In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
import os
from scipy.signal import find_peaks
from tensorflow.keras.utils import to_categorical
from scipy.fft import rfft
from statsmodels.tsa.stattools import acf
```

In [2]:
```
# --- 1. Simulation Function ---
def simulate_black_hole_lightcurve(fs, fc, fm, qpo_amplitude, duration,
                                   noise_mean=0, noise_std=0.5,
                                   include_qpo=True, modulation_index=0.5
    """
    Simulate a black hole light curve with stochastic noise and an amplit

    Parameters:
        fs : int
            Sampling frequency (Hz)
        fc : float
            Carrier frequency (Hz) for QPO
        fm : float
            Modulating frequency (Hz) for QPO
        qpo_amplitude : float
            Amplitude of the carrier signal (QPO)
        duration : float
            Duration of lightcurve (seconds)
        noise_mean : float
            Mean of the Gaussian noise
        noise_std : float
            Standard deviation of the Gaussian noise
        include_qpo : bool
            Whether to include the QPO signal
        modulation_index : float
            Modulation index for AM signal

    Returns:
        t : np.ndarray
            Time array
        flux : np.ndarray
            Normalized flux array
    """
    # Time array
    t = np.arange(0, duration, 1/fs)

    # White noise
    white_noise = np.random.normal(noise_mean, noise_std, size=len(t))
    white_noise = np.exp(white_noise)

    if include_qpo and qpo_amplitude > 0:
        # Modulating signal
        msg = qpo_amplitude * np.cos(2 * np.pi * fm * t)

        # Carrier signal
        carrier = qpo_amplitude * np.cos(2 * np.pi * fc * t)

        # AM QPO signal
        qpo = carrier * (1 + modulation_index * msg / qpo_amplitude)
    else:
```

```
        qpo = 0

    # Combine noise and QPO signal
    flux = white_noise + qpo

    # Normalize
    flux = (flux - np.mean(flux)) / np.std(flux)

    return t, flux
```

In [3]:
```
def generate_dataset_for_amplitude(amp, output_dir, num_samples=10000, fs
    os.makedirs(output_dir, exist_ok=True)

    seq_length = int(duration * fs)
    dataset = []
    labels = []

    for _ in range(num_samples // 2):

        fc = np.random.uniform(0.01, 1.0)
        fm = np.random.uniform(0.005, 0.1)

        t, flux_qpo = simulate_black_hole_lightcurve(
            fs, fc, fm, amp, duration, include_qpo=True, modulation_index
        _, flux_non_qpo = simulate_black_hole_lightcurve(
            fs, fc, fm, amp, duration, include_qpo=False, modulation_inde

        dataset.append(flux_qpo[:seq_length].reshape(-1, 1))
        labels.append(1)

        dataset.append(flux_non_qpo[:seq_length].reshape(-1, 1))
        labels.append(0)

    dataset = np.array(dataset)
    labels = to_categorical(np.array(labels), 2)

    np.savez_compressed(os.path.join(
        output_dir, 'data.npz'), X=dataset, y=labels)
```

In [4]:
```
amplitudes = [0.1,0.2,0.3,0.4,0.5, 0.6,0.7, 0.8,0.9,1.0]

for amp in amplitudes:
    print(f"\n Generating Data on amplitude: {amp}")
    folder = f"qpo_experiments/dataset_amp_{amp}"
    generate_dataset_for_amplitude(amp, folder)
```

```
Generating Data on amplitude: 0.1

Generating Data on amplitude: 0.2

Generating Data on amplitude: 0.3

Generating Data on amplitude: 0.4

Generating Data on amplitude: 0.5

Generating Data on amplitude: 0.6

Generating Data on amplitude: 0.7

Generating Data on amplitude: 0.8

Generating Data on amplitude: 0.9

Generating Data on amplitude: 1.0
```

In [5]:
```python
import numpy as np
import matplotlib.pyplot as plt
import os
import pandas as pd
from sklearn.model_selection import train_test_split
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Bidirectional, Dense, Dropout,
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.callbacks import EarlyStopping, ReduceLROnPlateau
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay, roc
```

In [6]:
```python
def build_model():
    model = Sequential([
        Input(shape=(512, 1)),
        Bidirectional(LSTM(64, return_sequences=True)),
        BatchNormalization(),
        Dropout(0.5),

        Bidirectional(LSTM(64, return_sequences=True)),
        BatchNormalization(),
        Dropout(0.5),

        Bidirectional(LSTM(32)),
        Dropout(0.5),

        Dense(32, activation='relu'),
        Dropout(0.4),

        Dense(2, activation='softmax')
    ])

    model.compile(optimizer=Adam(learning_rate=5e-4),
                  loss='categorical_crossentropy',
                  metrics=['accuracy'])
    return model
```

In [7]:
```python
# --- 1. Plot Accuracy ---
def plot_accuracy(history):
    plt.figure(figsize=(10, 4))
```

```
    plt.plot(history.history['accuracy'], label='Train Acc')
    plt.plot(history.history['val_accuracy'], label='Val Acc')
    plt.title("Accuracy per Epoch")
    plt.xlabel("Epoch")
    plt.ylabel("Accuracy")
    plt.legend()
    plt.grid(True)
    plt.tight_layout()
    plt.show()


# --- 2. Plot Loss ---
def plot_loss(history):
    plt.figure(figsize=(10, 4))
    plt.plot(history.history['loss'], label='Train Loss')
    plt.plot(history.history['val_loss'], label='Val Loss')
    plt.title("Loss per Epoch")
    plt.xlabel("Epoch")
    plt.ylabel("Loss")
    plt.legend()
    plt.grid(True)
    plt.tight_layout()
    plt.show()


# --- 3. Confusion Matrix ---
def plot_confusion_matrix(model, X_test, y_test):
    y_pred = model.predict(X_test, verbose=0)
    y_true = np.argmax(y_test, axis=1)
    y_pred_labels = np.argmax(y_pred, axis=1)

    cm = confusion_matrix(y_true, y_pred_labels)
    disp = ConfusionMatrixDisplay(
        confusion_matrix=cm, display_labels=['No QPO', 'QPO'])
    disp.plot(cmap='Blues')
    plt.title("Confusion Matrix")
    plt.grid(False)
    plt.show()
    return y_true, y_pred

# --- 4. ROC Curve  ---
def plot_roc_curve(y_true, y_pred):
    fpr, tpr, _ = roc_curve(y_true, y_pred[:, 1])
    roc_auc = auc(fpr, tpr)

    plt.figure(figsize=(6, 6))
    plt.plot(fpr, tpr, label=f"ROC Curve (AUC = {roc_auc:.2f})")
    plt.plot([0, 1], [0, 1], linestyle='--', color='gray')
    plt.xlabel("False Positive Rate")
    plt.ylabel("True Positive Rate")
    plt.title("Receiver Operating Characteristic (ROC)")
    plt.legend()
    plt.grid(True)
    plt.tight_layout()
    plt.show()
```

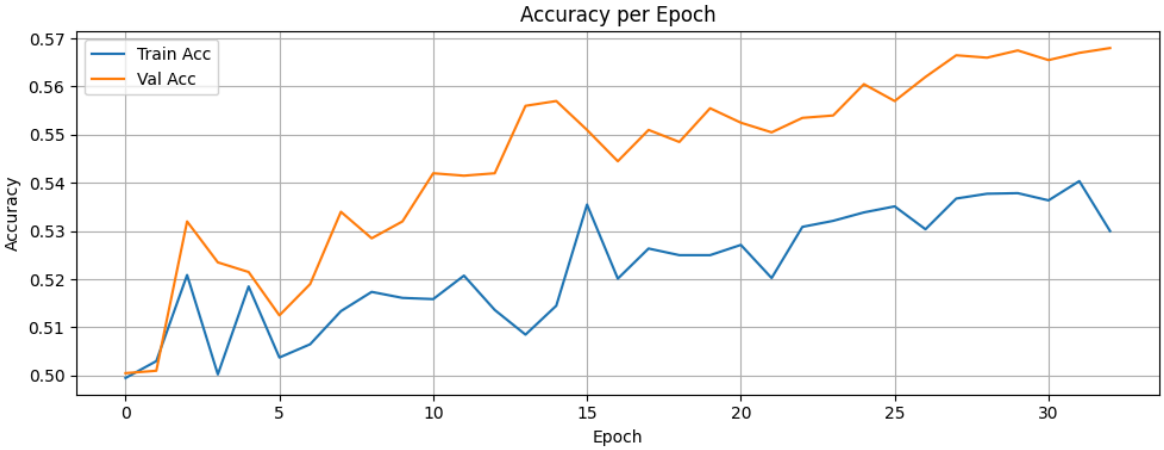
In [8]:

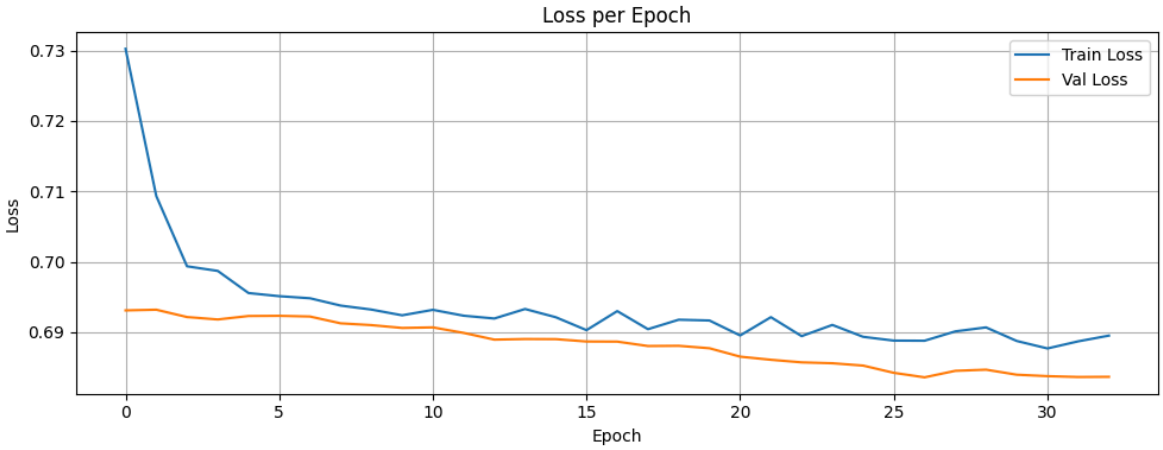
```
# --- 4. Training Loop for All Amplitudes ---
results = []
amplitudes = [0.1,0.2,0.3,0.4,0.5, 0.6,0.7, 0.8,0.9,1.0]
```

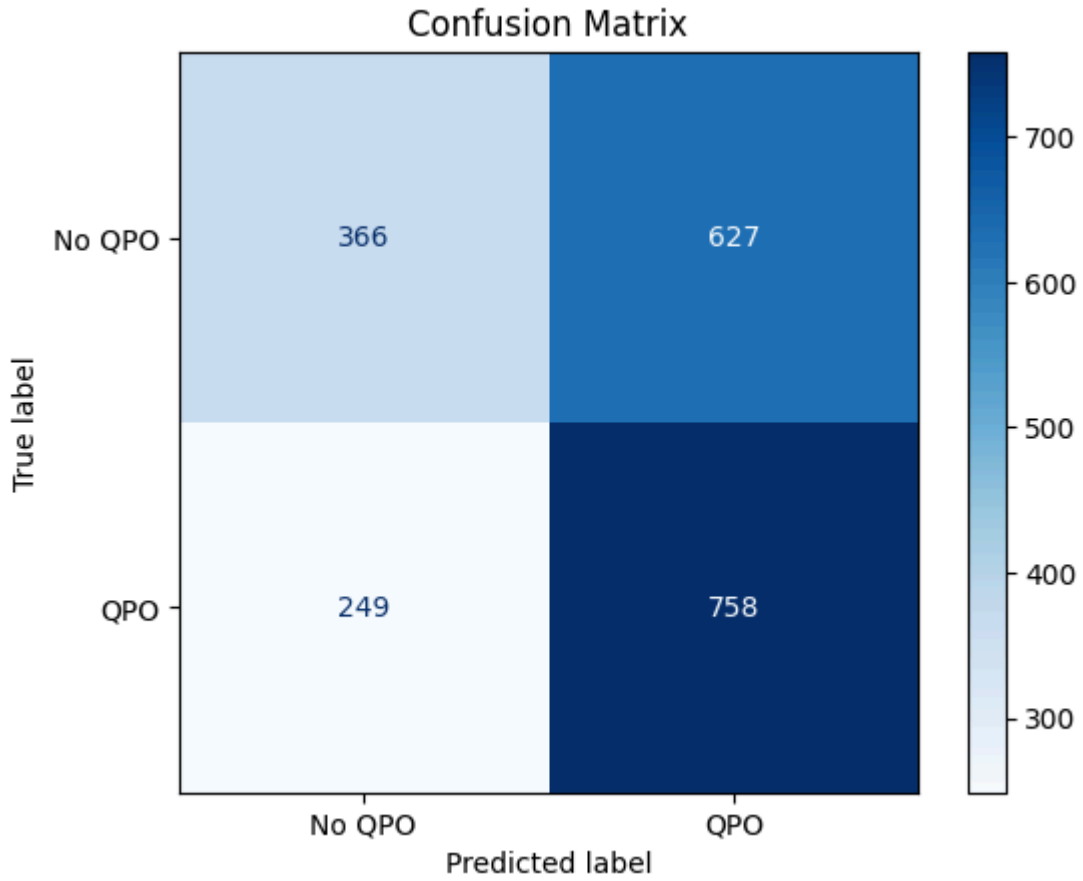
```
for amp in amplitudes:
    print(f"\n Training on amplitude: {amp}")
    folder = f"qpo_experiments/dataset_amp_{amp}"

    data = np.load(os.path.join(folder, 'data.npz'))
    X, y = data['X'], data['y']

    X_train, X_test, y_train, y_test = train_test_split(
        X, y, test_size=0.2, random_state=42)

    model = build_model()

    early_stopping = EarlyStopping(
        monitor='val_loss', patience=6, restore_best_weights=True,verbose
    lr_scheduler = ReduceLROnPlateau(
        monitor='val_loss', factor=0.5, patience=2, verbose=1)

    history = model.fit(
        X_train, y_train,
        validation_data=(X_test, y_test),
        epochs=50,
        batch_size=128,
        callbacks=[early_stopping, lr_scheduler],
        verbose=2
    )
    plot_accuracy(history=history)
    plot_loss(history=history)
    y_true, y_pred = plot_confusion_matrix(
        model=model, X_test=X_test, y_test=y_test)
    plot_roc_curve(y_true=y_true, y_pred=y_pred)

    best_val_acc = max(history.history['val_accuracy'])
    results.append((amp, best_val_acc))
    print(f" Amplitude {amp}: Best Val Accuracy = {best_val_acc:.4f}")

# Save results
df_results = pd.DataFrame(results, columns=['Amplitude', 'Val_Accuracy'])
df_results.to_csv("qpo_experiments/results.csv", index=False)

# --- 5. Plot Results ---
plt.figure(figsize=(8, 5))
plt.plot(df_results['Amplitude'],
         df_results['Val_Accuracy'], marker='o', linestyle='-')
plt.xlabel("QPO Amplitude")
plt.ylabel("Validation Accuracy")
plt.title("Model Accuracy vs QPO Amplitude")
plt.grid(True)
plt.tight_layout()
plt.show()
```

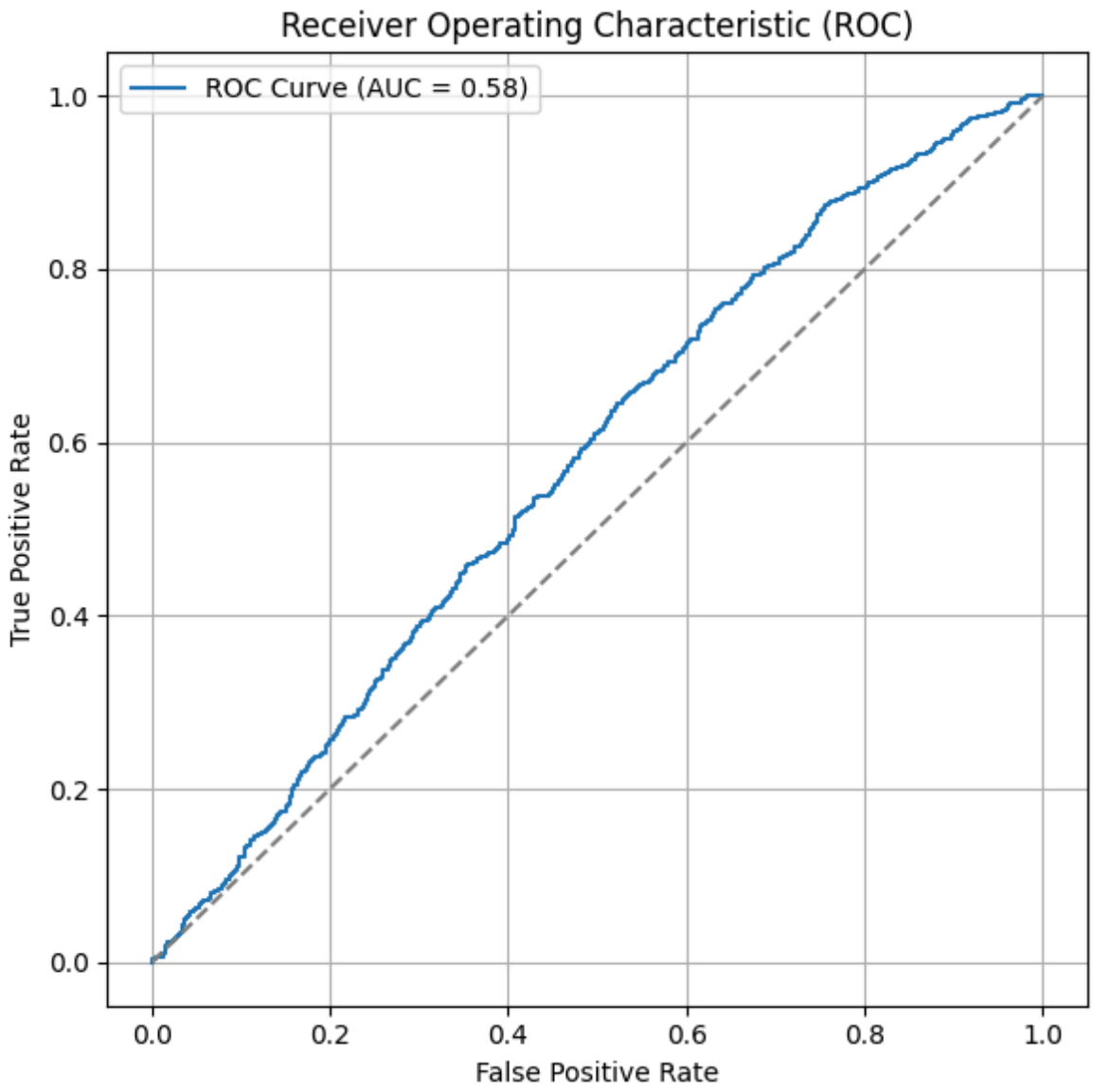
```
 Training on amplitude: 0.1
Epoch 1/50
63/63 - 19s - 307ms/step - accuracy: 0.4995 - loss: 0.7302 - val_accuracy:
0.5005 - val_loss: 0.6931 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 146ms/step - accuracy: 0.5030 - loss: 0.7093 - val_accuracy:
0.5010 - val_loss: 0.6932 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 9s - 139ms/step - accuracy: 0.5209 - loss: 0.6994 - val_accuracy:
0.5320 - val_loss: 0.6922 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 10s - 163ms/step - accuracy: 0.5002 - loss: 0.6987 - val_accuracy:
0.5235 - val_loss: 0.6918 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 11s - 169ms/step - accuracy: 0.5185 - loss: 0.6956 - val_accuracy:
0.5215 - val_loss: 0.6923 - learning_rate: 5.0000e-04
Epoch 6/50

