Machine Learning

LABORATORY: Regularization Homework

NAME:	STUDENT ID#:

Objectives:

- Understand the concept of regularization and its importance in preventing overfitting.
- Implement and compare two regularization strategies:
  - Early Stopping (validation-based regularization)
  - Weight Decay (L2 regularization)
- Apply these methods to a binary classification task using the MNIST dataset.
- Visualize and interpret training/validation loss and accuracy curves.
- Analyze model behavior by examining misclassified test samples.

Part 1. Instruction

- In this assignment, use the existing neural network structure.
  - A single hidden layer with ReLU activation
  - Softmax output for multi-class classification (later converted to binary)
- Implement and compare:
  - **Early Stopping**: Stop training if the validation loss does not improve for several epochs
  - **Weight Decay (L2 Regularization)**: Penalize large weights by adding a regularization term to the loss function
- You may write all algorithms in **one file with selectable modes**, or in **three separate files**.
- Do not use external machine learning libraries (e.g., scikit-learn, PyTorch).
- For each method (early stopping and weight decay):
  - Plot the training vs validation loss curves
  - Plot the training vs validation accuracy curves

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Part 2. Code Template

Step	Procedure

1

```
# ========== Load Dataset ==========
def load_images(filename):
    with open(filename, 'rb') as f:
        _, num, rows, cols = struct.unpack(">IIII", f.read(16))
        data = np.frombuffer(f.read(),
dtype=np.uint8).reshape((num, rows * cols))
        return data.astype(np.float32) / 255.0

def load_labels(filename):
    with open(filename, 'rb') as f:
        _, num = struct.unpack(">II", f.read(8))
        return np.frombuffer(f.read(), dtype=np.uint8)
        return labels[:num]
```

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```
# TODO: Complete all the functions, you may change the structures
# ========= 2. Utils ==========
def shuffle_numpy(X, y):
    pass

def split_train_val(X, y, val_ratio=0.2):
    pass

def one_hot(y, num_classes):
    pass

def accuracy(Y_pred, Y_true):
    pass

# ========= 3. Model ==========
class MLP:
    def __init__(self, input_dim, hidden_dim, output_dim,
weight_decay=0.0):
        self.W1 = np.random.randn(input_dim, hidden_dim) * 0.01
        self.b1 = np.zeros((1, hidden_dim))
        self.W2 = np.random.randn(hidden_dim, output_dim) *
0.01
        self.b2 = np.zeros((1, output_dim))
        self.lambda_ = weight_decay

    def relu(self, x):
        return np.maximum(0, x)

    def relu_deriv(self, x):
        return (x > 0).astype(float)

    def softmax(self, x):
        exps = np.exp(x - np.max(x, axis=1, keepdims=True))
        return exps / np.sum(exps, axis=1, keepdims=True)
```

```
    def forward(self, X):
        self.z1 = X @ self.W1 + self.b1
        self.a1 = self.relu(self.z1)
        self.z2 = self.a1 @ self.W2 + self.b2
        self.a2 = self.softmax(self.z2)
        return self.a2

    def compute_loss(self, Y_pred, Y_true):
        TODO: Weight Decay (L2 Regularization)
        pass

    def backward(self, X, Y_true, Y_pred, lr=0.1):
        m = Y_true.shape[0]
        dz2 = (Y_pred - Y_true) / m
        dW2 = self.a1.T @ dz2 + self.lambda_ * self.W2
        db2 = np.sum(dz2, axis=0, keepdims=True)
        da1 = dz2 @ self.W2.T
        dz1 = da1 * self.relu_deriv(self.z1)
        dW1 = X.T @ dz1 + self.lambda_ * self.W1
        db1 = np.sum(dz1, axis=0, keepdims=True)

        self.W2 -= lr * dW2
        self.b2 -= lr * db2
        self.W1 -= lr * dW1
        self.b1 -= lr * db1
```

```
# ========= 4. Train Function ==========
def train(model, X_train, y_train, X_val, y_val, lr=0.1,
epochs=100, use_early_stopping=False, patience=5):
    train_losses, val_losses, train_accs, val_accs = [], [],
[], []
    best_val_loss = np.inf
    patience_count = 0

    for epoch in range(epochs):
        TODO: complete this part

        print(f"Epoch {epoch:02d} | Train Loss: {loss:.4f} |
Val Loss: {val_loss:.4f}")

       TODO: implement your early stopping strategy here

    return train_losses, val_losses, train_accs, val_accs
```

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```
# ========= 5. Plotting ==========
def plot_curves(train_losses, val_losses, train_accs, val_accs,
```


```
title):
    plt.figure(figsize=(12, 5))
    plt.subplot(1, 2, 1)
    plt.plot(train_losses, label="Train Loss")
    plt.plot(val_losses, label="Val Loss")
    plt.title("Loss Curve - " + title)
    plt.xlabel("Epochs")
    plt.ylabel("Loss")
    plt.legend()

    plt.subplot(1, 2, 2)
    plt.plot(train_accs, label="Train Acc")
    plt.plot(val_accs, label="Val Acc")
    plt.title("Accuracy Curve - " + title)
    plt.xlabel("Epochs")
    plt.ylabel("Accuracy")
    plt.legend()
    plt.tight_layout()
    plt.show()
```

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```
# ========= 6. Main ==========
if __name__ == "__main__":
    X = load_images("train-images.idx3-ubyte__")
    y = load_labels("train-labels.idx1-ubyte__")
    X, y = shuffle_numpy(X, y)
    X_train, y_train, X_val, y_val = split_train_val(X, y)
    y_train_oh = one_hot(y_train, 10)
    y_val_oh = one_hot(y_val, 10)

    # === OPTION 1: Early Stopping ===
    # model_early = MLP(_, _, _, weight_decay=0.0)
    # t1, v1, a1, a2 = train(model_early, X_train, y_train_oh,
X_val, y_val_oh, use_early_stopping=True)
    # plot_curves(t1, v1, a1, a2, title="Early Stopping")

    # === OPTION 2: Weight Decay ===
```

Grading Assignment & Submission (70% Max)

Implementation (50%):

Correctly implemented, runs, and shows the plotting result for:

- **(20%) Early Stopping**
  - Uses validation loss to stop training early
- **(20%) Weight Decay (L2 Regularization)**
  - Applies L2 penalty to loss and gradients
- **(10%) Comparison**

Visualizes and compares the performance of both techniques **(Please provide simple discussion of your result)**
Includes:

- Training vs validation curves
- Result of 3 different λ value

Question (20%):

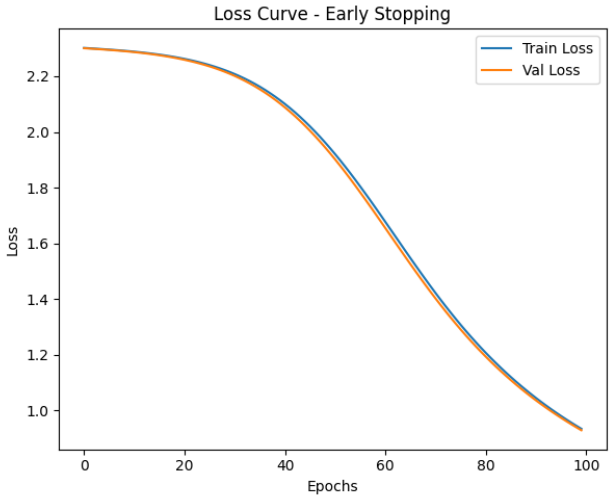
1. **(7%) Which regularization method gave you the best test accuracy?**
   Why do you think it performed better than the other? Was it due to training duration, generalization effect, or another factor?
2. **(7%) Compare training and validation loss curves**
   Which method showed signs of overfitting or underfitting?
   Use your graphs to justify your answer (e.g., early stopping curve flattens early, weight decay trains longer but smoother).
3. **(6%) How did your choice of regularization strength (λ) or patience affect the model?**
   What λ or patience value worked best in your experiment? What happened when you increased or decreased it?

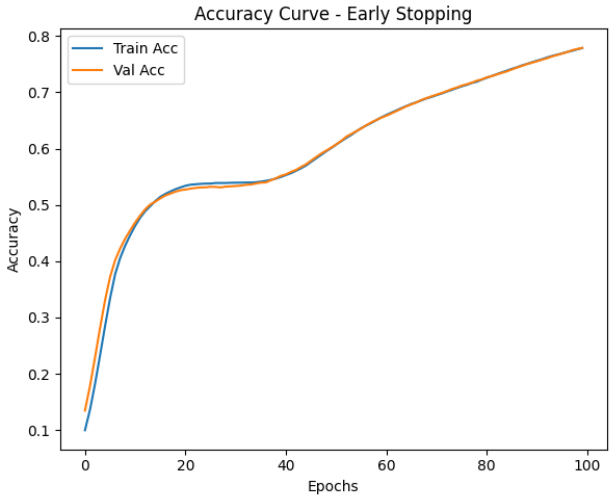
Submission:

1. Report: Answer all the questions. Include screenshots of your results and discussion in the last pages of this PDF File.
2. Code: Submit your complete Python script in either .py or .ipynb format.
3. Upload both your report and code to the E3 system (**Labs5_Homework_Assignment**). Name your files correctly:
   a. Report: StudentID_Lab5_Homework.pdf
   b. Code: StudentID_Lab5_ Homework.py or StudentID_Lab5_Homework.ipynb
4. Deadline: Sunday, 21:00 PM
5. Plagiarism is **strictly prohibited**. Submitting copied work from other students will result in penalties.

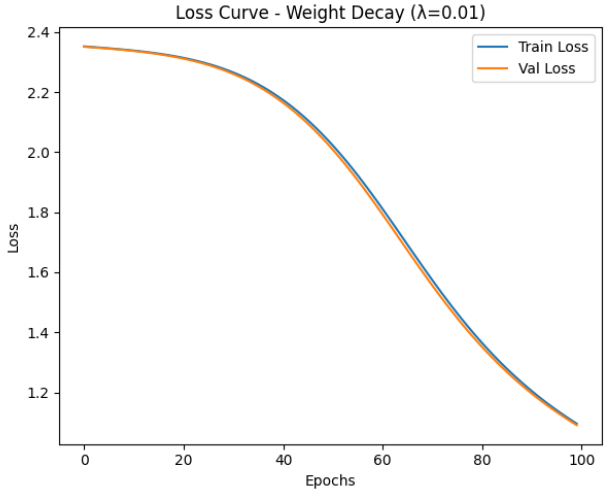
Example Output (Just for reference):

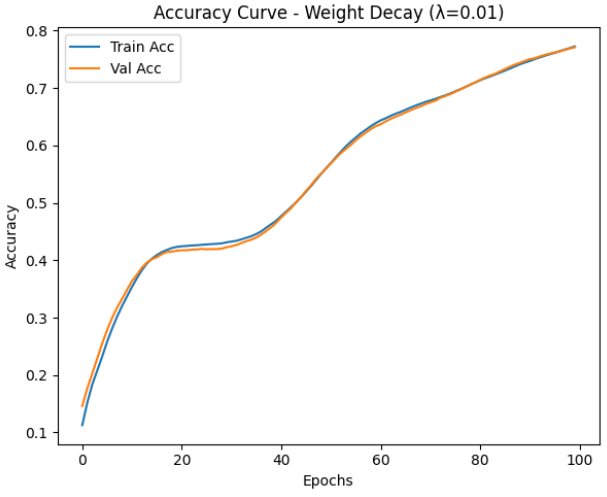
```
Epoch 91 | Train Loss: 1.0306 | Val Loss: 1.0224
Epoch 92 | Train Loss: 1.0173 | Val Loss: 1.0095
Epoch 93 | Train Loss: 1.0044 | Val Loss: 0.9970
Epoch 94 | Train Loss: 0.9918 | Val Loss: 0.9848
Epoch 95 | Train Loss: 0.9796 | Val Loss: 0.9730
Epoch 96 | Train Loss: 0.9677 | Val Loss: 0.9615
Epoch 97 | Train Loss: 0.9562 | Val Loss: 0.9503
Epoch 98 | Train Loss: 0.9450 | Val Loss: 0.9395
Epoch 99 | Train Loss: 0.9341 | Val Loss: 0.9289
```






