Machine Learning

1. **Introduction to Machine Learning [5 hours]**
   - 1.1 Definition and Evolution of Machine Learning
   - 1.2 Types of Machine Learning
     - Supervised Learning
     - Unsupervised Learning
     - Reinforcement Learning
     - Active Learning
   - 1.3 Machine Learning Workflow
     - Problem Definition
     - Data Collection and Preprocessing
     - Model Selection
     - Model Evaluation and Validation
     - Model Deployment
   - 1.4 Challenges in Machine Learning
     - Data Quality Issues
     - Computational complexity
     - Interpretability and Explainability
     - Ethical Considerations

2. **Supervised Learning [10 hours]**
   - 2.1 Types of Supervised Learning: Regression and Classification
   - 2.2 Regression
     - 2.2.1 Linear Regression
       - Simple and Multiple Regression
       - Polynomial Regression
     - 2.2.2 Regularization Techniques
       - Ridge Regression
       - Lasso Regression
       - Bias-variance Tradeoff
     - 2.2.3 Support Vector Regression
   - 2.3 Classification
     - 2.3.1 Logistic Regression
       - Binary Classification
       - Multi-class classification
     - 2.3.2 K-Nearest Neighbors (KNN)
     - 2.3.3 Support Vector Machine (SVM)
       - Hyperplane ad Support Vectors
       - Kernels and its Types: Linear, Polynomial, Radial Basis Function (RBF)
       - SVM for Linear and Non-linear classification
     - 2.3.4 Decision Trees
       - Construction and pruning of decision trees
       - Ensemble Methods: Bagging, Random forests

3. Unsupervised Learning [10 hours]

3.1 Basic concept of Unsupervised Learning

3.2 Types of Unsupervised Learning:
Clustering
Dimensionality Reduction
Association Rule Learning

3.3 Clustering:
K-Means Clustering
Hierarchical Clustering: Agglomerative and Divisive
Density-Based Clustering: DBSCAN

3.4 Dimensionality Reduction:
Principal Component Analysis (PCA)
Linear Discriminant Analysis (LDA)

4. Artificial Neural Network [12 hours]

4.1 Introduction to Neural Network
Neural Network Architectures: Feedforward, Convolution, Recurrent
Perceptron: Single Layer perceptron, Multilayer perceptron, Backpropagation

4.2 Training Neural Network
Forward and Backward propagation:
Forward propagation
Backpropagation and Gradient Descent
Loss Functions:
Role of loss function
Mean Squared Error (MSE)
Cross-entropy Loss
Regularization techniques:
Overfitting and underfitting
Regularization methods: L1, L2, Dropout, Batch normalization

4.3 Advanced Neural Network Architecture
Convolution Neural Networks (CNNs):
CNNs and their components
Convolution, Pooling and fully connected layers
Application in Image processing and computer vision
Recurrent Neural Networks:
Basics of RNNs
Long Short-term Memory (LSTM)
Gradient Recurrent Units (GRU)
Applications of Time-series prediction

5. Model Evaluation and Validation [8 hours]

5.1 Need of Model Evaluation in ML

5.2 Model Evaluation Metrics

5.2.1 Classification Metrics
Accuracy, Precision, Recall and F1 score
Confusion matrix
ROC and PR-Curve

5.2.2 Regression Metrics:
Mean Absolute Error (MAE)
Mean-Squared Error (MSE)
Root Mean Squared Error (RMSE)
R-Squared

5.3 Model Validation Techniques:
Train-Test Split
Cross-validation: K-fold Cross Validation

5.4 Hyper-parameter Tuning: Grid Search, Random Search