AI+ Data & Robotics (120hrs and 20 Days)

Duration: 120 Hrs
Days: 20
Exam Code: AT-120

Executive Summary:

This curriculum is designed to provide an **integrated learning experience** in **Artificial Intelligence (AI)** and **Robotics**, with a strong focus on the application of **data science** techniques in the development of intelligent robotic systems. The program spans over **20 days**, with **6 hours per day**, combining both **theoretical foundations** and **hands-on applications** to ensure a comprehensive understanding of key concepts in **data science**, **machine learning**, **deep learning**, and **robotics**.

Day 1–2: Module 1 - Introduction to AI and Data Science (6 hours per day)

- **Topic 1.1: Introduction to AI and Data Science**
  - Definition, applications, and subfields of AI (ML, Deep Learning, NLP)
  - Role of AI in various industries
  - Use-case examples
  - Case studies
- **Topic 1.2: The AI Development Life Cycle**
  - Overview of the AI development life cycle
  - Key steps in building AI models
  - Use-case examples
  - Case studies
- **Topic 1.3: Data Sources and Its Types**
  - Overview of Data and Its Sources
  - Types of Data: Structured, Semi-structured, Unstructured
  - Data Storage Technologies: Relational and NoSQL Databases
  - Use-case examples
  - Case studies
  - Hands-on exercises

Module 2: Python Programming for Data Science

- **Topic 2.1: Introduction to Python Programming**
  - Importance of Python in data science
  - Basic Python programming concepts:
    - Variables and Data Types
    - Control Flow (if-else) and Loops
    - Functions
    - Lists and Dictionaries
    - Tuples in Python

        - Differences Between Lists, Tuples, and Dictionaries
        - Object-Oriented Programming (OOP)
    - Hands-on exercises
- **Topic 2.2: Python Programming for Data Science and ML**
    - Introduction to Python libraries for Data Science:
        - NumPy
        - Pandas
        - Scikit-Learn
        - Matplotlib
        - Seaborn
    - Hands-on exercises

Day 3–4: Module 3 - Data Science and Machine Learning (6 hours per day)

- **Topic 3.1: Data Science Life Cycle and Machine Learning Overview**
    - Basic concepts of Data Science
    - Overview of Machine Learning and its working models
    - Phases of machine learning: Business problem understanding, data preparation, exploratory data analysis (EDA)
    - Handling outliers and Data Transformation Techniques
    - Data Visualization and types of Data Visualization
    - **Real-time Data Processing for Robotics**:
        - Techniques for processing and analyzing data in real-time, focusing on streaming data for robotics.
    - Use-case examples
    - Case studies
    - Hands-on exercises
- **Topic 3.2: Supervised Learning Algorithms**
    - Supervised Learning concepts and working diagram
    - Supervised Learning Algorithms and their application in robotics:
        - Classification vs. Regression
        - Random Forest
        - Logistic Regression
        - SVM
        - Decision Trees
    - **Time Series Forecasting for Predictive Modeling**:
        - Techniques such as ARIMA, Exponential Smoothing, and Seasonal Decomposition for forecasting time-based data (e.g., stock prices, demand trends)
    - Use-case examples
    - Case studies
    - Hands-on exercises
- **Topic 3.3: Unsupervised Learning**
    - Unsupervised Learning concepts and working diagram
    - Unsupervised Learning Algorithms and their application in robotics:

        - Clustering
        - Dimensionality reduction
        - Association rule mining algorithms
    - Uncovering data patterns and relationships without labels, empowering robots with nuanced understanding and adaptable responses to diverse environments
    - Use-case examples
    - Case studies
    - Hands-on exercises

Day 5–6: Module 4 - Deep Learning Foundations (6 hours per day)

- **Topic 4.1: Introduction to Neural Networks and Deep Learning**
    - Neural Network concepts and applications
    - Structure and types of neural networks (Feedforward, CNNs, RNNs)
    - **Meta-learning and AutoML: Enhancing Model Training and Selection**:
        - Introduction to Meta-learning for optimizing models by learning how to learn
        - AutoML for automating hyperparameter tuning and model selection processes
    - Use-case examples
    - Case studies
    - Hands-on exercises
- **Topic 4.2: Convolutional Neural Networks (CNNs) for Image Recognition**
    - CNN concepts and applications
    - How CNN works
    - Use-case examples
    - Case studies
    - Hands-on exercises
- **Topic 4.3: Sensor Fusion for Robotics**
    - How to combine data from multiple sensors (e.g., LiDAR, cameras) to improve robotic perception and decision-making.

Day 7–8: Module 5 - Advanced AI and Robotics (6 hours per day)

- **Topic 5.1: Robotics and AI Integration**
    - Basics of robotics and intelligent agents
    - Introduction to ROS (Robot Operating System)
    - Role of AI in robotics
    - Types of AI used in robotics
    - Use-case examples
    - Case studies
    - Hands-on exercises

- **Topic 5.2: Deep Learning, Neural Networks, and Their Relevance to Robotics**
  - Impact of Deep Learning in robotics
  - Impact of Neural Networks in robotics
  - Use-case examples
  - Case studies
  - Hands-on exercises
- **Topic 5.3: Reinforcement Learning for Robotics**
  - Fundamentals of Reinforcement Learning (RL)
  - Applications of RL in robotics
  - Use-case examples
  - Case studies
  - Hands-on exercises
- **Topic 5.4: ROS 2.0 and Cloud Robotics**
  - Introduction to ROS 2.0 for robotic development and cloud robotics for offloading computation.

