, 1st Edition, IBM Corporation, 2012.

References:

1. Big Data and Business Analytics, Jay Liebowitz, Auerbach Publications, CRC press (2013)
2. Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop, Tom Plunkett, Mark Hornick, McGraw-Hill/Osborne Media (2013), Oracle press.
3. Professional Hadoop Solutions, Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, Wiley, ISBN: 9788126551071, 2015.
4. Understanding Big data, Chris Eaton, Dirk deroos et al. , McGraw Hill, 2012.
5. Intelligent Data Analysis, Michael Berthold, David J. Hand, Springer, 2007.
6. Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Bill Franks, 1st Edition, Wiley and SAS Business Series, 2012.

ENTERPRISE CLOUD CONCEPTS LAB (LAB - IV)**M.Tech AI I Year II Sem.**

L	T	P	C
0	0	4	2

Prerequisite: Computer Networks, OS, DBMS, Programming.**Course Outcomes:**

1. Understand importance of cloud architecture
2. Illustrating the fundamental concepts of cloud security
3. Analyze various cloud computing mechanisms
4. Understanding the architecture and working of cloud computing.

List of Experiments:

1. Install Virtualbox/VMware Workstation with different flavors of linux or windows OS on top of windows7 or 8.
2. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs
3. Install Google App Engine. Create a hello world app and other simple web applications using python/java..
4. Find a procedure to transfer the files from one virtual machine to another virtual machine.
5. Find a procedure to launch virtual machine using trystack (Online Openstack Demo Version)
6. Install Hadoop single node cluster and run simple applications like word count.

E-Resources:

1. <https://www.iitk.ac.in/nt/faq/vbox.htm>
2. <https://www.google.com/urlsa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjqrNG0za73AhXZt1YBHZ21DWEQFnoECAMQAQ&url=http%3A%2F%2Fwww.cs.columbia.edu%2F~sedwards%2Fclasses%2F2015%2F1102-fall%2Flinuxvm.pdf&usg=AOvVaw3xZPuF5xVgk-AQnBRsTtHz>
3. <https://www.cloudsimtutorials.online/cloudsim/>
4. <https://edwardsamuel.wordpress.com/2014/10/25/tutorial-creating-openstack-instance-in-trystack/>
5. <https://www.edureka.co/blog/install-hadoop-single-node-hadoop-cluster>

BLOCKCHAIN TECHNOLOGY (PROFESSIONAL ELECTIVE - V)

M.Tech AI II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites:

- Knowledge in information security and applied cryptography.
- Knowledge in Computer Networks

Course Outcomes:

1. Understand blockchain fundamentals, types, consensus protocols, and cryptocurrencies.
2. Analyze public, private, and consortium blockchains with smart contracts and platforms.
3. Apply blockchain concepts to design solutions using permissioned networks and ICOs.
4. Evaluate blockchain security, scalability, identity, and regulatory aspects.
5. Develop blockchain applications using Python/Hyperledger and study real-world case studies.

UNIT-I

Fundamentals of Blockchain: Introduction, Origin of Blockchain, Blockchain Solution, Components of Blockchain, Block in a Blockchain, The Technology and the Future.

Blockchain Types and Consensus Mechanism: Introduction, Decentralization and Distribution, Types of Blockchain, Consensus Protocol.

Cryptocurrency – Bitcoin, Altcoin and Token: Introduction, Bitcoin and the Cryptocurrency, Cryptocurrency Basics, Types of Cryptocurrencies, Cryptocurrency Usage.

UNIT-II

Public Blockchain System: Introduction, Public Blockchain, Popular Public Blockchains, The Bitcoin Blockchain, Ethereum Blockchain.

Smart Contracts: Introduction, Smart Contract, Characteristics of a Smart Contract, Types of Smart Contracts, Types of Oracles, Smart Contracts in Ethereum, Smart Contracts in Industry.

