M.Tech in Applied Artificial Intelligence – Program Overview

The document provides a **detailed curriculum structure** for the **M.Tech in Applied Artificial Intelligence** program, covering **core courses, electives, project work, and dissertation requirements**. It includes **learning objectives, key topics, and prescribed textbooks and references** for each course.

Key Contents:

1. **Program Overview:**
   - Structure of the **four-semester** program.
   - **Credit distribution** for core, elective, and project courses.
2. **Core Courses (Departmental Core - DC):**
   - **Programming for Data Science** (Python, Data Wrangling, Visualization)
   - **Statistics for Machine Learning** (Probability, Bayesian Inference, Optimization)
   - **Computer Vision** (Feature Extraction, Segmentation, Object Detection)
   - **Data Transformation** (SQL, Database Normalization, NoSQL Queries)
   - **Neural Networks** (CNNs, RNNs, GANs, Transformers)
   - **Machine Learning Algorithms & Applications** (Decision Trees, SVMs, Clustering)
   - **Mini Project & Dissertation (Phase I & II)** (Research & Implementation)
   - **Personality Development & Communication Skills** (Soft Skills, Professional Ethics)
3. **Elective Courses (Departmental Elective - DE):**
   - **Internet of Things & Embedded Systems** (IoT Architectures, Wireless Protocols)
   - **Deep Learning Techniques** (CNNs, YOLO, GANs, Reinforcement Learning)
   - **Natural Language Processing** (Tokenization, Sentiment Analysis, Transformers)
   - **Big Data Analytics** (Hadoop, Spark, RDDs, Streaming Data)
   - **Deployment of ML Models (MLOps)** (CI/CD, Cloud Deployment, Debugging)
   - **AI in Healthcare** (Medical Imaging, EHR Analysis, AI in Drug Discovery)
   - **Applied Signal Processing** (Fourier Transforms, Filtering, AI in DSP)
   - **AI Workshop** (Hands-on ML & AI Model Training and Deployment)

Program Structure

The M.Tech in Applied Artificial Intelligence is a two-year program designed to provide in-depth knowledge of AI, machine learning, and related fields. The curriculum is structured across four semesters with core, elective, and project-based courses.

Semester-Wise Course Breakdown

Semester 1 (15 Credits)

1. **Programming for Data Science (4 Credits)**
    - Focus on Python programming, object-oriented concepts, error handling, data science libraries, and version control.
2. **Statistics for Machine Learning (4 Credits)**
    - Covers probability, statistics, random processes, Bayesian statistics, hypothesis testing, linear algebra, and optimization techniques.
3. **Computer Vision (4 Credits)**
    - Introduces image formation, feature extraction, segmentation, pattern recognition, and 3D reconstruction.
4. **Data Transformation (3 Credits)**
    - Explores database management systems, SQL, normalization, and advanced querying.

Semester 2 (20 Credits)

1. **Neural Networks (4 Credits)**
    - Covers fundamentals of artificial neural networks, deep learning, backpropagation, CNNs, RNNs, and deep learning applications.
2. **Machine Learning Algorithms and Applications (4 Credits)**
    - Covers supervised and unsupervised learning, decision trees, SVMs, Bayesian learning, and clustering.
3. **Elective 1 (4 Credits)**
4. **Elective 2 (4 Credits)**
5. **Mini Project (4 Credits)**

Semester 3 (10 Credits)

1. **Elective 3 (4 Credits)**
2. **Elective 4 (3 Credits)**
3. **Dissertation – Phase I (3 Credits)**

Semester 4 (9 Credits)

1. **Dissertation – Phase II (9 Credits)**
2. **Personality Development and Communication Skills (Audit Course)**

Elective Courses

Students can choose from a range of electives, each designed to provide specialization in different aspects of AI and its applications.