Day 9–10: Module 6 - Generative AI and NLP (6 hours per day)

- **Topic 6.1: Generative AI (GANs, VAEs)**
  - Overview of Generative Models and their working diagrams
  - Types of Generative Models
  - Applications of Generative AI in robotics
  - **Generative AI for Data Augmentation and Synthetic Data Generation**:
    - How GANs and VAEs can generate additional training data for imbalanced datasets (e.g., generating synthetic images, text, or sensor data)
  - Use-case examples
  - Case studies
  - Hands-on exercises
- **Topic 6.2: NLP for Robotics**
  - Basics of Natural Language Processing (NLP) and its application in robotics
  - NLP algorithms for recognizing and processing voice commands
  - **Human-Robot Interaction (HRI): Voice-Controlled Robots**:
    - Teach how robots can use voice-activated control systems for seamless human interaction (e.g., assistive robots in healthcare, customer service robots in retail)
  - **Fine-tuning Large Language Models (LLMs) for Robotics Applications**:
    - Fine-tuning models like GPT-3, BERT, or T5 for NLP tasks (text summarization, question answering, language translation) in robotic systems
  - Use-case examples
  - Case studies
  - Hands-on exercises
- **Topic 6.3: Edge Computing for Real-time Decision-making in Robotics**

- How edge computing enables real-time data processing directly on robots for autonomous tasks.

Day 11–12: Module 7 - AI in Robotics and Automation (6 hours per day)

- **Topic 7.1: Neural Networks and Robotics**
  - Understanding Artificial Neural Networks (ANNs) in robotic perception
  - Feedforward and Backpropagation concepts and their application in robotics
  - Use-case examples
  - Case studies
  - Hands-on exercises
- **Topic 7.2: Transfer Learning and Pretrained Models**
  - Transfer Learning basic concepts
  - Understanding pretrained models
  - **Transfer Learning for Robotic Perception Tasks**:
    - How pretrained models for image recognition, object detection, or pose estimation can be adapted for robotic tasks such as navigation and object manipulation
  - Use-case examples
  - Case studies
  - Hands-on exercises

Day 13–14: Module 8 - AI in Industrial Robotics (6 hours per day)

- **Topic 8.1: Autonomous Systems and Intelligent Agents**
  - Characteristics of Autonomous Systems
  - Basics of Intelligent Agents and their impact in robotics
  - Examples of autonomous systems (e.g., self-driving cars)
  - **Swarm Robotics: Collaborative Multi-Robot Systems**:
    - Introduction to swarm robotics, where multiple robots collaborate to solve tasks (e.g., warehouse automation, search-and-rescue operations, environmental monitoring)
  - Use-case examples
  - Case studies
  - Hands-on exercises
- **Topic 8.2: AI-Driven Automation**
  - Basic concepts of AI-driven automation
  - Characteristics of AI-driven automation systems
  - Automation frameworks for robotic processes in industrial applications
  - **Robotics Safety Standards and Compliance**:
    - Focus on ISO safety standards and robotic safety regulations to ensure compliance in human-robot interactions
  - Use-case examples

    - Case studies
    - Hands-on exercises
- **Topic 8.3: Industrial Robotics in Quality Control and Predictive Maintenance**
    - How AI is applied in automated production lines, quality control, and predictive maintenance in industrial settings.

Day 15–16: Module 9 - Advanced Robotics: AI for Smart Devices (6 hours per day)

- **Topic 9.1: AI in IoT and Smart Devices**
    - IoT concepts and applications
    - Understanding smart devices and their applications
    - Role of AI in securing IoT devices and networks
    - Use-case examples
    - Case studies
    - Hands-on exercises
- **Topic 9.2: Reinforcement Learning in Robotics for Optimization**
    - Use of RL to optimize robotic tasks and processes
    - Use-case examples
    - Case studies
    - Hands-on exercises
- **Topic 9.3: Advanced NLP Applications for Voice-controlled Robots**
    - Development of voice-controlled robots and human-robot dialogue systems for real-world interactions in complex environments.

Day 17–18: Module 10 - Ethics and AI Governance (6 hours per day)

- **Topic 10.1: Ethical Considerations in AI and Robotics**
    - Ethical implications of AI, fairness, and transparency in AI-driven systems
    - **MLOps: Managing the AI Lifecycle from Development to Production**:
        - Discuss CI/CD pipelines, model versioning, and monitoring for model drift and performance
    - Use-case examples
    - Case studies
- **Topic 10.2: AI and Policy Frameworks**
    - Exploring policies and regulations for AI safety and ethics
    - **Ethical AI Frameworks and AI Regulation (GDPR, EU AI Act, etc.)**:
        - Dive deeper into ethical AI concerns like algorithmic fairness, transparency, and explore GDPR and EU regulations for AI-driven decision-making and data privacy
    - Use-case examples
    - Case studies
    - Hands-on exercises

Day 19–20: Module 11 - Capstone Project and Final Review (6 hours per day)

- **Topic 11.1: Designing AI Solutions for Real-World Challenges**
  - Design and implementation of a comprehensive AI project integrating robotics, data science, and machine learning
  - Preparing and presenting AI-driven capstone projects
- **Topic 11.2: Final Project Presentation and Review**
  - Reviewing key concepts from the curriculum
  - Real-world capstone project presentations