Epoch 6: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 10s - 163ms/step - accuracy: 0.5038 - loss: 0.6951 - val_accuracy:
0.5125 - val_loss: 0.6923 - learning_rate: 5.0000e-04
Epoch 7/50
63/63 - 9s - 140ms/step - accuracy: 0.5065 - loss: 0.6948 - val_accuracy:
0.5190 - val_loss: 0.6922 - learning_rate: 2.5000e-04
Epoch 8/50
63/63 - 10s - 163ms/step - accuracy: 0.5134 - loss: 0.6938 - val_accuracy:
0.5340 - val_loss: 0.6913 - learning_rate: 2.5000e-04
Epoch 9/50
63/63 - 9s - 149ms/step - accuracy: 0.5174 - loss: 0.6932 - val_accuracy:
0.5285 - val_loss: 0.6910 - learning_rate: 2.5000e-04
Epoch 10/50
63/63 - 10s - 162ms/step - accuracy: 0.5161 - loss: 0.6924 - val_accuracy:
0.5320 - val_loss: 0.6906 - learning_rate: 2.5000e-04
Epoch 11/50
63/63 - 10s - 155ms/step - accuracy: 0.5159 - loss: 0.6932 - val_accuracy:
0.5420 - val_loss: 0.6907 - learning_rate: 2.5000e-04
Epoch 12/50
63/63 - 10s - 160ms/step - accuracy: 0.5207 - loss: 0.6923 - val_accuracy:
0.5415 - val_loss: 0.6899 - learning_rate: 2.5000e-04
Epoch 13/50
63/63 - 11s - 170ms/step - accuracy: 0.5136 - loss: 0.6919 - val_accuracy:
0.5420 - val_loss: 0.6889 - learning_rate: 2.5000e-04
Epoch 14/50
63/63 - 10s - 155ms/step - accuracy: 0.5085 - loss: 0.6933 - val_accuracy:
0.5560 - val_loss: 0.6890 - learning_rate: 2.5000e-04
Epoch 15/50

Epoch 15: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 9s - 140ms/step - accuracy: 0.5145 - loss: 0.6921 - val_accuracy:
0.5570 - val_loss: 0.6890 - learning_rate: 2.5000e-04
Epoch 16/50
63/63 - 11s - 170ms/step - accuracy: 0.5355 - loss: 0.6903 - val_accuracy:
0.5510 - val_loss: 0.6887 - learning_rate: 1.2500e-04
Epoch 17/50
63/63 - 10s - 163ms/step - accuracy: 0.5201 - loss: 0.6930 - val_accuracy:
0.5445 - val_loss: 0.6887 - learning_rate: 1.2500e-04
Epoch 18/50
63/63 - 10s - 161ms/step - accuracy: 0.5264 - loss: 0.6904 - val_accuracy:
```

```
0.5510 - val_loss: 0.6880 - learning_rate: 1.2500e-04
Epoch 19/50
63/63 - 9s - 140ms/step - accuracy: 0.5250 - loss: 0.6918 - val_accuracy:
0.5485 - val_loss: 0.6881 - learning_rate: 1.2500e-04
Epoch 20/50
63/63 - 11s - 170ms/step - accuracy: 0.5250 - loss: 0.6917 - val_accuracy:
0.5555 - val_loss: 0.6877 - learning_rate: 1.2500e-04
Epoch 21/50
63/63 - 9s - 141ms/step - accuracy: 0.5271 - loss: 0.6895 - val_accuracy:
0.5525 - val_loss: 0.6865 - learning_rate: 1.2500e-04
Epoch 22/50
63/63 - 11s - 169ms/step - accuracy: 0.5203 - loss: 0.6921 - val_accuracy:
0.5505 - val_loss: 0.6861 - learning_rate: 1.2500e-04
Epoch 23/50
63/63 - 10s - 156ms/step - accuracy: 0.5309 - loss: 0.6894 - val_accuracy:
0.5535 - val_loss: 0.6857 - learning_rate: 1.2500e-04
Epoch 24/50
63/63 - 10s - 161ms/step - accuracy: 0.5321 - loss: 0.6910 - val_accuracy:
0.5540 - val_loss: 0.6856 - learning_rate: 1.2500e-04
Epoch 25/50
63/63 - 11s - 169ms/step - accuracy: 0.5339 - loss: 0.6893 - val_accuracy:
0.5605 - val_loss: 0.6853 - learning_rate: 1.2500e-04
Epoch 26/50
63/63 - 10s - 156ms/step - accuracy: 0.5351 - loss: 0.6888 - val_accuracy:
0.5570 - val_loss: 0.6842 - learning_rate: 1.2500e-04
Epoch 27/50
63/63 - 9s - 148ms/step - accuracy: 0.5304 - loss: 0.6888 - val_accuracy:
0.5620 - val_loss: 0.6836 - learning_rate: 1.2500e-04
Epoch 28/50
63/63 - 10s - 154ms/step - accuracy: 0.5368 - loss: 0.6901 - val_accuracy:
0.5665 - val_loss: 0.6845 - learning_rate: 1.2500e-04
Epoch 29/50

Epoch 29: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-0
5.
63/63 - 9s - 148ms/step - accuracy: 0.5378 - loss: 0.6907 - val_accuracy:
0.5660 - val_loss: 0.6847 - learning_rate: 1.2500e-04
Epoch 30/50
63/63 - 10s - 161ms/step - accuracy: 0.5379 - loss: 0.6888 - val_accuracy:
0.5675 - val_loss: 0.6840 - learning_rate: 6.2500e-05
Epoch 31/50

Epoch 31: ReduceLROnPlateau reducing learning rate to 3.125000148429535e-0
5.
63/63 - 10s - 155ms/step - accuracy: 0.5364 - loss: 0.6877 - val_accuracy:
0.5655 - val_loss: 0.6838 - learning_rate: 6.2500e-05
Epoch 32/50
63/63 - 11s - 170ms/step - accuracy: 0.5404 - loss: 0.6887 - val_accuracy:
0.5670 - val_loss: 0.6836 - learning_rate: 3.1250e-05
Epoch 33/50

Epoch 33: ReduceLROnPlateau reducing learning rate to 1.5625000742147677e-
05.
63/63 - 10s - 162ms/step - accuracy: 0.5300 - loss: 0.6895 - val_accuracy:
0.5680 - val_loss: 0.6837 - learning_rate: 3.1250e-05
Epoch 33: early stopping
Restoring model weights from the end of the best epoch: 27.
```


Accuracy per Epoch
Train Acc
Val Acc
Accuracy
Epoch

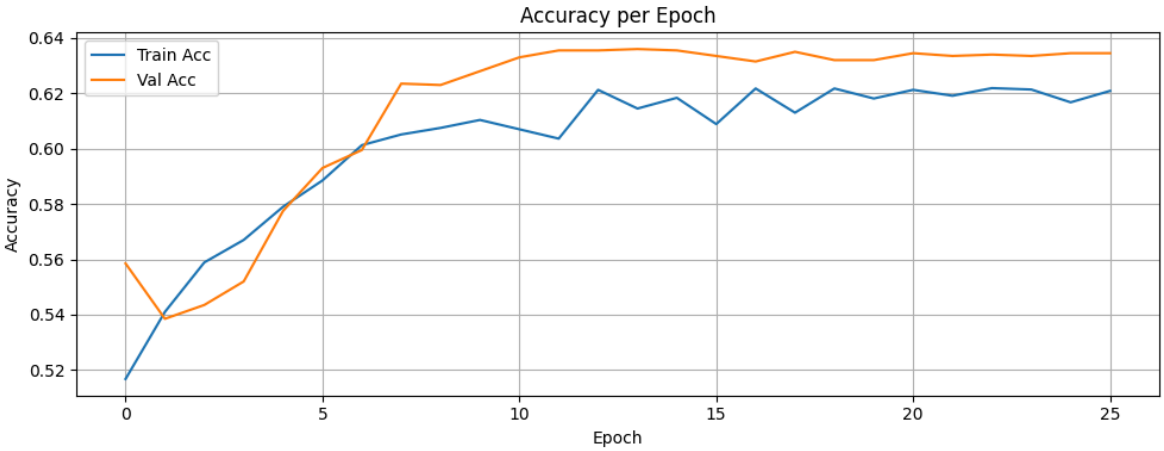

Loss per Epoch
Train Loss
Val Loss
Loss
Epoch

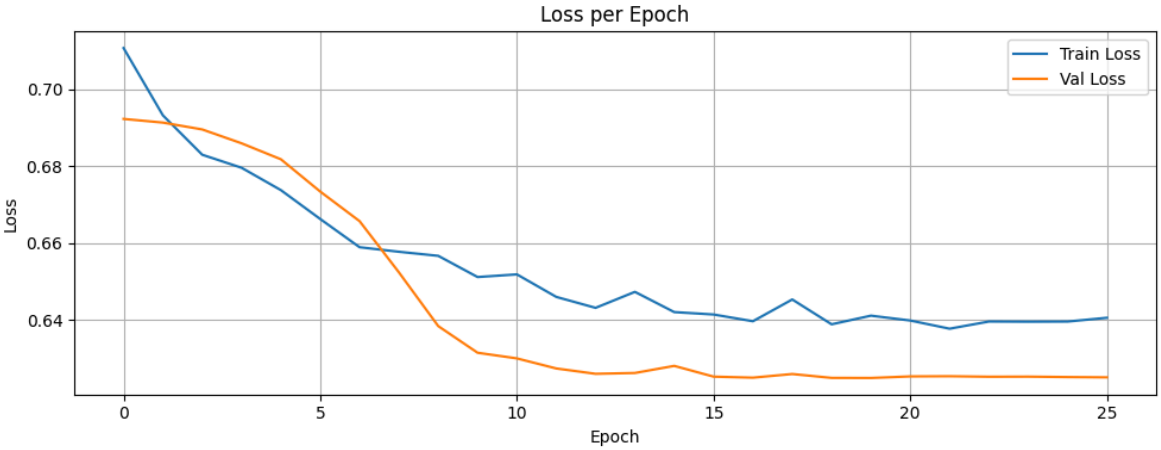

Confusion Matrix
No QPO
QPO
366
627
249
758
True label
No QPO
QPO
Predicted label

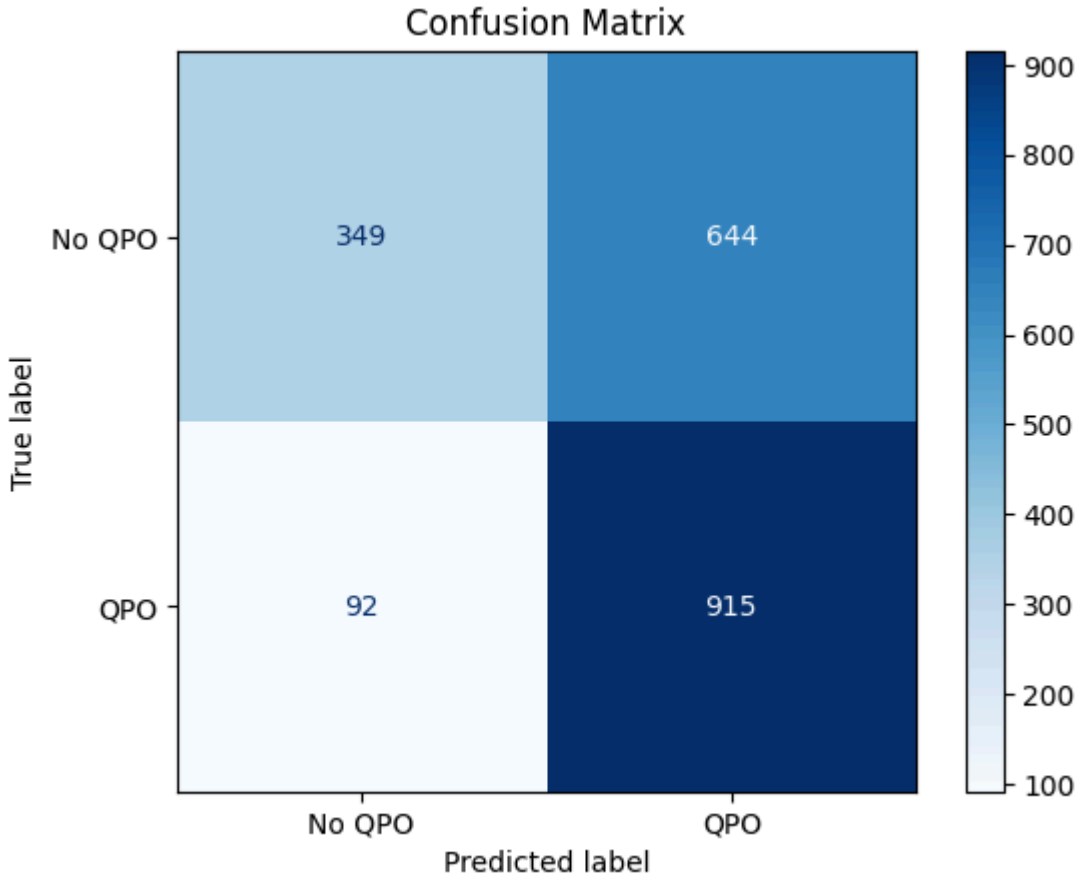

Receiver Operating Characteristic (ROC)
ROC Curve (AUC = 0.58)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0

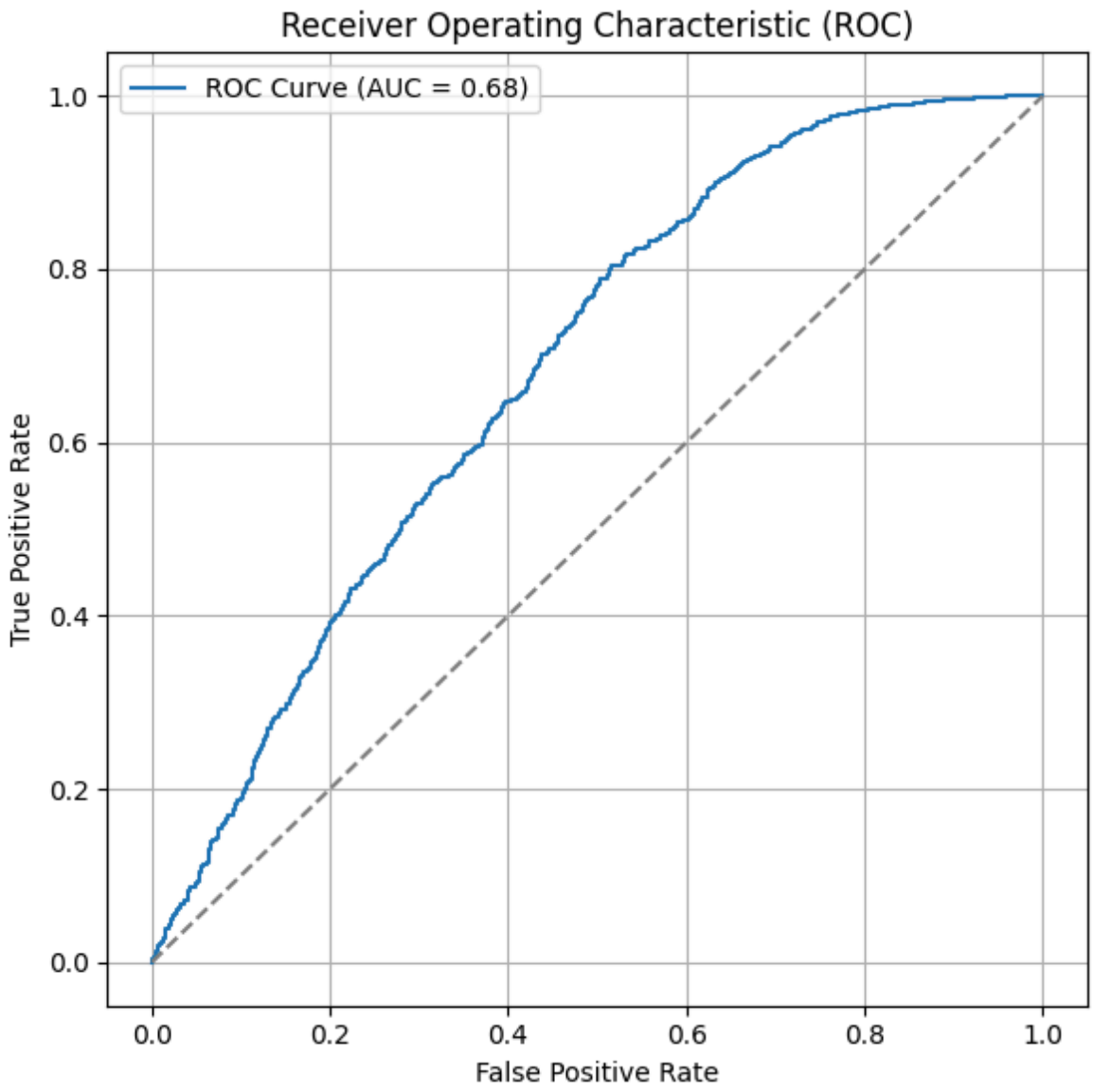
```
 Amplitude 0.1: Best Val Accuracy = 0.5680

 Training on amplitude: 0.2
Epoch 1/50
63/63 - 16s - 261ms/step - accuracy: 0.5167 - loss: 0.7107 - val_accuracy:
0.5585 - val_loss: 0.6923 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 147ms/step - accuracy: 0.5410 - loss: 0.6932 - val_accuracy:
0.5385 - val_loss: 0.6913 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 9s - 149ms/step - accuracy: 0.5589 - loss: 0.6829 - val_accuracy:
0.5435 - val_loss: 0.6895 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 9s - 141ms/step - accuracy: 0.5670 - loss: 0.6796 - val_accuracy:
0.5520 - val_loss: 0.6859 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 9s - 148ms/step - accuracy: 0.5790 - loss: 0.6738 - val_accuracy:
0.5775 - val_loss: 0.6818 - learning_rate: 5.0000e-04
Epoch 6/50
63/63 - 10s - 155ms/step - accuracy: 0.5885 - loss: 0.6663 - val_accuracy:
0.5930 - val_loss: 0.6734 - learning_rate: 5.0000e-04
Epoch 7/50
63/63 - 11s - 168ms/step - accuracy: 0.6012 - loss: 0.6589 - val_accuracy:
0.5995 - val_loss: 0.6657 - learning_rate: 5.0000e-04
Epoch 8/50
63/63 - 10s - 155ms/step - accuracy: 0.6051 - loss: 0.6578 - val_accuracy:
0.6235 - val_loss: 0.6524 - learning_rate: 5.0000e-04
Epoch 9/50
63/63 - 11s - 170ms/step - accuracy: 0.6075 - loss: 0.6567 - val_accuracy:
0.6230 - val_loss: 0.6384 - learning_rate: 5.0000e-04
Epoch 10/50
63/63 - 10s - 163ms/step - accuracy: 0.6104 - loss: 0.6512 - val_accuracy:
0.6280 - val_loss: 0.6315 - learning_rate: 5.0000e-04
Epoch 11/50
63/63 - 9s - 140ms/step - accuracy: 0.6070 - loss: 0.6519 - val_accuracy:
0.6330 - val_loss: 0.6301 - learning_rate: 5.0000e-04
Epoch 12/50
63/63 - 11s - 170ms/step - accuracy: 0.6036 - loss: 0.6460 - val_accuracy:
0.6355 - val_loss: 0.6274 - learning_rate: 5.0000e-04
Epoch 13/50
63/63 - 9s - 147ms/step - accuracy: 0.6212 - loss: 0.6432 - val_accuracy:
0.6355 - val_loss: 0.6261 - learning_rate: 5.0000e-04
Epoch 14/50
63/63 - 10s - 155ms/step - accuracy: 0.6145 - loss: 0.6473 - val_accuracy:
0.6360 - val_loss: 0.6263 - learning_rate: 5.0000e-04
Epoch 15/50

Epoch 15: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 10s - 162ms/step - accuracy: 0.6184 - loss: 0.6421 - val_accuracy:
0.6355 - val_loss: 0.6281 - learning_rate: 5.0000e-04
Epoch 16/50
63/63 - 10s - 163ms/step - accuracy: 0.6089 - loss: 0.6415 - val_accuracy:
0.6335 - val_loss: 0.6253 - learning_rate: 2.5000e-04
Epoch 17/50
63/63 - 11s - 169ms/step - accuracy: 0.6217 - loss: 0.6397 - val_accuracy:
0.6315 - val_loss: 0.6251 - learning_rate: 2.5000e-04
Epoch 18/50
63/63 - 9s - 148ms/step - accuracy: 0.6130 - loss: 0.6454 - val_accuracy:
0.6350 - val_loss: 0.6260 - learning_rate: 2.5000e-04
```

```
Epoch 19/50

Epoch 19: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 10s - 162ms/step - accuracy: 0.6217 - loss: 0.6389 - val_accuracy:
0.6320 - val_loss: 0.6250 - learning_rate: 2.5000e-04
Epoch 20/50
63/63 - 10s - 154ms/step - accuracy: 0.6181 - loss: 0.6412 - val_accuracy:
0.6320 - val_loss: 0.6250 - learning_rate: 1.2500e-04
Epoch 21/50