UNIT-III

Private Blockchain System: Introduction, Key Characteristics of Private Blockchain, Why We Need Private Blockchain, Private Blockchain Examples, Private Blockchain and Open Source, E-commerce Site Example, Various Commands (Instructions) in E-commerce Blockchain, Smart Contract in Private Environment, State Machine, Different Algorithms of Permissioned Blockchain, Byzantine Fault, Multichain.

Consortium Blockchain: Introduction, Key Characteristics of Consortium Blockchain, Why We Need Consortium Blockchain, Hyperledger Platform, Overview of Ripple, Overview of Corda.

Initial Coin Offering: Introduction, Blockchain Fundraising Methods, Launching an ICO, Investing in an ICO, Pros and Cons of Initial Coin Offering, Successful Initial Coin Offerings, Evolution of ICO, ICO Platforms.

UNIT-IV

Security in Blockchain: Introduction, Security Aspects in Bitcoin, Security and Privacy Challenges of Blockchain in General, Performance and Scalability, Identity Management and Authentication, Regulatory Compliance and Assurance, Safeguarding Blockchain Smart Contract (DApp), Security Aspects in Hyperledger Fabric.

Applications of Blockchain: Introduction, Blockchain in Banking and Finance, Blockchain in Education, Blockchain in Energy, Blockchain in Healthcare, Blockchain in Real-estate, Blockchain in Supply Chain, The Blockchain and IoT. Limitations and Challenges of Blockchain.

UNIT-V

Blockchain Case Studies: Case Study 1 – Retail, Case Study 2 – Banking and Financial Services, Case Study 3 – Healthcare, Case Study 4 – Energy and Utilities.

Blockchain Platform using Python: Introduction, Learn How to Use Python Online Editor, Basic Programming Using Python, Python Packages for Blockchain.

Blockchain platform using Hyperledger Fabric: Introduction, Components of Hyperledger Fabric Network, Chain codes from Developer.ibm.com, Blockchain Application Using Fabric Java SDK.

TEXT BOOK:

1. "Blockchain Technology", Chandramouli Subramanian, Asha A.George, Abhilasj K A and Meena Karthikeyan , Universities Press.

REFERENCES:

1. Michael Juntao Yuan, Building Blockchain Apps, Pearson, India.
2. Blockchain Blueprint for Economy, Melanie Swan, SPD O'reilly.
3. Blockchain for Business, Jai Singh Arun, Jerry Cuomo, Nitin Gaur, Pearson.

NATURE INSPIRED COMPUTING (PROFESSIONAL ELECTIVE - V)

M.Tech AI II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Algorithms and Data Structures, Mathematical Foundation, AI, Machine Learning**Course Outcomes:**

1. Understand the fundamentals of bio-inspired models, swarm intelligence, and evolutionary algorithms for solving optimization problems.
2. Apply genetic algorithms with crossover, mutation, and Markov processes to real-world problem solving.
3. Analyze ant colony optimization models, variations, and applications in combinatorial optimization.
4. Implement particle swarm optimization, artificial bee colony algorithms, and evaluate their effectiveness through case studies.
5. Explore and compare advanced nature-inspired techniques such as simulated annealing, cuckoo search, firefly, bat, harmony search, and artificial immune systems in diverse applications.

Unit I: Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-organization, swarm and evolutionary algorithms. Optimization problems – single and multi-objective optimization, heuristic, meta-heuristic and hyper heuristic functions.

Unit II: Genetic algorithms - Mathematical foundation, Genetic problem solving, crossover and mutation. genetic algorithms and Markov process, applications of genetic algorithms

Unit III: Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimization, variations of ACO, case studies.

Unit IV: Particle Swarm algorithms - particles moves, particle swarm optimization, variable length PSO, applications of PSO, case studies. Artificial Bee Colony algorithms - ABC basics, ABC in optimization, multi-dimensional bee colony algorithms, applications of bee algorithms, case studies.

Unit V: Selected nature inspired techniques - Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Firey algorithm, SDA algorithm, bat algorithm, case studies. Other nature inspired techniques - Social spider algorithm, Cultural algorithms, Harmony search algorithm, Intelligent water drops algorithm, Artificial immune system, Flower pollination algorithm, case studies.