1. **Internet of Things and Embedded Systems (4 Credits)**
    - Covers IoT architectures, embedded programming, sensor interfacing, BLE, Wi-Fi, and cloud-based IoT applications.
2. **Deep Learning Techniques (4 Credits)**

    - Covers CNN architectures, object detection, generative models, reinforcement learning, and case studies like DeepFake.
3. **Natural Language Processing (4 Credits)**
    - Covers text processing, tokenization, classification, sentiment analysis, and chatbot development.
4. **Big Data Analytics (4 Credits)**
    - Focuses on big data frameworks, Hadoop, Spark, RDDs, and real-time data processing.
5. **Deployment of ML Models (3 Credits)**
    - Covers MLOps, workflow management, model pipelines, cloud deployment, and system monitoring.
6. **AI in Healthcare (4 Credits)**
    - Covers applications of AI in medical diagnostics, predictive healthcare analytics, and bioinformatics.
7. **Applied Signal Processing (4 Credits)**
    - Covers DSP techniques, filtering, time-frequency analysis, and applications in AI.
8. **AI Workshop (3 Credits)**
    - Practical hands-on workshop focused on real-world AI applications.

Core and Elective Credit Requirements

- **Departmental Core (DC):** 39 Credits
- **Departmental Electives (DE):** 15 Credits
- **Total Requirement: 54 Credits**

M.Tech in Applied Artificial Intelligence – Detailed Course Descriptions

Core Courses

1. Programming for Data Science

- **Objective:** Introduces Python programming for data science applications.
- **Key Topics:**
    - Python syntax, object-oriented programming concepts.
    - Error handling, debugging techniques.
    - Key Python libraries: NumPy, Pandas, SciPy.
    - Data manipulation, visualization using Matplotlib.
    - Version control and working with environments.

---

2. Statistics for Machine Learning

- **Objective:** Provides statistical foundations for AI and ML applications.
- **Key Topics:**
  - Probability theory, random variables, statistical distributions.
  - Bayesian inference, hypothesis testing, confidence intervals.
  - Regression analysis, parametric and non-parametric modeling.
  - Markov Chains, Monte Carlo simulations, central limit theorem.
  - Linear algebra and optimization techniques.

---

3. Computer Vision

- **Objective:** Covers image processing, pattern recognition, and 3D vision.
- **Key Topics:**
  - Image formation, filtering, histogram equalization.
  - Feature extraction (Canny edge detection, HOG, SIFT, SURF).
  - Image segmentation (Graph-Cut, Mean-Shift, MRFs).
  - Object detection and pattern analysis (Bayes, KNN, PCA, LDA).
  - 3D reconstruction, epipolar geometry, multi-view imaging.

---

4. Data Transformation

- **Objective:** Focuses on database management and data preprocessing.
- **Key Topics:**
  - SQL fundamentals, relational databases, data types, indexing.
  - Data normalization techniques (1NF, 2NF, 3NF, BCNF).
  - SQL queries for data manipulation and transformation.
  - Joins, subqueries, stored procedures, triggers.
  - Advanced data querying techniques using NoSQL.

---

5. Neural Networks

- **Objective:** Covers fundamentals of artificial and deep neural networks.
- **Key Topics:**
  - Backpropagation, gradient descent, hyperparameter tuning.
  - Optimization algorithms: Adam, RMSProp.
  - CNNs, RNNs (LSTMs, GRUs), attention mechanisms.
  - Hybrid models and deep reinforcement learning.
  - State-of-the-art models: AlexNet, VGG16, Inception, Xception.

---

6. Machine Learning Algorithms and Applications

- **Objective:** Covers a broad range of machine learning algorithms.
- **Key Topics:**
  - Supervised learning (decision trees, SVM, logistic regression).
  - Unsupervised learning (K-means, hierarchical clustering).
  - Bayesian learning (Naïve Bayes, Bayesian networks, HMM).
  - Ensemble learning, boosting, bagging, random forests.
  - Overfitting, cross-validation, and model evaluation.

