## Course: Foundations and Applications of AI, ML, and Deep Learning

**Course Description:**
The Foundations and Applications of AI, ML, and Deep Learning course is designed to provide participants with a robust understanding of core concepts, algorithms, and practical implementations in Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL). This program offers a comprehensive journey from fundamental principles to advanced applications, empowering learners to develop cutting-edge solutions in various domains using deep learning frameworks and tools.

## Course Objectives:

1. Understand the foundational concepts of AI, ML, and DL and their real-world applications.
2. Gain in-depth knowledge of neural networks, including architecture, training, and optimization.
3. Learn to apply advanced deep learning techniques, such as convolutional and recurrent networks.
4. Master practical implementations using transfer learning and generative AI. 5. Develop hands-on experience through coding exercises and real-world projects.

## Course Outline:

### Module 1: Introduction to AI, ML, and Deep Learning

- Overview of Artificial Intelligence, Machine Learning, and Deep Learning
- Applications and impact of AI/ML/DL across industries

### Module 2: Neural Networks Overview

- Fundamentals of neural networks
- Types of neural networks (e.g., feedforward, convolutional, recurrent)

### Module 3: Perceptrons and Multilayer Perceptrons

- Perceptron model and geometric intuition
- Training perceptrons and perceptron loss function
- Limitations of perceptrons and introduction to multilayer perceptrons

**Module 4: Neural Network Fundamentals**

- Forward propagation and making predictions with neural networks
- Understanding loss functions in deep learning
- Backpropagation algorithm and gradient descent

**Module 5: Optimization and Regularization Techniques**

- Gradient descent variants and challenges (e.g., vanishing/exploding gradients)
- Activation functions and their roles in learning
- Regularization techniques (e.g., dropout, L1/L2 regularization)

**Module 6: Convolutional Neural Networks**

- Convolution operation: kernel, padding, and stride
- Pooling layers and their significance
- Architectures and backpropagation in CNNs

**Module 7: Transfer Learning and Fine-Tuning**

- Concept of transfer learning and pre-trained models
- Fine-tuning pre-trained models for domain-specific tasks

**Module 8: Recurrent Neural Networks and Natural Language Processing**

- Basics of RNNs, LSTMs, and GRUs
- Natural Language Processing (NLP) applications using RNNs

**Module 9: Generative AI and Large Language Models**

- Introduction to generative AI models
- Working with large language models (e.g., GPT)

## Projects

1. **Handwritten Digit Classification**: Build an artificial neural network for digit recognition using the MNIST dataset.
2. **Image Classification with CNNs**: Design and train a custom convolutional neural network for image classification tasks.
3. **Transfer Learning**: Implement transfer learning using a pre-trained model (e.g., ResNet or VGG) for a specific image classification task.
4. **Next Word Prediction**: Develop an LSTM-based model to predict the next word in a

sentence.

5. **Generative AI Application**: Create a generative AI project, such as a text generator or Retrieval-Augmented Generation (RAG) system.

## Instructional Methods:

● **Lectures:** Interactive sessions with theoretical concepts and practical examples. ● **Hands-on Coding Exercises:** Step-by-step coding demonstrations in Google Colab. ● **Projects:** Real-world problem-solving through collaborative and individual projects.

## Prerequisites:

- Basic programming knowledge, preferably in Python
- Familiarity with linear algebra, calculus, and basic statistics

This course blends theoretical understanding with hands-on application, preparing participants for careers in AI, ML, and Deep Learning.