

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.
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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.
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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.
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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.
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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.
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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.
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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.
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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.
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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.
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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.
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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.
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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).
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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).
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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).
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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.
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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*.
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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*.
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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*.
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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*.
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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*.
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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*.
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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.
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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*.
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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*.
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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.
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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.
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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.