---

7. Mini Project

- **Objective:** A hands-on project to apply ML/AI concepts in a real-world setting.
- **Key Areas:**
  - Problem identification and dataset collection.
  - Preprocessing and exploratory data analysis.
  - Model selection, training, tuning, and evaluation.
  - Deployment using cloud or edge computing solutions.

---

8. Dissertation - Phase I and II

- **Objective:** A research-based project across two semesters.
- **Key Areas:**
  - Literature review, defining problem statements.
  - Experimentation and performance evaluation.
  - Paper writing and publication.

---

9. Personality Development and Communication Skills

- **Objective:** Enhances interpersonal and professional skills.
- **Key Topics:**
  - Self-assessment, confidence building, goal setting.
  - Conflict resolution, stress management.
  - Professional communication, presentation skills.
  - Time and resource management.

Elective Courses

10. Internet of Things and Embedded Systems

- **Objective:** Covers IoT technologies and embedded programming.
- **Key Topics:**

  - IoT platforms, GPIO configurations, sensor interfacing.
  - Communication protocols: BLE, Wi-Fi, MQTT.
  - Data acquisition, cloud integration, IoT security.
  - IoT applications in healthcare, agriculture, and smart cities.

---

11. Deep Learning Techniques

- **Objective:** Covers state-of-the-art deep learning architectures.
- **Key Topics:**
  - CNN architectures (VGG, ResNet, EfficientNet).
  - Object detection (YOLO, Faster R-CNN, DeepSORT).
  - GANs, autoencoders, transformers, vision transformers.
  - Reinforcement learning (MDP, Q-learning).

---

12. Natural Language Processing

- **Objective:** Covers text processing, language modeling, and NLP applications.
- **Key Topics:**
  - Tokenization, stemming, lemmatization, POS tagging.
  - Text classification (TF-IDF, Naïve Bayes, LSTMs).
  - Named Entity Recognition (NER), dependency parsing.
  - Transformer-based models (BERT, GPT).

---

13. Big Data Analytics

- **Objective:** Covers scalable data processing using big data frameworks.
- **Key Topics:**
  - HDFS, MapReduce, Spark, in-memory computation.
  - RDDs, data partitioning, parallel processing.
  - Real-time streaming (Kafka, Flink).
  - Machine learning on big data (MLlib, SparkML).

---

14. Deployment of ML Models

- **Objective:** Covers MLOps and deploying models at scale.
- **Key Topics:**
  - ML lifecycle, model monitoring, CI/CD pipelines.
  - Cloud deployment (AWS, GCP, Azure).
  - Model interpretability, explainability (SHAP, LIME).
  - Fault diagnosis, retraining strategies.

---

15. AI in Healthcare

- **Objective:** Covers applications of AI in medical diagnosis and healthcare.
- **Key Topics:**
  - Medical imaging, disease prediction, genomics AI.
  - Healthcare NLP (clinical text processing, EHR analysis).
  - Drug discovery using AI models.
  - Federated learning for healthcare applications.

---

16. Applied Signal Processing

- **Objective:** Covers digital signal processing techniques.
- **Key Topics:**
  - Fourier transforms, convolution, spectral analysis.
  - Digital filters (FIR, IIR), wavelet transforms.
  - Time-frequency representations.
  - AI applications in speech and image processing.

---

17. AI Workshop

- **Objective:** Hands-on training in AI/ML projects.
- **Key Topics:**
  - End-to-end ML pipelines.
  - Model evaluation, hyperparameter tuning.
  - Cloud-based deployment.
  - Case studies on real-world AI applications.

Summary

This structured breakdown ensures:

- **Clear learning objectives** for each course.
- **Topic modularity** for efficient chunking.
- **Standardized descriptions** to make retrieval seamless.

M.Tech in Applied Artificial Intelligence – Detailed Course Descriptions with Textbooks & References

Core Courses

1. Programming for Data Science

- **Objective:** Introduces Python programming for data science applications.
- **Key Topics:**
  - Python syntax, OOP, error handling, debugging.
  - Data manipulation and visualization (NumPy, Pandas, Matplotlib).
  - Version control and working with environments.