TEXT BOOKS:

1. Albert Y. Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
2. Floreano, D. and C. Mattiussi - "Bio-Inspired Artificial Intelligence: Theories methods, and Technologies" IT Press, 2008.

REFERENCES:

1. Leandro Nunes de Castro - " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
2. Marco Dorigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005
3. Vinod Chandra S S, Anand H S - "Machine Learning: A Practitioner's Approach", Prentice Hall of India, New Delhi, 2020

CONVERSATIONAL AI (PROFESSIONAL ELECTIVE - V)

M.Tech AI II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: AI, Machine Learning, Natural Language Processing**Course Outcomes:**

1. Understand the fundamentals, evolution, and design principles of dialogue systems.
2. Apply rule-based techniques, architectures, and tools to develop dialogue systems.
3. Analyze statistical and reinforcement learning-based dialogue models, including MDPs and POMDPs.
4. Evaluate dialogue systems using frameworks, task-oriented metrics, and user experience measures.
5. Implement end-to-end neural dialogue systems for task-oriented and open-domain applications.

UNIT-I Introducing Dialogue Systems

What's a Dialogue System? A Brief History Of Dialogue Systems, Present-Day Dialogue Systems, Modeling Conversation Dialogue Systems, Designing and Developing Dialogue Systems

UNIT-II Rule-Based Dialogue Systems: Architecture, Methods, and Tools

A Typical Dialogue Systems Architecture, Designing a Dialogue System, Tools for Developing Dialogue Systems, Rule-Based Techniques in Dialogue Systems Participating in the Alexa Prize

UNIT-III Statistical Data-Driven Dialogue Systems

Motivating the Statistical Data-Driven Approach, Dialogue Components in the Statistical Data-Driven Approach, Reinforcement Learning (RL), Representing Dialogue as a Markov Decision Process, From MDPs to POMDPs, Dialogue State Tracking, Dialogue Policy, Problems and Issues with Reinforcement Learning in POMDPs

UNIT-IV Evaluating Dialogue Systems

How to Conduct the Evaluation, Evaluating Task-Oriented Dialogue Systems, Evaluating Open-Domain Dialogue Systems, Evaluation Frameworks- PARADISE, Quality of Experience (QoE), Interaction Quality, Best Way to Evaluate Dialogue Systems.

UNIT-V End-to-End Neural Dialogue Systems

Neural Network Approaches to Dialogue Modeling, A Neural Conversational Model, Introduction to the Technology of Neural Dialogue, Retrieval-Based Response Generation, Task-Oriented Neural Dialogue Systems, Open-Domain Neural Dialogue Systems, Some Issues and Current Solutions, Dialogue Systems: Datasets, Competitions, Tasks, and Challenges.

TEXT BOOKS:

1. Michael McTear, "Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots", Second Edition, Moran and Claypool Publishers, 2020.

REFERENCE BOOKS

1. Cathy Pearl, "Designing Voice User Interfaces: Principles of Conversational Experiences", O'REILLY, 2016.
2. Web Services, G. Alonso, F. Casati and others, Springer.

PROMPT ENGINEERING (PROFESSIONAL ELECTIVE - V)**M.Tech AI II Year I Sem.**

L	T	P	C
3	0	0	3

Prerequisites: AI, Machine Learning, Natural Language Processing, Programming**Course Outcomes:**

1. Explain and apply the core principles of prompt engineering for guiding generative AI outputs effectively.
2. Describe the underlying architecture and functionality of state-of-the-art large language models (LLMs).
3. Generate and manipulate structured outputs (JSON, YAML, CSV) using ChatGPT with advanced prompting techniques.
4. Implement text chunking, tokenization, and format control using tools like SpaCy, Tiktoken, and Python.
5. Utilize vector databases such as FAISS and Pinecone in Retrieval-Augmented Generation (RAG) pipelines for efficient information retrieval.