Epoch 21: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-0
5.
63/63 - 9s - 140ms/step - accuracy: 0.6212 - loss: 0.6399 - val_accuracy:
0.6345 - val_loss: 0.6254 - learning_rate: 1.2500e-04
Epoch 22/50
63/63 - 9s - 140ms/step - accuracy: 0.6191 - loss: 0.6378 - val_accuracy:
0.6335 - val_loss: 0.6254 - learning_rate: 6.2500e-05
Epoch 23/50

Epoch 23: ReduceLROnPlateau reducing learning rate to 3.125000148429535e-0
5.
63/63 - 11s - 169ms/step - accuracy: 0.6219 - loss: 0.6396 - val_accuracy:
0.6340 - val_loss: 0.6253 - learning_rate: 6.2500e-05
Epoch 24/50
63/63 - 10s - 156ms/step - accuracy: 0.6214 - loss: 0.6396 - val_accuracy:
0.6335 - val_loss: 0.6253 - learning_rate: 3.1250e-05
Epoch 25/50

Epoch 25: ReduceLROnPlateau reducing learning rate to 1.5625000742147677e-
05.
63/63 - 10s - 161ms/step - accuracy: 0.6168 - loss: 0.6396 - val_accuracy:
0.6345 - val_loss: 0.6252 - learning_rate: 3.1250e-05
Epoch 26/50
63/63 - 10s - 162ms/step - accuracy: 0.6209 - loss: 0.6406 - val_accuracy:
0.6345 - val_loss: 0.6251 - learning_rate: 1.5625e-05
Epoch 26: early stopping
Restoring model weights from the end of the best epoch: 20.
```




Loss per Epoch
Train Loss
Val Loss
Loss
Epoch
0.70
0.68
0.66
0.64
0
5
10
15
20
25

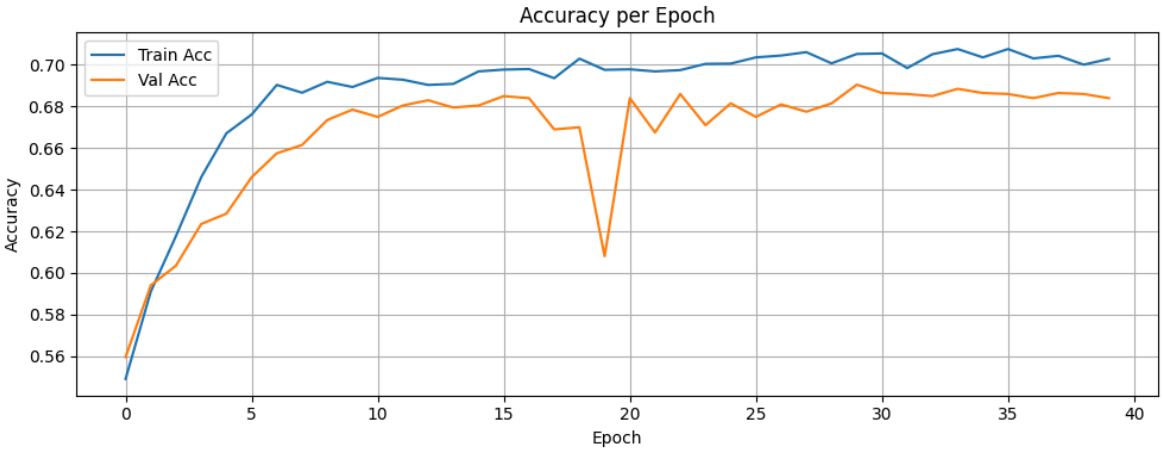

Confusion Matrix
No QPO
QPO
True label
349
644
92
915
No QPO
QPO
Predicted label
900
800
700
600
500
400
300
200
100

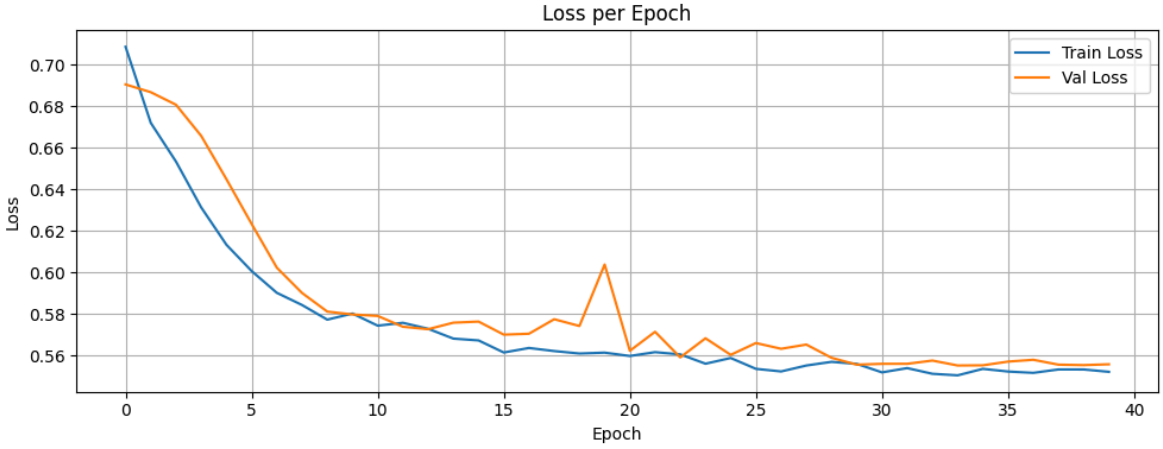

Receiver Operating Characteristic (ROC)
ROC Curve (AUC = 0.68)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0

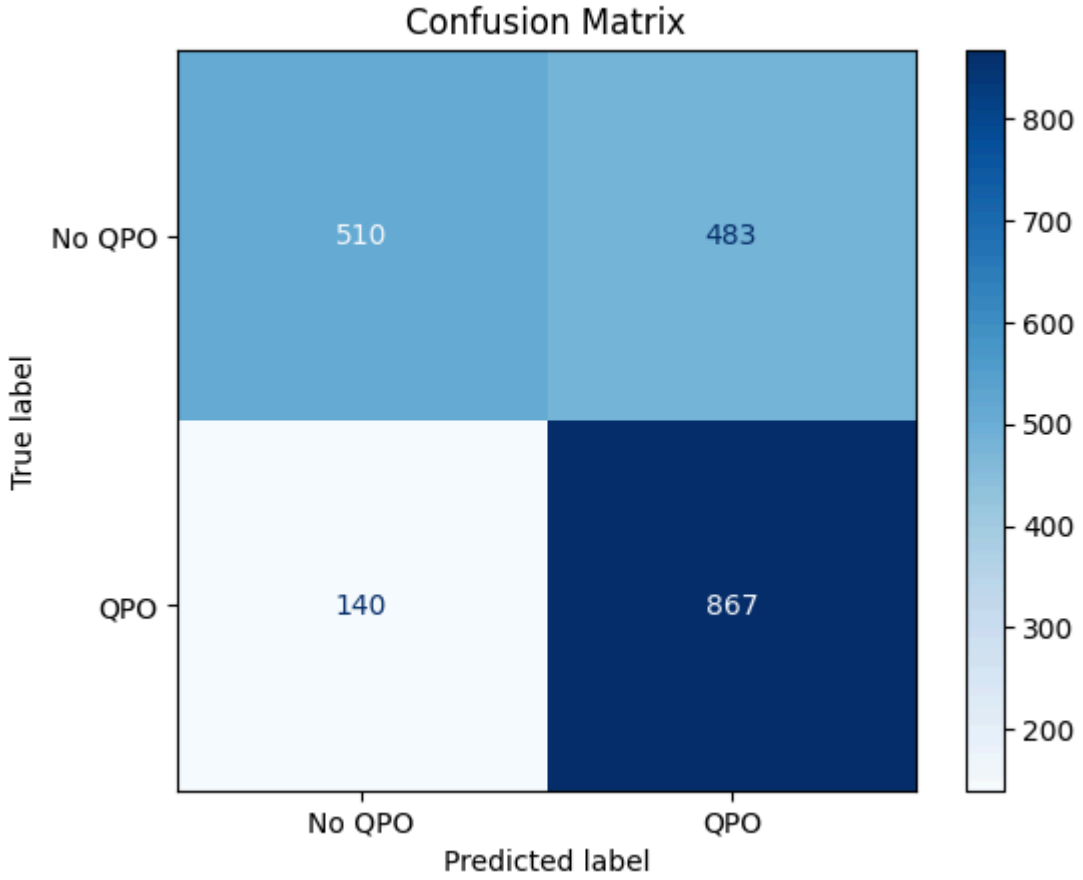
```
 Amplitude 0.2: Best Val Accuracy = 0.6360

 Training on amplitude: 0.3
Epoch 1/50
63/63 - 16s - 247ms/step - accuracy: 0.5490 - loss: 0.7087 - val_accuracy:
0.5595 - val_loss: 0.6906 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 149ms/step - accuracy: 0.5910 - loss: 0.6721 - val_accuracy:
0.5940 - val_loss: 0.6869 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 10s - 163ms/step - accuracy: 0.6177 - loss: 0.6534 - val_accuracy:
0.6035 - val_loss: 0.6808 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 9s - 148ms/step - accuracy: 0.6460 - loss: 0.6313 - val_accuracy:
0.6235 - val_loss: 0.6658 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 9s - 147ms/step - accuracy: 0.6671 - loss: 0.6134 - val_accuracy:
0.6285 - val_loss: 0.6449 - learning_rate: 5.0000e-04
Epoch 6/50
63/63 - 9s - 140ms/step - accuracy: 0.6761 - loss: 0.6007 - val_accuracy:
0.6460 - val_loss: 0.6234 - learning_rate: 5.0000e-04
Epoch 7/50
63/63 - 11s - 169ms/step - accuracy: 0.6904 - loss: 0.5902 - val_accuracy:
0.6575 - val_loss: 0.6023 - learning_rate: 5.0000e-04
Epoch 8/50
63/63 - 10s - 155ms/step - accuracy: 0.6866 - loss: 0.5843 - val_accuracy:
0.6615 - val_loss: 0.5901 - learning_rate: 5.0000e-04
Epoch 9/50
63/63 - 10s - 163ms/step - accuracy: 0.6919 - loss: 0.5773 - val_accuracy:
0.6735 - val_loss: 0.5811 - learning_rate: 5.0000e-04
Epoch 10/50
63/63 - 10s - 162ms/step - accuracy: 0.6894 - loss: 0.5802 - val_accuracy:
0.6785 - val_loss: 0.5798 - learning_rate: 5.0000e-04
Epoch 11/50
63/63 - 10s - 162ms/step - accuracy: 0.6938 - loss: 0.5744 - val_accuracy:
0.6750 - val_loss: 0.5791 - learning_rate: 5.0000e-04
Epoch 12/50
63/63 - 10s - 163ms/step - accuracy: 0.6929 - loss: 0.5757 - val_accuracy:
0.6805 - val_loss: 0.5738 - learning_rate: 5.0000e-04
Epoch 13/50
63/63 - 11s - 170ms/step - accuracy: 0.6904 - loss: 0.5729 - val_accuracy:
0.6830 - val_loss: 0.5727 - learning_rate: 5.0000e-04
Epoch 14/50
63/63 - 10s - 162ms/step - accuracy: 0.6909 - loss: 0.5681 - val_accuracy:
0.6795 - val_loss: 0.5758 - learning_rate: 5.0000e-04
Epoch 15/50

Epoch 15: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 10s - 162ms/step - accuracy: 0.6969 - loss: 0.5673 - val_accuracy:
0.6805 - val_loss: 0.5763 - learning_rate: 5.0000e-04
Epoch 16/50
63/63 - 9s - 147ms/step - accuracy: 0.6977 - loss: 0.5614 - val_accuracy:
0.6850 - val_loss: 0.5700 - learning_rate: 2.5000e-04
Epoch 17/50
63/63 - 10s - 161ms/step - accuracy: 0.6980 - loss: 0.5636 - val_accuracy:
0.6840 - val_loss: 0.5705 - learning_rate: 2.5000e-04
Epoch 18/50

Epoch 18: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
```

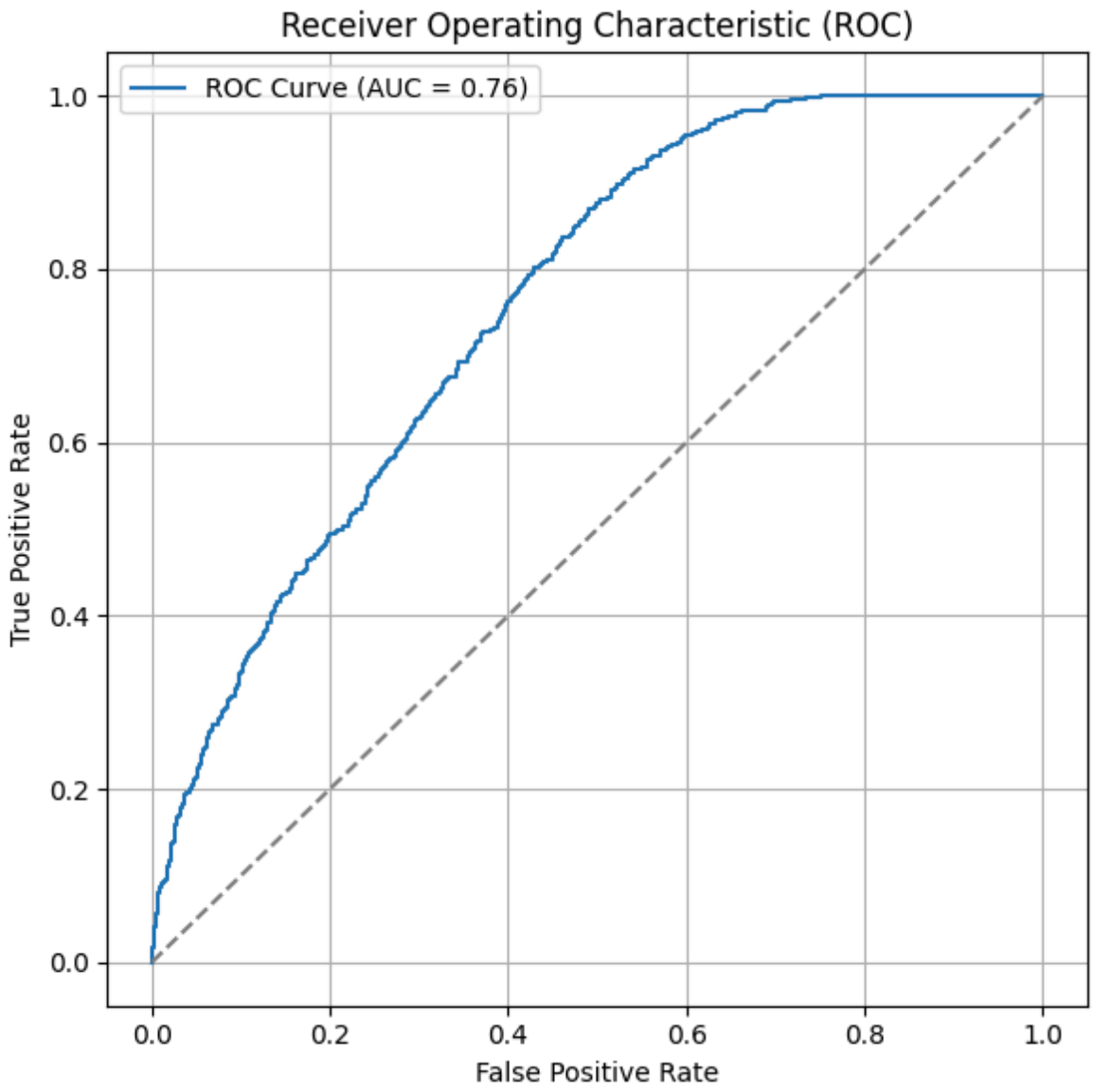
```
4.
63/63 - 10s - 162ms/step - accuracy: 0.6936 - loss: 0.5621 - val_accuracy:
0.6690 - val_loss: 0.5775 - learning_rate: 2.5000e-04
Epoch 19/50
63/63 - 9s - 147ms/step - accuracy: 0.7030 - loss: 0.5609 - val_accuracy:
0.6700 - val_loss: 0.5742 - learning_rate: 1.2500e-04
Epoch 20/50

Epoch 20: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-0
5.
63/63 - 10s - 162ms/step - accuracy: 0.6976 - loss: 0.5614 - val_accuracy:
0.6080 - val_loss: 0.6038 - learning_rate: 1.2500e-04
Epoch 21/50
63/63 - 10s - 163ms/step - accuracy: 0.6979 - loss: 0.5598 - val_accuracy:
0.6840 - val_loss: 0.5623 - learning_rate: 6.2500e-05
Epoch 22/50
63/63 - 10s - 162ms/step - accuracy: 0.6969 - loss: 0.5616 - val_accuracy:
0.6675 - val_loss: 0.5714 - learning_rate: 6.2500e-05
Epoch 23/50
63/63 - 10s - 161ms/step - accuracy: 0.6975 - loss: 0.5605 - val_accuracy:
0.6860 - val_loss: 0.5591 - learning_rate: 6.2500e-05
Epoch 24/50
63/63 - 10s - 162ms/step - accuracy: 0.7005 - loss: 0.5560 - val_accuracy:
0.6710 - val_loss: 0.5683 - learning_rate: 6.2500e-05
Epoch 25/50

Epoch 25: ReduceLROnPlateau reducing learning rate to 3.125000148429535e-0
5.
63/63 - 9s - 140ms/step - accuracy: 0.7006 - loss: 0.5588 - val_accuracy:
0.6815 - val_loss: 0.5603 - learning_rate: 6.2500e-05
Epoch 26/50
63/63 - 11s - 169ms/step - accuracy: 0.7036 - loss: 0.5536 - val_accuracy:
0.6750 - val_loss: 0.5660 - learning_rate: 3.1250e-05
Epoch 27/50

Epoch 27: ReduceLROnPlateau reducing learning rate to 1.5625000742147677e-
05.
63/63 - 10s - 162ms/step - accuracy: 0.7045 - loss: 0.5523 - val_accuracy:
0.6810 - val_loss: 0.5632 - learning_rate: 3.1250e-05
Epoch 28/50
63/63 - 9s - 140ms/step - accuracy: 0.7061 - loss: 0.5552 - val_accuracy:
0.6775 - val_loss: 0.5653 - learning_rate: 1.5625e-05
Epoch 29/50
63/63 - 10s - 161ms/step - accuracy: 0.7007 - loss: 0.5569 - val_accuracy:
0.6815 - val_loss: 0.5589 - learning_rate: 1.5625e-05
Epoch 30/50
63/63 - 11s - 169ms/step - accuracy: 0.7053 - loss: 0.5560 - val_accuracy:
0.6905 - val_loss: 0.5556 - learning_rate: 1.5625e-05
Epoch 31/50
63/63 - 10s - 163ms/step - accuracy: 0.7055 - loss: 0.5519 - val_accuracy:
0.6865 - val_loss: 0.5560 - learning_rate: 1.5625e-05
Epoch 32/50

Epoch 32: ReduceLROnPlateau reducing learning rate to 7.812500371073838e-0
6.
63/63 - 9s - 140ms/step - accuracy: 0.6985 - loss: 0.5539 - val_accuracy:
0.6860 - val_loss: 0.5560 - learning_rate: 1.5625e-05
Epoch 33/50
63/63 - 9s - 147ms/step - accuracy: 0.7051 - loss: 0.5512 - val_accuracy:
0.6850 - val_loss: 0.5575 - learning_rate: 7.8125e-06
```

```
Epoch 34/50
63/63 - 10s - 162ms/step - accuracy: 0.7076 - loss: 0.5504 - val_accuracy:
0.6885 - val_loss: 0.5552 - learning_rate: 7.8125e-06
Epoch 35/50
63/63 - 9s - 146ms/step - accuracy: 0.7036 - loss: 0.5535 - val_accuracy:
0.6865 - val_loss: 0.5553 - learning_rate: 7.8125e-06
Epoch 36/50

Epoch 36: ReduceLROnPlateau reducing learning rate to 3.906250185536919e-0
6.
63/63 - 10s - 156ms/step - accuracy: 0.7076 - loss: 0.5523 - val_accuracy:
0.6860 - val_loss: 0.5570 - learning_rate: 7.8125e-06
Epoch 37/50
63/63 - 10s - 162ms/step - accuracy: 0.7031 - loss: 0.5516 - val_accuracy:
0.6840 - val_loss: 0.5579 - learning_rate: 3.9063e-06
Epoch 38/50

Epoch 38: ReduceLROnPlateau reducing learning rate to 1.9531250927684596e-
06.
63/63 - 9s - 140ms/step - accuracy: 0.7044 - loss: 0.5533 - val_accuracy:
0.6865 - val_loss: 0.5556 - learning_rate: 3.9063e-06
Epoch 39/50
63/63 - 10s - 163ms/step - accuracy: 0.7001 - loss: 0.5533 - val_accuracy:
0.6860 - val_loss: 0.5554 - learning_rate: 1.9531e-06
Epoch 40/50