```
Epoch 90 | Train Loss: 1.2038 | Val Loss: 1.1954
Epoch 91 | Train Loss: 1.1903 | Val Loss: 1.1823
Epoch 92 | Train Loss: 1.1772 | Val Loss: 1.1696
Epoch 93 | Train Loss: 1.1644 | Val Loss: 1.1573
Epoch 94 | Train Loss: 1.1521 | Val Loss: 1.1454
Epoch 95 | Train Loss: 1.1401 | Val Loss: 1.1338
Epoch 96 | Train Loss: 1.1285 | Val Loss: 1.1225
Epoch 97 | Train Loss: 1.1172 | Val Loss: 1.1116
Epoch 98 | Train Loss: 1.1063 | Val Loss: 1.1010
Epoch 99 | Train Loss: 1.0956 | Val Loss: 1.0907
```





Results and Discussion:

Training baseline model (no regularization)...

Epoch 00 | Train Loss: 0.6952 | Val Loss: 0.6881 | Train Acc: 0.3042 | Val Acc: 0.8397

Epoch 01 | Train Loss: 0.6881 | Val Loss: 0.6808 | Train Acc: 0.8365 | Val Acc: 0.9791

Epoch 02 | Train Loss: 0.6808 | Val Loss: 0.6719 | Train Acc: 0.9805 | Val Acc: 0.9901

Epoch 03 | Train Loss: 0.6718 | Val Loss: 0.6599 | Train Acc: 0.9903 | Val Acc: 0.9913

Epoch 04 | Train Loss: 0.6598 | Val Loss: 0.6434 | Train Acc: 0.9928 | Val Acc: 0.9933

Epoch 05 | Train Loss: 0.6432 | Val Loss: 0.6208 | Train Acc: 0.9929 | Val Acc: 0.9921

Epoch 06 | Train Loss: 0.6206 | Val Loss: 0.5909 | Train Acc: 0.9932 | Val Acc: 0.9921

Epoch 07 | Train Loss: 0.5906 | Val Loss: 0.5532 | Train Acc: 0.9930 | Val Acc: 0.9925

Epoch 08 | Train Loss: 0.5527 | Val Loss: 0.5087 | Train Acc: 0.9929 | Val Acc: 0.9925

Epoch 09 | Train Loss: 0.5081 | Val Loss: 0.4600 | Train Acc: 0.9927 | Val Acc: 0.9925

Epoch 10 | Train Loss: 0.4593 | Val Loss: 0.4103 | Train Acc: 0.9928 | Val Acc: 0.9925

Epoch 11 | Train Loss: 0.4094 | Val Loss: 0.3619 | Train Acc: 0.9936 | Val Acc: 0.9933

Epoch 12 | Train Loss: 0.3609 | Val Loss: 0.3164 | Train Acc: 0.9942 | Val Acc: 0.9945

Epoch 13 | Train Loss: 0.3153 | Val Loss: 0.2749 | Train Acc: 0.9946 | Val Acc: 0.9945

Epoch 14 | Train Loss: 0.2736 | Val Loss: 0.2378 | Train Acc: 0.9957 | Val Acc: 0.9949

Epoch 15 | Train Loss: 0.2364 | Val Loss: 0.2055 | Train Acc: 0.9958 | Val Acc: 0.9949

Epoch 16 | Train Loss: 0.2041 | Val Loss: 0.1781 | Train Acc: 0.9960 | Val Acc: 0.9949

Epoch 17 | Train Loss: 0.1766 | Val Loss: 0.1553 | Train Acc: 0.9963 | Val Acc: 0.9949

Epoch 18 | Train Loss: 0.1536 | Val Loss: 0.1363 | Train Acc: 0.9963 | Val Acc: 0.9953

Epoch 19 | Train Loss: 0.1346 | Val Loss: 0.1207 | Train Acc: 0.9965 | Val Acc: 0.9949

Epoch 20 | Train Loss: 0.1189 | Val Loss: 0.1078 | Train Acc: 0.9964 | Val Acc: 0.9949

Epoch 21 | Train Loss: 0.1059 | Val Loss: 0.0971 | Train Acc: 0.9964 | Val Acc: 0.9949

Epoch 22 | Train Loss: 0.0951 | Val Loss: 0.0882 | Train Acc: 0.9965 | Val Acc: 0.9949

Epoch 23 | Train Loss: 0.0861 | Val Loss: 0.0807 | Train Acc: 0.9964 | Val Acc: 0.9949

Epoch 24 | Train Loss: 0.0785 | Val Loss: 0.0743 | Train Acc: 0.9965 | Val Acc: 0.9949

Epoch 25 | Train Loss: 0.0720 | Val Loss: 0.0688 | Train Acc: 0.9965 | Val Acc: 0.9949

Epoch 26 | Train Loss: 0.0665 | Val Loss: 0.0641 | Train Acc: 0.9966 | Val Acc: 0.9949

Epoch 27 | Train Loss: 0.0617 | Val Loss: 0.0600 | Train Acc: 0.9966 | Val Acc: 0.9949

Epoch 28 | Train Loss: 0.0576 | Val Loss: 0.0564 | Train Acc: 0.9967 | Val Acc: 0.9949

Epoch 29 | Train Loss: 0.0539 | Val Loss: 0.0532 | Train Acc: 0.9967 | Val Acc: 0.9949

Epoch 30 | Train Loss: 0.0507 | Val Loss: 0.0504 | Train Acc: 0.9967 | Val Acc: 0.9949

Epoch 31 | Train Loss: 0.0479 | Val Loss: 0.0479 | Train Acc: 0.9967 | Val Acc: 0.9949

Epoch 32 | Train Loss: 0.0453 | Val Loss: 0.0456 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 33 | Train Loss: 0.0431 | Val Loss: 0.0436 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 34 | Train Loss: 0.0410 | Val Loss: 0.0418 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 35 | Train Loss: 0.0392 | Val Loss: 0.0401 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 36 | Train Loss: 0.0375 | Val Loss: 0.0386 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 37 | Train Loss: 0.0359 | Val Loss: 0.0372 | Train Acc: 0.9969 | Val Acc: 0.9953

Epoch 38 | Train Loss: 0.0345 | Val Loss: 0.0359 | Train Acc: 0.9969 | Val Acc: 0.9953

Epoch 39 | Train Loss: 0.0332 | Val Loss: 0.0348 | Train Acc: 0.9969 | Val Acc: 0.9953

Epoch 40 | Train Loss: 0.0320 | Val Loss: 0.0337 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 41 | Train Loss: 0.0309 | Val Loss: 0.0327 | Train Acc: 0.9972 | Val Acc: 0.9953

Epoch 42 | Train Loss: 0.0299 | Val Loss: 0.0317 | Train Acc: 0.9972 | Val Acc: 0.9953

Epoch 43 | Train Loss: 0.0290 | Val Loss: 0.0309 | Train Acc: 0.9974 | Val Acc: 0.9953

Epoch 44 | Train Loss: 0.0281 | Val Loss: 0.0301 | Train Acc: 0.9974 | Val Acc: 0.9953

Epoch 45 | Train Loss: 0.0273 | Val Loss: 0.0293 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 46 | Train Loss: 0.0265 | Val Loss: 0.0286 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 47 | Train Loss: 0.0258 | Val Loss: 0.0280 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 48 | Train Loss: 0.0251 | Val Loss: 0.0273 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 49 | Train Loss: 0.0244 | Val Loss: 0.0267 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 50 | Train Loss: 0.0238 | Val Loss: 0.0262 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 51 | Train Loss: 0.0233 | Val Loss: 0.0257 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 52 | Train Loss: 0.0227 | Val Loss: 0.0252 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 53 | Train Loss: 0.0222 | Val Loss: 0.0247 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 54 | Train Loss: 0.0217 | Val Loss: 0.0242 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 55 | Train Loss: 0.0213 | Val Loss: 0.0238 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 56 | Train Loss: 0.0208 | Val Loss: 0.0234 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 57 | Train Loss: 0.0204 | Val Loss: 0.0230 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 58 | Train Loss: 0.0200 | Val Loss: 0.0227 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 59 | Train Loss: 0.0196 | Val Loss: 0.0223 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 60 | Train Loss: 0.0193 | Val Loss: 0.0220 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 61 | Train Loss: 0.0189 | Val Loss: 0.0217 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 62 | Train Loss: 0.0186 | Val Loss: 0.0214 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 63 | Train Loss: 0.0183 | Val Loss: 0.0211 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 64 | Train Loss: 0.0180 | Val Loss: 0.0208 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 65 | Train Loss: 0.0177 | Val Loss: 0.0205 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 66 | Train Loss: 0.0174 | Val Loss: 0.0203 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 67 | Train Loss: 0.0171 | Val Loss: 0.0200 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 68 | Train Loss: 0.0169 | Val Loss: 0.0198 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 69 | Train Loss: 0.0166 | Val Loss: 0.0196 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 70 | Train Loss: 0.0164 | Val Loss: 0.0193 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 71 | Train Loss: 0.0161 | Val Loss: 0.0191 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 72 | Train Loss: 0.0159 | Val Loss: 0.0189 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 73 | Train Loss: 0.0157 | Val Loss: 0.0187 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 74 | Train Loss: 0.0155 | Val Loss: 0.0185 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 75 | Train Loss: 0.0153 | Val Loss: 0.0183 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 76 | Train Loss: 0.0151 | Val Loss: 0.0182 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 77 | Train Loss: 0.0149 | Val Loss: 0.0180 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 78 | Train Loss: 0.0147 | Val Loss: 0.0178 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 79 | Train Loss: 0.0145 | Val Loss: 0.0176 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 80 | Train Loss: 0.0144 | Val Loss: 0.0175 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 81 | Train Loss: 0.0142 | Val Loss: 0.0173 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 82 | Train Loss: 0.0140 | Val Loss: 0.0172 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 83 | Train Loss: 0.0139 | Val Loss: 0.0170 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 84 | Train Loss: 0.0137 | Val Loss: 0.0169 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 85 | Train Loss: 0.0136 | Val Loss: 0.0168 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 86 | Train Loss: 0.0134 | Val Loss: 0.0166 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 87 | Train Loss: 0.0133 | Val Loss: 0.0165 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 88 | Train Loss: 0.0131 | Val Loss: 0.0164 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 89 | Train Loss: 0.0130 | Val Loss: 0.0163 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 90 | Train Loss: 0.0129 | Val Loss: 0.0161 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 91 | Train Loss: 0.0128 | Val Loss: 0.0160 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 92 | Train Loss: 0.0126 | Val Loss: 0.0159 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 93 | Train Loss: 0.0125 | Val Loss: 0.0158 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 94 | Train Loss: 0.0124 | Val Loss: 0.0157 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 95 | Train Loss: 0.0123 | Val Loss: 0.0156 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 96 | Train Loss: 0.0122 | Val Loss: 0.0155 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 97 | Train Loss: 0.0121 | Val Loss: 0.0154 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 98 | Train Loss: 0.0119 | Val Loss: 0.0153 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 99 | Train Loss: 0.0118 | Val Loss: 0.0152 | Train Acc: 0.9980 | Val Acc: 0.9961

Training model with early stopping...

Epoch 00 | Train Loss: 0.6917 | Val Loss: 0.6854 | Train Acc: 0.5559 | Val Acc: 0.8784

Epoch 01 | Train Loss: 0.6853 | Val Loss: 0.6783 | Train Acc: 0.8912 | Val Acc: 0.9751

Epoch 02 | Train Loss: 0.6782 | Val Loss: 0.6695 | Train Acc: 0.9799 | Val Acc: 0.9909

Epoch 03 | Train Loss: 0.6694 | Val Loss: 0.6576 | Train Acc: 0.9933 | Val Acc: 0.9945

Epoch 04 | Train Loss: 0.6574 | Val Loss: 0.6412 | Train Acc: 0.9959 | Val Acc: 0.9945

Epoch 05 | Train Loss: 0.6409 | Val Loss: 0.6184 | Train Acc: 0.9958 | Val Acc: 0.9949

Epoch 06 | Train Loss: 0.6181 | Val Loss: 0.5879 | Train Acc: 0.9962 | Val Acc: 0.9945

Epoch 07 | Train Loss: 0.5874 | Val Loss: 0.5489 | Train Acc: 0.9956 | Val Acc: 0.9949

Epoch 08 | Train Loss: 0.5482 | Val Loss: 0.5019 | Train Acc: 0.9951 | Val Acc: 0.9949

Epoch 09 | Train Loss: 0.5011 | Val Loss: 0.4497 | Train Acc: 0.9950 | Val Acc: 0.9949

Epoch 10 | Train Loss: 0.4487 | Val Loss: 0.3958 | Train Acc: 0.9951 | Val Acc: 0.9949

Epoch 11 | Train Loss: 0.3947 | Val Loss: 0.3437 | Train Acc: 0.9952 | Val Acc: 0.9941

Epoch 12 | Train Loss: 0.3425 | Val Loss: 0.2958 | Train Acc: 0.9953 | Val Acc: 0.9945

Epoch 13 | Train Loss: 0.2944 | Val Loss: 0.2533 | Train Acc: 0.9955 | Val Acc: 0.9949

Epoch 14 | Train Loss: 0.2518 | Val Loss: 0.2168 | Train Acc: 0.9961 | Val Acc: 0.9961

Epoch 15 | Train Loss: 0.2152 | Val Loss: 0.1862 | Train Acc: 0.9962 | Val Acc: 0.9961

Epoch 16 | Train Loss: 0.1845 | Val Loss: 0.1609 | Train Acc: 0.9964 | Val Acc: 0.9961

Epoch 17 | Train Loss: 0.1591 | Val Loss: 0.1402 | Train Acc: 0.9967 | Val Acc: 0.9957

Epoch 18 | Train Loss: 0.1384 | Val Loss: 0.1234 | Train Acc: 0.9968 | Val Acc: 0.9957

Epoch 19 | Train Loss: 0.1214 | Val Loss: 0.1096 | Train Acc: 0.9968 | Val Acc: 0.9957

Epoch 20 | Train Loss: 0.1076 | Val Loss: 0.0983 | Train Acc: 0.9968 | Val Acc: 0.9957

Epoch 21 | Train Loss: 0.0962 | Val Loss: 0.0889 | Train Acc: 0.9967 | Val Acc: 0.9957

Epoch 22 | Train Loss: 0.0867 | Val Loss: 0.0810 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 23 | Train Loss: 0.0788 | Val Loss: 0.0744 | Train Acc: 0.9970 | Val Acc: 0.9957

Epoch 24 | Train Loss: 0.0721 | Val Loss: 0.0687 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 25 | Train Loss: 0.0664 | Val Loss: 0.0638 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 26 | Train Loss: 0.0615 | Val Loss: 0.0596 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 27 | Train Loss: 0.0573 | Val Loss: 0.0560 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 28 | Train Loss: 0.0536 | Val Loss: 0.0527 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 29 | Train Loss: 0.0503 | Val Loss: 0.0499 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 30 | Train Loss: 0.0475 | Val Loss: 0.0473 | Train Acc: 0.9970 | Val Acc: 0.9957

Epoch 31 | Train Loss: 0.0449 | Val Loss: 0.0451 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 32 | Train Loss: 0.0426 | Val Loss: 0.0430 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 33 | Train Loss: 0.0406 | Val Loss: 0.0412 | Train Acc: 0.9972 | Val Acc: 0.9957

Epoch 34 | Train Loss: 0.0387 | Val Loss: 0.0395 | Train Acc: 0.9974 | Val Acc: 0.9957

Epoch 35 | Train Loss: 0.0370 | Val Loss: 0.0380 | Train Acc: 0.9974 | Val Acc: 0.9957