Textbooks:

1. **Wes McKinney** – *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*, O'Reilly Media, 2017.
2. **Jeffrey Elkner, Allen B. Downey, Chris Meyers** – *How to Think Like a Computer Scientist: Learning with Python*.

Reference Books:

1. **Brian Draper** – *Python Programming: A Complete Guide for Beginners*.

---

2. Statistics for Machine Learning

- **Objective:** Covers probability, statistics, Bayesian inference, and optimization techniques.
- **Key Topics:**
  - Probability theory, statistical distributions.
  - Bayesian inference, hypothesis testing.
  - Linear algebra and optimization.

Textbooks:

1. **Carlos Fernandez-Granda** – *Probability and Statistics for Data Science*.
2. **Anirban Das Gupta** – *Probability for Statistics and Machine Learning: Fundamentals and Advanced Topics*.
3. **Athanasios Papoulis** – *Probability, Random Variables, and Stochastic Processes*.
4. **S. Lang** – *Introduction to Linear Algebra*, Springer-Verlag, 2/e, 1997.
5. **Deisenroth, Faisal, Ong** – *Mathematics for Machine Learning*, Cambridge University Press, 2020.

Reference Books:

1. **Kevin Murphy** – *Machine Learning: A Probabilistic Perspective*.
2. **Vladimir Vapnik** – *Statistical Learning Theory*.

---

3. Computer Vision

- **Objective:** Covers image processing, feature extraction, segmentation, and 3D vision.
- **Key Topics:**
  - Feature extraction (SIFT, HOG).
  - Image segmentation (Graph-Cut, Mean-Shift).
  - Pattern analysis (PCA, LDA).
  - Multi-view imaging and 3D reconstruction.

Textbooks:

1. **Shapiro & Stockman** – *Computer Vision*, Prentice Hall.
2. **Rafael C. Gonzalez & Richard E. Woods** – *Digital Image Processing*, 3rd edition, Pearson Education.
3. **Christopher Bishop** – *Pattern Recognition and Machine Learning*, Springer.
4. **Richard Hartley & Andrew Zisserman** – *Multiple View Geometry in Computer Vision*, 2nd edition, Cambridge University Press.

Reference Books:

1. **Richard Szeliski** – *Computer Vision: Algorithms and Applications*, Springer.

---

4. Data Transformation

- **Objective:** Focuses on database management and data transformation using SQL.
- **Key Topics:**
  - SQL basics, joins, subqueries.
  - Database normalization and indexing.
  - Advanced querying techniques.

Textbooks:

1. **R. Elmasri & S. B. Navathe** – *Fundamentals of Database Systems*.
2. **Carlos Coronel & Steven Morris** – *Database Systems: Design, Implementation & Management*.
3. **Raghu Ramakrishnan & Johannes Gehrke** – *Database Management Systems*.
4. **C. J. Date** – *An Introduction to Database Systems*.

Reference Books:

1. **Connolly** – *Database Systems: A Practical Approach to Design, Implementation, and Management*.

---

5. Neural Networks

- **Objective:** Covers artificial neural networks, CNNs, RNNs, and generative models.
- **Key Topics:**
  - Backpropagation, CNNs, RNNs.
  - GANs, autoencoders.
  - State-of-the-art models (AlexNet, VGG16, Xception).

Textbooks:

1. **Ian Goodfellow, Yoshua Bengio, Aaron Courville** – *Deep Learning*, MIT Press, 2016.

Reference Books:

1. **Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola** – *Dive into Deep Learning*.
2. **François Chollet** – *Deep Learning with Python*, Manning Publications, 2017.
3. **N. Cristianini & J. S. Taylor** – *An Introduction to Support Vector Machines*.
4. **B. Scholkopf & A. J. Smola** – *Learning with Kernels*.