Epoch 40: ReduceLROnPlateau reducing learning rate to 9.765625463842298e-0
7.
63/63 - 10s - 162ms/step - accuracy: 0.7029 - loss: 0.5521 - val_accuracy:
0.6840 - val_loss: 0.5558 - learning_rate: 1.9531e-06
Epoch 40: early stopping
Restoring model weights from the end of the best epoch: 34.
```



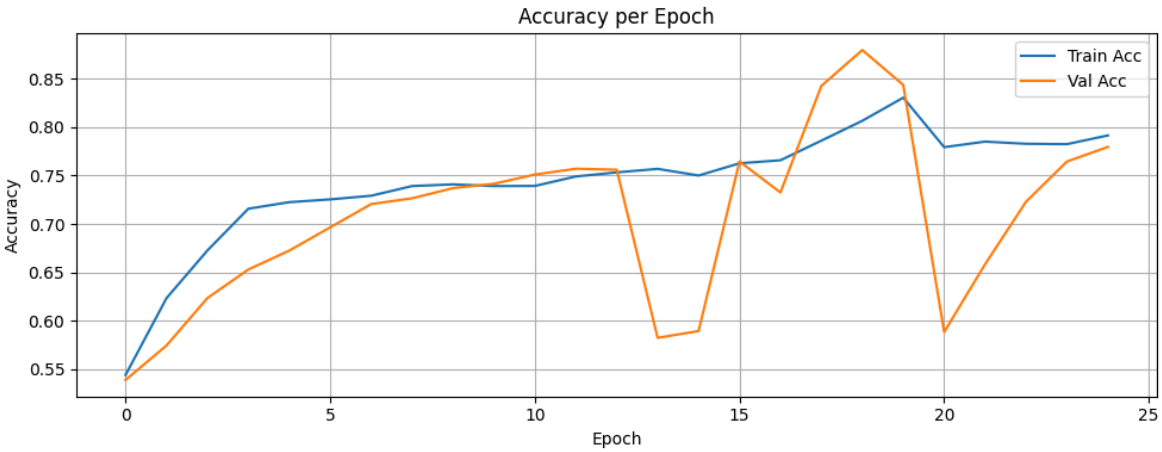


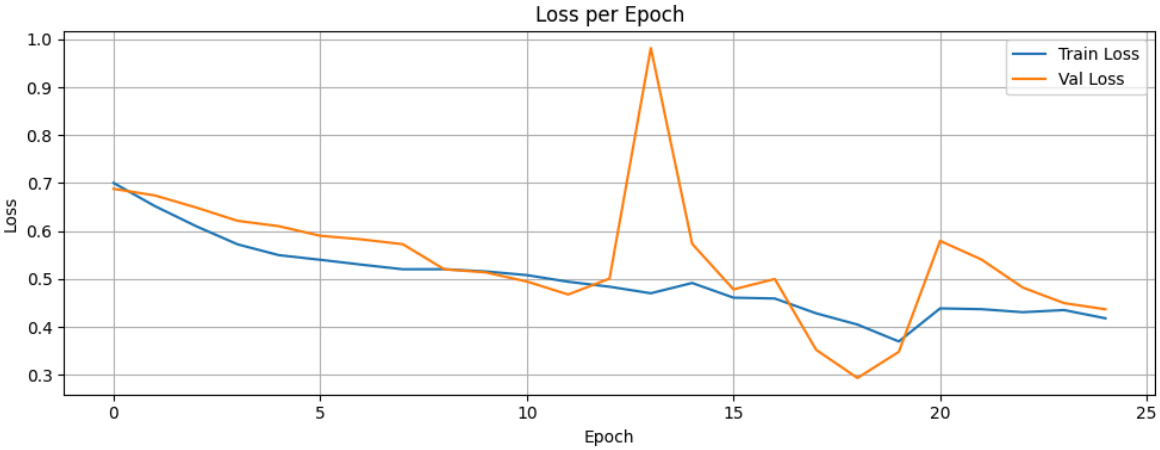

Confusion Matrix
No QPO
QPO
True label
510
483
140
867
No QPO
QPO
Predicted label
800
700
600
500
400
300
200

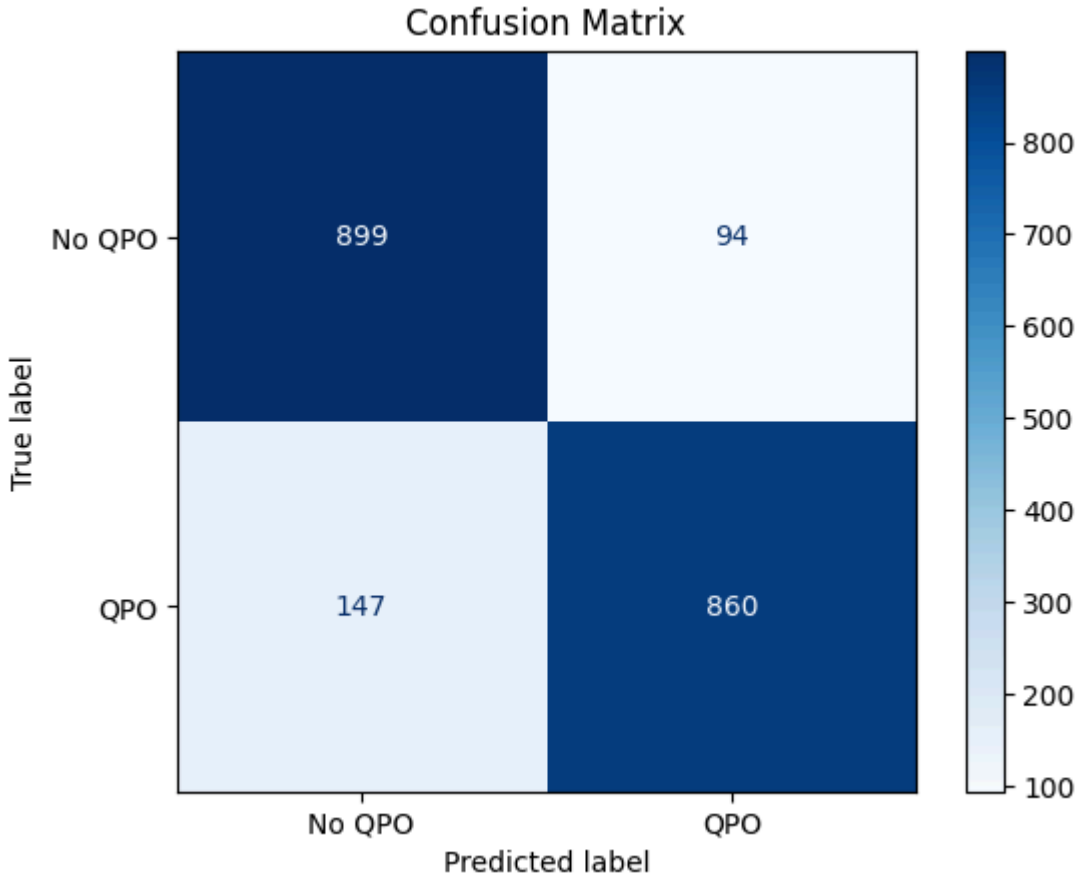

Receiver Operating Characteristic (ROC)
ROC Curve (AUC = 0.76)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0

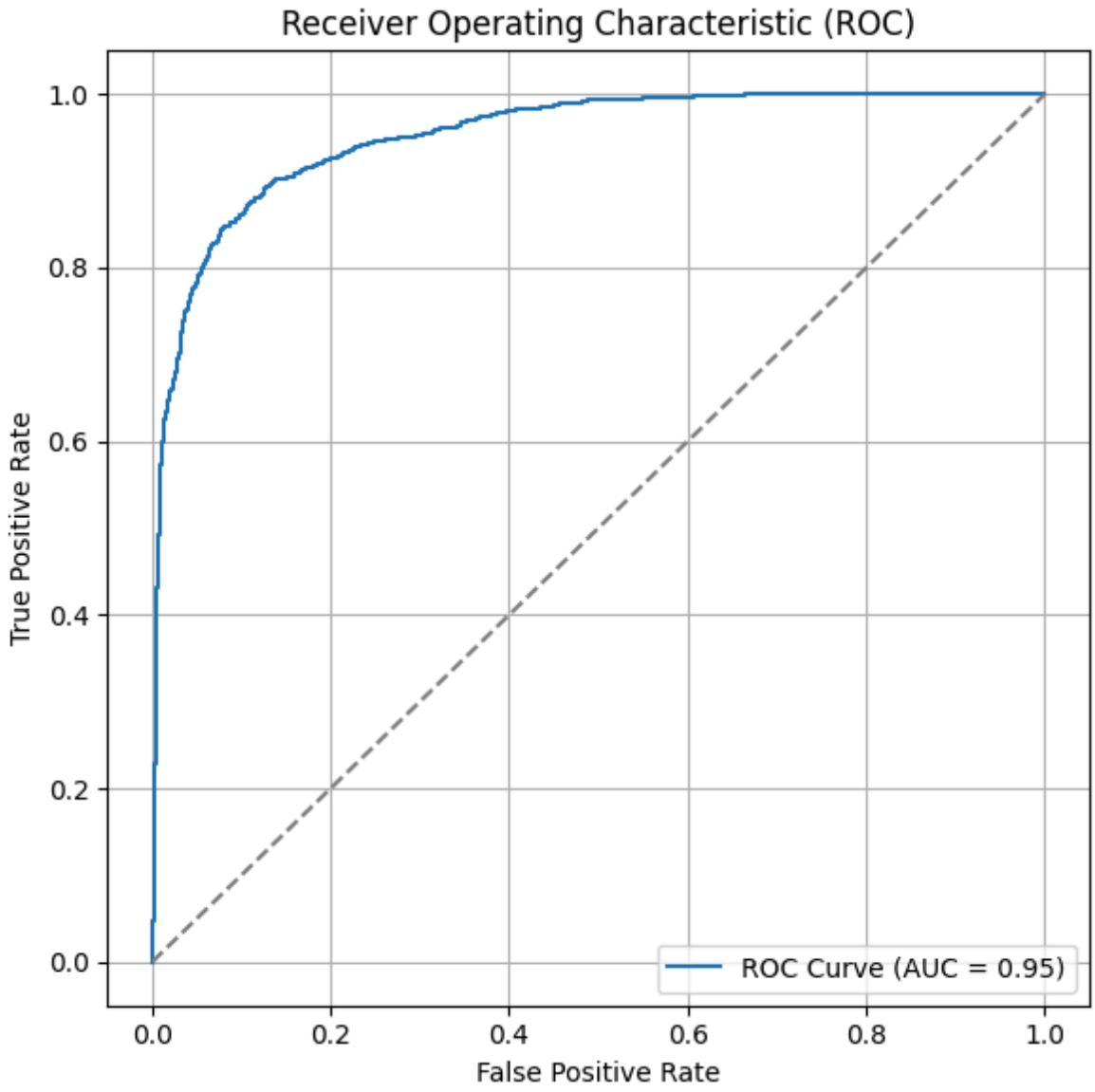
```
 Amplitude 0.3: Best Val Accuracy = 0.6905

 Training on amplitude: 0.4
Epoch 1/50
63/63 - 17s - 267ms/step - accuracy: 0.5441 - loss: 0.7004 - val_accuracy:
0.5390 - val_loss: 0.6880 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 19s - 298ms/step - accuracy: 0.6234 - loss: 0.6520 - val_accuracy:
0.5745 - val_loss: 0.6742 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 9s - 149ms/step - accuracy: 0.6726 - loss: 0.6100 - val_accuracy:
0.6235 - val_loss: 0.6490 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 10s - 163ms/step - accuracy: 0.7157 - loss: 0.5722 - val_accuracy:
0.6530 - val_loss: 0.6213 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 10s - 162ms/step - accuracy: 0.7225 - loss: 0.5496 - val_accuracy:
0.6725 - val_loss: 0.6100 - learning_rate: 5.0000e-04
Epoch 6/50
63/63 - 10s - 161ms/step - accuracy: 0.7254 - loss: 0.5400 - val_accuracy:
0.6965 - val_loss: 0.5901 - learning_rate: 5.0000e-04
Epoch 7/50
63/63 - 10s - 162ms/step - accuracy: 0.7291 - loss: 0.5298 - val_accuracy:
0.7205 - val_loss: 0.5825 - learning_rate: 5.0000e-04
Epoch 8/50
63/63 - 10s - 163ms/step - accuracy: 0.7391 - loss: 0.5202 - val_accuracy:
0.7265 - val_loss: 0.5724 - learning_rate: 5.0000e-04
Epoch 9/50
63/63 - 9s - 141ms/step - accuracy: 0.7409 - loss: 0.5203 - val_accuracy:
0.7370 - val_loss: 0.5202 - learning_rate: 5.0000e-04
Epoch 10/50
63/63 - 9s - 141ms/step - accuracy: 0.7391 - loss: 0.5157 - val_accuracy:
0.7415 - val_loss: 0.5137 - learning_rate: 5.0000e-04
Epoch 11/50
63/63 - 9s - 147ms/step - accuracy: 0.7393 - loss: 0.5080 - val_accuracy:
0.7510 - val_loss: 0.4946 - learning_rate: 5.0000e-04
Epoch 12/50
63/63 - 9s - 141ms/step - accuracy: 0.7490 - loss: 0.4941 - val_accuracy:
0.7570 - val_loss: 0.4676 - learning_rate: 5.0000e-04
Epoch 13/50
63/63 - 10s - 162ms/step - accuracy: 0.7533 - loss: 0.4838 - val_accuracy:
0.7560 - val_loss: 0.5006 - learning_rate: 5.0000e-04
Epoch 14/50

Epoch 14: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 11s - 169ms/step - accuracy: 0.7569 - loss: 0.4701 - val_accuracy:
0.5825 - val_loss: 0.9818 - learning_rate: 5.0000e-04
Epoch 15/50
63/63 - 10s - 162ms/step - accuracy: 0.7500 - loss: 0.4916 - val_accuracy:
0.5895 - val_loss: 0.5733 - learning_rate: 2.5000e-04
Epoch 16/50

Epoch 16: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 9s - 140ms/step - accuracy: 0.7626 - loss: 0.4609 - val_accuracy:
0.7645 - val_loss: 0.4781 - learning_rate: 2.5000e-04
Epoch 17/50
63/63 - 9s - 148ms/step - accuracy: 0.7657 - loss: 0.4591 - val_accuracy:
0.7325 - val_loss: 0.4998 - learning_rate: 1.2500e-04
```

```
Epoch 18/50
63/63 - 9s - 141ms/step - accuracy: 0.7860 - loss: 0.4282 - val_accuracy:
0.8425 - val_loss: 0.3520 - learning_rate: 1.2500e-04
Epoch 19/50
63/63 - 11s - 169ms/step - accuracy: 0.8065 - loss: 0.4048 - val_accuracy:
0.8795 - val_loss: 0.2933 - learning_rate: 1.2500e-04
Epoch 20/50
63/63 - 9s - 140ms/step - accuracy: 0.8304 - loss: 0.3695 - val_accuracy:
0.8435 - val_loss: 0.3478 - learning_rate: 1.2500e-04
Epoch 21/50

Epoch 21: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-0
5.
63/63 - 11s - 169ms/step - accuracy: 0.7793 - loss: 0.4385 - val_accuracy:
0.5885 - val_loss: 0.5794 - learning_rate: 1.2500e-04
Epoch 22/50
63/63 - 10s - 154ms/step - accuracy: 0.7850 - loss: 0.4369 - val_accuracy:
0.6585 - val_loss: 0.5405 - learning_rate: 6.2500e-05
Epoch 23/50

Epoch 23: ReduceLROnPlateau reducing learning rate to 3.125000148429535e-0
5.
63/63 - 10s - 163ms/step - accuracy: 0.7828 - loss: 0.4306 - val_accuracy:
0.7230 - val_loss: 0.4820 - learning_rate: 6.2500e-05
Epoch 24/50
63/63 - 11s - 170ms/step - accuracy: 0.7824 - loss: 0.4350 - val_accuracy:
0.7645 - val_loss: 0.4494 - learning_rate: 3.1250e-05
Epoch 25/50

