Machine Learning

1. Introduction to Machine Learning

- What is Machine Learning; definition and applications
- Types of learning: supervised, unsupervised, (brief intro to reinforcement)
- Role of ML in AI, data science, and industry applications

2. Mathematics & Statistics for Machine Learning

- Linear Algebra essentials: vectors and matrices
- Probability & Statistics basics
- Calculus: gradients and optimization
- Bias-variance tradeoff concepts

3. Python Programming & Libraries for ML

- Python basics for ML implementation
- Libraries: NumPy, Pandas, Matplotlib
- Introduction to Scikit-Learn for ML modeling

4. Data Preprocessing & Feature Engineering

- Cleaning datasets, handling missing values
- Scaling and normalization
- Feature selection and extraction

5. Supervised Learning: Regression Methods

- Linear regression: simple and multiple
- Cost function and gradient descent
- Polynomial regression and model tuning

6. Supervised Learning: Classification Algorithms

- **Logistic regression**
- **K-nearest neighbors (KNN)**
- **Support Vector Machines (SVM)**
- **Decision trees and Naive Bayes**

7. Model Evaluation, Validation & Selection

- **Train/test split, cross-validation**
- **Confusion matrix and metrics: precision, recall, F1-score**
- **ROC curve and AUC**

8. Unsupervised Learning: Clustering Techniques

- **K-means clustering**
- **Hierarchical clustering**
- **DBSCAN and cluster validation**

9. Unsupervised Learning: Dimensionality Reduction

- **Principal Component Analysis (PCA)**
- **t-SNE and other dimensionality techniques**
- **Curse of dimensionality**

10. Ensemble Methods & Advanced Supervised Methods

- **Bagging and Random Forests**
- **Boosting algorithms (e.g., AdaBoost, Gradient Boosting)**
- **Handling imbalance and advanced classifiers**

11. Introduction to Neural Networks

- **Basics of neural networks**
- **Perceptrons and multi-layer networks**
- **Brief intro to deep learning concepts**

12. Practical Machine Learning Projects & Case Studies

- **Implementation of ML models on real datasets**
- **End-to-end model workflow**
- **Problem statements and group presentations**

13. Industry Tools & ML Deployment Basics

- **Using ML tools like Jupyter, Google Colab**
- **Introduction to model saving and basic deployment**
- **Overview of cloud / ML Ops basics**

14. Ethics, Challenges & Emerging Trends in ML

- **AI & ML ethics**
- **Challenges like bias, explainability**
- **Trends: AutoML, scalable machine learning**