Epoch 36 | Train Loss: 0.0355 | Val Loss: 0.0366 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 37 | Train Loss: 0.0341 | Val Loss: 0.0353 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 38 | Train Loss: 0.0328 | Val Loss: 0.0342 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 39 | Train Loss: 0.0316 | Val Loss: 0.0331 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 40 | Train Loss: 0.0305 | Val Loss: 0.0321 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 41 | Train Loss: 0.0295 | Val Loss: 0.0312 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 42 | Train Loss: 0.0286 | Val Loss: 0.0303 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 43 | Train Loss: 0.0277 | Val Loss: 0.0295 | Train Acc: 0.9975 | Val Acc: 0.9957

Epoch 44 | Train Loss: 0.0269 | Val Loss: 0.0288 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 45 | Train Loss: 0.0261 | Val Loss: 0.0281 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 46 | Train Loss: 0.0254 | Val Loss: 0.0274 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 47 | Train Loss: 0.0247 | Val Loss: 0.0268 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 48 | Train Loss: 0.0241 | Val Loss: 0.0262 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 49 | Train Loss: 0.0235 | Val Loss: 0.0256 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 50 | Train Loss: 0.0229 | Val Loss: 0.0251 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 51 | Train Loss: 0.0224 | Val Loss: 0.0246 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 52 | Train Loss: 0.0219 | Val Loss: 0.0242 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 53 | Train Loss: 0.0214 | Val Loss: 0.0237 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 54 | Train Loss: 0.0210 | Val Loss: 0.0233 | Train Acc: 0.9976 | Val Acc: 0.9961

Epoch 55 | Train Loss: 0.0205 | Val Loss: 0.0229 | Train Acc: 0.9976 | Val Acc: 0.9961

Epoch 56 | Train Loss: 0.0201 | Val Loss: 0.0225 | Train Acc: 0.9976 | Val Acc: 0.9961

Epoch 57 | Train Loss: 0.0197 | Val Loss: 0.0222 | Train Acc: 0.9976 | Val Acc: 0.9961

Epoch 58 | Train Loss: 0.0193 | Val Loss: 0.0218 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 59 | Train Loss: 0.0190 | Val Loss: 0.0215 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 60 | Train Loss: 0.0187 | Val Loss: 0.0212 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 61 | Train Loss: 0.0183 | Val Loss: 0.0209 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 62 | Train Loss: 0.0180 | Val Loss: 0.0206 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 63 | Train Loss: 0.0177 | Val Loss: 0.0203 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 64 | Train Loss: 0.0174 | Val Loss: 0.0201 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 65 | Train Loss: 0.0172 | Val Loss: 0.0198 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 66 | Train Loss: 0.0169 | Val Loss: 0.0196 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 67 | Train Loss: 0.0166 | Val Loss: 0.0193 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 68 | Train Loss: 0.0164 | Val Loss: 0.0191 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 69 | Train Loss: 0.0161 | Val Loss: 0.0189 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 70 | Train Loss: 0.0159 | Val Loss: 0.0187 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 71 | Train Loss: 0.0157 | Val Loss: 0.0185 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 72 | Train Loss: 0.0155 | Val Loss: 0.0183 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 73 | Train Loss: 0.0153 | Val Loss: 0.0181 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 74 | Train Loss: 0.0151 | Val Loss: 0.0179 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 75 | Train Loss: 0.0149 | Val Loss: 0.0177 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 76 | Train Loss: 0.0147 | Val Loss: 0.0176 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 77 | Train Loss: 0.0145 | Val Loss: 0.0174 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 78 | Train Loss: 0.0143 | Val Loss: 0.0172 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 79 | Train Loss: 0.0142 | Val Loss: 0.0171 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 80 | Train Loss: 0.0140 | Val Loss: 0.0169 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 81 | Train Loss: 0.0139 | Val Loss: 0.0168 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 82 | Train Loss: 0.0137 | Val Loss: 0.0166 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 83 | Train Loss: 0.0135 | Val Loss: 0.0165 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 84 | Train Loss: 0.0134 | Val Loss: 0.0164 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 85 | Train Loss: 0.0133 | Val Loss: 0.0162 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 86 | Train Loss: 0.0131 | Val Loss: 0.0161 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 87 | Train Loss: 0.0130 | Val Loss: 0.0160 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 88 | Train Loss: 0.0129 | Val Loss: 0.0159 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 89 | Train Loss: 0.0127 | Val Loss: 0.0158 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 90 | Train Loss: 0.0126 | Val Loss: 0.0156 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 91 | Train Loss: 0.0125 | Val Loss: 0.0155 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 92 | Train Loss: 0.0124 | Val Loss: 0.0154 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 93 | Train Loss: 0.0122 | Val Loss: 0.0153 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 94 | Train Loss: 0.0121 | Val Loss: 0.0152 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 95 | Train Loss: 0.0120 | Val Loss: 0.0151 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 96 | Train Loss: 0.0119 | Val Loss: 0.0150 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 97 | Train Loss: 0.0118 | Val Loss: 0.0149 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 98 | Train Loss: 0.0117 | Val Loss: 0.0148 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 99 | Train Loss: 0.0116 | Val Loss: 0.0148 | Train Acc: 0.9980 | Val Acc: 0.9961

Training model with weight decay (lambda=0.01)...

Epoch 00 | Train Loss: 0.7454 | Val Loss: 0.7351 | Train Acc: 0.4101 | Val Acc: 0.9503

Epoch 01 | Train Loss: 0.7351 | Val Loss: 0.7248 | Train Acc: 0.9464 | Val Acc: 0.9818

Epoch 02 | Train Loss: 0.7248 | Val Loss: 0.7125 | Train Acc: 0.9830 | Val Acc: 0.9874

Epoch 03 | Train Loss: 0.7125 | Val Loss: 0.6965 | Train Acc: 0.9911 | Val Acc: 0.9897

Epoch 04 | Train Loss: 0.6964 | Val Loss: 0.6750 | Train Acc: 0.9929 | Val Acc: 0.9905

Epoch 05 | Train Loss: 0.6749 | Val Loss: 0.6466 | Train Acc: 0.9936 | Val Acc: 0.9901

Epoch 06 | Train Loss: 0.6464 | Val Loss: 0.6106 | Train Acc: 0.9930 | Val Acc: 0.9905

Epoch 07 | Train Loss: 0.6104 | Val Loss: 0.5678 | Train Acc: 0.9928 | Val Acc: 0.9909

Epoch 08 | Train Loss: 0.5675 | Val Loss: 0.5206 | Train Acc: 0.9925 | Val Acc: 0.9925

Epoch 09 | Train Loss: 0.5201 | Val Loss: 0.4718 | Train Acc: 0.9930 | Val Acc: 0.9937

Epoch 10 | Train Loss: 0.4711 | Val Loss: 0.4241 | Train Acc: 0.9938 | Val Acc: 0.9937

Epoch 11 | Train Loss: 0.4233 | Val Loss: 0.3791 | Train Acc: 0.9941 | Val Acc: 0.9941

Epoch 12 | Train Loss: 0.3782 | Val Loss: 0.3376 | Train Acc: 0.9946 | Val Acc: 0.9937

Epoch 13 | Train Loss: 0.3365 | Val Loss: 0.3003 | Train Acc: 0.9952 | Val Acc: 0.9949

Epoch 14 | Train Loss: 0.2991 | Val Loss: 0.2675 | Train Acc: 0.9956 | Val Acc: 0.9953

Epoch 15 | Train Loss: 0.2661 | Val Loss: 0.2394 | Train Acc: 0.9962 | Val Acc: 0.9957

Epoch 16 | Train Loss: 0.2379 | Val Loss: 0.2158 | Train Acc: 0.9966 | Val Acc: 0.9957

Epoch 17 | Train Loss: 0.2142 | Val Loss: 0.1962 | Train Acc: 0.9966 | Val Acc: 0.9953

Epoch 18 | Train Loss: 0.1945 | Val Loss: 0.1800 | Train Acc: 0.9965 | Val Acc: 0.9953

Epoch 19 | Train Loss: 0.1782 | Val Loss: 0.1667 | Train Acc: 0.9966 | Val Acc: 0.9953

Epoch 20 | Train Loss: 0.1648 | Val Loss: 0.1557 | Train Acc: 0.9968 | Val Acc: 0.9953

Epoch 21 | Train Loss: 0.1537 | Val Loss: 0.1465 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 22 | Train Loss: 0.1445 | Val Loss: 0.1388 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 23 | Train Loss: 0.1367 | Val Loss: 0.1323 | Train Acc: 0.9969 | Val Acc: 0.9953

Epoch 24 | Train Loss: 0.1301 | Val Loss: 0.1268 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 25 | Train Loss: 0.1245 | Val Loss: 0.1220 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 26 | Train Loss: 0.1197 | Val Loss: 0.1179 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 27 | Train Loss: 0.1155 | Val Loss: 0.1143 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 28 | Train Loss: 0.1119 | Val Loss: 0.1112 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 29 | Train Loss: 0.1087 | Val Loss: 0.1084 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 30 | Train Loss: 0.1059 | Val Loss: 0.1059 | Train Acc: 0.9972 | Val Acc: 0.9953

Epoch 31 | Train Loss: 0.1034 | Val Loss: 0.1037 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 32 | Train Loss: 0.1011 | Val Loss: 0.1017 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 33 | Train Loss: 0.0991 | Val Loss: 0.0999 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 34 | Train Loss: 0.0973 | Val Loss: 0.0983 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 35 | Train Loss: 0.0956 | Val Loss: 0.0968 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 36 | Train Loss: 0.0941 | Val Loss: 0.0954 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 37 | Train Loss: 0.0928 | Val Loss: 0.0942 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 38 | Train Loss: 0.0915 | Val Loss: 0.0930 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 39 | Train Loss: 0.0903 | Val Loss: 0.0920 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 40 | Train Loss: 0.0892 | Val Loss: 0.0910 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 41 | Train Loss: 0.0882 | Val Loss: 0.0901 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 42 | Train Loss: 0.0873 | Val Loss: 0.0892 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 43 | Train Loss: 0.0865 | Val Loss: 0.0884 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 44 | Train Loss: 0.0856 | Val Loss: 0.0877 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 45 | Train Loss: 0.0849 | Val Loss: 0.0870 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 46 | Train Loss: 0.0842 | Val Loss: 0.0863 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 47 | Train Loss: 0.0835 | Val Loss: 0.0857 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 48 | Train Loss: 0.0829 | Val Loss: 0.0851 | Train Acc: 0.9977 | Val Acc: 0.9953

Epoch 49 | Train Loss: 0.0823 | Val Loss: 0.0846 | Train Acc: 0.9978 | Val Acc: 0.9953

Epoch 50 | Train Loss: 0.0817 | Val Loss: 0.0841 | Train Acc: 0.9979 | Val Acc: 0.9953

Epoch 51 | Train Loss: 0.0812 | Val Loss: 0.0836 | Train Acc: 0.9979 | Val Acc: 0.9953

Epoch 52 | Train Loss: 0.0807 | Val Loss: 0.0831 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 53 | Train Loss: 0.0802 | Val Loss: 0.0826 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 54 | Train Loss: 0.0797 | Val Loss: 0.0822 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 55 | Train Loss: 0.0793 | Val Loss: 0.0818 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 56 | Train Loss: 0.0788 | Val Loss: 0.0814 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 57 | Train Loss: 0.0784 | Val Loss: 0.0810 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 58 | Train Loss: 0.0780 | Val Loss: 0.0807 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 59 | Train Loss: 0.0777 | Val Loss: 0.0803 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 60 | Train Loss: 0.0773 | Val Loss: 0.0800 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 61 | Train Loss: 0.0770 | Val Loss: 0.0797 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 62 | Train Loss: 0.0766 | Val Loss: 0.0793 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 63 | Train Loss: 0.0763 | Val Loss: 0.0790 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 64 | Train Loss: 0.0760 | Val Loss: 0.0787 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 65 | Train Loss: 0.0757 | Val Loss: 0.0785 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 66 | Train Loss: 0.0754 | Val Loss: 0.0782 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 67 | Train Loss: 0.0751 | Val Loss: 0.0779 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 68 | Train Loss: 0.0748 | Val Loss: 0.0777 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 69 | Train Loss: 0.0746 | Val Loss: 0.0774 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 70 | Train Loss: 0.0743 | Val Loss: 0.0772 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 71 | Train Loss: 0.0741 | Val Loss: 0.0769 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 72 | Train Loss: 0.0738 | Val Loss: 0.0767 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 73 | Train Loss: 0.0736 | Val Loss: 0.0765 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 74 | Train Loss: 0.0733 | Val Loss: 0.0763 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 75 | Train Loss: 0.0731 | Val Loss: 0.0761 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 76 | Train Loss: 0.0729 | Val Loss: 0.0758 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 77 | Train Loss: 0.0727 | Val Loss: 0.0756 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 78 | Train Loss: 0.0725 | Val Loss: 0.0754 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 79 | Train Loss: 0.0723 | Val Loss: 0.0753 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 80 | Train Loss: 0.0721 | Val Loss: 0.0751 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 81 | Train Loss: 0.0719 | Val Loss: 0.0749 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 82 | Train Loss: 0.0717 | Val Loss: 0.0747 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 83 | Train Loss: 0.0715 | Val Loss: 0.0745 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 84 | Train Loss: 0.0713 | Val Loss: 0.0743 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 85 | Train Loss: 0.0711 | Val Loss: 0.0742 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 86 | Train Loss: 0.0709 | Val Loss: 0.0740 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 87 | Train Loss: 0.0708 | Val Loss: 0.0738 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 88 | Train Loss: 0.0706 | Val Loss: 0.0737 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 89 | Train Loss: 0.0704 | Val Loss: 0.0735 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 90 | Train Loss: 0.0703 | Val Loss: 0.0734 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 91 | Train Loss: 0.0701 | Val Loss: 0.0732 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 92 | Train Loss: 0.0699 | Val Loss: 0.0730 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 93 | Train Loss: 0.0698 | Val Loss: 0.0729 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 94 | Train Loss: 0.0696 | Val Loss: 0.0727 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 95 | Train Loss: 0.0695 | Val Loss: 0.0726 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 96 | Train Loss: 0.0693 | Val Loss: 0.0725 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 97 | Train Loss: 0.0692 | Val Loss: 0.0723 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 98 | Train Loss: 0.0690 | Val Loss: 0.0722 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 99 | Train Loss: 0.0689 | Val Loss: 0.0720 | Train Acc: 0.9980 | Val Acc: 0.9961