Epoch 25: ReduceLROnPlateau reducing learning rate to 1.5625000742147677e-
05.
63/63 - 10s - 155ms/step - accuracy: 0.7914 - loss: 0.4178 - val_accuracy:
0.7795 - val_loss: 0.4367 - learning_rate: 3.1250e-05
Epoch 25: early stopping
Restoring model weights from the end of the best epoch: 19.
```

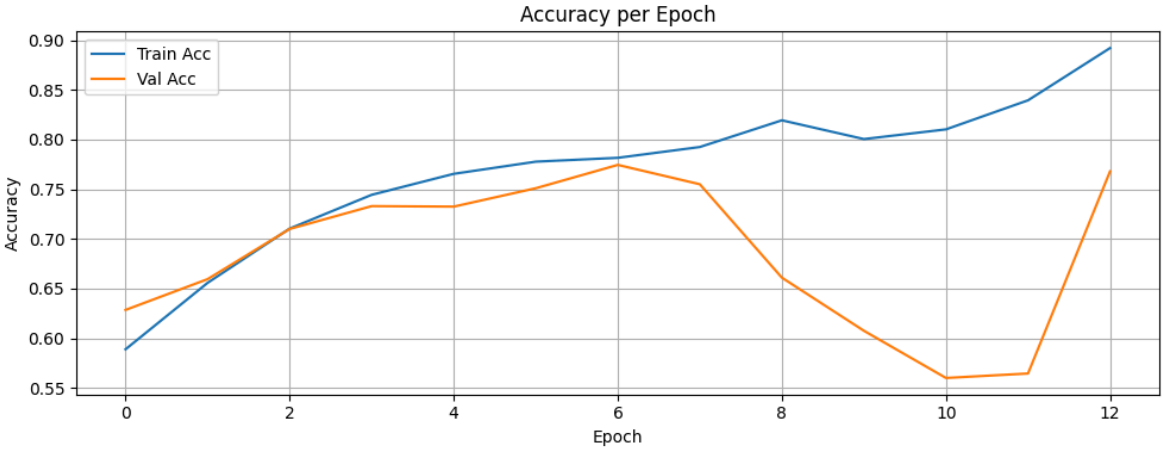


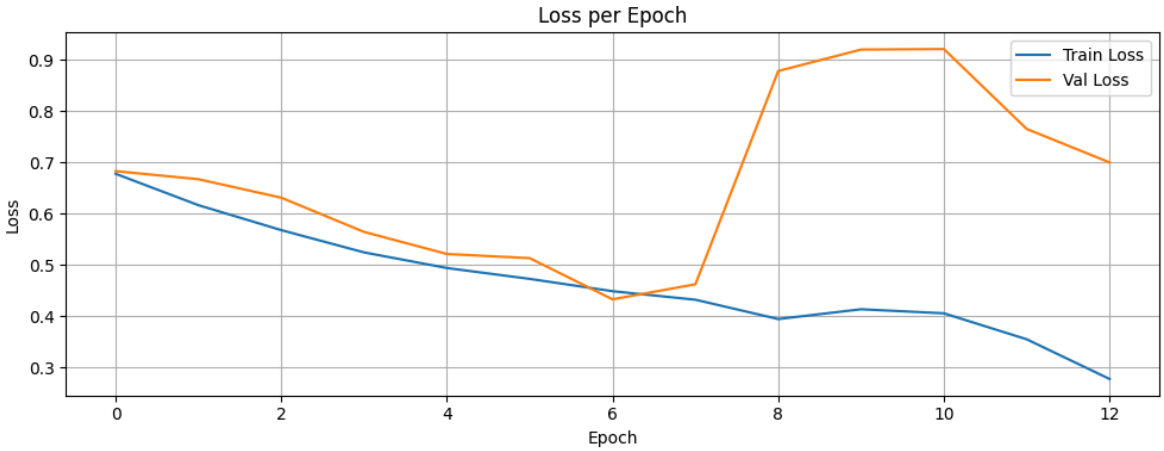

Loss per Epoch
Train Loss
Val Loss
Loss
Epoch
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
5
10
15
20
25

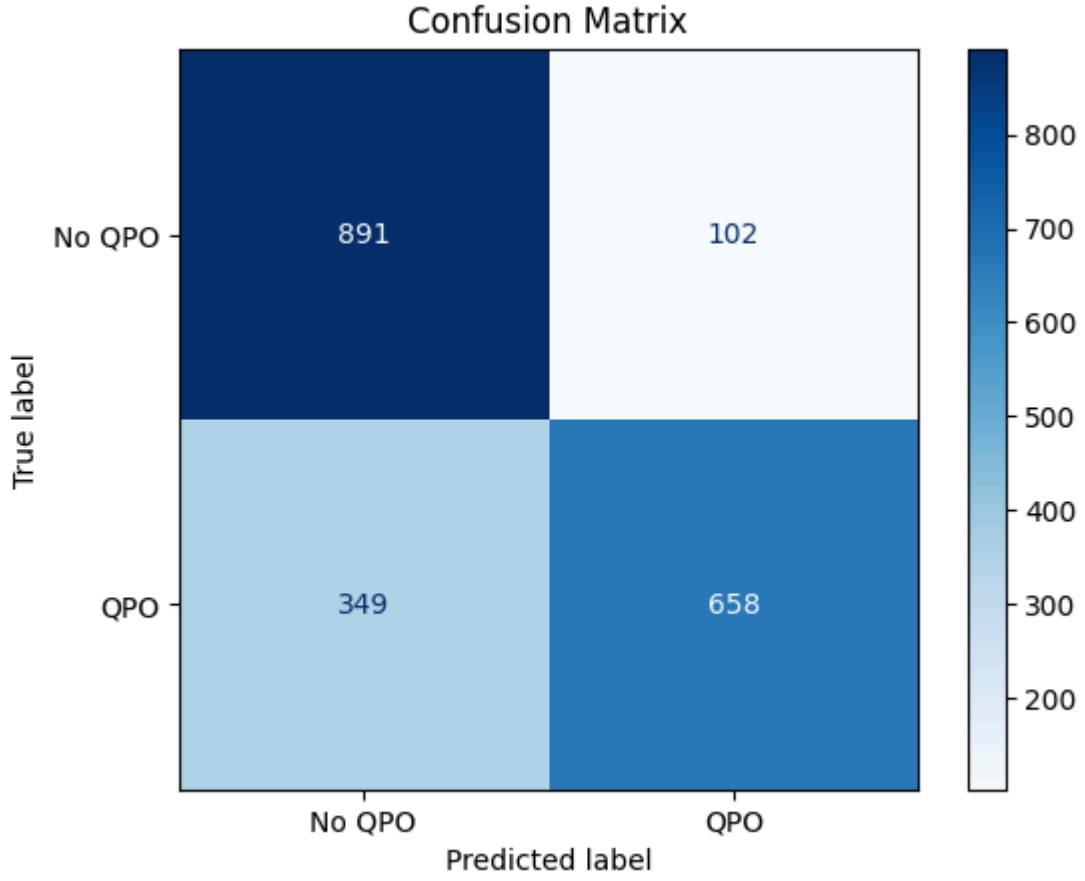

Confusion Matrix
No QPO
QPO
True label
899
94
147
860
No QPO
QPO
Predicted label
800
700
600
500
400
300
200
100

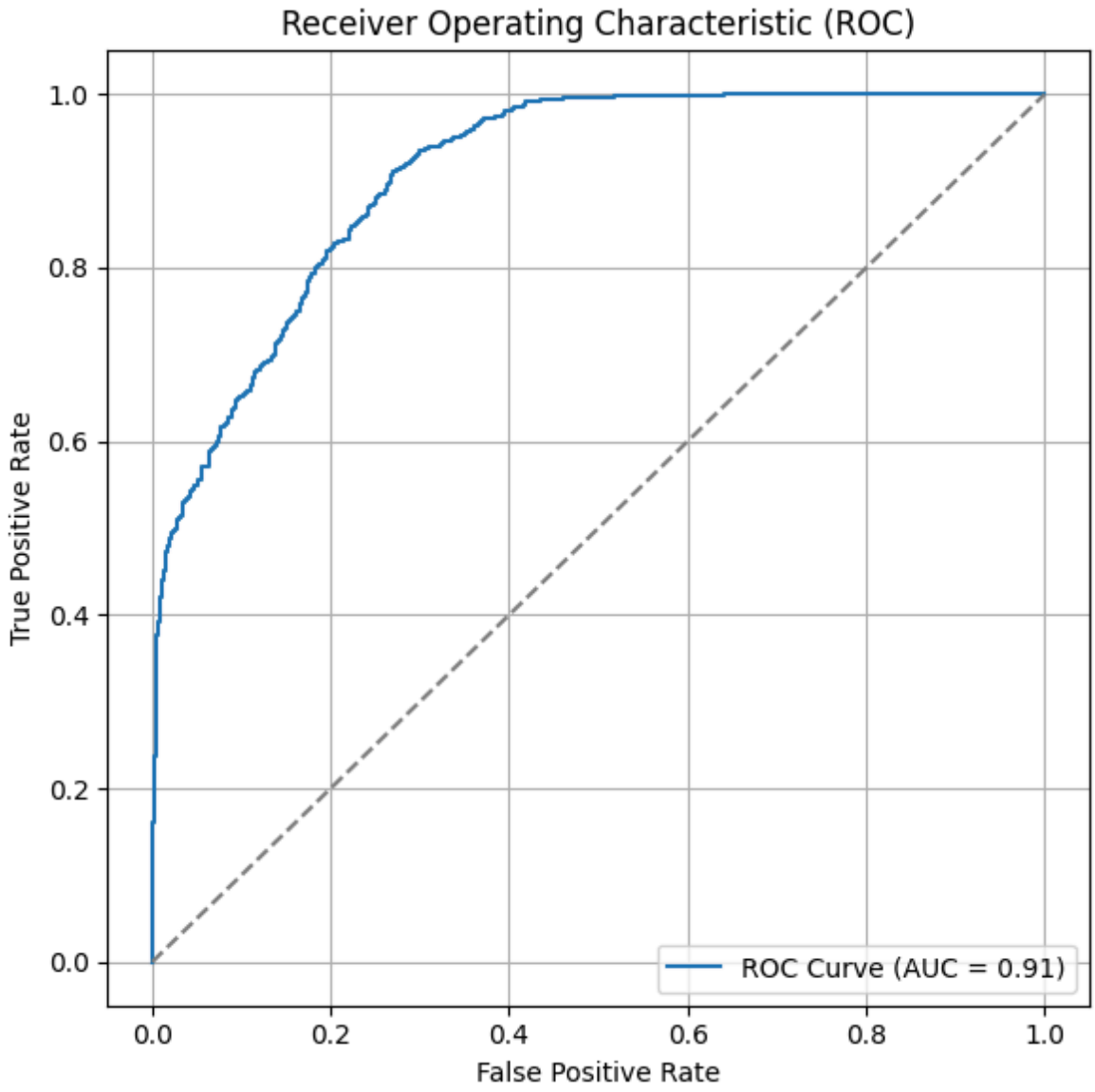

Receiver Operating Characteristic (ROC)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
ROC Curve (AUC = 0.95)

```
 Amplitude 0.4: Best Val Accuracy = 0.8795

 Training on amplitude: 0.5
Epoch 1/50
63/63 - 16s - 255ms/step - accuracy: 0.5889 - loss: 0.6783 - val_accuracy:
0.6285 - val_loss: 0.6834 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 142ms/step - accuracy: 0.6557 - loss: 0.6171 - val_accuracy:
0.6595 - val_loss: 0.6677 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 9s - 141ms/step - accuracy: 0.7104 - loss: 0.5684 - val_accuracy:
0.7100 - val_loss: 0.6317 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 11s - 170ms/step - accuracy: 0.7444 - loss: 0.5249 - val_accuracy:
0.7330 - val_loss: 0.5649 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 10s - 154ms/step - accuracy: 0.7655 - loss: 0.4945 - val_accuracy:
0.7325 - val_loss: 0.5219 - learning_rate: 5.0000e-04
Epoch 6/50
63/63 - 9s - 141ms/step - accuracy: 0.7778 - loss: 0.4733 - val_accuracy:
0.7510 - val_loss: 0.5137 - learning_rate: 5.0000e-04
Epoch 7/50
63/63 - 11s - 169ms/step - accuracy: 0.7816 - loss: 0.4493 - val_accuracy:
0.7745 - val_loss: 0.4334 - learning_rate: 5.0000e-04
Epoch 8/50
63/63 - 10s - 154ms/step - accuracy: 0.7925 - loss: 0.4327 - val_accuracy:
0.7550 - val_loss: 0.4628 - learning_rate: 5.0000e-04
Epoch 9/50

Epoch 9: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 11s - 169ms/step - accuracy: 0.8194 - loss: 0.3950 - val_accuracy:
0.6610 - val_loss: 0.8787 - learning_rate: 5.0000e-04
Epoch 10/50
63/63 - 10s - 163ms/step - accuracy: 0.8005 - loss: 0.4141 - val_accuracy:
0.6075 - val_loss: 0.9206 - learning_rate: 2.5000e-04
Epoch 11/50

Epoch 11: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 9s - 140ms/step - accuracy: 0.8102 - loss: 0.4062 - val_accuracy:
0.5600 - val_loss: 0.9216 - learning_rate: 2.5000e-04
Epoch 12/50
63/63 - 9s - 148ms/step - accuracy: 0.8395 - loss: 0.3555 - val_accuracy:
0.5645 - val_loss: 0.7657 - learning_rate: 1.2500e-04
Epoch 13/50

Epoch 13: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-0
5.
63/63 - 9s - 140ms/step - accuracy: 0.8921 - loss: 0.2781 - val_accuracy:
0.7680 - val_loss: 0.7005 - learning_rate: 1.2500e-04
Epoch 13: early stopping
Restoring model weights from the end of the best epoch: 7.
```


Accuracy per Epoch
Train Acc
Val Acc
Accuracy
Epoch
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0
2
4
6
8
10
12

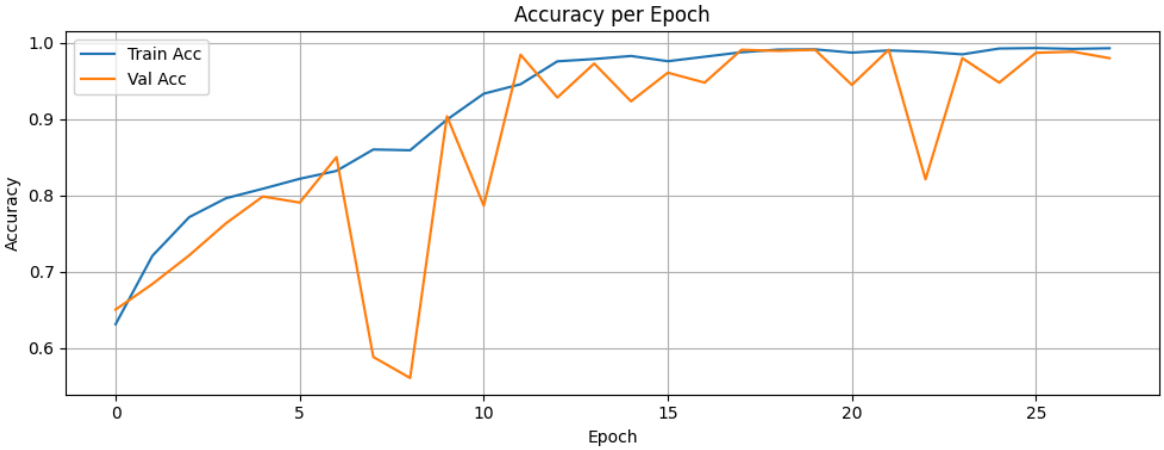

Loss per Epoch
Train Loss
Val Loss
Loss
Epoch
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
2
4
6
8
10
12

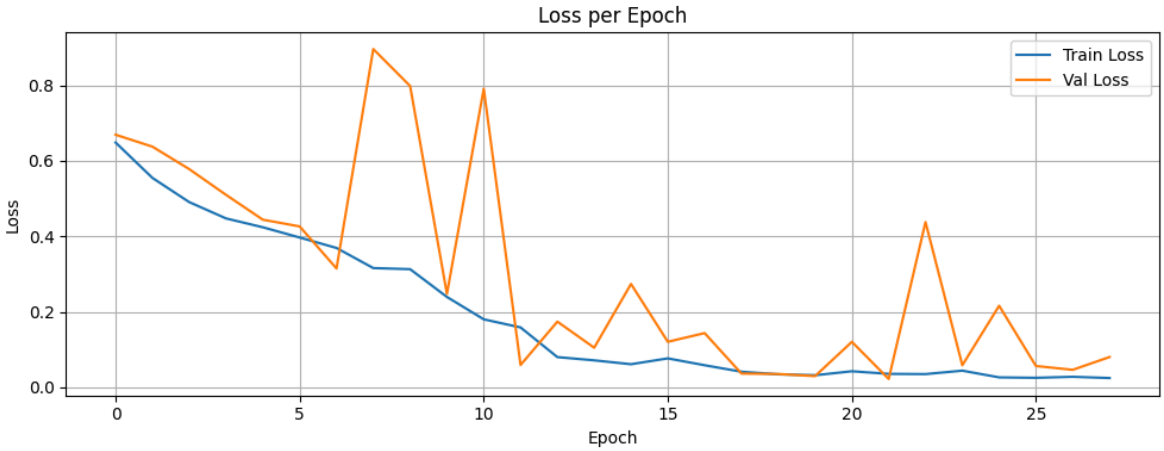

Confusion Matrix
No QPO
QPO
True label
891
102
349
658
No QPO
QPO
Predicted label
800
700
600
500
400
300
200

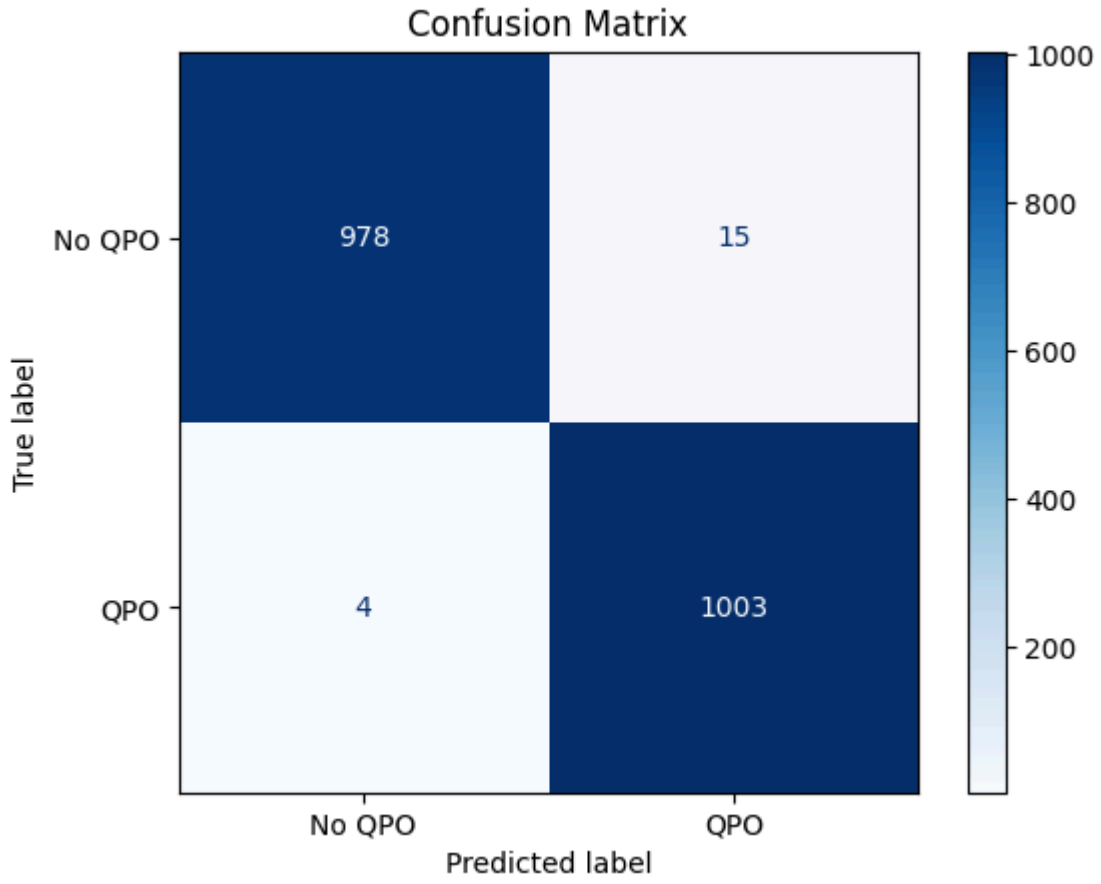

Receiver Operating Characteristic (ROC)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
ROC Curve (AUC = 0.91)

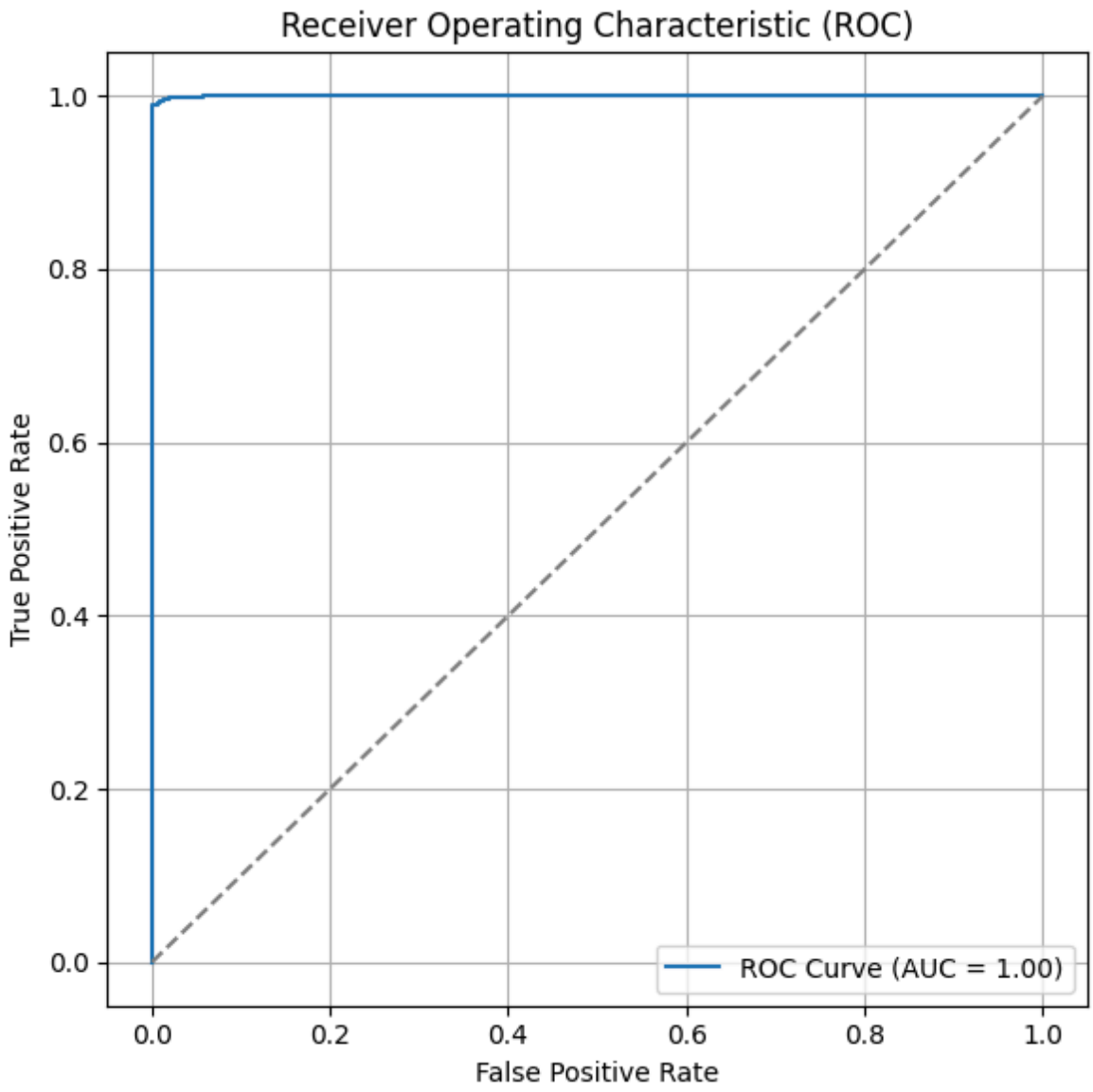
```
 Amplitude 0.5: Best Val Accuracy = 0.7745

