**1. Introduction to Deep Learning**

* **Core Concepts:**
  + Neural Networks
  + Activation Functions (ReLU, Sigmoid, Tanh)
  + Loss Functions (Cross-Entropy, MSE)
  + Optimizers (SGD, Adam, RMSprop)
* **Frameworks Overview:**
  + TensorFlow, Keras, PyTorch
* **Getting Started:**
  + Installation and Setup of Frameworks
  + Writing First Deep Learning Model

**2. Neural Networks**

* **Basic Structures:**
  + Perceptron
  + Multi-layer Perceptron (MLP)
* **Training Techniques:**
  + Backpropagation and Gradient Descent
* **Implementation:**
  + Neural Networks from Scratch
  + Using TensorFlow/Keras for Basic Networks
* **Model Evaluation:**
  + Accuracy, Precision, Recall, F1-Score

**3. Convolutional Neural Networks (CNNs)**

* **Core Components:**
  + Convolutional Layers
  + Pooling (Max, Average)
  + Padding, Strides
* **Transfer Learning:**
  + Concepts and Applications
* **CNN Architectures:**
  + LeNet, AlexNet, VGG, ResNet, Inception
* **Additional Architectures:**
  + Xception, SqueezeNet
* **Transformation Models:**
  + ResNet50, ResNet101, ResNet152
  + InceptionV3, InceptionResNetV2
  + DenseNet121, DenseNet169
* **Applications:**
  + Image Classification (CIFAR-10, MNIST)
  + Feature Maps and Visualization

**4. Advanced CNN Architectures**

* **Deep Architectures:**
  + DenseNet
  + EfficientNet
  + MobileNet
* **Segmentation Models:**
  + UNet (for Image Segmentation)
  + SegNet
* **Detection and Localization:**
  + Feature Pyramid Networks (FPN)
* **Model Optimization:**
  + Quantization, Pruning, and Knowledge Distillation

**5. Image Augmentation and Regularization Techniques**

* **Techniques:**
  + Data Augmentation (Rotation, Flipping, Scaling)
  + Dropout and its Variants
  + Batch Normalization
* **Transfer Learning:**
  + Fine-tuning Pre-trained Models
  + Custom Layer Addition
* **Advanced Regularization:**
  + Label Smoothing
  + Early Stopping

**6. Object Detection**

* **Core Concepts:**
  + Bounding Boxes, Intersection over Union (IoU)
  + Non-Max Suppression (NMS)
* **Detection Algorithms:**
  + YOLO (You Only Look Once)
  + SSD (Single Shot MultiBox Detector)
  + Faster R-CNN
  + RetinaNet
* **Region Proposal Networks:**
  + Region Proposal Network (RPN)
  + Region-based Fully Convolutional Networks (R-FCN)
* **Hands-On Projects:**
  + Implementing Object Detection Models with COCO Dataset

**7. Video Processing and Action Recognition**

* **Video Processing Techniques:**
  + Temporal Convolutions
  + Frame Extraction and Preprocessing
* **Recurrent Neural Networks (RNNs):**
  + LSTM (Long Short-Term Memory)
  + GRU (Gated Recurrent Units)
* **Advanced Architectures:**
  + 3D-CNNs for Spatiotemporal Data
  + Two-stream Networks (Spatial and Temporal Streams)
  + SlowFast Networks
* **Applications:**
  + Video Classification
  + Action Recognition in Videos (e.g., UCF101, Kinetics datasets)

**8. Generative Models for Images**

* **Generative Adversarial Networks (GANs):**
  + Basic GAN, DCGAN (Deep Convolutional GAN)
  + Conditional GAN (cGAN)
  + CycleGAN, Pix2Pix
* **Variational Autoencoders (VAEs):**
  + Basic VAE
  + β-VAE (Beta VAE)
* **Advanced Generative Models:**
  + StyleGAN, BigGAN
* **Applications:**
  + Image Synthesis and Generation
  + Style Transfer, Super-Resolution

**9. Image and Video Segmentation**

* **Segmentation Techniques:**
  + Semantic Segmentation (UNet, SegNet)
  + Instance Segmentation (Mask R-CNN)
* **Advanced Architectures:**
  + DeepLab (v3, v3+)
  + PSPNet (Pyramid Scene Parsing Network)
* **3D Segmentation for Medical Imaging:**
  + 3D-UNet, VNet
* **Hands-On Projects:**
  + Medical Imaging Segmentation
  + COCO and Cityscapes Datasets

**10. Advanced Topics**

* **Attention Mechanisms:**
  + Self-Attention, Multi-Head Attention
  + Attention in CNNs (SENet, CBAM)
* **Transformers in Vision:**
  + Vision Transformers (ViT)
  + Data-Efficient Image Transformers (DeiT)
* **Graph Neural Networks (GNNs):**
  + Basics of GNNs
  + Applications in Vision (e.g., GCN for Scene Graph Generation)
* **Neural Architecture Search (NAS):**
  + AutoML and EfficientNet Search
* **Cutting-Edge Models:**
  + Swin Transformer, MLP-Mixer
* **Ethics and Bias in AI:**
  + Understanding Model Bias
  + Fairness in AI Systems

**11. Project Work**

* **Comprehensive Projects:**
  + Video Classification Pipeline
  + Custom Object Detection System
* **Capstone Projects:**
  + End-to-End Deep Learning Pipeline for Medical Imaging
  + Autonomous Driving: Perception and Decision Making
* **Competitions and Open Source:**
  + Kaggle Competitions (ImageNet, COCO)
  + Contributing to Open-Source Deep Learning Projects