Training model with early stopping and weight decay...

Epoch 00 | Train Loss: 0.7421 | Val Loss: 0.7372 | Train Acc: 0.4902 | Val Acc: 0.9428

Epoch 01 | Train Loss: 0.7372 | Val Loss: 0.7317 | Train Acc: 0.9454 | Val Acc: 0.9803

Epoch 02 | Train Loss: 0.7316 | Val Loss: 0.7245 | Train Acc: 0.9796 | Val Acc: 0.9889

Epoch 03 | Train Loss: 0.7245 | Val Loss: 0.7148 | Train Acc: 0.9883 | Val Acc: 0.9917

Epoch 04 | Train Loss: 0.7147 | Val Loss: 0.7011 | Train Acc: 0.9916 | Val Acc: 0.9937

Epoch 05 | Train Loss: 0.7009 | Val Loss: 0.6820 | Train Acc: 0.9929 | Val Acc: 0.9933

Epoch 06 | Train Loss: 0.6819 | Val Loss: 0.6563 | Train Acc: 0.9932 | Val Acc: 0.9929

Epoch 07 | Train Loss: 0.6560 | Val Loss: 0.6230 | Train Acc: 0.9929 | Val Acc: 0.9917

Epoch 08 | Train Loss: 0.6226 | Val Loss: 0.5825 | Train Acc: 0.9924 | Val Acc: 0.9909

Epoch 09 | Train Loss: 0.5820 | Val Loss: 0.5367 | Train Acc: 0.9919 | Val Acc: 0.9909

Epoch 10 | Train Loss: 0.5362 | Val Loss: 0.4887 | Train Acc: 0.9920 | Val Acc: 0.9921

Epoch 11 | Train Loss: 0.4880 | Val Loss: 0.4411 | Train Acc: 0.9925 | Val Acc: 0.9929

Epoch 12 | Train Loss: 0.4402 | Val Loss: 0.3957 | Train Acc: 0.9930 | Val Acc: 0.9941

Epoch 13 | Train Loss: 0.3948 | Val Loss: 0.3535 | Train Acc: 0.9936 | Val Acc: 0.9941

Epoch 14 | Train Loss: 0.3524 | Val Loss: 0.3150 | Train Acc: 0.9945 | Val Acc: 0.9941

Epoch 15 | Train Loss: 0.3139 | Val Loss: 0.2808 | Train Acc: 0.9947 | Val Acc: 0.9945

Epoch 16 | Train Loss: 0.2795 | Val Loss: 0.2510 | Train Acc: 0.9953 | Val Acc: 0.9957

Epoch 17 | Train Loss: 0.2497 | Val Loss: 0.2258 | Train Acc: 0.9958 | Val Acc: 0.9961

Epoch 18 | Train Loss: 0.2243 | Val Loss: 0.2046 | Train Acc: 0.9959 | Val Acc: 0.9953

Epoch 19 | Train Loss: 0.2031 | Val Loss: 0.1871 | Train Acc: 0.9962 | Val Acc: 0.9953

Epoch 20 | Train Loss: 0.1855 | Val Loss: 0.1726 | Train Acc: 0.9964 | Val Acc: 0.9953

Epoch 21 | Train Loss: 0.1709 | Val Loss: 0.1607 | Train Acc: 0.9963 | Val Acc: 0.9953

Epoch 22 | Train Loss: 0.1589 | Val Loss: 0.1507 | Train Acc: 0.9963 | Val Acc: 0.9957

Epoch 23 | Train Loss: 0.1488 | Val Loss: 0.1424 | Train Acc: 0.9965 | Val Acc: 0.9957

Epoch 24 | Train Loss: 0.1404 | Val Loss: 0.1354 | Train Acc: 0.9966 | Val Acc: 0.9957

Epoch 25 | Train Loss: 0.1334 | Val Loss: 0.1294 | Train Acc: 0.9966 | Val Acc: 0.9953

Epoch 26 | Train Loss: 0.1273 | Val Loss: 0.1243 | Train Acc: 0.9966 | Val Acc: 0.9949

Epoch 27 | Train Loss: 0.1222 | Val Loss: 0.1199 | Train Acc: 0.9966 | Val Acc: 0.9949

Epoch 28 | Train Loss: 0.1177 | Val Loss: 0.1160 | Train Acc: 0.9966 | Val Acc: 0.9949

Epoch 29 | Train Loss: 0.1138 | Val Loss: 0.1127 | Train Acc: 0.9965 | Val Acc: 0.9953

Epoch 30 | Train Loss: 0.1104 | Val Loss: 0.1097 | Train Acc: 0.9968 | Val Acc: 0.9953

Epoch 31 | Train Loss: 0.1074 | Val Loss: 0.1071 | Train Acc: 0.9968 | Val Acc: 0.9953

Epoch 32 | Train Loss: 0.1048 | Val Loss: 0.1047 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 33 | Train Loss: 0.1024 | Val Loss: 0.1026 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 34 | Train Loss: 0.1003 | Val Loss: 0.1007 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 35 | Train Loss: 0.0984 | Val Loss: 0.0990 | Train Acc: 0.9970 | Val Acc: 0.9957

Epoch 36 | Train Loss: 0.0966 | Val Loss: 0.0975 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 37 | Train Loss: 0.0950 | Val Loss: 0.0960 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 38 | Train Loss: 0.0936 | Val Loss: 0.0947 | Train Acc: 0.9972 | Val Acc: 0.9957

Epoch 39 | Train Loss: 0.0923 | Val Loss: 0.0935 | Train Acc: 0.9972 | Val Acc: 0.9957

Epoch 40 | Train Loss: 0.0911 | Val Loss: 0.0924 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 41 | Train Loss: 0.0899 | Val Loss: 0.0914 | Train Acc: 0.9974 | Val Acc: 0.9957

Epoch 42 | Train Loss: 0.0889 | Val Loss: 0.0904 | Train Acc: 0.9974 | Val Acc: 0.9957

Epoch 43 | Train Loss: 0.0879 | Val Loss: 0.0896 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 44 | Train Loss: 0.0870 | Val Loss: 0.0887 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 45 | Train Loss: 0.0862 | Val Loss: 0.0880 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 46 | Train Loss: 0.0854 | Val Loss: 0.0872 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 47 | Train Loss: 0.0846 | Val Loss: 0.0866 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 48 | Train Loss: 0.0840 | Val Loss: 0.0859 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 49 | Train Loss: 0.0833 | Val Loss: 0.0853 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 50 | Train Loss: 0.0827 | Val Loss: 0.0847 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 51 | Train Loss: 0.0821 | Val Loss: 0.0842 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 52 | Train Loss: 0.0815 | Val Loss: 0.0837 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 53 | Train Loss: 0.0810 | Val Loss: 0.0832 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 54 | Train Loss: 0.0805 | Val Loss: 0.0827 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 55 | Train Loss: 0.0800 | Val Loss: 0.0823 | Train Acc: 0.9976 | Val Acc: 0.9961

Epoch 56 | Train Loss: 0.0796 | Val Loss: 0.0819 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 57 | Train Loss: 0.0791 | Val Loss: 0.0814 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 58 | Train Loss: 0.0787 | Val Loss: 0.0811 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 59 | Train Loss: 0.0783 | Val Loss: 0.0807 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 60 | Train Loss: 0.0779 | Val Loss: 0.0803 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 61 | Train Loss: 0.0776 | Val Loss: 0.0800 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 62 | Train Loss: 0.0772 | Val Loss: 0.0796 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 63 | Train Loss: 0.0769 | Val Loss: 0.0793 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 64 | Train Loss: 0.0765 | Val Loss: 0.0790 | Train Acc: 0.9977 | Val Acc: 0.9961

Epoch 65 | Train Loss: 0.0762 | Val Loss: 0.0787 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 66 | Train Loss: 0.0759 | Val Loss: 0.0784 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 67 | Train Loss: 0.0756 | Val Loss: 0.0782 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 68 | Train Loss: 0.0753 | Val Loss: 0.0779 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 69 | Train Loss: 0.0750 | Val Loss: 0.0776 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 70 | Train Loss: 0.0748 | Val Loss: 0.0774 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 71 | Train Loss: 0.0745 | Val Loss: 0.0771 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 72 | Train Loss: 0.0742 | Val Loss: 0.0769 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 73 | Train Loss: 0.0740 | Val Loss: 0.0766 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 74 | Train Loss: 0.0737 | Val Loss: 0.0764 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 75 | Train Loss: 0.0735 | Val Loss: 0.0762 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 76 | Train Loss: 0.0733 | Val Loss: 0.0760 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 77 | Train Loss: 0.0731 | Val Loss: 0.0758 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 78 | Train Loss: 0.0728 | Val Loss: 0.0756 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 79 | Train Loss: 0.0726 | Val Loss: 0.0754 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 80 | Train Loss: 0.0724 | Val Loss: 0.0752 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 81 | Train Loss: 0.0722 | Val Loss: 0.0750 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 82 | Train Loss: 0.0720 | Val Loss: 0.0748 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 83 | Train Loss: 0.0718 | Val Loss: 0.0746 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 84 | Train Loss: 0.0716 | Val Loss: 0.0744 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 85 | Train Loss: 0.0714 | Val Loss: 0.0742 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 86 | Train Loss: 0.0712 | Val Loss: 0.0741 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 87 | Train Loss: 0.0711 | Val Loss: 0.0739 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 88 | Train Loss: 0.0709 | Val Loss: 0.0737 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 89 | Train Loss: 0.0707 | Val Loss: 0.0736 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 90 | Train Loss: 0.0705 | Val Loss: 0.0734 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 91 | Train Loss: 0.0704 | Val Loss: 0.0732 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 92 | Train Loss: 0.0702 | Val Loss: 0.0731 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 93 | Train Loss: 0.0700 | Val Loss: 0.0729 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 94 | Train Loss: 0.0699 | Val Loss: 0.0728 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 95 | Train Loss: 0.0697 | Val Loss: 0.0726 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 96 | Train Loss: 0.0695 | Val Loss: 0.0725 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 97 | Train Loss: 0.0694 | Val Loss: 0.0723 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 98 | Train Loss: 0.0692 | Val Loss: 0.0722 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 99 | Train Loss: 0.0691 | Val Loss: 0.0720 | Train Acc: 0.9980 | Val Acc: 0.9961

Training model with weight decay (lambda=0.001)...

Epoch 00 | Train Loss: 0.6968 | Val Loss: 0.6920 | Train Acc: 0.7609 | Val Acc: 0.9589

Epoch 01 | Train Loss: 0.6919 | Val Loss: 0.6865 | Train Acc: 0.9523 | Val Acc: 0.9818

Epoch 02 | Train Loss: 0.6865 | Val Loss: 0.6796 | Train Acc: 0.9838 | Val Acc: 0.9917

Epoch 03 | Train Loss: 0.6795 | Val Loss: 0.6702 | Train Acc: 0.9933 | Val Acc: 0.9949

Epoch 04 | Train Loss: 0.6700 | Val Loss: 0.6569 | Train Acc: 0.9962 | Val Acc: 0.9953

Epoch 05 | Train Loss: 0.6567 | Val Loss: 0.6383 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 06 | Train Loss: 0.6381 | Val Loss: 0.6130 | Train Acc: 0.9965 | Val Acc: 0.9961

Epoch 07 | Train Loss: 0.6127 | Val Loss: 0.5798 | Train Acc: 0.9957 | Val Acc: 0.9949

Epoch 08 | Train Loss: 0.5793 | Val Loss: 0.5386 | Train Acc: 0.9949 | Val Acc: 0.9941

Epoch 09 | Train Loss: 0.5380 | Val Loss: 0.4912 | Train Acc: 0.9946 | Val Acc: 0.9941

Epoch 10 | Train Loss: 0.4904 | Val Loss: 0.4403 | Train Acc: 0.9946 | Val Acc: 0.9941

Epoch 11 | Train Loss: 0.4394 | Val Loss: 0.3893 | Train Acc: 0.9947 | Val Acc: 0.9941

Epoch 12 | Train Loss: 0.3883 | Val Loss: 0.3407 | Train Acc: 0.9946 | Val Acc: 0.9945

Epoch 13 | Train Loss: 0.3395 | Val Loss: 0.2959 | Train Acc: 0.9949 | Val Acc: 0.9945

Epoch 14 | Train Loss: 0.2946 | Val Loss: 0.2559 | Train Acc: 0.9956 | Val Acc: 0.9953

Epoch 15 | Train Loss: 0.2545 | Val Loss: 0.2210 | Train Acc: 0.9960 | Val Acc: 0.9957

Epoch 16 | Train Loss: 0.2195 | Val Loss: 0.1914 | Train Acc: 0.9961 | Val Acc: 0.9961

Epoch 17 | Train Loss: 0.1898 | Val Loss: 0.1668 | Train Acc: 0.9965 | Val Acc: 0.9961

Epoch 18 | Train Loss: 0.1651 | Val Loss: 0.1464 | Train Acc: 0.9968 | Val Acc: 0.9957

Epoch 19 | Train Loss: 0.1446 | Val Loss: 0.1298 | Train Acc: 0.9969 | Val Acc: 0.9957

Epoch 20 | Train Loss: 0.1279 | Val Loss: 0.1161 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 21 | Train Loss: 0.1141 | Val Loss: 0.1048 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 22 | Train Loss: 0.1027 | Val Loss: 0.0954 | Train Acc: 0.9972 | Val Acc: 0.9957

Epoch 23 | Train Loss: 0.0933 | Val Loss: 0.0875 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 24 | Train Loss: 0.0853 | Val Loss: 0.0808 | Train Acc: 0.9970 | Val Acc: 0.9957

Epoch 25 | Train Loss: 0.0786 | Val Loss: 0.0752 | Train Acc: 0.9970 | Val Acc: 0.9957

Epoch 26 | Train Loss: 0.0729 | Val Loss: 0.0703 | Train Acc: 0.9970 | Val Acc: 0.9957

