**AI and Data Science Course Syllabus (40 Weeks)**

**(Tentative)**

Instructor Name: Nasir Hussain   
Course Duration: 40 Weeks  
Sessions: 2 Sessions per Week (2 hours each)  
Course Level: Beginner to Advanced  
Course Pre-requisites: Basic knowledge of programming is preferred but not mandatory.

**Course Objectives:**

* Master Python programming fundamentals.
* Learn object-oriented programming (OOP) concepts in Python.
* Utilize Python libraries for data analysis and visualization.
* Understand statistical and probability concepts in Python.
* Apply machine learning algorithms using Scikit-learn.
* Explore deep learning with Tensorflow, including CNNs, RNNs, and ANNs.
* Learn about generative AI models, including Transformers and Large Language Models (LLMs)

**Module 1: Programming Fundamentals using Python (Weeks 1–5)**

**Week 1-2:**

* Introduction to Python: Variables, Data Types, Operators, and Expressions
* Control Flow in Python: If-else, Loops (For and While)
* Functions in Python: Defining and Calling Functions, Scope of Variables
* Hands-on: Basic Python programs

**Week 3-4:**

* Data Structures: Lists, Tuples, Dictionaries, and Sets
* String Manipulation and Operations
* File Handling: Reading and Writing Files
* Hands-on: File I/O operations and data manipulation

**Week 5:**

Exception Handling and Debugging Techniques

Working with Modules and Packages in Python

Hands-on: Error handling in Python programs

**Module 2: Object-Oriented Programming in Python (Weeks 6–8)**

**Week 6-7:**

* Introduction to OOP Concepts: Classes, Objects, and Methods
* Encapsulation, Abstraction, Inheritance, and Polymorphism
* Hands-on: Building Classes and using OOP principles in real-world scenarios

**Week 8:**

Advanced OOP: Magic Methods, Static Methods, Class Methods

Hands-on: Create a small project using OOP in Python

**Module 3: Statistics and Data Analytics (Weeks 9–18)**

**Week 9-10:**

* **NumPy Fundamentals:** Arrays, Vectorization, Indexing, and Slicing
* Broadcasting, Array Math Operations
* Hands-on: Basic Data Manipulation with NumPy

**Week 11-12:**

* **Pandas for Data Science:** Dataframes, Series, Indexing, and Filtering Data
* Merging, Grouping, and Aggregating Data in Pandas
* Hands-on: Data Manipulation and Analysis with Pandas

**Week 13:**

* **Matplotlib for Data Visualization:** Creating Line Plots, Bar Charts, Histograms, Scatter Plots
* Customizing Visualizations (Legends, Titles, Axes)
* Hands-on: Plotting real-world data using Matplotlib

**Week 14:**

* **Seaborn for Advanced Visualization:** Heat-maps, Pair Plots, Violin Plots
* Hands-on: Creating Advanced Visualizations with Seaborn

**Module 4: Statistics and Probability in Python (Weeks 15–18)**

**Week 15-16:**

* Descriptive Statistics: Mean, Median, Mode, Variance, Standard Deviation
* Probability Theory: Distributions, Random Variables, and Events
* Hands-on: Implementing Descriptive Statistics with Python

**Week 17:**

* Inferential Statistics: Hypothesis Testing, P-Value, Confidence Intervals
* Correlation and Covariance
* Hands-on: Hypothesis Testing in Python

**Week 18:**

* Statistical Models: Linear Regression, Correlation Coefficient
* Hands-on: Build and Evaluate a Regression Model

**Module 5: Machine Learning using Scikit-learn (Weeks 19–26)**

**Week 19-20:**

* Introduction to Machine Learning: Supervised vs Unsupervised Learning
* Train-Test Split, Cross-Validation, and Model Evaluation Metrics
* Linear Regression in Depth: Gradient Descent, Regularization (L1, L2)
* Hands-on: Implement Linear Regression

**Week 21-22:**

* Classification Algorithms: Logistic Regression, Decision Trees, Random Forests
* Evaluation Metrics: Precision, Recall, F1-Score, ROC-AUC
* Hands-on: Build and Evaluate a Classification Model

**Week 23-24:**

* Clustering Algorithms: K-Means, Hierarchical Clustering, DBSCAN
* Dimensionality Reduction: PCA (Principal Component Analysis)
* Hands-on: Clustering and Dimensionality Reduction

**Week 25-26:**

* Support Vector Machines (SVM): Theory and Implementation
* K-Nearest Neighbors (KNN): Theory and Implementation
* Hands-on: Implement SVM and KNN on real datasets

**Module 6: Deep Learning with Tensorflow (Weeks 27–33)**

**Week 27-28:**

* Introduction to Neural Networks (NN): Perceptrons, Activation Functions, Forward and Backpropagation
* Hands-on: Build a basic Neural Network using TensorFlow

**Week 29-30:**

* Convolutional Neural Networks (CNN): Filters, Pooling, Layers, Image Classification
* Hands-on: Build and Train CNN for Image Classification

**Week 31-32:**

* Recurrent Neural Networks (RNN): Sequence Modeling, LSTMs, GRUs
* Time Series Forecasting with RNNs
* Hands-on: Implement RNN for Sequence Data

**Week 33:**

* Autoencoders and GANs: Unsupervised Representation Learning
* Hands-on: Build an Autoencoder for Dimensionality Reduction

**Module 7: Generative AI and Transformers (Weeks 34–39)**

**Week 34-35:**

* Introduction to Transformers and Attention Mechanism: Self-attention, Positional Encoding
* Large Language Models (LLMs): GPT, BERT
* Hands-on: Implement Text Generation with Pre-trained LLMs (Hugging Face, OpenAI API)

**Week 36-37:**

* LangChain for Building AI Applications: Combining Language Models with External Tools
* Building AI-powered Conversational Agents
* Hands-on: Create AI-powered chatbots using LangChain and Transformers

**Week 38-39:**

* Generative Adversarial Networks (GANs): Architecture and Applications in Image and Text Generation
* Hands-on: Build and Train a GAN for Image Generation

**Module 8: Final Project and Presentations (Week 40)**

**Week 40:**

* Project Presentations: Students present their final projects demonstrating AI or data science applications.
* Peer Review and Feedback
* Course Wrap-Up: Final discussions and feedback