UNIT – I**Fundamentals and Principles of Prompting**

Overview of the Five Principles of Prompting: Give Direction, Specify Format, Provide Examples, Evaluate Quality, Divide Labor.

UNIT – II**Introduction to Large Language Models for Text Generation**

What Are Text Generation Models, Vector Representations: The Numerical Essence of Language, Transformer Architecture: Orchestrating Contextual Relationships, Probabilistic Text Generation: The Decision Mechanism, Historical Underpinnings: The Rise of Transformer Architectures, OpenAI's Generative Pretrained Transformers, GPT-3.5-turbo and ChatGPT, GPT-4, Google's Gemini, Meta's Llama and Open Source.

UNIT – III**Standard Practices for Text Generation with ChatGPT- Part-A**

Generating Lists, Hierarchical List Generation, When to Avoid Using Regular Expressions, Generating JSON, YAML Filtering YAML Payloads, Handling Invalid Payloads in YAML, Diverse Format Generation with ChatGPT, Mock CSV Data, Universal Translation Through LLMs, Ask for Context, Text Style Unbundling, Identifying the Desired Textual Features, Generating New Content with the Extracted Features, Extracting Specific Textual Features with LLMs.

UNIT – IV**Standard Practices for Text Generation with ChatGPT- Part-B**

Chunking Text, Benefits of Chunking Text, Scenarios for Chunking Text, Poor Chunking Example, Chunking Strategies, Sentence Detection Using SpaCy, building a Simple Chunking Algorithm in Python, Sliding Window Chunking, Text Chunking Packages, Text Chunking with Tiktoken, Encodings, Understanding the Tokenization of Strings.

UNIT – V**Vector Databases with FAISS and Pinecone**

Retrieval Augmented Generation (RAG), Introducing Embeddings, Document Loading Memory Retrieval with FAISS, RAG with Lang Chain, Hosted Vector Databases with Pinecone, Self- Querying, Alternative Retrieval Mechanisms.

TEXTBOOK:

1. Phoenix J, Taylor M. Prompt engineering for generative AI. " O'Reilly Media, Inc."; 2024 May 16.

REFERENCES:

1. Tunstall L, Von Werra L, Wolf T. Natural language processing with transformers. " O'Reilly Media, Inc."; 2022 Jan 26.
2. Foster D. Generative deep learning. " O'Reilly Media, Inc."; 2022 Jun 28.

FUNDAMENTALS OF AI (OPEN ELECTIVE)

M.Tech AI II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Mathematical Foundation, Data structures and algorithms, Programming**Course Outcomes:**

1. Gain the knowledge of what is AI, risks and benefits of AI, limits of AI and the ethics involved in building an AI application.
2. Understand the nature of environments and the structure of agents.
3. Possess the ability to select a search algorithm for a problem and characterize its time and space complexities.
4. Possess the skill for representing knowledge using the appropriate technique
5. Gain an understanding of the applications of AI

Unit – I**Foundations of AI:** Introduction to AI, History of AI, Strong and Weak AI, The State of the Art, Risks and Benefits of AI**Philosophy, Ethics and Safety of AI:** The Limits of AI, Machine thinking capability, The Ethics of AI**Intelligent Agents:** Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.**Unit – II****Solving Problems by Searching:** Problem – Solving Agents**Uninformed Search Strategies:** Best-First Search, Breadth-First Search, Uniform-Cost Search, Depth-First Search, Iterative Deepening Search and Bidirectional Search**Informed Search Strategies:** Greedy Best-First Search, A* Search**Unit – III****Logical Agents:** Knowledge-based agents, Propositional Logic, Propositional Theorem Proving**First-Order Logic:** Syntax and Semantics of First-Order Logic**Inference in First-Order Logic:** Propositional Vs. First-Order Inference, Unification and First-Order Inference, Forward Chaining, Backward Chaining**Knowledge Representation:** Ontological Engineering, Categories and Objects, Events**Unit – IV****Quantifying Uncertainty:** Basic Probability Notation, Inference Using Full-Joint Distributions, Independence, Bayes' Rule and its Use, Naive Bayes Models**Probabilistic Reasoning:** Representing Knowledge in an Uncertain Domain, The semantics of Bayesian Networks, Exact Inference in Bayesian Networks**Unit – V****Learning from Examples:** Forms of Learning, Supervised Learning, Learning Decision Trees, Model Selection, Linear Regression and Classification, Ensemble Learning**Natural Language Processing:** Language Models, Grammar, Parsing, Complications of Real Natural Language, Natural Language Tasks**Robotics:** Robots, Robot Hardware, Kind of Problems solved, Application Domains**Computer Vision:** Simple Image Features, Using Computer Vision**TEXT BOOKS:**