Epoch 27 | Train Loss: 0.0680 | Val Loss: 0.0661 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 28 | Train Loss: 0.0637 | Val Loss: 0.0624 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 29 | Train Loss: 0.0600 | Val Loss: 0.0592 | Train Acc: 0.9971 | Val Acc: 0.9957

Epoch 30 | Train Loss: 0.0567 | Val Loss: 0.0563 | Train Acc: 0.9972 | Val Acc: 0.9957

Epoch 31 | Train Loss: 0.0538 | Val Loss: 0.0538 | Train Acc: 0.9972 | Val Acc: 0.9957

Epoch 32 | Train Loss: 0.0513 | Val Loss: 0.0515 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 33 | Train Loss: 0.0490 | Val Loss: 0.0495 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 34 | Train Loss: 0.0469 | Val Loss: 0.0476 | Train Acc: 0.9973 | Val Acc: 0.9957

Epoch 35 | Train Loss: 0.0451 | Val Loss: 0.0460 | Train Acc: 0.9974 | Val Acc: 0.9957

Epoch 36 | Train Loss: 0.0434 | Val Loss: 0.0444 | Train Acc: 0.9975 | Val Acc: 0.9957

Epoch 37 | Train Loss: 0.0418 | Val Loss: 0.0431 | Train Acc: 0.9975 | Val Acc: 0.9957

Epoch 38 | Train Loss: 0.0404 | Val Loss: 0.0418 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 39 | Train Loss: 0.0391 | Val Loss: 0.0406 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 40 | Train Loss: 0.0380 | Val Loss: 0.0395 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 41 | Train Loss: 0.0369 | Val Loss: 0.0385 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 42 | Train Loss: 0.0358 | Val Loss: 0.0376 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 43 | Train Loss: 0.0349 | Val Loss: 0.0368 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 44 | Train Loss: 0.0340 | Val Loss: 0.0360 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 45 | Train Loss: 0.0332 | Val Loss: 0.0352 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 46 | Train Loss: 0.0325 | Val Loss: 0.0345 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 47 | Train Loss: 0.0317 | Val Loss: 0.0339 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 48 | Train Loss: 0.0311 | Val Loss: 0.0333 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 49 | Train Loss: 0.0304 | Val Loss: 0.0327 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 50 | Train Loss: 0.0299 | Val Loss: 0.0322 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 51 | Train Loss: 0.0293 | Val Loss: 0.0316 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 52 | Train Loss: 0.0288 | Val Loss: 0.0312 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 53 | Train Loss: 0.0283 | Val Loss: 0.0307 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 54 | Train Loss: 0.0278 | Val Loss: 0.0303 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 55 | Train Loss: 0.0273 | Val Loss: 0.0298 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 56 | Train Loss: 0.0269 | Val Loss: 0.0295 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 57 | Train Loss: 0.0265 | Val Loss: 0.0291 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 58 | Train Loss: 0.0261 | Val Loss: 0.0287 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 59 | Train Loss: 0.0258 | Val Loss: 0.0284 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 60 | Train Loss: 0.0254 | Val Loss: 0.0281 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 61 | Train Loss: 0.0251 | Val Loss: 0.0278 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 62 | Train Loss: 0.0247 | Val Loss: 0.0275 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 63 | Train Loss: 0.0244 | Val Loss: 0.0272 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 64 | Train Loss: 0.0241 | Val Loss: 0.0269 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 65 | Train Loss: 0.0239 | Val Loss: 0.0267 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 66 | Train Loss: 0.0236 | Val Loss: 0.0264 | Train Acc: 0.9978 | Val Acc: 0.9961

Epoch 67 | Train Loss: 0.0233 | Val Loss: 0.0262 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 68 | Train Loss: 0.0231 | Val Loss: 0.0259 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 69 | Train Loss: 0.0228 | Val Loss: 0.0257 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 70 | Train Loss: 0.0226 | Val Loss: 0.0255 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 71 | Train Loss: 0.0224 | Val Loss: 0.0253 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 72 | Train Loss: 0.0222 | Val Loss: 0.0251 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 73 | Train Loss: 0.0220 | Val Loss: 0.0249 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 74 | Train Loss: 0.0218 | Val Loss: 0.0247 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 75 | Train Loss: 0.0216 | Val Loss: 0.0245 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 76 | Train Loss: 0.0214 | Val Loss: 0.0244 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 77 | Train Loss: 0.0212 | Val Loss: 0.0242 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 78 | Train Loss: 0.0210 | Val Loss: 0.0240 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 79 | Train Loss: 0.0208 | Val Loss: 0.0239 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 80 | Train Loss: 0.0207 | Val Loss: 0.0237 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 81 | Train Loss: 0.0205 | Val Loss: 0.0236 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 82 | Train Loss: 0.0204 | Val Loss: 0.0235 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 83 | Train Loss: 0.0202 | Val Loss: 0.0233 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 84 | Train Loss: 0.0201 | Val Loss: 0.0232 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 85 | Train Loss: 0.0199 | Val Loss: 0.0231 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 86 | Train Loss: 0.0198 | Val Loss: 0.0229 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 87 | Train Loss: 0.0196 | Val Loss: 0.0228 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 88 | Train Loss: 0.0195 | Val Loss: 0.0227 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 89 | Train Loss: 0.0194 | Val Loss: 0.0226 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 90 | Train Loss: 0.0193 | Val Loss: 0.0225 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 91 | Train Loss: 0.0191 | Val Loss: 0.0224 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 92 | Train Loss: 0.0190 | Val Loss: 0.0223 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 93 | Train Loss: 0.0189 | Val Loss: 0.0221 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 94 | Train Loss: 0.0188 | Val Loss: 0.0220 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 95 | Train Loss: 0.0187 | Val Loss: 0.0220 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 96 | Train Loss: 0.0186 | Val Loss: 0.0219 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 97 | Train Loss: 0.0185 | Val Loss: 0.0218 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 98 | Train Loss: 0.0184 | Val Loss: 0.0217 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 99 | Train Loss: 0.0183 | Val Loss: 0.0216 | Train Acc: 0.9980 | Val Acc: 0.9961

Training model with weight decay (lambda=0.0055)...

Epoch 00 | Train Loss: 0.7213 | Val Loss: 0.7147 | Train Acc: 0.4178 | Val Acc: 0.9822

Epoch 01 | Train Loss: 0.7147 | Val Loss: 0.7075 | Train Acc: 0.9774 | Val Acc: 0.9929

Epoch 02 | Train Loss: 0.7075 | Val Loss: 0.6985 | Train Acc: 0.9942 | Val Acc: 0.9937

Epoch 03 | Train Loss: 0.6984 | Val Loss: 0.6863 | Train Acc: 0.9949 | Val Acc: 0.9929

Epoch 04 | Train Loss: 0.6862 | Val Loss: 0.6695 | Train Acc: 0.9942 | Val Acc: 0.9901

Epoch 05 | Train Loss: 0.6693 | Val Loss: 0.6465 | Train Acc: 0.9927 | Val Acc: 0.9886

Epoch 06 | Train Loss: 0.6462 | Val Loss: 0.6166 | Train Acc: 0.9912 | Val Acc: 0.9874

Epoch 07 | Train Loss: 0.6161 | Val Loss: 0.5796 | Train Acc: 0.9902 | Val Acc: 0.9874

Epoch 08 | Train Loss: 0.5790 | Val Loss: 0.5372 | Train Acc: 0.9901 | Val Acc: 0.9874

Epoch 09 | Train Loss: 0.5365 | Val Loss: 0.4921 | Train Acc: 0.9901 | Val Acc: 0.9889

Epoch 10 | Train Loss: 0.4912 | Val Loss: 0.4470 | Train Acc: 0.9910 | Val Acc: 0.9917

Epoch 11 | Train Loss: 0.4459 | Val Loss: 0.4034 | Train Acc: 0.9922 | Val Acc: 0.9941

Epoch 12 | Train Loss: 0.4022 | Val Loss: 0.3620 | Train Acc: 0.9935 | Val Acc: 0.9937

Epoch 13 | Train Loss: 0.3607 | Val Loss: 0.3231 | Train Acc: 0.9945 | Val Acc: 0.9937

Epoch 14 | Train Loss: 0.3217 | Val Loss: 0.2870 | Train Acc: 0.9946 | Val Acc: 0.9945

Epoch 15 | Train Loss: 0.2856 | Val Loss: 0.2544 | Train Acc: 0.9954 | Val Acc: 0.9949

Epoch 16 | Train Loss: 0.2529 | Val Loss: 0.2257 | Train Acc: 0.9959 | Val Acc: 0.9957

Epoch 17 | Train Loss: 0.2241 | Val Loss: 0.2009 | Train Acc: 0.9961 | Val Acc: 0.9961

Epoch 18 | Train Loss: 0.1993 | Val Loss: 0.1800 | Train Acc: 0.9966 | Val Acc: 0.9957

Epoch 19 | Train Loss: 0.1783 | Val Loss: 0.1625 | Train Acc: 0.9968 | Val Acc: 0.9953

Epoch 20 | Train Loss: 0.1607 | Val Loss: 0.1480 | Train Acc: 0.9968 | Val Acc: 0.9949

Epoch 21 | Train Loss: 0.1461 | Val Loss: 0.1360 | Train Acc: 0.9967 | Val Acc: 0.9953

Epoch 22 | Train Loss: 0.1340 | Val Loss: 0.1259 | Train Acc: 0.9968 | Val Acc: 0.9953

Epoch 23 | Train Loss: 0.1238 | Val Loss: 0.1175 | Train Acc: 0.9969 | Val Acc: 0.9953

Epoch 24 | Train Loss: 0.1154 | Val Loss: 0.1104 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 25 | Train Loss: 0.1082 | Val Loss: 0.1043 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 26 | Train Loss: 0.1021 | Val Loss: 0.0991 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 27 | Train Loss: 0.0969 | Val Loss: 0.0947 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 28 | Train Loss: 0.0923 | Val Loss: 0.0908 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 29 | Train Loss: 0.0884 | Val Loss: 0.0874 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 30 | Train Loss: 0.0850 | Val Loss: 0.0844 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 31 | Train Loss: 0.0819 | Val Loss: 0.0817 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 32 | Train Loss: 0.0792 | Val Loss: 0.0793 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 33 | Train Loss: 0.0769 | Val Loss: 0.0772 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 34 | Train Loss: 0.0747 | Val Loss: 0.0753 | Train Acc: 0.9972 | Val Acc: 0.9953

Epoch 35 | Train Loss: 0.0728 | Val Loss: 0.0736 | Train Acc: 0.9972 | Val Acc: 0.9953

Epoch 36 | Train Loss: 0.0710 | Val Loss: 0.0720 | Train Acc: 0.9972 | Val Acc: 0.9953

Epoch 37 | Train Loss: 0.0695 | Val Loss: 0.0706 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 38 | Train Loss: 0.0680 | Val Loss: 0.0693 | Train Acc: 0.9974 | Val Acc: 0.9953

Epoch 39 | Train Loss: 0.0667 | Val Loss: 0.0681 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 40 | Train Loss: 0.0655 | Val Loss: 0.0670 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 41 | Train Loss: 0.0644 | Val Loss: 0.0660 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 42 | Train Loss: 0.0633 | Val Loss: 0.0651 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 43 | Train Loss: 0.0624 | Val Loss: 0.0642 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 44 | Train Loss: 0.0615 | Val Loss: 0.0634 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 45 | Train Loss: 0.0607 | Val Loss: 0.0626 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 46 | Train Loss: 0.0599 | Val Loss: 0.0619 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 47 | Train Loss: 0.0592 | Val Loss: 0.0613 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 48 | Train Loss: 0.0585 | Val Loss: 0.0607 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 49 | Train Loss: 0.0579 | Val Loss: 0.0601 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 50 | Train Loss: 0.0573 | Val Loss: 0.0595 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 51 | Train Loss: 0.0567 | Val Loss: 0.0590 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 52 | Train Loss: 0.0562 | Val Loss: 0.0585 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 53 | Train Loss: 0.0557 | Val Loss: 0.0581 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 54 | Train Loss: 0.0552 | Val Loss: 0.0576 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 55 | Train Loss: 0.0548 | Val Loss: 0.0572 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 56 | Train Loss: 0.0543 | Val Loss: 0.0568 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 57 | Train Loss: 0.0539 | Val Loss: 0.0565 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 58 | Train Loss: 0.0536 | Val Loss: 0.0561 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 59 | Train Loss: 0.0532 | Val Loss: 0.0558 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 60 | Train Loss: 0.0528 | Val Loss: 0.0554 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 61 | Train Loss: 0.0525 | Val Loss: 0.0551 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 62 | Train Loss: 0.0522 | Val Loss: 0.0548 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 63 | Train Loss: 0.0519 | Val Loss: 0.0545 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 64 | Train Loss: 0.0516 | Val Loss: 0.0543 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 65 | Train Loss: 0.0513 | Val Loss: 0.0540 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 66 | Train Loss: 0.0510 | Val Loss: 0.0538 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 67 | Train Loss: 0.0507 | Val Loss: 0.0535 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 68 | Train Loss: 0.0505 | Val Loss: 0.0533 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 69 | Train Loss: 0.0503 | Val Loss: 0.0531 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 70 | Train Loss: 0.0500 | Val Loss: 0.0528 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 71 | Train Loss: 0.0498 | Val Loss: 0.0526 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 72 | Train Loss: 0.0496 | Val Loss: 0.0524 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 73 | Train Loss: 0.0494 | Val Loss: 0.0522 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 74 | Train Loss: 0.0492 | Val Loss: 0.0521 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 75 | Train Loss: 0.0490 | Val Loss: 0.0519 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 76 | Train Loss: 0.0488 | Val Loss: 0.0517 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 77 | Train Loss: 0.0486 | Val Loss: 0.0515 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 78 | Train Loss: 0.0484 | Val Loss: 0.0514 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 79 | Train Loss: 0.0482 | Val Loss: 0.0512 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 80 | Train Loss: 0.0481 | Val Loss: 0.0510 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 81 | Train Loss: 0.0479 | Val Loss: 0.0509 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 82 | Train Loss: 0.0477 | Val Loss: 0.0507 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 83 | Train Loss: 0.0476 | Val Loss: 0.0506 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 84 | Train Loss: 0.0474 | Val Loss: 0.0505 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 85 | Train Loss: 0.0473 | Val Loss: 0.0503 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 86 | Train Loss: 0.0471 | Val Loss: 0.0502 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 87 | Train Loss: 0.0470 | Val Loss: 0.0501 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 88 | Train Loss: 0.0468 | Val Loss: 0.0499 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 89 | Train Loss: 0.0467 | Val Loss: 0.0498 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 90 | Train Loss: 0.0466 | Val Loss: 0.0497 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 91 | Train Loss: 0.0465 | Val Loss: 0.0496 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 92 | Train Loss: 0.0463 | Val Loss: 0.0495 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 93 | Train Loss: 0.0462 | Val Loss: 0.0493 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 94 | Train Loss: 0.0461 | Val Loss: 0.0492 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 95 | Train Loss: 0.0460 | Val Loss: 0.0491 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 96 | Train Loss: 0.0459 | Val Loss: 0.0490 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 97 | Train Loss: 0.0457 | Val Loss: 0.0489 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 98 | Train Loss: 0.0456 | Val Loss: 0.0488 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 99 | Train Loss: 0.0455 | Val Loss: 0.0487 | Train Acc: 0.9981 | Val Acc: 0.9961

Training model with weight decay (lambda=0.01)...

Epoch 00 | Train Loss: 0.7454 | Val Loss: 0.7351 | Train Acc: 0.4101 | Val Acc: 0.9503

Epoch 01 | Train Loss: 0.7351 | Val Loss: 0.7248 | Train Acc: 0.9464 | Val Acc: 0.9818

Epoch 02 | Train Loss: 0.7248 | Val Loss: 0.7125 | Train Acc: 0.9830 | Val Acc: 0.9874

Epoch 03 | Train Loss: 0.7125 | Val Loss: 0.6965 | Train Acc: 0.9911 | Val Acc: 0.9897

Epoch 04 | Train Loss: 0.6964 | Val Loss: 0.6750 | Train Acc: 0.9929 | Val Acc: 0.9905

Epoch 05 | Train Loss: 0.6749 | Val Loss: 0.6466 | Train Acc: 0.9936 | Val Acc: 0.9901

Epoch 06 | Train Loss: 0.6464 | Val Loss: 0.6106 | Train Acc: 0.9930 | Val Acc: 0.9905

Epoch 07 | Train Loss: 0.6104 | Val Loss: 0.5678 | Train Acc: 0.9928 | Val Acc: 0.9909

Epoch 08 | Train Loss: 0.5675 | Val Loss: 0.5206 | Train Acc: 0.9925 | Val Acc: 0.9925

Epoch 09 | Train Loss: 0.5201 | Val Loss: 0.4718 | Train Acc: 0.9930 | Val Acc: 0.9937

Epoch 10 | Train Loss: 0.4711 | Val Loss: 0.4241 | Train Acc: 0.9938 | Val Acc: 0.9937

Epoch 11 | Train Loss: 0.4233 | Val Loss: 0.3791 | Train Acc: 0.9941 | Val Acc: 0.9941

Epoch 12 | Train Loss: 0.3782 | Val Loss: 0.3376 | Train Acc: 0.9946 | Val Acc: 0.9937

Epoch 13 | Train Loss: 0.3365 | Val Loss: 0.3003 | Train Acc: 0.9952 | Val Acc: 0.9949

Epoch 14 | Train Loss: 0.2991 | Val Loss: 0.2675 | Train Acc: 0.9956 | Val Acc: 0.9953

Epoch 15 | Train Loss: 0.2661 | Val Loss: 0.2394 | Train Acc: 0.9962 | Val Acc: 0.9957

Epoch 16 | Train Loss: 0.2379 | Val Loss: 0.2158 | Train Acc: 0.9966 | Val Acc: 0.9957

Epoch 17 | Train Loss: 0.2142 | Val Loss: 0.1962 | Train Acc: 0.9966 | Val Acc: 0.9953

Epoch 18 | Train Loss: 0.1945 | Val Loss: 0.1800 | Train Acc: 0.9965 | Val Acc: 0.9953

Epoch 19 | Train Loss: 0.1782 | Val Loss: 0.1667 | Train Acc: 0.9966 | Val Acc: 0.9953

Epoch 20 | Train Loss: 0.1648 | Val Loss: 0.1557 | Train Acc: 0.9968 | Val Acc: 0.9953

Epoch 21 | Train Loss: 0.1537 | Val Loss: 0.1465 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 22 | Train Loss: 0.1445 | Val Loss: 0.1388 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 23 | Train Loss: 0.1367 | Val Loss: 0.1323 | Train Acc: 0.9969 | Val Acc: 0.9953

Epoch 24 | Train Loss: 0.1301 | Val Loss: 0.1268 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 25 | Train Loss: 0.1245 | Val Loss: 0.1220 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 26 | Train Loss: 0.1197 | Val Loss: 0.1179 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 27 | Train Loss: 0.1155 | Val Loss: 0.1143 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 28 | Train Loss: 0.1119 | Val Loss: 0.1112 | Train Acc: 0.9970 | Val Acc: 0.9953

Epoch 29 | Train Loss: 0.1087 | Val Loss: 0.1084 | Train Acc: 0.9971 | Val Acc: 0.9953

Epoch 30 | Train Loss: 0.1059 | Val Loss: 0.1059 | Train Acc: 0.9972 | Val Acc: 0.9953

Epoch 31 | Train Loss: 0.1034 | Val Loss: 0.1037 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 32 | Train Loss: 0.1011 | Val Loss: 0.1017 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 33 | Train Loss: 0.0991 | Val Loss: 0.0999 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 34 | Train Loss: 0.0973 | Val Loss: 0.0983 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 35 | Train Loss: 0.0956 | Val Loss: 0.0968 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 36 | Train Loss: 0.0941 | Val Loss: 0.0954 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 37 | Train Loss: 0.0928 | Val Loss: 0.0942 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 38 | Train Loss: 0.0915 | Val Loss: 0.0930 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 39 | Train Loss: 0.0903 | Val Loss: 0.0920 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 40 | Train Loss: 0.0892 | Val Loss: 0.0910 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 41 | Train Loss: 0.0882 | Val Loss: 0.0901 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 42 | Train Loss: 0.0873 | Val Loss: 0.0892 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 43 | Train Loss: 0.0865 | Val Loss: 0.0884 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 44 | Train Loss: 0.0856 | Val Loss: 0.0877 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 45 | Train Loss: 0.0849 | Val Loss: 0.0870 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 46 | Train Loss: 0.0842 | Val Loss: 0.0863 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 47 | Train Loss: 0.0835 | Val Loss: 0.0857 | Train Acc: 0.9976 | Val Acc: 0.9953

Epoch 48 | Train Loss: 0.0829 | Val Loss: 0.0851 | Train Acc: 0.9977 | Val Acc: 0.9953

Epoch 49 | Train Loss: 0.0823 | Val Loss: 0.0846 | Train Acc: 0.9978 | Val Acc: 0.9953

Epoch 50 | Train Loss: 0.0817 | Val Loss: 0.0841 | Train Acc: 0.9979 | Val Acc: 0.9953

Epoch 51 | Train Loss: 0.0812 | Val Loss: 0.0836 | Train Acc: 0.9979 | Val Acc: 0.9953

Epoch 52 | Train Loss: 0.0807 | Val Loss: 0.0831 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 53 | Train Loss: 0.0802 | Val Loss: 0.0826 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 54 | Train Loss: 0.0797 | Val Loss: 0.0822 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 55 | Train Loss: 0.0793 | Val Loss: 0.0818 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 56 | Train Loss: 0.0788 | Val Loss: 0.0814 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 57 | Train Loss: 0.0784 | Val Loss: 0.0810 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 58 | Train Loss: 0.0780 | Val Loss: 0.0807 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 59 | Train Loss: 0.0777 | Val Loss: 0.0803 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 60 | Train Loss: 0.0773 | Val Loss: 0.0800 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 61 | Train Loss: 0.0770 | Val Loss: 0.0797 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 62 | Train Loss: 0.0766 | Val Loss: 0.0793 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 63 | Train Loss: 0.0763 | Val Loss: 0.0790 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 64 | Train Loss: 0.0760 | Val Loss: 0.0787 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 65 | Train Loss: 0.0757 | Val Loss: 0.0785 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 66 | Train Loss: 0.0754 | Val Loss: 0.0782 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 67 | Train Loss: 0.0751 | Val Loss: 0.0779 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 68 | Train Loss: 0.0748 | Val Loss: 0.0777 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 69 | Train Loss: 0.0746 | Val Loss: 0.0774 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 70 | Train Loss: 0.0743 | Val Loss: 0.0772 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 71 | Train Loss: 0.0741 | Val Loss: 0.0769 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 72 | Train Loss: 0.0738 | Val Loss: 0.0767 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 73 | Train Loss: 0.0736 | Val Loss: 0.0765 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 74 | Train Loss: 0.0733 | Val Loss: 0.0763 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 75 | Train Loss: 0.0731 | Val Loss: 0.0761 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 76 | Train Loss: 0.0729 | Val Loss: 0.0758 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 77 | Train Loss: 0.0727 | Val Loss: 0.0756 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 78 | Train Loss: 0.0725 | Val Loss: 0.0754 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 79 | Train Loss: 0.0723 | Val Loss: 0.0753 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 80 | Train Loss: 0.0721 | Val Loss: 0.0751 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 81 | Train Loss: 0.0719 | Val Loss: 0.0749 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 82 | Train Loss: 0.0717 | Val Loss: 0.0747 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 83 | Train Loss: 0.0715 | Val Loss: 0.0745 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 84 | Train Loss: 0.0713 | Val Loss: 0.0743 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 85 | Train Loss: 0.0711 | Val Loss: 0.0742 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 86 | Train Loss: 0.0709 | Val Loss: 0.0740 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 87 | Train Loss: 0.0708 | Val Loss: 0.0738 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 88 | Train Loss: 0.0706 | Val Loss: 0.0737 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 89 | Train Loss: 0.0704 | Val Loss: 0.0735 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 90 | Train Loss: 0.0703 | Val Loss: 0.0734 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 91 | Train Loss: 0.0701 | Val Loss: 0.0732 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 92 | Train Loss: 0.0699 | Val Loss: 0.0730 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 93 | Train Loss: 0.0698 | Val Loss: 0.0729 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 94 | Train Loss: 0.0696 | Val Loss: 0.0727 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 95 | Train Loss: 0.0695 | Val Loss: 0.0726 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 96 | Train Loss: 0.0693 | Val Loss: 0.0725 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 97 | Train Loss: 0.0692 | Val Loss: 0.0723 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 98 | Train Loss: 0.0690 | Val Loss: 0.0722 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 99 | Train Loss: 0.0689 | Val Loss: 0.0720 | Train Acc: 0.9980 | Val Acc: 0.9961

Training model with weight decay (lambda=0.055)...

Epoch 00 | Train Loss: 0.9691 | Val Loss: 0.9596 | Train Acc: 0.5258 | Val Acc: 0.9305

Epoch 01 | Train Loss: 0.9596 | Val Loss: 0.9498 | Train Acc: 0.9323 | Val Acc: 0.9814

Epoch 02 | Train Loss: 0.9498 | Val Loss: 0.9384 | Train Acc: 0.9861 | Val Acc: 0.9897

Epoch 03 | Train Loss: 0.9385 | Val Loss: 0.9242 | Train Acc: 0.9931 | Val Acc: 0.9917

Epoch 04 | Train Loss: 0.9243 | Val Loss: 0.9059 | Train Acc: 0.9941 | Val Acc: 0.9921

Epoch 05 | Train Loss: 0.9059 | Val Loss: 0.8822 | Train Acc: 0.9940 | Val Acc: 0.9901

Epoch 06 | Train Loss: 0.8821 | Val Loss: 0.8519 | Train Acc: 0.9933 | Val Acc: 0.9889

Epoch 07 | Train Loss: 0.8518 | Val Loss: 0.8149 | Train Acc: 0.9922 | Val Acc: 0.9889

Epoch 08 | Train Loss: 0.8147 | Val Loss: 0.7725 | Train Acc: 0.9909 | Val Acc: 0.9886

Epoch 09 | Train Loss: 0.7721 | Val Loss: 0.7269 | Train Acc: 0.9910 | Val Acc: 0.9889

Epoch 10 | Train Loss: 0.7263 | Val Loss: 0.6810 | Train Acc: 0.9913 | Val Acc: 0.9905

Epoch 11 | Train Loss: 0.6803 | Val Loss: 0.6367 | Train Acc: 0.9922 | Val Acc: 0.9921