 Training on amplitude: 0.6
Epoch 1/50
63/63 - 16s - 247ms/step - accuracy: 0.6314 - loss: 0.6483 - val_accuracy:
0.6505 - val_loss: 0.6690 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 140ms/step - accuracy: 0.7209 - loss: 0.5546 - val_accuracy:
0.6840 - val_loss: 0.6373 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 11s - 170ms/step - accuracy: 0.7715 - loss: 0.4905 - val_accuracy:
0.7215 - val_loss: 0.5779 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 9s - 148ms/step - accuracy: 0.7962 - loss: 0.4473 - val_accuracy:
0.7635 - val_loss: 0.5097 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 9s - 148ms/step - accuracy: 0.8086 - loss: 0.4239 - val_accuracy:
0.7985 - val_loss: 0.4439 - learning_rate: 5.0000e-04
Epoch 6/50
63/63 - 9s - 140ms/step - accuracy: 0.8216 - loss: 0.3967 - val_accuracy:
0.7905 - val_loss: 0.4261 - learning_rate: 5.0000e-04
Epoch 7/50
63/63 - 9s - 141ms/step - accuracy: 0.8320 - loss: 0.3691 - val_accuracy:
0.8500 - val_loss: 0.3148 - learning_rate: 5.0000e-04
Epoch 8/50
63/63 - 10s - 162ms/step - accuracy: 0.8600 - loss: 0.3158 - val_accuracy:
0.5885 - val_loss: 0.8959 - learning_rate: 5.0000e-04
Epoch 9/50

Epoch 9: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 9s - 139ms/step - accuracy: 0.8590 - loss: 0.3129 - val_accuracy:
0.5610 - val_loss: 0.7980 - learning_rate: 5.0000e-04
Epoch 10/50
63/63 - 11s - 170ms/step - accuracy: 0.8990 - loss: 0.2394 - val_accuracy:
0.9035 - val_loss: 0.2474 - learning_rate: 2.5000e-04
Epoch 11/50
63/63 - 10s - 163ms/step - accuracy: 0.9330 - loss: 0.1801 - val_accuracy:
0.7865 - val_loss: 0.7907 - learning_rate: 2.5000e-04
Epoch 12/50
63/63 - 10s - 155ms/step - accuracy: 0.9454 - loss: 0.1586 - val_accuracy:
0.9840 - val_loss: 0.0592 - learning_rate: 2.5000e-04
Epoch 13/50
63/63 - 9s - 148ms/step - accuracy: 0.9754 - loss: 0.0800 - val_accuracy:
0.9280 - val_loss: 0.1740 - learning_rate: 2.5000e-04
Epoch 14/50

Epoch 14: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 9s - 147ms/step - accuracy: 0.9784 - loss: 0.0715 - val_accuracy:
0.9725 - val_loss: 0.1049 - learning_rate: 2.5000e-04
Epoch 15/50
63/63 - 9s - 140ms/step - accuracy: 0.9824 - loss: 0.0612 - val_accuracy:
0.9230 - val_loss: 0.2737 - learning_rate: 1.2500e-04
Epoch 16/50

Epoch 16: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-0
5.
63/63 - 11s - 170ms/step - accuracy: 0.9755 - loss: 0.0767 - val_accuracy:
0.9605 - val_loss: 0.1206 - learning_rate: 1.2500e-04
```

```
Epoch 17/50
63/63 - 10s - 155ms/step - accuracy: 0.9814 - loss: 0.0585 - val_accuracy:
0.9475 - val_loss: 0.1436 - learning_rate: 6.2500e-05
Epoch 18/50
63/63 - 9s - 148ms/step - accuracy: 0.9872 - loss: 0.0413 - val_accuracy:
0.9905 - val_loss: 0.0365 - learning_rate: 6.2500e-05
Epoch 19/50
63/63 - 9s - 140ms/step - accuracy: 0.9908 - loss: 0.0345 - val_accuracy:
0.9890 - val_loss: 0.0353 - learning_rate: 6.2500e-05
Epoch 20/50
63/63 - 9s - 141ms/step - accuracy: 0.9910 - loss: 0.0320 - val_accuracy:
0.9905 - val_loss: 0.0297 - learning_rate: 6.2500e-05
Epoch 21/50
63/63 - 9s - 148ms/step - accuracy: 0.9868 - loss: 0.0426 - val_accuracy:
0.9445 - val_loss: 0.1205 - learning_rate: 6.2500e-05
Epoch 22/50
63/63 - 10s - 155ms/step - accuracy: 0.9896 - loss: 0.0357 - val_accuracy:
0.9905 - val_loss: 0.0221 - learning_rate: 6.2500e-05
Epoch 23/50
63/63 - 9s - 147ms/step - accuracy: 0.9879 - loss: 0.0351 - val_accuracy:
0.8210 - val_loss: 0.4377 - learning_rate: 6.2500e-05
Epoch 24/50

Epoch 24: ReduceLROnPlateau reducing learning rate to 3.125000148429535e-0
5.
63/63 - 10s - 154ms/step - accuracy: 0.9845 - loss: 0.0442 - val_accuracy:
0.9795 - val_loss: 0.0585 - learning_rate: 6.2500e-05
Epoch 25/50
63/63 - 11s - 170ms/step - accuracy: 0.9921 - loss: 0.0264 - val_accuracy:
0.9475 - val_loss: 0.2160 - learning_rate: 3.1250e-05
Epoch 26/50

Epoch 26: ReduceLROnPlateau reducing learning rate to 1.5625000742147677e-
05.
63/63 - 10s - 163ms/step - accuracy: 0.9927 - loss: 0.0253 - val_accuracy:
0.9865 - val_loss: 0.0565 - learning_rate: 3.1250e-05
Epoch 27/50
63/63 - 10s - 162ms/step - accuracy: 0.9916 - loss: 0.0279 - val_accuracy:
0.9880 - val_loss: 0.0464 - learning_rate: 1.5625e-05
Epoch 28/50

Epoch 28: ReduceLROnPlateau reducing learning rate to 7.812500371073838e-0
6.
63/63 - 9s - 140ms/step - accuracy: 0.9925 - loss: 0.0246 - val_accuracy:
0.9795 - val_loss: 0.0803 - learning_rate: 1.5625e-05
Epoch 28: early stopping
Restoring model weights from the end of the best epoch: 22.
```


Accuracy per Epoch
Train Acc
Val Acc
Accuracy
Epoch
1.0
0.9
0.8
0.7
0.6
0
5
10
15
20
25

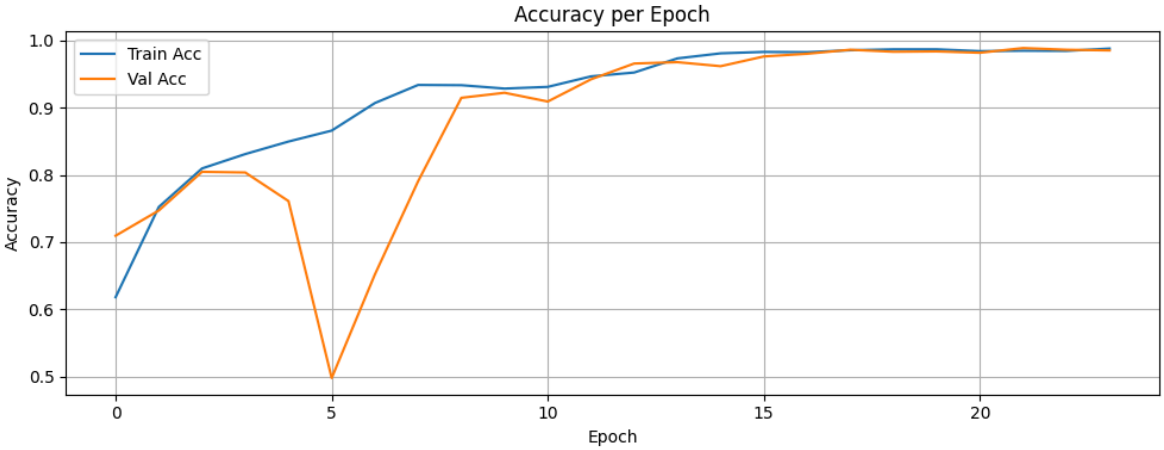

Loss per Epoch
Train Loss
Val Loss
Loss
Epoch
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25

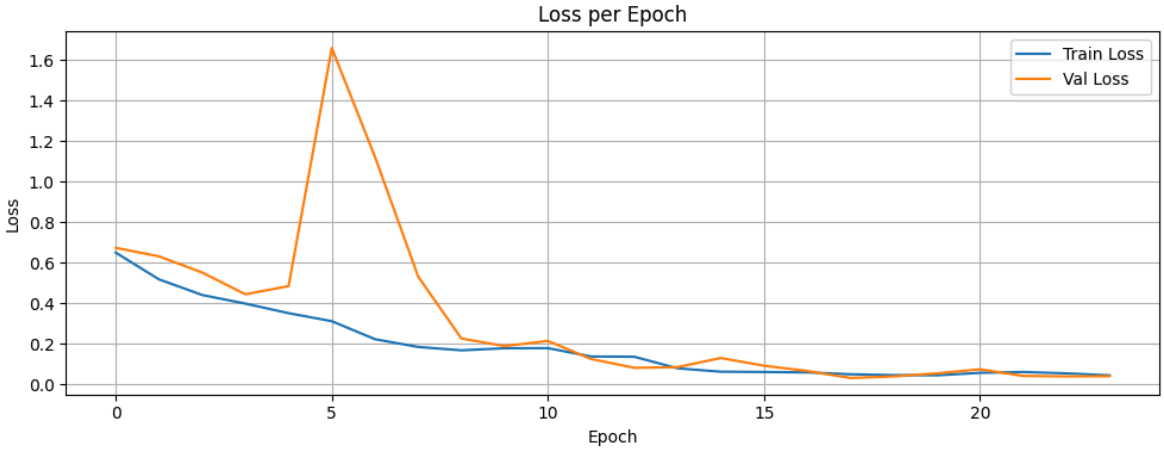

Confusion Matrix
No QPO
QPO
True label
978
15
4
1003
No QPO
QPO
Predicted label
1000
800
600
400
200

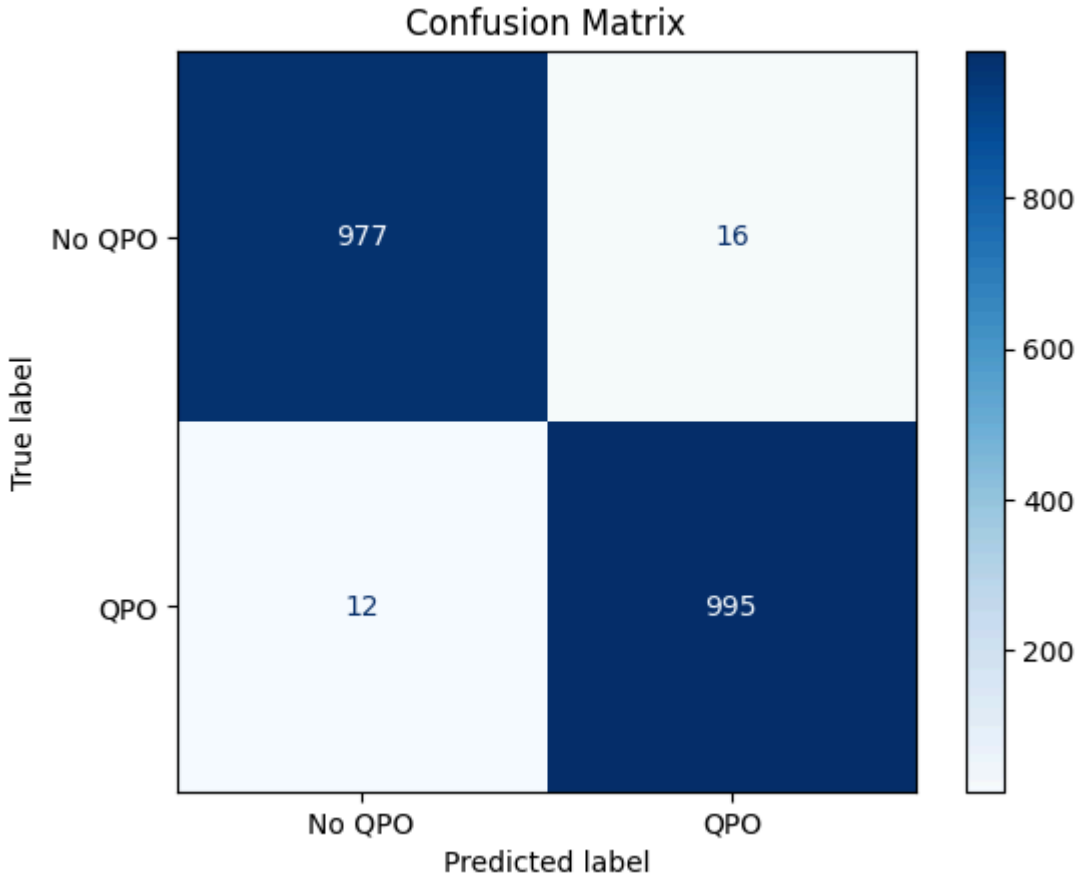

Receiver Operating Characteristic (ROC)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
ROC Curve (AUC = 1.00)

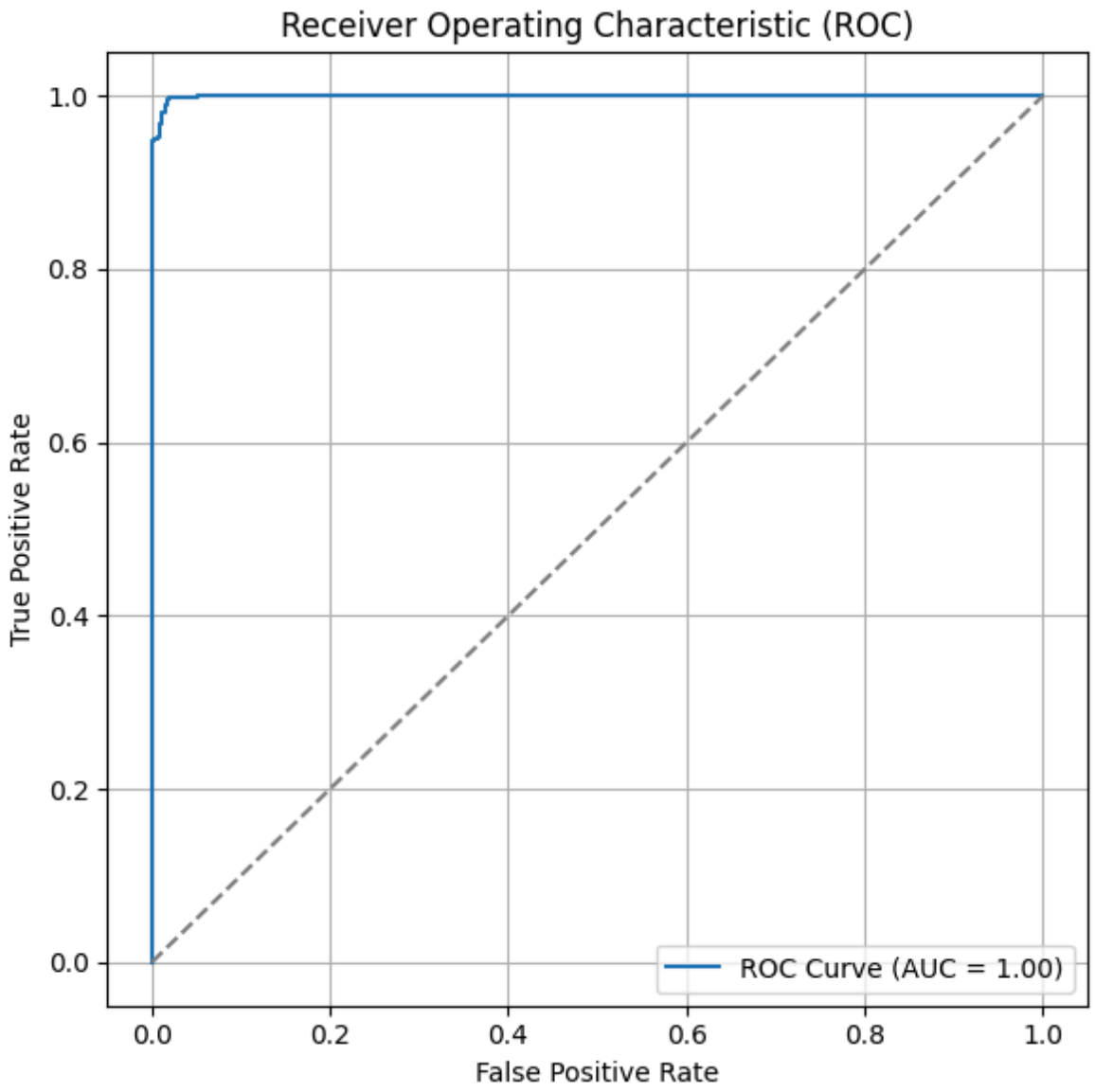
```
 Amplitude 0.6: Best Val Accuracy = 0.9905

 Training on amplitude: 0.7
Epoch 1/50
63/63 - 16s - 260ms/step - accuracy: 0.6181 - loss: 0.6505 - val_accuracy:
0.7095 - val_loss: 0.6738 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 142ms/step - accuracy: 0.7523 - loss: 0.5186 - val_accuracy:
0.7470 - val_loss: 0.6323 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 10s - 163ms/step - accuracy: 0.8095 - loss: 0.4416 - val_accuracy:
0.8045 - val_loss: 0.5524 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 9s - 149ms/step - accuracy: 0.8309 - loss: 0.3990 - val_accuracy:
0.8035 - val_loss: 0.4450 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 9s - 141ms/step - accuracy: 0.8495 - loss: 0.3520 - val_accuracy:
0.7610 - val_loss: 0.4855 - learning_rate: 5.0000e-04
Epoch 6/50

Epoch 6: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 10s - 161ms/step - accuracy: 0.8658 - loss: 0.3125 - val_accuracy:
0.4980 - val_loss: 1.6592 - learning_rate: 5.0000e-04
Epoch 7/50
63/63 - 10s - 161ms/step - accuracy: 0.9068 - loss: 0.2236 - val_accuracy:
0.6520 - val_loss: 1.1225 - learning_rate: 2.5000e-04
Epoch 8/50

Epoch 8: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 9s - 148ms/step - accuracy: 0.9336 - loss: 0.1853 - val_accuracy:
0.7905 - val_loss: 0.5319 - learning_rate: 2.5000e-04
Epoch 9/50
63/63 - 10s - 155ms/step - accuracy: 0.9333 - loss: 0.1689 - val_accuracy:
0.9145 - val_loss: 0.2269 - learning_rate: 1.2500e-04
Epoch 10/50
63/63 - 10s - 162ms/step - accuracy: 0.9283 - loss: 0.1789 - val_accuracy:
0.9220 - val_loss: 0.1895 - learning_rate: 1.2500e-04
Epoch 11/50
63/63 - 9s - 141ms/step - accuracy: 0.9308 - loss: 0.1796 - val_accuracy:
0.9090 - val_loss: 0.2151 - learning_rate: 1.2500e-04
Epoch 12/50
63/63 - 9s - 148ms/step - accuracy: 0.9464 - loss: 0.1384 - val_accuracy:
0.9420 - val_loss: 0.1260 - learning_rate: 1.2500e-04
Epoch 13/50
63/63 - 10s - 155ms/step - accuracy: 0.9521 - loss: 0.1371 - val_accuracy:
0.9655 - val_loss: 0.0827 - learning_rate: 1.2500e-04
Epoch 14/50
63/63 - 9s - 141ms/step - accuracy: 0.9731 - loss: 0.0801 - val_accuracy:
0.9675 - val_loss: 0.0859 - learning_rate: 1.2500e-04
Epoch 15/50

Epoch 15: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-0
5.
63/63 - 10s - 162ms/step - accuracy: 0.9806 - loss: 0.0634 - val_accuracy:
0.9615 - val_loss: 0.1308 - learning_rate: 1.2500e-04
Epoch 16/50
63/63 - 9s - 147ms/step - accuracy: 0.9827 - loss: 0.0619 - val_accuracy:
0.9760 - val_loss: 0.0929 - learning_rate: 6.2500e-05
```

```
Epoch 17/50
63/63 - 9s - 148ms/step - accuracy: 0.9824 - loss: 0.0600 - val_accuracy:
0.9800 - val_loss: 0.0669 - learning_rate: 6.2500e-05
Epoch 18/50
63/63 - 9s - 148ms/step - accuracy: 0.9852 - loss: 0.0507 - val_accuracy:
0.9860 - val_loss: 0.0324 - learning_rate: 6.2500e-05
Epoch 19/50
63/63 - 10s - 154ms/step - accuracy: 0.9866 - loss: 0.0467 - val_accuracy:
0.9830 - val_loss: 0.0402 - learning_rate: 6.2500e-05
Epoch 20/50