1. "Artificial Intelligence a Modern Approach", Fourth Edition, Stuart J. Russell & Peter Norvig – Pearson.

REFERENCE BOOKS:

1. "Artificial Intelligence", Elaine Rich, Kevin Knight & Shivashankar B Nair – McGraw Hill Education.
2. Artificial Intelligence, 3rd Edn, E. Rich and K.Knight (TMH)
3. Artificial Intelligence, 3rd Edn., Patrick Henny Winston, Pearson Education.
4. Artificial Intelligence, Shivani Goel, Pearson Education.
5. Artificial Intelligence and Expert systems – Patterson, Pearson Education

BIG DATA TECHNOLOGIES (OPEN ELECTIVE)

M.Tech AI II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisite: Data Warehousing, Data Mining.**Courses Outcomes**

1. Ability to explain the foundations, definitions, and challenges of Big Data and various Analytical tools.
2. Ability to program using HADOOP and Map reduce, NOSQL
3. Ability to understand the importance of Big Data in Social Media and Mining.
4. Ability to gain knowledge on data analysis tools like Hive,Pig.
5. Ability to analyze the role of coordination services zookeeper

Unit I**Getting an Overview of Big Data**

Big Data, History of Data Management – Evolution of Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics, Careers in Big Data, Future of Big Data

Technologies for Handling Big Data

Distributed and Parallel Computing for Big Data, Introducing Hadoop, Cloud Computing and Big Data, In-Memory Computing Technology for Big Data.

Unit II**Understanding Hadoop Ecosystem**

Hadoop Ecosystem, Hadoop Distributed File System, MapReduce, Hadoop YARN, Hbase, Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, Oozie

Understanding MapReduce Fundamentals and HBase

The MapReduce Framework, Techniques to Optimize MapReduce Jobs, Uses of MapReduce, Role of HBase in Big Data Processing

Unit III**Exploring Hive**

Introducing Hive, Getting Started with Hive, Data Types in Hive, Built-In Functions in Hive, Hive DDL, Data Manipulation in Hive, Data Retrieval Queries, Using JOINS in Hive

Analyzing Data with Pig

Introducing Pig, Running Pig, Getting Started with Pig Latin, Working with Operators in Pig, Working with Functions in Pig

Unit IV**Using Oozie**

Introducing Oozie, Installing and Configuring Oozie, Understanding the Oozie Workflow, Oozie Coordinator, Oozie Bundle, Oozie Parameterization with EL, Oozie Job Execution Model, Accessing Oozie, Oozie SLA

NoSQL Data Management

Introduction to NoSQL, Aggregate Data Models, Key Value Data Model, Document Databases, Relationships, Graph Databases, Schema-Less Databases, Materialized Views, Distribution Models, Sharding, MapReduce Partitioning and Combining, Composing MapReduce Calculations

Unit V

Zookeeper: Installing and Running ZooKeeper, An Example, Group Membership in ZooKeeper, Creating the Group, Joining a Group, Listing Members in a Group, The ZooKeeper Service, Data Model, Operations, Implementation, Consistency, Sessions, Building Applications with ZooKeeper, A Configuration, Service, The Resilient ZooKeeper Application, A Lock Service, More Distributed Data Structures and Protocols, ZooKeeper in Production

