Artificial Intelligence Course Outline

Machine Learning

1. **Introduction to Machine Learning**
   - What is Machine Learning?
   - Applications of Machine Learning
   - Types of Machine Learning (Supervised, Unsupervised, Reinforcement)
   - Machine Learning Workflow
2. **Data Preprocessing**
   - Data Cleaning (handling missing values, outliers)
   - Feature Scaling (standardization, normalization)
   - Feature Selection and Extraction
   - Encoding Categorical Data
3. **Exploratory Data Analysis (EDA)**
   - Descriptive Statistics
   - Data Visualization (Matplotlib, Seaborn)
   - Identifying Patterns and Trends
4. **Introduction to Supervised Learning**
   - Key Concepts (Features, Labels, Training vs Testing)
   - Evaluation Metrics (Accuracy, Precision, Recall, F1 Score)

5. **Simple Linear Regression**
   - Concept and Applications
   - Least Squares Method
   - Evaluation Metrics (MSE, RMSE, R^2 Score)
6. **Multiple Linear Regression**
   - Multivariate Analysis
   - Assumptions and Diagnostics
7. **Gradient Descent**
   - Concept and Intuition
   - Batch, Stochastic, and Mini-Batch Gradient Descent

End-to-End Project

- **House Price Prediction**
  Use linear regression and regularization techniques to predict house prices based on historical

data.

8. **Regularization**
    - Ridge Regression
    - Lasso Regression
    - Elastic Net
9. **Logistic Regression**
    - Sigmoid Function
    - Decision Boundary
    - Applications (e.g., binary classification)

End-to-End Project

- **Customer Churn Prediction**
  Build a model to predict customer churn using real-world datasets. Apply preprocessing, EDA, and a supervised learning algorithm.

10. **K-Fold Cross Validation**
    - Concept of Cross Validation
    - Bias-Variance Tradeoff
11. **Naive Bayes**
    - Bayes' Theorem
    - Gaussian, Multinomial, and Bernoulli Naive Bayes
12. **Support Vector Machine (SVM)**
    - Hyperplanes and Margins
    - Kernel Trick (Linear, Polynomial, RBF)
13. **Decision Tree**
    - Entropy and Information Gain
    - Gini Impurity
14. **Random Forest**
    - Bagging and Ensemble Techniques
    - Feature Importance

End-to-End Project

- **Spam Email Classification**
  Build a classifier using Naive Bayes, SVM, or Random Forest to distinguish spam emails from non-spam emails.

15. **K-Nearest Neighbors (KNN)**
    - Distance Metrics (Euclidean, Manhattan)
    - Choosing K
16. **Clustering**
    - K-Means Clustering
    - Hierarchical Clustering
    - DBSCAN
17. **Dimensionality Reduction**
    - Principal Component Analysis (PCA)
    - t-SNE

End-to-End Project

- **Movie Recommendation System**
  Build a system to recommend movies using clustering techniques.

Deep Learning

1. **Introduction to Deep Learning**
    - What is Deep Learning?
    - Differences Between Machine Learning and Deep Learning
    - Applications of Deep Learning
2. **Neural Networks Basics**
    - Biological Neurons vs. Artificial Neurons
    - Perceptron Model
    - Activation Functions (Sigmoid, Tanh, ReLU, Leaky ReLU)
    - Forward Propagation and Backpropagation
3. **Training Neural Networks**
    - Gradient Descent Optimization
    - Loss Functions (MSE, Cross-Entropy)
    - Overfitting and Underfitting
    - Weight Initialization Techniques
4. **Deep Neural Networks (DNN)**
    - Multi-Layer Perceptrons (MLP)
    - Batch Normalization
    - Dropout Regularization

End-to-End Project

- **Digit Recognition**
  Build a model to classify handwritten digits using a deep neural network and the MNIST dataset.

5. **Convolutional Neural Networks (CNN)**
   - Convolution Operations
   - Pooling Layers (Max Pooling, Average Pooling)
   - Architectures (LeNet, AlexNet, VGG, ResNet)
   - Applications (Image Classification, Object Detection)
6. **Recurrent Neural Networks (RNN)**
   - Sequence Modeling
   - Vanishing Gradient Problem
   - Long Short-Term Memory (LSTM)
   - Gated Recurrent Units (GRU)

End-to-End Project

- **Sentiment Analysis**
  Build a sentiment analysis model for text data using RNNs or LSTMs.

7. **Autoencoders**
   - Concept and Applications
   - Denoising Autoencoders
   - Variational Autoencoders
8. **Generative Adversarial Networks (GANs)**
   - Generator and Discriminator
   - Training Dynamics
   - Applications (Image Generation, Style Transfer)

End-to-End Project

- **Face Detection**
  Build a system to detect faces in images or videos using a Convolutional Neural Network (CNN).

9. **Natural Language Processing (NLP) with Deep Learning**
    - Word Embeddings (Word2Vec, GloVe)
    - Attention Mechanism
    - Transformers (BERT, GPT models)
10. **Advanced Topics in Deep Learning**
    - Transfer Learning
    - Reinforcement Learning Basics
    - Hyperparameter Tuning (Grid Search, Random Search, Bayesian Optimization)

End-to-End Project

- **Chatbot Development**
  Build a chatbot using a transformer model like BERT or GPT.

Deep Learning Frameworks

- TensorFlow and Keras
- PyTorch