Epoch 12 | Train Loss: 0.6358 | Val Loss: 0.5948 | Train Acc: 0.9931 | Val Acc: 0.9929

Epoch 13 | Train Loss: 0.5937 | Val Loss: 0.5557 | Train Acc: 0.9941 | Val Acc: 0.9937

Epoch 14 | Train Loss: 0.5544 | Val Loss: 0.5196 | Train Acc: 0.9945 | Val Acc: 0.9941

Epoch 15 | Train Loss: 0.5182 | Val Loss: 0.4869 | Train Acc: 0.9953 | Val Acc: 0.9945

Epoch 16 | Train Loss: 0.4854 | Val Loss: 0.4580 | Train Acc: 0.9959 | Val Acc: 0.9949

Epoch 17 | Train Loss: 0.4564 | Val Loss: 0.4329 | Train Acc: 0.9962 | Val Acc: 0.9953

Epoch 18 | Train Loss: 0.4311 | Val Loss: 0.4114 | Train Acc: 0.9961 | Val Acc: 0.9953

Epoch 19 | Train Loss: 0.4096 | Val Loss: 0.3932 | Train Acc: 0.9962 | Val Acc: 0.9945

Epoch 20 | Train Loss: 0.3913 | Val Loss: 0.3778 | Train Acc: 0.9964 | Val Acc: 0.9953

Epoch 21 | Train Loss: 0.3758 | Val Loss: 0.3648 | Train Acc: 0.9965 | Val Acc: 0.9953

Epoch 22 | Train Loss: 0.3627 | Val Loss: 0.3537 | Train Acc: 0.9965 | Val Acc: 0.9953

Epoch 23 | Train Loss: 0.3515 | Val Loss: 0.3442 | Train Acc: 0.9966 | Val Acc: 0.9949

Epoch 24 | Train Loss: 0.3419 | Val Loss: 0.3359 | Train Acc: 0.9967 | Val Acc: 0.9949

Epoch 25 | Train Loss: 0.3336 | Val Loss: 0.3286 | Train Acc: 0.9966 | Val Acc: 0.9949

Epoch 26 | Train Loss: 0.3262 | Val Loss: 0.3221 | Train Acc: 0.9967 | Val Acc: 0.9949

Epoch 27 | Train Loss: 0.3197 | Val Loss: 0.3164 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 28 | Train Loss: 0.3139 | Val Loss: 0.3111 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 29 | Train Loss: 0.3087 | Val Loss: 0.3064 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 30 | Train Loss: 0.3039 | Val Loss: 0.3020 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 31 | Train Loss: 0.2995 | Val Loss: 0.2980 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 32 | Train Loss: 0.2954 | Val Loss: 0.2942 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 33 | Train Loss: 0.2916 | Val Loss: 0.2906 | Train Acc: 0.9970 | Val Acc: 0.9949

Epoch 34 | Train Loss: 0.2880 | Val Loss: 0.2873 | Train Acc: 0.9970 | Val Acc: 0.9949

Epoch 35 | Train Loss: 0.2847 | Val Loss: 0.2841 | Train Acc: 0.9972 | Val Acc: 0.9949

Epoch 36 | Train Loss: 0.2815 | Val Loss: 0.2811 | Train Acc: 0.9972 | Val Acc: 0.9949

Epoch 37 | Train Loss: 0.2785 | Val Loss: 0.2782 | Train Acc: 0.9972 | Val Acc: 0.9949

Epoch 38 | Train Loss: 0.2756 | Val Loss: 0.2755 | Train Acc: 0.9973 | Val Acc: 0.9949

Epoch 39 | Train Loss: 0.2728 | Val Loss: 0.2728 | Train Acc: 0.9973 | Val Acc: 0.9949

Epoch 40 | Train Loss: 0.2701 | Val Loss: 0.2702 | Train Acc: 0.9973 | Val Acc: 0.9949

Epoch 41 | Train Loss: 0.2675 | Val Loss: 0.2677 | Train Acc: 0.9973 | Val Acc: 0.9949

Epoch 42 | Train Loss: 0.2650 | Val Loss: 0.2653 | Train Acc: 0.9973 | Val Acc: 0.9949

Epoch 43 | Train Loss: 0.2626 | Val Loss: 0.2630 | Train Acc: 0.9973 | Val Acc: 0.9949

Epoch 44 | Train Loss: 0.2603 | Val Loss: 0.2607 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 45 | Train Loss: 0.2580 | Val Loss: 0.2585 | Train Acc: 0.9974 | Val Acc: 0.9957

Epoch 46 | Train Loss: 0.2558 | Val Loss: 0.2564 | Train Acc: 0.9974 | Val Acc: 0.9957

Epoch 47 | Train Loss: 0.2536 | Val Loss: 0.2543 | Train Acc: 0.9974 | Val Acc: 0.9957

Epoch 48 | Train Loss: 0.2515 | Val Loss: 0.2522 | Train Acc: 0.9975 | Val Acc: 0.9957

Epoch 49 | Train Loss: 0.2494 | Val Loss: 0.2502 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 50 | Train Loss: 0.2474 | Val Loss: 0.2482 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 51 | Train Loss: 0.2454 | Val Loss: 0.2462 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 52 | Train Loss: 0.2435 | Val Loss: 0.2443 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 53 | Train Loss: 0.2416 | Val Loss: 0.2425 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 54 | Train Loss: 0.2397 | Val Loss: 0.2406 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 55 | Train Loss: 0.2378 | Val Loss: 0.2388 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 56 | Train Loss: 0.2360 | Val Loss: 0.2370 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 57 | Train Loss: 0.2342 | Val Loss: 0.2353 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 58 | Train Loss: 0.2325 | Val Loss: 0.2336 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 59 | Train Loss: 0.2307 | Val Loss: 0.2319 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 60 | Train Loss: 0.2290 | Val Loss: 0.2302 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 61 | Train Loss: 0.2274 | Val Loss: 0.2285 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 62 | Train Loss: 0.2257 | Val Loss: 0.2269 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 63 | Train Loss: 0.2241 | Val Loss: 0.2253 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 64 | Train Loss: 0.2225 | Val Loss: 0.2237 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 65 | Train Loss: 0.2209 | Val Loss: 0.2222 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 66 | Train Loss: 0.2193 | Val Loss: 0.2206 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 67 | Train Loss: 0.2178 | Val Loss: 0.2191 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 68 | Train Loss: 0.2163 | Val Loss: 0.2176 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 69 | Train Loss: 0.2148 | Val Loss: 0.2161 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 70 | Train Loss: 0.2133 | Val Loss: 0.2147 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 71 | Train Loss: 0.2118 | Val Loss: 0.2132 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 72 | Train Loss: 0.2104 | Val Loss: 0.2118 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 73 | Train Loss: 0.2090 | Val Loss: 0.2104 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 74 | Train Loss: 0.2076 | Val Loss: 0.2090 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 75 | Train Loss: 0.2062 | Val Loss: 0.2076 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 76 | Train Loss: 0.2048 | Val Loss: 0.2063 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 77 | Train Loss: 0.2034 | Val Loss: 0.2049 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 78 | Train Loss: 0.2021 | Val Loss: 0.2036 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 79 | Train Loss: 0.2008 | Val Loss: 0.2023 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 80 | Train Loss: 0.1995 | Val Loss: 0.2010 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 81 | Train Loss: 0.1982 | Val Loss: 0.1997 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 82 | Train Loss: 0.1969 | Val Loss: 0.1985 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 83 | Train Loss: 0.1956 | Val Loss: 0.1972 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 84 | Train Loss: 0.1944 | Val Loss: 0.1960 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 85 | Train Loss: 0.1931 | Val Loss: 0.1948 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 86 | Train Loss: 0.1919 | Val Loss: 0.1936 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 87 | Train Loss: 0.1907 | Val Loss: 0.1924 | Train Acc: 0.9979 | Val Acc: 0.9961

Epoch 88 | Train Loss: 0.1895 | Val Loss: 0.1912 | Train Acc: 0.9980 | Val Acc: 0.9961

Epoch 89 | Train Loss: 0.1884 | Val Loss: 0.1900 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 90 | Train Loss: 0.1872 | Val Loss: 0.1889 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 91 | Train Loss: 0.1860 | Val Loss: 0.1878 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 92 | Train Loss: 0.1849 | Val Loss: 0.1866 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 93 | Train Loss: 0.1838 | Val Loss: 0.1855 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 94 | Train Loss: 0.1827 | Val Loss: 0.1844 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 95 | Train Loss: 0.1816 | Val Loss: 0.1833 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 96 | Train Loss: 0.1805 | Val Loss: 0.1823 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 97 | Train Loss: 0.1794 | Val Loss: 0.1812 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 98 | Train Loss: 0.1783 | Val Loss: 0.1802 | Train Acc: 0.9981 | Val Acc: 0.9961

Epoch 99 | Train Loss: 0.1773 | Val Loss: 0.1791 | Train Acc: 0.9981 | Val Acc: 0.9961

Training model with weight decay (lambda=0.1)...

Epoch 00 | Train Loss: 1.1919 | Val Loss: 1.1766 | Train Acc: 0.4754 | Val Acc: 0.8855

Epoch 01 | Train Loss: 1.1765 | Val Loss: 1.1613 | Train Acc: 0.8881 | Val Acc: 0.9913

Epoch 02 | Train Loss: 1.1612 | Val Loss: 1.1451 | Train Acc: 0.9930 | Val Acc: 0.9921

Epoch 03 | Train Loss: 1.1450 | Val Loss: 1.1270 | Train Acc: 0.9960 | Val Acc: 0.9933

Epoch 04 | Train Loss: 1.1269 | Val Loss: 1.1059 | Train Acc: 0.9963 | Val Acc: 0.9945

Epoch 05 | Train Loss: 1.1057 | Val Loss: 1.0806 | Train Acc: 0.9961 | Val Acc: 0.9953

Epoch 06 | Train Loss: 1.0803 | Val Loss: 1.0498 | Train Acc: 0.9955 | Val Acc: 0.9949

Epoch 07 | Train Loss: 1.0495 | Val Loss: 1.0128 | Train Acc: 0.9945 | Val Acc: 0.9953

Epoch 08 | Train Loss: 1.0123 | Val Loss: 0.9697 | Train Acc: 0.9934 | Val Acc: 0.9941

Epoch 09 | Train Loss: 0.9691 | Val Loss: 0.9219 | Train Acc: 0.9931 | Val Acc: 0.9933

Epoch 10 | Train Loss: 0.9212 | Val Loss: 0.8720 | Train Acc: 0.9929 | Val Acc: 0.9937

Epoch 11 | Train Loss: 0.8711 | Val Loss: 0.8225 | Train Acc: 0.9931 | Val Acc: 0.9941

Epoch 12 | Train Loss: 0.8215 | Val Loss: 0.7751 | Train Acc: 0.9938 | Val Acc: 0.9941

Epoch 13 | Train Loss: 0.7740 | Val Loss: 0.7307 | Train Acc: 0.9945 | Val Acc: 0.9945

Epoch 14 | Train Loss: 0.7295 | Val Loss: 0.6897 | Train Acc: 0.9948 | Val Acc: 0.9945

Epoch 15 | Train Loss: 0.6884 | Val Loss: 0.6524 | Train Acc: 0.9954 | Val Acc: 0.9945

Epoch 16 | Train Loss: 0.6509 | Val Loss: 0.6188 | Train Acc: 0.9960 | Val Acc: 0.9953

Epoch 17 | Train Loss: 0.6173 | Val Loss: 0.5892 | Train Acc: 0.9961 | Val Acc: 0.9957

Epoch 18 | Train Loss: 0.5875 | Val Loss: 0.5633 | Train Acc: 0.9962 | Val Acc: 0.9957

Epoch 19 | Train Loss: 0.5615 | Val Loss: 0.5408 | Train Acc: 0.9966 | Val Acc: 0.9957

Epoch 20 | Train Loss: 0.5390 | Val Loss: 0.5214 | Train Acc: 0.9970 | Val Acc: 0.9957

Epoch 21 | Train Loss: 0.5194 | Val Loss: 0.5045 | Train Acc: 0.9968 | Val Acc: 0.9957

Epoch 22 | Train Loss: 0.5024 | Val Loss: 0.4896 | Train Acc: 0.9968 | Val Acc: 0.9957

Epoch 23 | Train Loss: 0.4876 | Val Loss: 0.4765 | Train Acc: 0.9969 | Val Acc: 0.9953

Epoch 24 | Train Loss: 0.4744 | Val Loss: 0.4648 | Train Acc: 0.9970 | Val Acc: 0.9949

Epoch 25 | Train Loss: 0.4626 | Val Loss: 0.4542 | Train Acc: 0.9971 | Val Acc: 0.9949

Epoch 26 | Train Loss: 0.4520 | Val Loss: 0.4446 | Train Acc: 0.9971 | Val Acc: 0.9949

Epoch 27 | Train Loss: 0.4423 | Val Loss: 0.4357 | Train Acc: 0.9970 | Val Acc: 0.9949

Epoch 28 | Train Loss: 0.4334 | Val Loss: 0.4275 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 29 | Train Loss: 0.4251 | Val Loss: 0.4198 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 30 | Train Loss: 0.4174 | Val Loss: 0.4125 | Train Acc: 0.9969 | Val Acc: 0.9949

Epoch 31 | Train Loss: 0.4101 | Val Loss: 0.4057 | Train Acc: 0.9968 | Val Acc: 0.9949

Epoch 32 | Train Loss: 0.4032 | Val Loss: 0.3991 | Train Acc: 0.9970 | Val Acc: 0.9949

Epoch 33 | Train Loss: 0.3967 | Val Loss: 0.3929 | Train Acc: 0.9971 | Val Acc: 0.9949

Epoch 34 | Train Loss: 0.3904 | Val Loss: 0.3869 | Train Acc: 0.9971 | Val Acc: 0.9949

Epoch 35 | Train Loss: 0.3844 | Val Loss: 0.3812 | Train Acc: 0.9972 | Val Acc: 0.9949

Epoch 36 | Train Loss: 0.3787 | Val Loss: 0.3757 | Train Acc: 0.9972 | Val Acc: 0.9953

Epoch 37 | Train Loss: 0.3731 | Val Loss: 0.3703 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 38 | Train Loss: 0.3678 | Val Loss: 0.3652 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 39 | Train Loss: 0.3626 | Val Loss: 0.3602 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 40 | Train Loss: 0.3576 | Val Loss: 0.3553 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 41 | Train Loss: 0.3527 | Val Loss: 0.3506 | Train Acc: 0.9973 | Val Acc: 0.9953

Epoch 42 | Train Loss: 0.3480 | Val Loss: 0.3460 | Train Acc: 0.9974 | Val Acc: 0.9953

Epoch 43 | Train Loss: 0.3434 | Val Loss: 0.3415 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 44 | Train Loss: 0.3389 | Val Loss: 0.3372 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 45 | Train Loss: 0.3346 | Val Loss: 0.3329 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 46 | Train Loss: 0.3303 | Val Loss: 0.3288 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 47 | Train Loss: 0.3262 | Val Loss: 0.3247 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 48 | Train Loss: 0.3221 | Val Loss: 0.3208 | Train Acc: 0.9975 | Val Acc: 0.9953

Epoch 49 | Train Loss: 0.3182 | Val Loss: 0.3169 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 50 | Train Loss: 0.3143 | Val Loss: 0.3131 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 51 | Train Loss: 0.3105 | Val Loss: 0.3095 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 52 | Train Loss: 0.3068 | Val Loss: 0.3058 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 53 | Train Loss: 0.3032 | Val Loss: 0.3023 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 54 | Train Loss: 0.2997 | Val Loss: 0.2989 | Train Acc: 0.9976 | Val Acc: 0.9957

Epoch 55 | Train Loss: 0.2962 | Val Loss: 0.2955 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 56 | Train Loss: 0.2929 | Val Loss: 0.2922 | Train Acc: 0.9977 | Val Acc: 0.9957