Sqoop: Getting Sqoop, Sqoop Connectors, A Sample Import, Generated Code, Imports: A Deeper Look, Working with Imported Data, Importing Large Objects, Performing an Export, Exports: A Deeper Look

TEXT BOOKS:

3. Big data, blackbook, Dream Tech Press, 2015

4. Hadoop: The Definitive Guide, Tom White, 3rd Edition, O'Reilly Media, 2012.

REFERENCES:

1. Big Data Analytics, Seema Acharya, Subhashini Chellappan, Wiley 2015.
2. Simon Walkowiak, Big Data Analytics with R, Packt Publishing, ISBN: 9781786466457
3. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business, Michael Minelli, Michehe Chambers, 1st Edition, Ambiga Dhiraj, Wiley CIO Series, 2013.
4. Big Data Analytics: Disruptive Technologies for Changing the Game, Arvind Sathi, 1st Edition, IBM Corporation, 2012.

LARGE LANGUAGE MODELS (OPEN ELECTIVE)

M.Tech AI II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: AI, Machine Learning, Deep Learning**Course Outcomes (COs)**

1. Understand the architecture and inner workings of transformer-based LLMs.
2. Apply prompt engineering and fine-tuning techniques for domain-specific tasks.
3. Evaluate LLM performance using standard metrics and benchmarks.
4. Identify challenges in LLM training, deployment, and scaling.
5. Analyze ethical, legal, and societal implications of LLM usage.

UNIT 1 – Foundations of Large Language Models

Introduction to LLMs: Definition, scope, and historical evolution from statistical NLP to transformers. The Transformer architecture: Attention mechanisms, self-attention, multi-head attention. Pretraining objectives: Masked language modeling (MLM), Causal language modeling (CLM). Evolution of LLMs: BERT, GPT series, T5, LLaMA, Mistral.

UNIT 2 – Training and Fine-Tuning LLMs

Pretraining datasets and tokenization: BPE, SentencePiece, WordPiece. Fine-tuning approaches: Full fine-tuning, LoRA, adapters, instruction tuning. Domain adaptation and few-shot/zero-shot learning. Data augmentation for LLMs and prompt-based tuning.

UNIT 3 – Prompt Engineering and Applications

Principles of prompt design: Zero-shot, few-shot, and chain-of-thought prompting. System prompts, role prompting, and context length optimization.

Use cases: Text generation, summarization, code generation, question answering, chatbots. Tools & frameworks: Lang Chain, Llama Index, Hugging Face Transformers.

UNIT 4 – Evaluation and Deployment of LLMs

Evaluation metrics: Perplexity, BLEU, ROUGE, METEOR, human evaluation.

Benchmark datasets: GLUE, SuperGLUE, HELM, BIG-bench.

Deployment strategies: API-based deployment, on-prem deployment, inference optimization.

Scaling and latency considerations; quantization and pruning for LLMs.

UNIT 5 – Ethics, Safety, and Future Directions

Bias, fairness, and toxicity in LLMs. Hallucination problem and mitigation techniques. Legal and regulatory issues: Copyright, data privacy, AI Act. Trends in LLM research: Multimodal LLMs, retrieval-augmented generation (RAG), open-source LLM ecosystems.

TEXT BOOKS:

4. Vaswani, A. et al. (2017) *Attention Is All You Need* – NIPS Conference Paper.
5. Lewis, P. et al. (2021) *Language Models are Few-Shot Learners* – OpenAI Research Paper.
6. Tunstall, L., von Werra, L., & Wolf, T. (2022) *Natural Language Processing with Transformers* – O'Reilly Media.

REFERENCE BOOKS:

5. Bommasani, R. et al. (2021) *On the Opportunities and Risks of Foundation Models* – Stanford CRFM.
6. Jurafsky, D., & Martin, J. H. (2023) *Speech and Language Processing* (3rd Edition draft) – Pearson.
7. Mollick, E., & Mollick, L. (2024) *Co-Intelligence: Living and Working with AI* – Little, Brown Spark.
8. Hugging Face Documentation – <https://huggingface.co/docs/>