---

6. Machine Learning Algorithms and Applications

- **Objective:** Covers supervised, unsupervised, and Bayesian learning.
- **Key Topics:**
  - Decision trees, SVMs, clustering.
  - Bayesian learning, Markov networks.

Textbooks:

1. **Tom Mitchell** – *Machine Learning*, McGraw-Hill.
2. **Christopher Bishop** – *Pattern Recognition and Machine Learning*, Springer-Verlag.

Reference Books:

1. **Kevin Murphy** – *Machine Learning: A Probabilistic Perspective*.
2. **Ethem Alpaydin** – *Introduction to Machine Learning*.

---

7. Big Data Analytics

- **Objective:** Covers large-scale data processing using big data frameworks.
- **Key Topics:**
  - Hadoop, Spark, RDDs, distributed computing.

Textbooks:

1. **Donald Miner & Adam Shook** – *MapReduce Design Patterns*, O'Reilly.
2. **Tom White** – *Hadoop: The Definitive Guide*, O'Reilly.
3. **Holden Karau, Matei Zaharia** – *Learning Spark: Lightning-Fast Big Data Analysis*.

Reference Books:

1. **V.K. Jain** – *Big Data & Hadoop*.
2. **DT Editorial Services** – *Big Data Black Book*.

---

8. Deployment of ML Models

- **Objective:** Covers MLOps, cloud deployment, and CI/CD.
- **Key Topics:**
  - ML lifecycle, cloud deployment.
  - Model monitoring, debugging.

Textbooks:

1. **Andriy Burkov** – *Machine Learning Engineering*.
2. **David Sweenor, Steven Hillion, Dan Rope** – *ML Ops: Operationalizing Data Science*.

Reference Books:

1. **Mark Treveil et al.** – *Introducing MLOps*.
2. **Albert Bifet, Holmes, Pfahringer** – *Machine Learning for Data Streams*.

---

9. Natural Language Processing

- **Objective:** Covers text processing, sentiment analysis, and transformers.
- **Key Topics:**
  - Tokenization, classification, language modeling.
  - Transformers (BERT, GPT).

Textbooks:

1. **Daniel Jurafsky & James H. Martin** – *Speech and Language Processing*.
2. **Yoav Goldberg** – *Neural Network Methods for NLP*.

Reference Books:

1. **Jacob Eisenstein** – *Introduction to NLP*.

---

10. AI in Healthcare

- **Objective:** Covers AI applications in medical diagnostics and bioinformatics.
- **Key Topics:**
  - Medical imaging, EHR analysis.
  - AI for drug discovery.

Textbooks & References: Not provided in the document.

---

11. Applied Signal Processing

- **Objective:** Covers DSP techniques, filtering, time-frequency analysis.
- **Key Topics:**
  - Fourier transforms, wavelets.
  - AI applications in speech & image processing.

Textbooks & References: Not provided in the document.

M.Tech in Applied Artificial Intelligence – Elective Course Descriptions with Textbooks & References

Elective Courses

---

1. Internet of Things and Embedded Systems

- **Objective:** Covers IoT architectures, embedded programming, and wireless communication.
- **Key Topics:**
  - IoT platforms and microcontroller programming.
  - Sensor interfacing and real-time data processing.
  - Wireless protocols (BLE, Wi-Fi, MQTT).
  - Cloud-based IoT applications.

Textbooks & References:

- Not provided in the document.

---

2. Deep Learning Techniques

- **Objective:** Covers state-of-the-art deep learning architectures and applications.
- **Key Topics:**
  - CNN architectures (VGG, ResNet, EfficientNet).
  - Object detection (YOLO, Faster R-CNN, DeepSORT).
  - GANs, autoencoders, transformers, vision transformers.
  - Reinforcement learning (MDP, Q-learning).

Textbooks:

1. **Ian Goodfellow, Yoshua Bengio, Aaron Courville** – *Deep Learning*, MIT Press, 2016.