Epoch 20: ReduceLROnPlateau reducing learning rate to 3.125000148429535e-0
5.
63/63 - 11s - 170ms/step - accuracy: 0.9866 - loss: 0.0456 - val_accuracy:
0.9835 - val_loss: 0.0550 - learning_rate: 6.2500e-05
Epoch 21/50
63/63 - 9s - 140ms/step - accuracy: 0.9839 - loss: 0.0578 - val_accuracy:
0.9815 - val_loss: 0.0751 - learning_rate: 3.1250e-05
Epoch 22/50

Epoch 22: ReduceLROnPlateau reducing learning rate to 1.5625000742147677e-
05.
63/63 - 9s - 141ms/step - accuracy: 0.9845 - loss: 0.0619 - val_accuracy:
0.9885 - val_loss: 0.0428 - learning_rate: 3.1250e-05
Epoch 23/50
63/63 - 9s - 148ms/step - accuracy: 0.9843 - loss: 0.0552 - val_accuracy:
0.9860 - val_loss: 0.0402 - learning_rate: 1.5625e-05
Epoch 24/50

Epoch 24: ReduceLROnPlateau reducing learning rate to 7.812500371073838e-0
6.
63/63 - 10s - 162ms/step - accuracy: 0.9877 - loss: 0.0455 - val_accuracy:
0.9850 - val_loss: 0.0414 - learning_rate: 1.5625e-05
Epoch 24: early stopping
Restoring model weights from the end of the best epoch: 18.
```



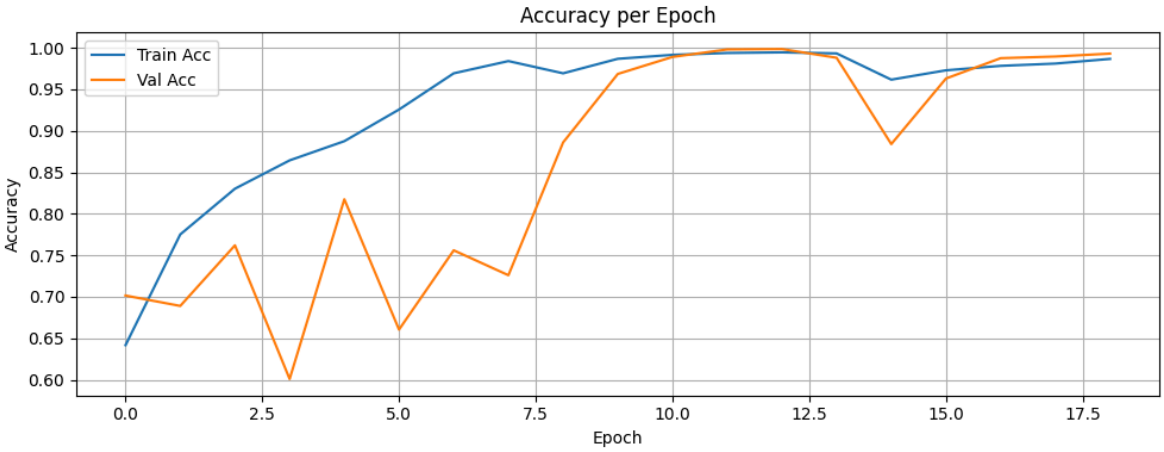

Loss per Epoch
Train Loss
Val Loss
Loss
Epoch
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20

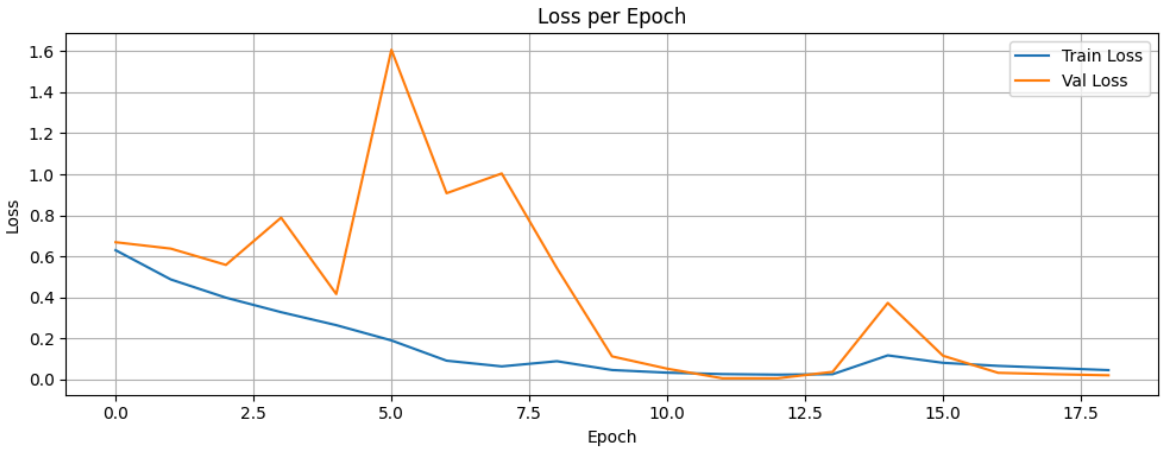

Confusion Matrix
No QPO
QPO
True label
977
16
12
995
No QPO
QPO
Predicted label
800
600
400
200

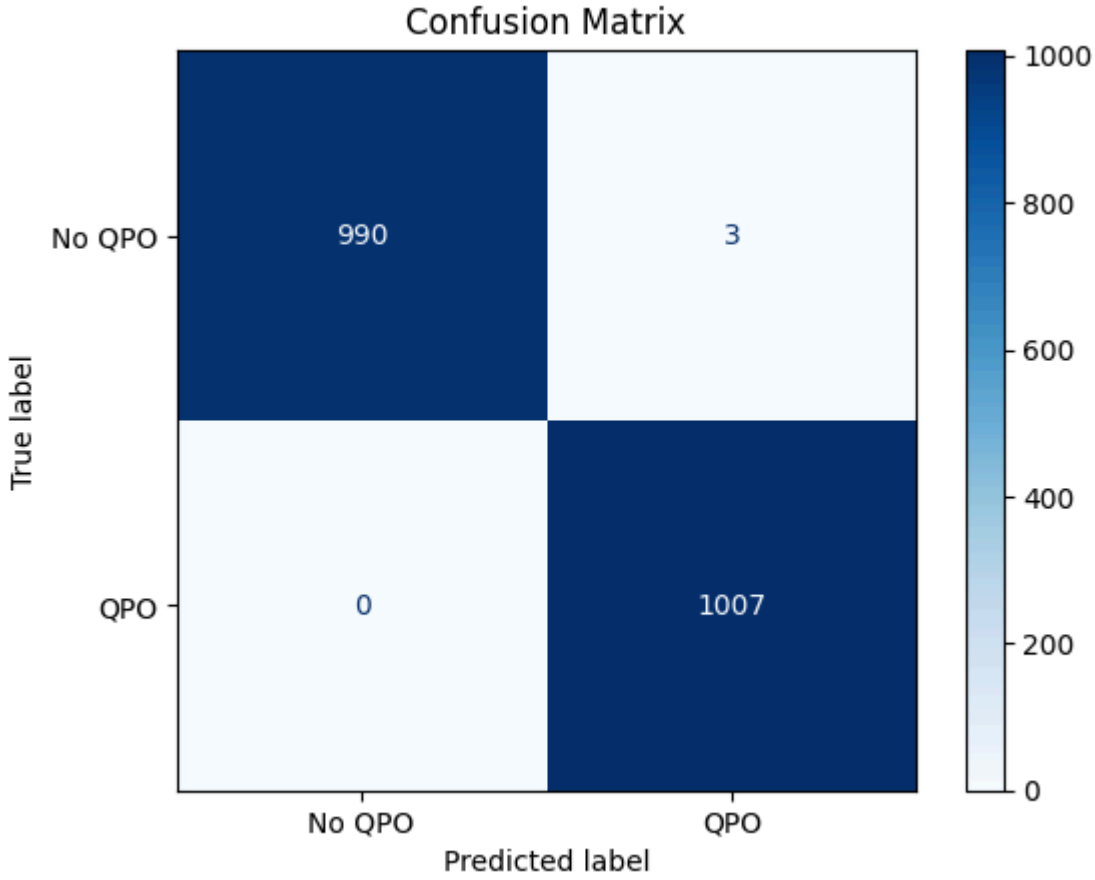

Receiver Operating Characteristic (ROC)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
ROC Curve (AUC = 1.00)

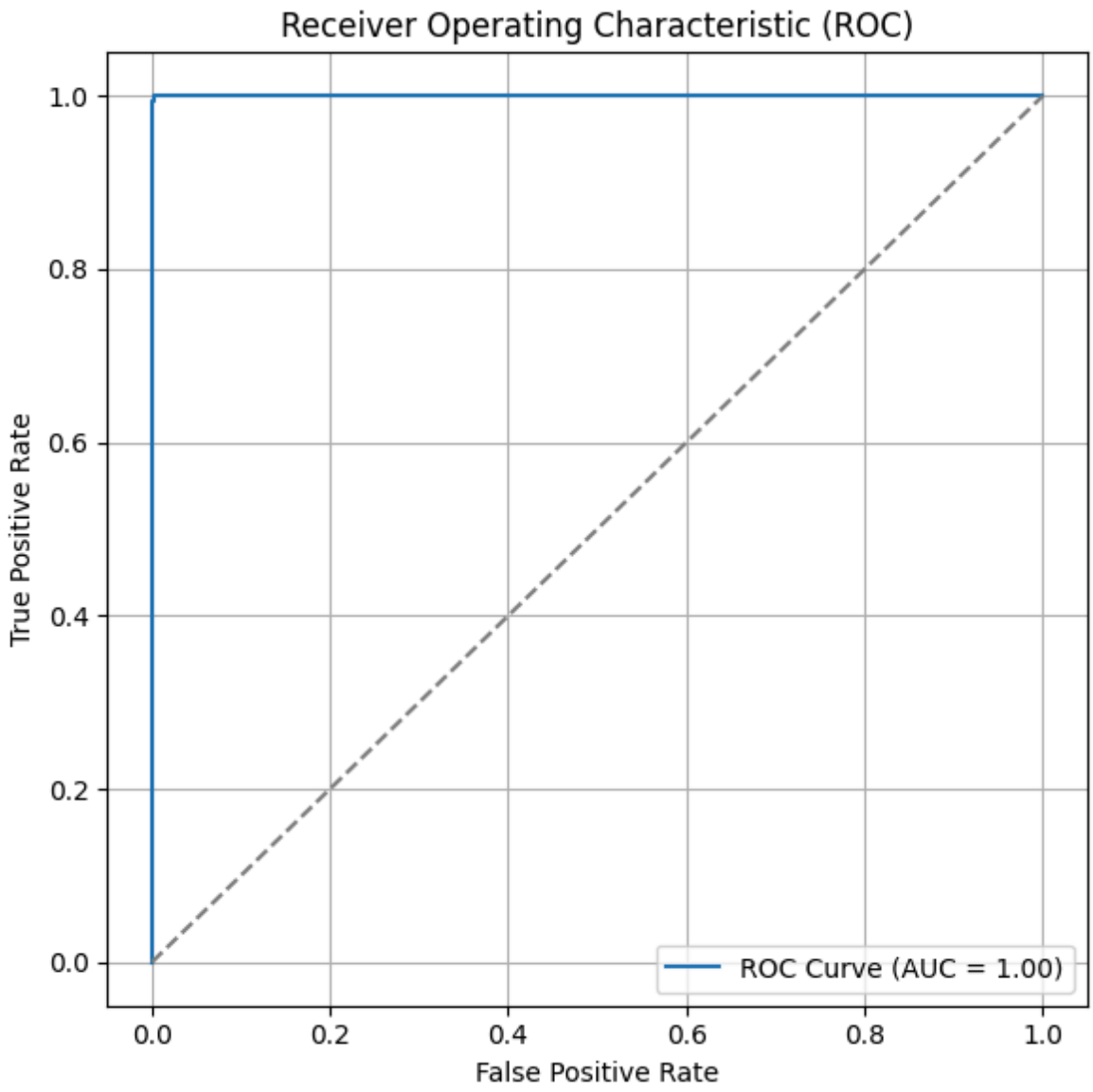
```
 Amplitude 0.7: Best Val Accuracy = 0.9885

 Training on amplitude: 0.8
Epoch 1/50
63/63 - 16s - 255ms/step - accuracy: 0.6417 - loss: 0.6299 - val_accuracy:
0.7015 - val_loss: 0.6688 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 148ms/step - accuracy: 0.7751 - loss: 0.4874 - val_accuracy:
0.6890 - val_loss: 0.6377 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 10s - 155ms/step - accuracy: 0.8303 - loss: 0.3985 - val_accuracy:
0.7620 - val_loss: 0.5584 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 10s - 162ms/step - accuracy: 0.8644 - loss: 0.3279 - val_accuracy:
0.6010 - val_loss: 0.7886 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 9s - 141ms/step - accuracy: 0.8875 - loss: 0.2646 - val_accuracy:
0.8175 - val_loss: 0.4163 - learning_rate: 5.0000e-04
Epoch 6/50
63/63 - 9s - 140ms/step - accuracy: 0.9256 - loss: 0.1902 - val_accuracy:
0.6605 - val_loss: 1.6068 - learning_rate: 5.0000e-04
Epoch 7/50

Epoch 7: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 9s - 141ms/step - accuracy: 0.9693 - loss: 0.0914 - val_accuracy:
0.7560 - val_loss: 0.9078 - learning_rate: 5.0000e-04
Epoch 8/50
63/63 - 9s - 141ms/step - accuracy: 0.9840 - loss: 0.0636 - val_accuracy:
0.7260 - val_loss: 1.0040 - learning_rate: 2.5000e-04
Epoch 9/50

Epoch 9: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 10s - 162ms/step - accuracy: 0.9693 - loss: 0.0889 - val_accuracy:
0.8860 - val_loss: 0.5428 - learning_rate: 2.5000e-04
Epoch 10/50
63/63 - 9s - 147ms/step - accuracy: 0.9868 - loss: 0.0458 - val_accuracy:
0.9685 - val_loss: 0.1123 - learning_rate: 1.2500e-04
Epoch 11/50
63/63 - 10s - 162ms/step - accuracy: 0.9915 - loss: 0.0330 - val_accuracy:
0.9890 - val_loss: 0.0524 - learning_rate: 1.2500e-04
Epoch 12/50
63/63 - 9s - 148ms/step - accuracy: 0.9937 - loss: 0.0260 - val_accuracy:
0.9980 - val_loss: 0.0055 - learning_rate: 1.2500e-04
Epoch 13/50
63/63 - 9s - 141ms/step - accuracy: 0.9945 - loss: 0.0233 - val_accuracy:
0.9985 - val_loss: 0.0054 - learning_rate: 1.2500e-04
Epoch 14/50
63/63 - 10s - 162ms/step - accuracy: 0.9933 - loss: 0.0255 - val_accuracy:
0.9880 - val_loss: 0.0370 - learning_rate: 1.2500e-04
Epoch 15/50

Epoch 15: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-0
5.
63/63 - 9s - 140ms/step - accuracy: 0.9616 - loss: 0.1173 - val_accuracy:
0.8840 - val_loss: 0.3730 - learning_rate: 1.2500e-04
Epoch 16/50
63/63 - 9s - 148ms/step - accuracy: 0.9729 - loss: 0.0810 - val_accuracy:
0.9630 - val_loss: 0.1155 - learning_rate: 6.2500e-05
```

```
Epoch 17/50

Epoch 17: ReduceLROnPlateau reducing learning rate to 3.125000148429535e-0
5.
63/63 - 10s - 155ms/step - accuracy: 0.9783 - loss: 0.0661 - val_accuracy:
0.9875 - val_loss: 0.0322 - learning_rate: 6.2500e-05
Epoch 18/50
63/63 - 10s - 162ms/step - accuracy: 0.9810 - loss: 0.0559 - val_accuracy:
0.9895 - val_loss: 0.0254 - learning_rate: 3.1250e-05
Epoch 19/50