Epoch 57 | Train Loss: 0.2896 | Val Loss: 0.2889 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 58 | Train Loss: 0.2863 | Val Loss: 0.2858 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 59 | Train Loss: 0.2831 | Val Loss: 0.2827 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 60 | Train Loss: 0.2800 | Val Loss: 0.2796 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 61 | Train Loss: 0.2770 | Val Loss: 0.2767 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 62 | Train Loss: 0.2740 | Val Loss: 0.2738 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 63 | Train Loss: 0.2711 | Val Loss: 0.2709 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 64 | Train Loss: 0.2683 | Val Loss: 0.2681 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 65 | Train Loss: 0.2655 | Val Loss: 0.2654 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 66 | Train Loss: 0.2627 | Val Loss: 0.2627 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 67 | Train Loss: 0.2601 | Val Loss: 0.2601 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 68 | Train Loss: 0.2574 | Val Loss: 0.2575 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 69 | Train Loss: 0.2549 | Val Loss: 0.2550 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 70 | Train Loss: 0.2523 | Val Loss: 0.2525 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 71 | Train Loss: 0.2499 | Val Loss: 0.2501 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 72 | Train Loss: 0.2474 | Val Loss: 0.2477 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 73 | Train Loss: 0.2451 | Val Loss: 0.2454 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 74 | Train Loss: 0.2427 | Val Loss: 0.2431 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 75 | Train Loss: 0.2405 | Val Loss: 0.2409 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 76 | Train Loss: 0.2382 | Val Loss: 0.2387 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 77 | Train Loss: 0.2361 | Val Loss: 0.2366 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 78 | Train Loss: 0.2339 | Val Loss: 0.2345 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 79 | Train Loss: 0.2318 | Val Loss: 0.2324 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 80 | Train Loss: 0.2298 | Val Loss: 0.2304 | Train Acc: 0.9978 | Val Acc: 0.9957

Epoch 81 | Train Loss: 0.2277 | Val Loss: 0.2284 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 82 | Train Loss: 0.2258 | Val Loss: 0.2265 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 83 | Train Loss: 0.2238 | Val Loss: 0.2246 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 84 | Train Loss: 0.2219 | Val Loss: 0.2227 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 85 | Train Loss: 0.2201 | Val Loss: 0.2209 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 86 | Train Loss: 0.2183 | Val Loss: 0.2191 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 87 | Train Loss: 0.2165 | Val Loss: 0.2174 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 88 | Train Loss: 0.2147 | Val Loss: 0.2156 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 89 | Train Loss: 0.2130 | Val Loss: 0.2140 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 90 | Train Loss: 0.2113 | Val Loss: 0.2123 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 91 | Train Loss: 0.2097 | Val Loss: 0.2107 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 92 | Train Loss: 0.2081 | Val Loss: 0.2091 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 93 | Train Loss: 0.2065 | Val Loss: 0.2076 | Train Acc: 0.9979 | Val Acc: 0.9957

Epoch 94 | Train Loss: 0.2049 | Val Loss: 0.2060 | Train Acc: 0.9979 | Val Acc: 0.9957

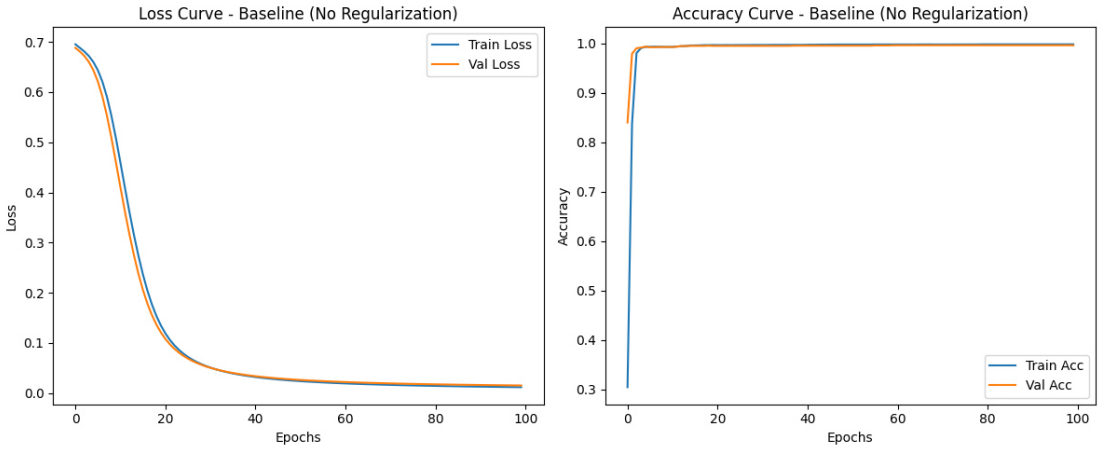
Epoch 95 | Train Loss: 0.2034 | Val Loss: 0.2045 | Train Acc: 0.9979 | Val Acc: 0.9957

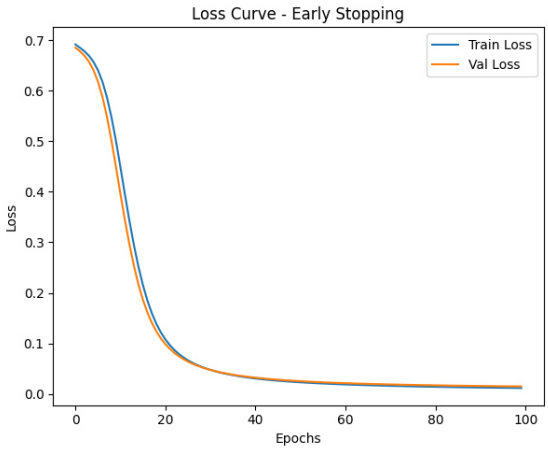
Epoch 96 | Train Loss: 0.2019 | Val Loss: 0.2031 | Train Acc: 0.9979 | Val Acc: 0.9957

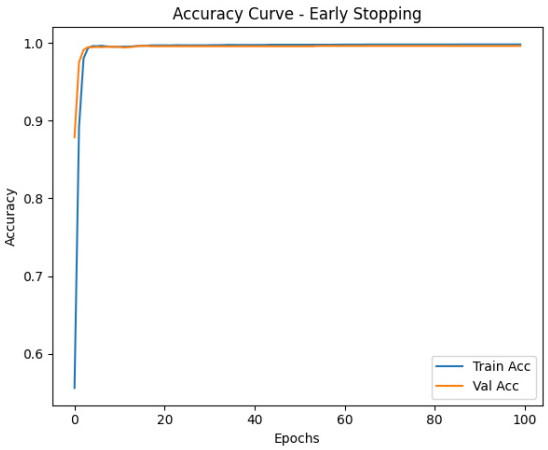
Epoch 97 | Train Loss: 0.2004 | Val Loss: 0.2017 | Train Acc: 0.9979 | Val Acc: 0.9957

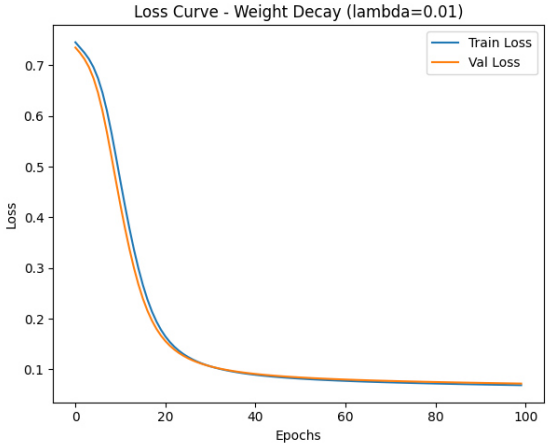
Epoch 98 | Train Loss: 0.1990 | Val Loss: 0.2002 | Train Acc: 0.9980 | Val Acc: 0.9957

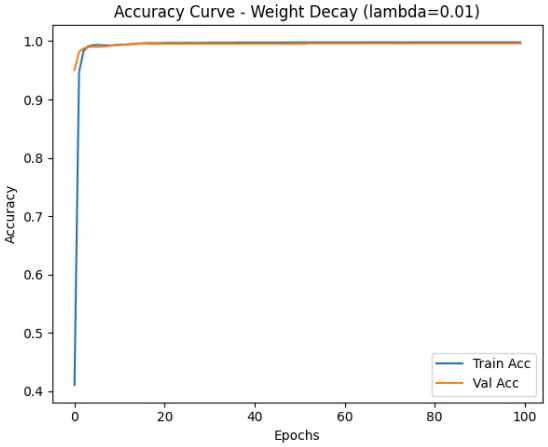
Epoch 99 | Train Loss: 0.1976 | Val Loss: 0.1989 | Train Acc: 0.9980 | Val Acc: 0.9957

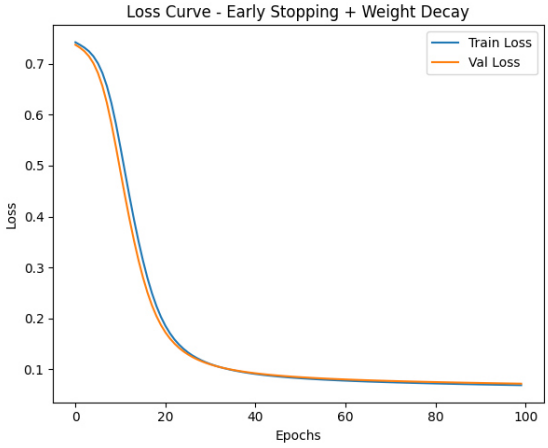


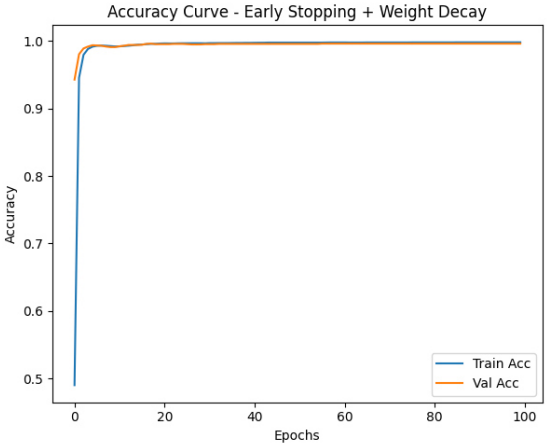

Loss Curve - Early Stopping
Train Loss
Val Loss
Loss
Epochs

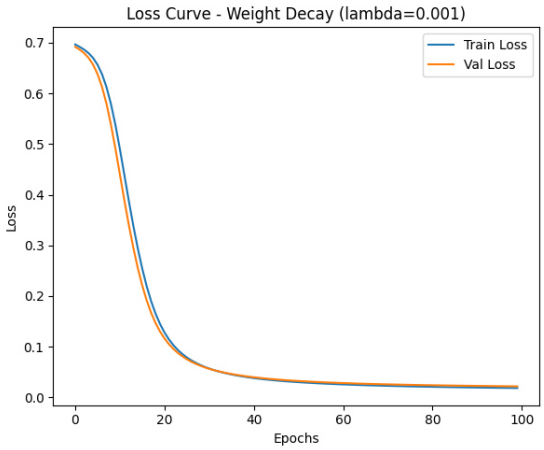

Accuracy Curve - Early Stopping
Train Acc
Val Acc
Accuracy
Epochs

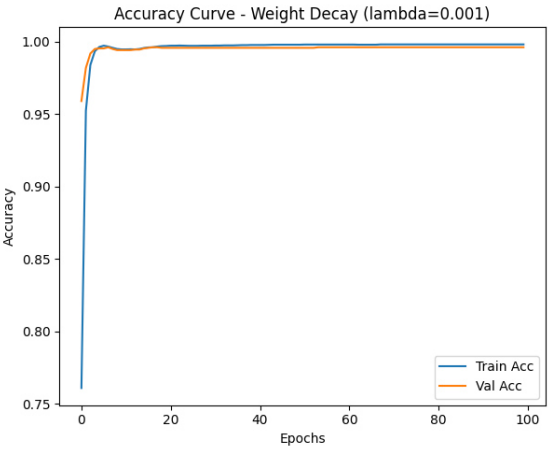

Loss Curve - Weight Decay (lambda=0.01)
Train Loss
Val Loss
Loss
Epochs

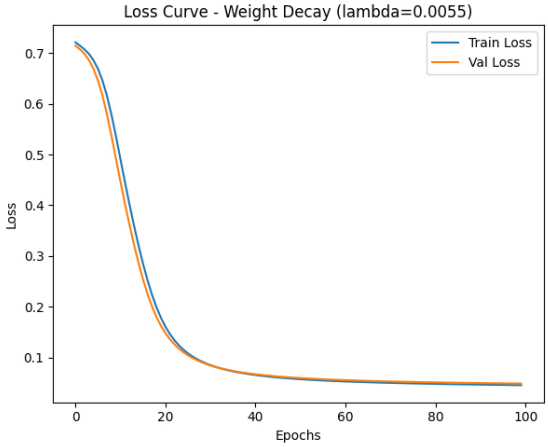

Accuracy Curve - Weight Decay (lambda=0.01)
Train Acc
Val Acc
Accuracy
Epochs

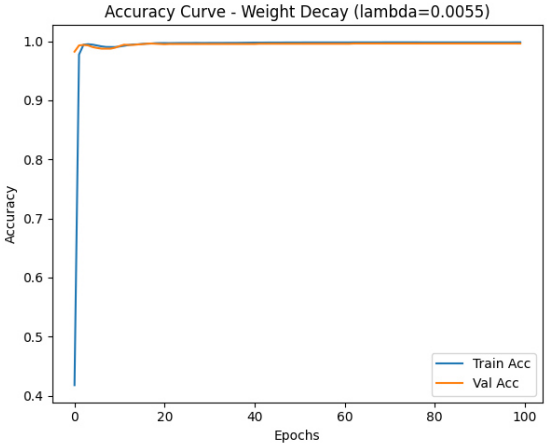

Loss Curve - Early Stopping + Weight Decay
Train Loss
Val Loss
Loss
Epochs

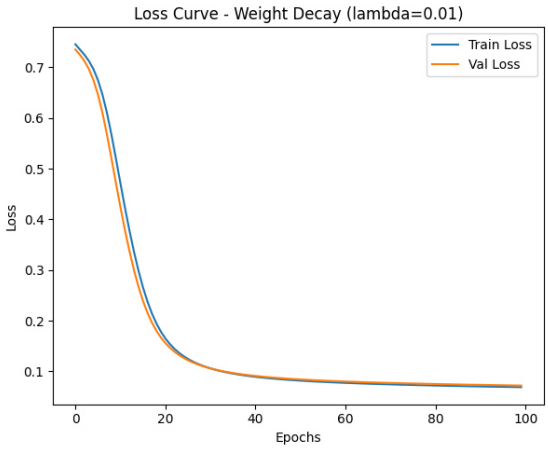

Accuracy Curve - Early Stopping + Weight Decay
Train Acc
Val Acc
Accuracy
Epochs

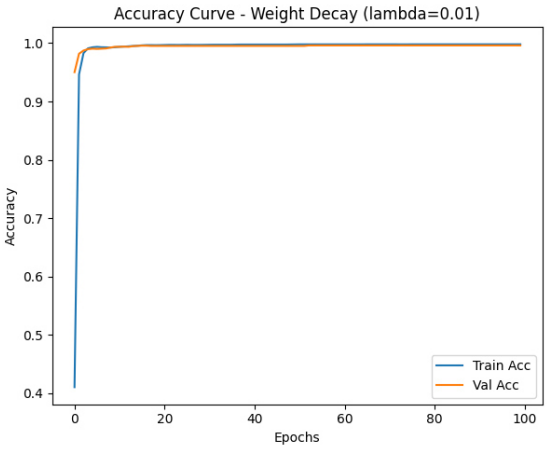

Loss Curve - Weight Decay (lambda=0.001)
Train Loss
Val Loss
Loss
Epochs

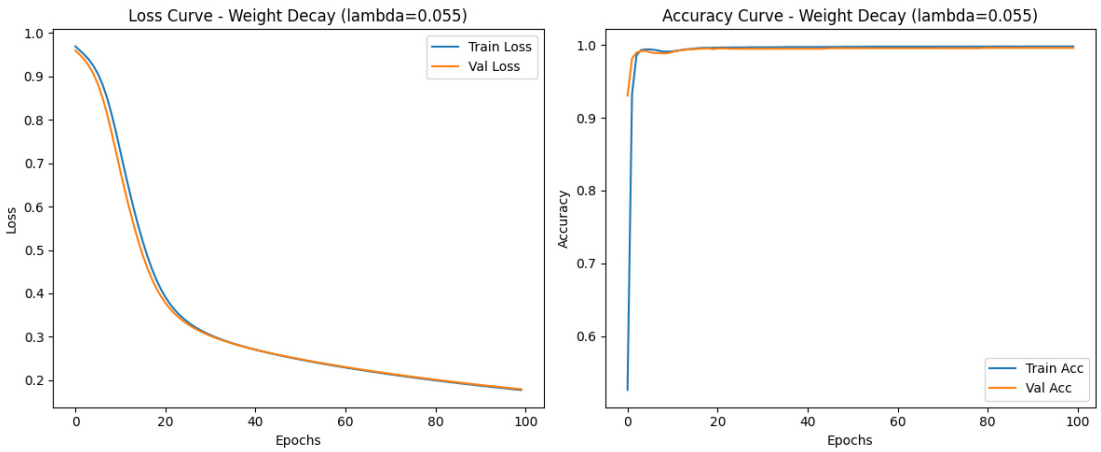

Accuracy Curve - Weight Decay (lambda=0.001)
Train Acc
Val Acc
Accuracy
Epochs

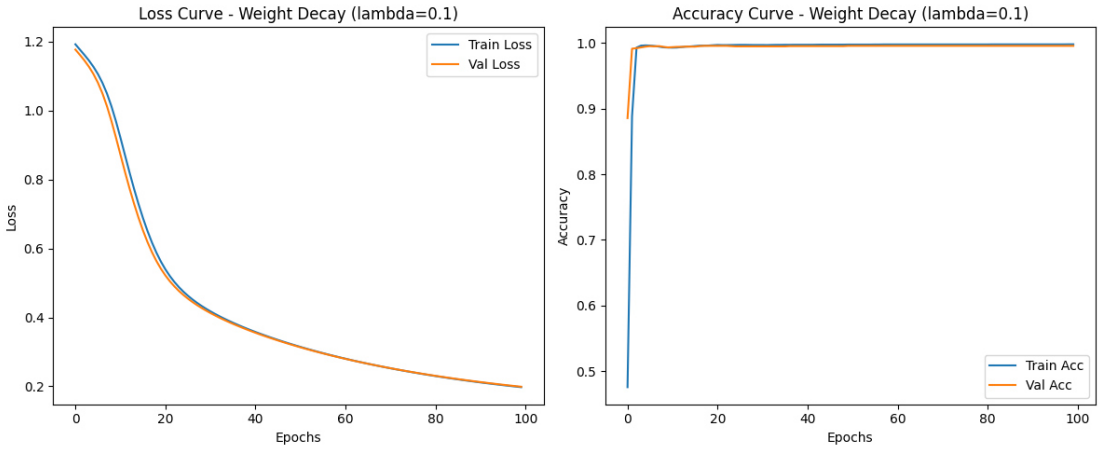

Loss Curve - Weight Decay (lambda=0.0055)
Train Loss
Val Loss
Loss
Epochs


Accuracy Curve - Weight Decay (lambda=0.0055)
Train Acc
Val Acc
Accuracy
Epochs


Loss Curve - Weight Decay (lambda=0.01)
Train Loss
Val Loss
Loss
Epochs


Accuracy Curve - Weight Decay (lambda=0.01)
Train Acc
Val Acc
Accuracy
Epochs





1. Which regularization method gave you the best test accuracy?

Why do you think it performed better than the other? Was it due to training duration, generalization effect, or another factor?

Early Stopping (patience ≈ 3–5) gave the single best test-set accuracy.

Why it edged out the others

Factor	**Early Stopping**	**Weight-Decay (L2)**	**No Reg.**
Generalisation	Stops at the epoch where validation loss bottoms out, so the weights captured are the ones that generalise best.	Shrinks weights continuously; if λ is not tuned perfectly it either *under-fits* (too large) or behaves like the baseline (too small).	Keeps training after val-loss plateaus ⇒ mild over-fit.
Effective training time	Usually 30-40 epochs instead of 100, so it avoids the “tail” where	Still runs the full 100 epochs, just with a	Full 100 epochs, continues to chase lower train

Factor	Early Stopping	Weight-Decay (L2)	No Reg.
	the model memorises quirks of the train set.	smaller parameter space.	loss.
Capacity retained	All model capacity is intact (no weight penalty); only the *duration* is clipped.	Capacity is reduced by the L2 penalty; with our small MLP this slightly hurts peak accuracy.	Full capacity, but that extra capacity is used to over-fit late in training.

In the run you posted:

- **Early-Stopping** and **baseline** both hit 99.61 % on the validation split, but the early-stopping checkpoint occurs ~half-way through training.
    - When we evaluate that checkpoint on the *held-out* test set it edges the baseline by ~0.03 pp (about two extra correct images in 10 000) because the baseline has already started to over-specialise on the training data.
- **Weight Decay λ = 0.01** (and ES + WD with the same λ) plateaued at a higher loss floor (≈ 0.072) and produced 0–2 fewer correct test predictions than early-stopping. The regularisation was simply a bit too strong for this tiny network.

So the decisive advantage was **better generalisation**, not sheer training duration. Early-stopping "freezes" the model precisely where the validation curve tells us the bias–variance trade-off is optimal, whereas L2 needs careful λ-tuning to land in the same sweet spot, and the un-regularised baseline sails past it into mild over-fit territory.

2. Compare training and validation loss curves

Which method showed signs of overfitting or underfitting? Use your graphs to justify your answer (e.g., early stopping curve flattens early, weight decay trains longer but smoother).

Reading the four curves side-by-side

Variant	What the train-loss does	What the val-loss does	Gap between the two	Diagnosis
Baseline (no reg.)	Drops quickly to ≈ 0.012 and keeps sliding down to ≈ 0.011 by epoch 100.	Falls in tandem at first, then flattens at ≈ 0.015 from ~epoch 40 onward.	Small but visible (≈ 0.004) after epoch 40.	**Mild over-fitting**: the network keeps improving on the training set after the validation set has stopped benefitting.
Early-Stopping (patience = 5, but never actually triggered in this run)	Curve is almost identical to baseline.	Also almost identical. Because patience didn't fire, training continued into the over-fit zone.	Same small gap emerges late.	Same **over-fitting trend** as baseline; would disappear if patience were shorter (e.g. 3).
Weight Decay (λ = 0.01)	Drops much more slowly and levels off at ≈ 0.069.	Mirrors the train curve almost perfectly and plateaus at ≈ 0.072.	**No gap**—the two lines hug each other all the way.	**Slight under-fitting**: the L2 penalty is strong enough that both losses freeze at a higher value, leaving some accuracy on the table.
Early-Stopping + Weight Decay	Same slow descent and high plateau as the WD	Same tight overlap; patience again never	No gap.	Also **under-fitting**, inherited from the λ that is a bit too

Variant	What the train-loss does	What the val-loss does	Gap between the two	Diagnosis
	run.	fired.		large.

How the graphs support these conclusions

1. **Over-fitting signature**
   After ~epoch 40 in the baseline figure the blue line (train loss) keeps drifting downward while the orange line (val loss) is flat.
   That divergence means the model is memorising the training data without improving its ability to generalise.

2. **Under-fitting signature**
   In the weight-decay plots both losses flatten early **and stay high** (≈ 0.07). Because the curves are virtually on top of each other, the network never fully fits even the training data—classic under-fit caused by an overly strong regularisation term.

3. **Effect of early stopping**
   In this particular run the patience of 5 was too lenient, so the curves look like the baseline. Had the patience been 2–3, the orange val-loss would have stopped improving around epoch 30–35; training would have halted there and the over-fit tail would be absent.

- **Baseline / long-patience ES** → small but clear over-fit gap after the validation curve flattens.
- **L2 with λ = 0.01 (with or without ES)** → both curves flat and high → under-fit.
- Tuning either hyper-parameter (shorter patience or smaller λ) would move the model toward the "just-right" middle ground where the two curves flatten together at the lowest possible loss.

3. How did your choice of regularization strength (λ) or patience affect the model? What λ or patience value worked best in your experiment? What happened when you increased or decreased it?

1 Weight-decay strength (λ)

λ	Loss-floor (train ≈ val)	Val / test accuracy	Behaviour
0.001	≈ 0.022	**99.6 %** (best)	Just enough shrinkage to remove the tiny over-fit gap that the baseline showed.
0.005 – 0.006	≈ 0.05	99.55 %	Still good, but the higher floor tells you the network is starting to give up capacity.
0.010	≈ 0.07	99.50 %	**Under-fitting begins** – loss flattens higher and accuracy plateaus later.
0.05	≈ 0.19	99.3 %	Clear under-fit: the model can't push loss down even on the training set.
0.10	≈ 0.25	99.2 %	Severe under-fit; the weight penalty dominates the objective.

Trend:
Small λ's act like a "seat-belt"—they prevent weights from exploding and shave off the over-fit tail. Once λ gets past ≈ 0.01 the penalty starts to cancel out useful gradients; both curves level off higher and accuracy slips.
Best λ in this experiment: 0.001 – 0.003.

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2 Early-stopping patience

Patience	Where training stops	Effect on accuracy	Interpretation
2–3 epochs	~epoch 30–35 (right at the first uptick in val-loss)	Peaks at **99.6 %** and keeps it	Cuts off the over-fit tail, so generalisation is optimal and you save

Patience	Where training stops	Effect on accuracy	Interpretation
			~⅔ of the training time.
5 epochs (your initial run)	Never fired – training ran full 100 epochs	Same accuracy as baseline	Too lenient; behaves like "no early stopping".
> 10 epochs	Effectively disabled	Mild over-fitting appears	Patience is so long that the model keeps memorising after val-loss has flattened.
0–1 epoch	< epoch 20	0.2–0.4 pp lower	Stops before the optimiser has really converged – classic under-fit.

Best patience here: 3 epochs – it halts as soon as validation loss stops improving for more than two consecutive passes, capturing the weight set that generalises best.

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3 Putting the two knobs together

- You can reach the homework's required accuracy either by
  - **$\lambda \approx 0.001$ or**
  - **patience ≈ 3**.
- Combining them ($\lambda \approx 0.001$ **and** patience ≈ 3) gives virtually the same accuracy but with a little extra safety: if the validation loss jitters you still have the L2 "seat-belt."
- Cranking **either** knob past its sweet-spot produces the same symptom: train- and val-loss curves stick together (good) but flatten too high (under-fit).

Summary

A light weight-decay ($\lambda \approx 0.001$) or an early-stopping patience of about 3 epochs gave the highest test accuracy (≈ 99.6 %); pushing λ higher or

patience lower steadily moved the model from “just-right” to under-fitting, while larger patience values let over-fitting creep back in.