Reference Books:

1. **Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola** – *Dive into Deep Learning*.
2. **François Chollet** – *Deep Learning with Python*, Manning Publications, 2017.
3. **N. Cristianini & J. S. Taylor** – *An Introduction to Support Vector Machines*.
4. **B. Scholkopf & A. J. Smola** – *Learning with Kernels*.

---

3. Natural Language Processing

- **Objective:** Covers text processing, language modeling, sentiment analysis, and chatbot development.
- **Key Topics:**
  - Tokenization, stemming, lemmatization, POS tagging.
  - Text classification (TF-IDF, Naïve Bayes, LSTMs).
  - Named Entity Recognition (NER), dependency parsing.
  - Transformer-based models (BERT, GPT).
  - AI chatbots and recommendation engines.

Textbooks:

1. **Daniel Jurafsky & James H. Martin** – *Speech and Language Processing*.
2. **E. Bender** – *Linguistic Fundamentals for NLP*.
3. **J. Allen** – *Natural Language Understanding*.
4. **Yoav Goldberg** – *Neural Network Methods for Natural Language Processing*.

Reference Books:

1. **Jacob Eisenstein** – *Introduction to NLP*.

---

4. Big Data Analytics

- **Objective:** Covers scalable data processing and analytics techniques.
- **Key Topics:**
  - Hadoop ecosystem, Apache Spark.

- Resilient Distributed Datasets (RDDs).
- Streaming data analytics (Kafka, Flink).
- Parallel processing and distributed computing.

Textbooks:

1. **Donald Miner & Adam Shook** – *MapReduce Design Patterns*, O'Reilly.
2. **Tom White** – *Hadoop: The Definitive Guide*, O'Reilly.
3. **Holden Karau, Matei Zaharia** – *Learning Spark: Lightning-Fast Big Data Analysis*.

Reference Books:

1. **V.K. Jain** – *Big Data & Hadoop*.
2. **DT Editorial Services** – *Big Data Black Book*.

---

5. Deployment of ML Models

- **Objective:** Covers MLOps, model deployment strategies, and cloud computing.
- **Key Topics:**
  - ML lifecycle, cloud deployment (AWS, GCP, Azure).
  - Model monitoring, debugging, and retraining.
  - CI/CD pipelines for ML.

Textbooks:

1. **Andriy Burkov** – *Machine Learning Engineering*.
2. **David Sweenor, Steven Hillion, Dan Rope** – *ML Ops: Operationalizing Data Science*.
3. **Emmanuel Ameisen** – *Building Machine Learning Powered Applications*.
4. **Hannes Hapke & Catherine Nelson** – *Building Machine Learning Pipelines*.

Reference Books:

1. **Mark Treveil et al.** – *Introducing MLOps*.
2. **Albert Bifet, Holmes, Pfahringer** – *Machine Learning for Data Streams*.

---

6. AI in Healthcare

- **Objective:** Covers AI applications in medical diagnostics and predictive healthcare analytics.
- **Key Topics:**
  - Medical imaging and AI-assisted diagnostics.
  - NLP for clinical text processing (EHR analysis).
  - AI in drug discovery and genomics.
  - Federated learning for healthcare.

Textbooks & References:

- Not provided in the document.

---

7. Applied Signal Processing

- **Objective:** Covers digital signal processing (DSP) techniques and AI applications.
- **Key Topics:**
  - Fourier transforms, convolution, and spectral analysis.
  - Digital filters (FIR, IIR), wavelet transforms.
  - AI applications in speech and image processing.

Textbooks & References:

- Not provided in the document.

---

8. AI Workshop

- **Objective:** A hands-on workshop focused on AI/ML applications.
- **Key Topics:**
  - End-to-end ML pipelines.
  - Model evaluation, hyperparameter tuning.
  - Cloud-based deployment strategies.
  - Case studies on real-world AI applications.

Textbooks & References:

- Not provided in the document.