Epoch 19: ReduceLROnPlateau reducing learning rate to 1.5625000742147677e-
05.
63/63 - 10s - 162ms/step - accuracy: 0.9866 - loss: 0.0453 - val_accuracy:
0.9930 - val_loss: 0.0203 - learning_rate: 3.1250e-05
Epoch 19: early stopping
Restoring model weights from the end of the best epoch: 13.
```

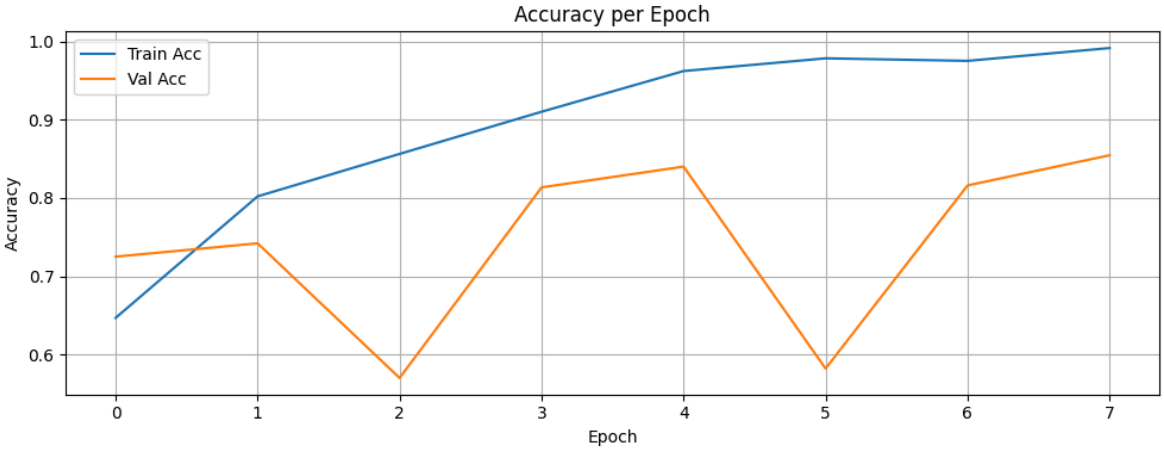


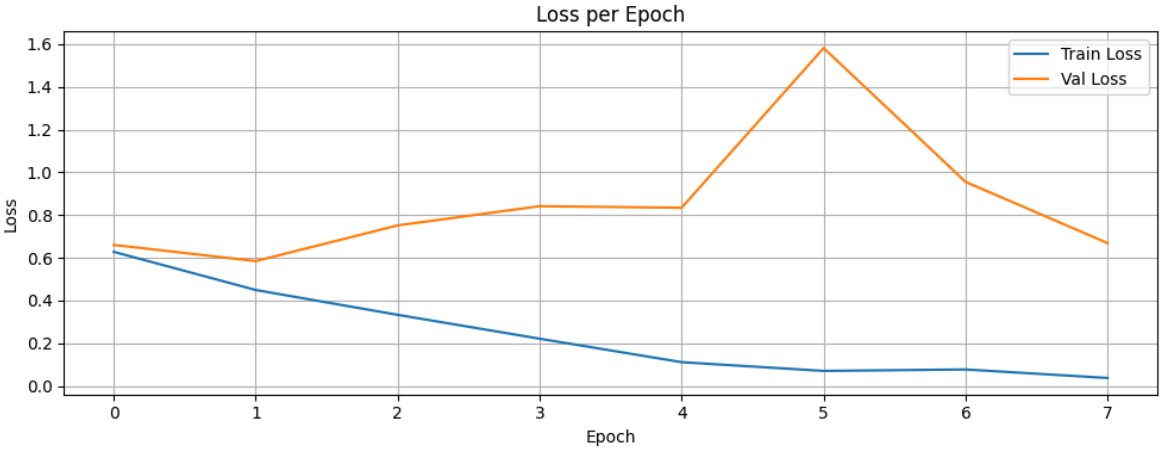


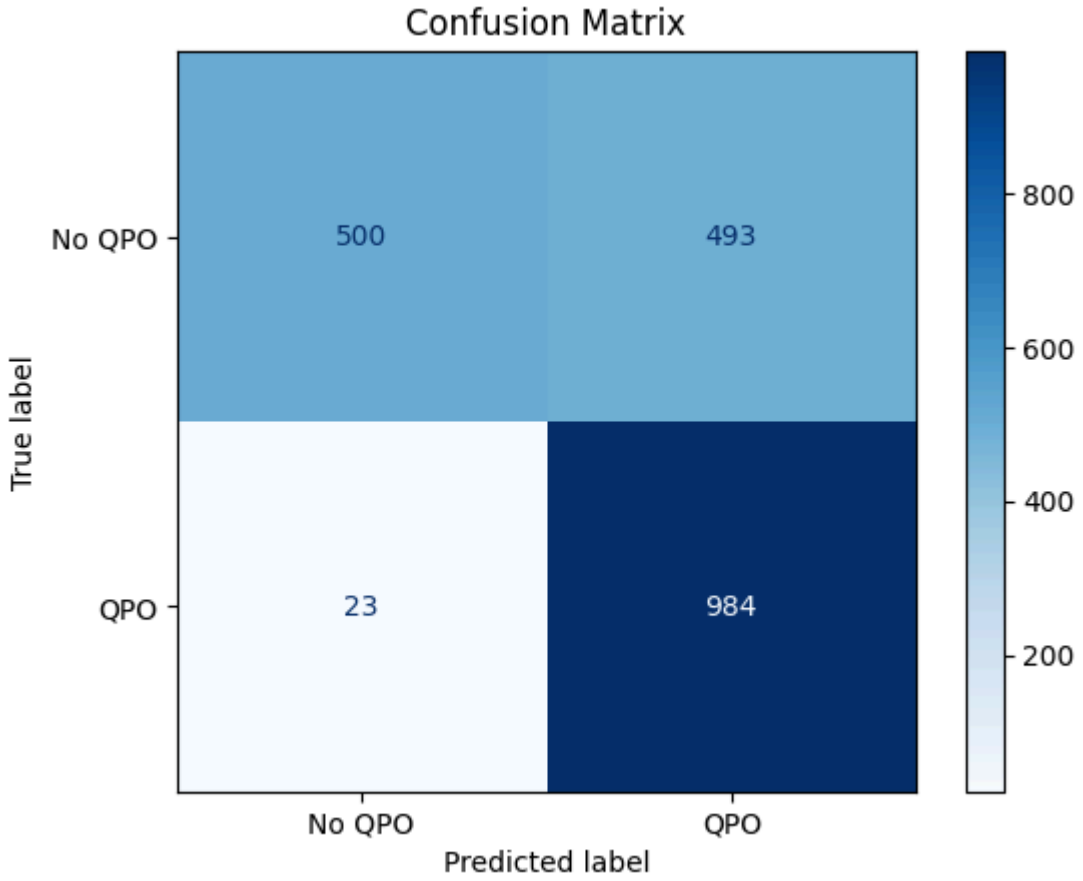

Confusion Matrix
No QPO
QPO
True label
990
3
0
1007
No QPO
QPO
Predicted label
1000
800
600
400
200
0

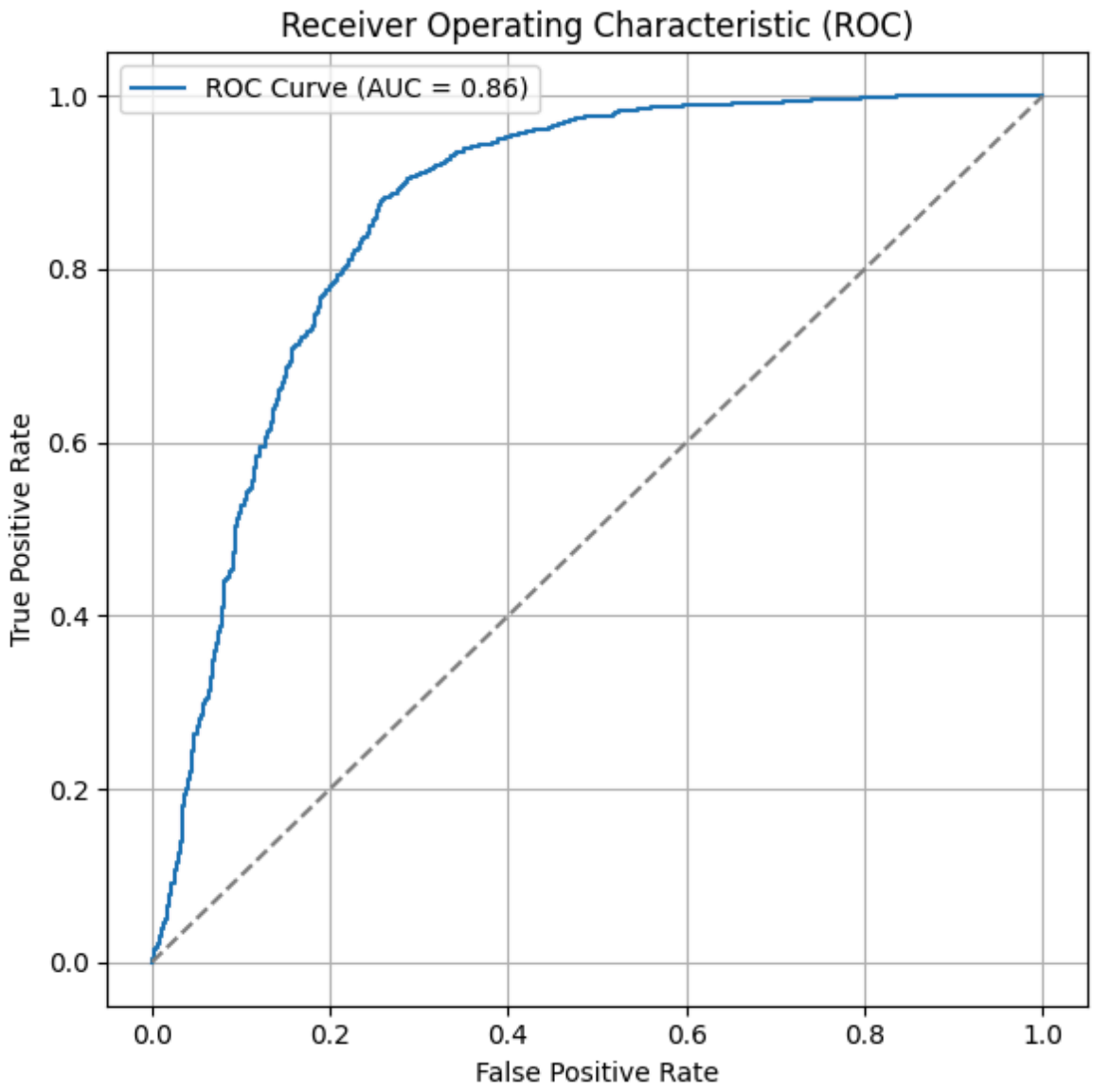

Receiver Operating Characteristic (ROC)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
ROC Curve (AUC = 1.00)

```
 Amplitude 0.8: Best Val Accuracy = 0.9985

 Training on amplitude: 0.9
Epoch 1/50
63/63 - 17s - 271ms/step - accuracy: 0.6467 - loss: 0.6281 - val_accuracy:
0.7250 - val_loss: 0.6605 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 147ms/step - accuracy: 0.8020 - loss: 0.4495 - val_accuracy:
0.7420 - val_loss: 0.5848 - learning_rate: 5.0000e-04
Epoch 3/50
63/63 - 9s - 142ms/step - accuracy: 0.8562 - loss: 0.3333 - val_accuracy:
0.5700 - val_loss: 0.7518 - learning_rate: 5.0000e-04
Epoch 4/50

Epoch 4: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 11s - 169ms/step - accuracy: 0.9101 - loss: 0.2214 - val_accuracy:
0.8135 - val_loss: 0.8418 - learning_rate: 5.0000e-04
Epoch 5/50
63/63 - 9s - 149ms/step - accuracy: 0.9621 - loss: 0.1116 - val_accuracy:
0.8400 - val_loss: 0.8345 - learning_rate: 2.5000e-04
Epoch 6/50

Epoch 6: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 9s - 141ms/step - accuracy: 0.9784 - loss: 0.0707 - val_accuracy:
0.5820 - val_loss: 1.5820 - learning_rate: 2.5000e-04
Epoch 7/50
63/63 - 10s - 160ms/step - accuracy: 0.9751 - loss: 0.0775 - val_accuracy:
0.8160 - val_loss: 0.9554 - learning_rate: 1.2500e-04
Epoch 8/50

Epoch 8: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-05.
63/63 - 11s - 169ms/step - accuracy: 0.9915 - loss: 0.0376 - val_accuracy:
0.8545 - val_loss: 0.6690 - learning_rate: 1.2500e-04
Epoch 8: early stopping
Restoring model weights from the end of the best epoch: 2.
```



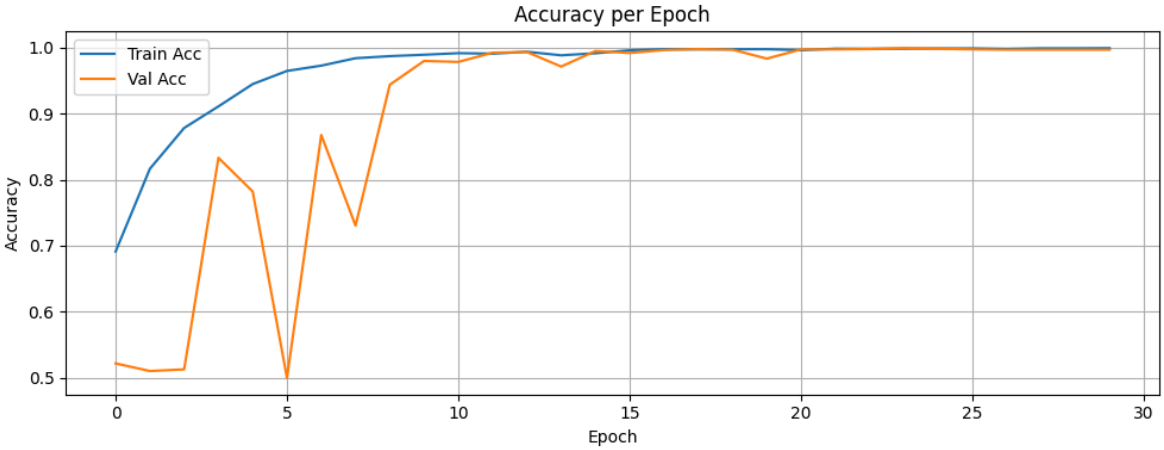

Loss per Epoch
Train Loss
Val Loss
Loss
Epoch
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
1
2
3
4
5
6
7

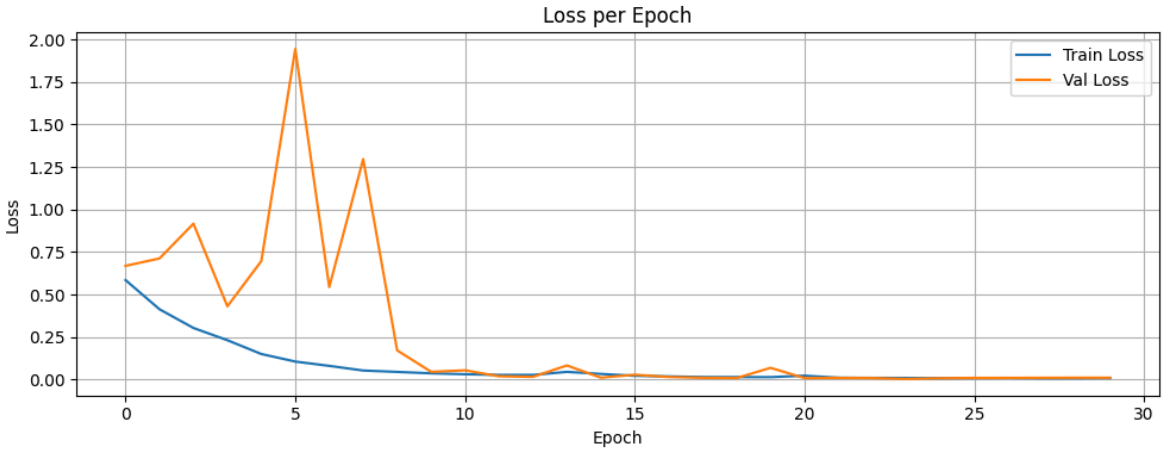

Confusion Matrix
No QPO
QPO
True label
500
493
23
984
No QPO
QPO
Predicted label
800
600
400
200

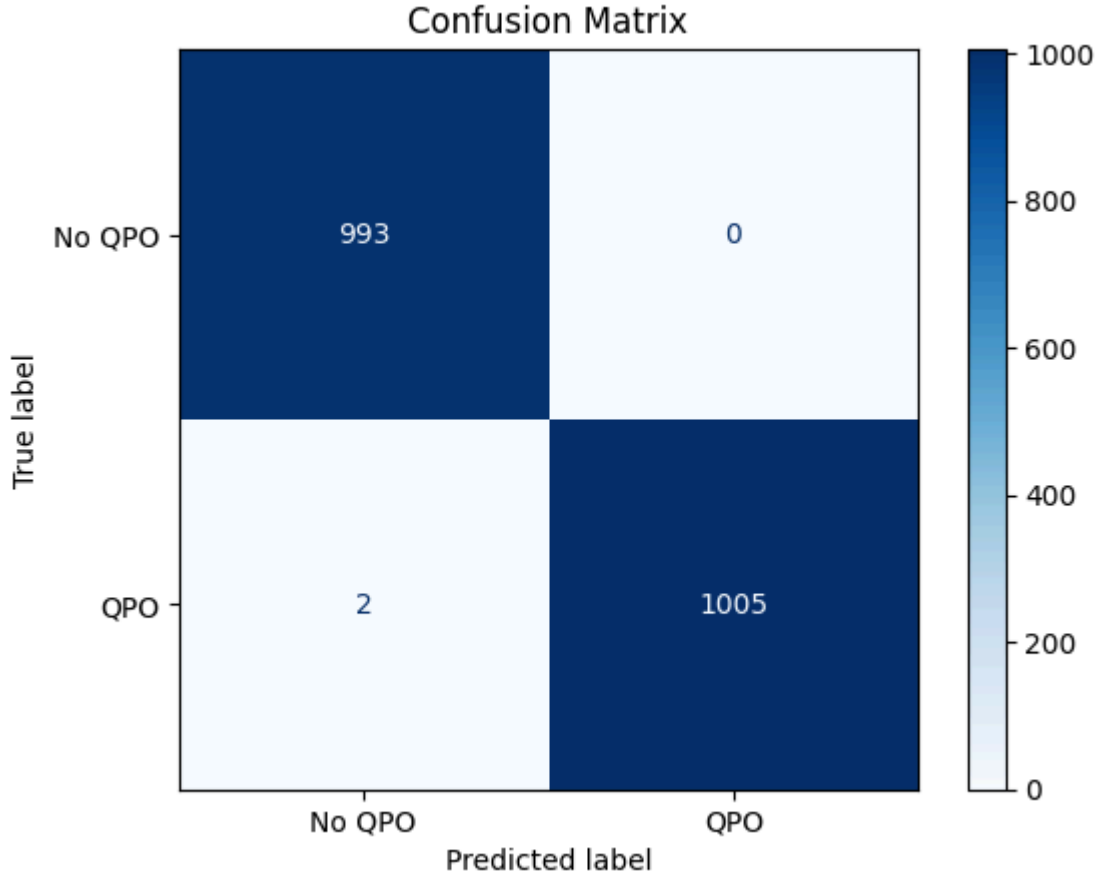

Receiver Operating Characteristic (ROC)
ROC Curve (AUC = 0.86)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0

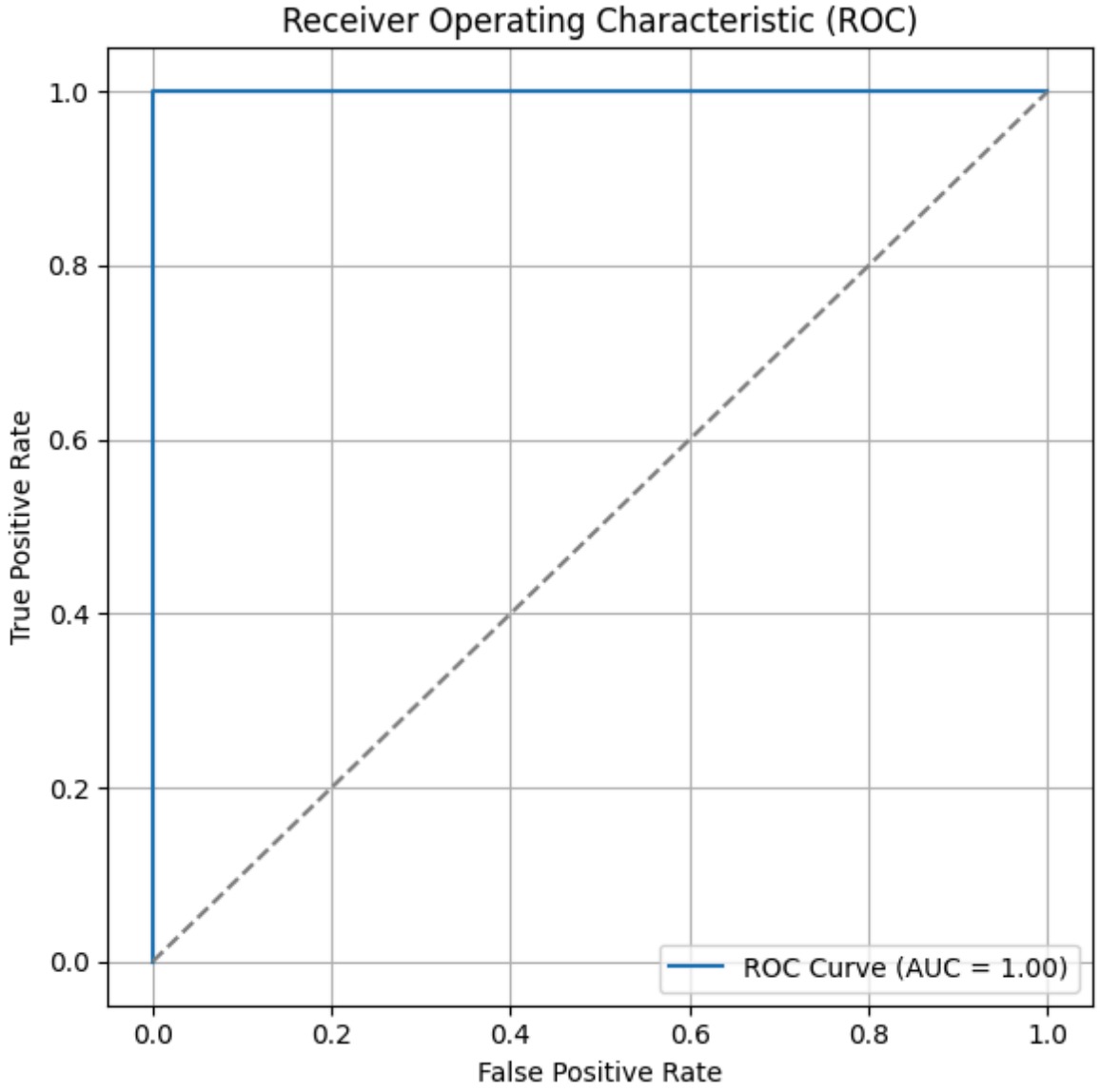
```
 Amplitude 0.9: Best Val Accuracy = 0.8545

 Training on amplitude: 1.0
Epoch 1/50
63/63 - 16s - 247ms/step - accuracy: 0.6913 - loss: 0.5854 - val_accuracy:
0.5220 - val_loss: 0.6691 - learning_rate: 5.0000e-04
Epoch 2/50
63/63 - 9s - 149ms/step - accuracy: 0.8164 - loss: 0.4138 - val_accuracy:
0.5105 - val_loss: 0.7126 - learning_rate: 5.0000e-04
Epoch 3/50

Epoch 3: ReduceLROnPlateau reducing learning rate to 0.000250000011874362
8.
63/63 - 10s - 163ms/step - accuracy: 0.8781 - loss: 0.3038 - val_accuracy:
0.5130 - val_loss: 0.9172 - learning_rate: 5.0000e-04
Epoch 4/50
63/63 - 10s - 155ms/step - accuracy: 0.9107 - loss: 0.2318 - val_accuracy:
0.8330 - val_loss: 0.4312 - learning_rate: 2.5000e-04
Epoch 5/50
63/63 - 9s - 148ms/step - accuracy: 0.9445 - loss: 0.1506 - val_accuracy:
0.7820 - val_loss: 0.6974 - learning_rate: 2.5000e-04
Epoch 6/50

Epoch 6: ReduceLROnPlateau reducing learning rate to 0.000125000005937181
4.
63/63 - 10s - 163ms/step - accuracy: 0.9644 - loss: 0.1063 - val_accuracy:
0.5000 - val_loss: 1.9440 - learning_rate: 2.5000e-04
Epoch 7/50
63/63 - 9s - 148ms/step - accuracy: 0.9724 - loss: 0.0809 - val_accuracy:
0.8675 - val_loss: 0.5443 - learning_rate: 1.2500e-04
Epoch 8/50

Epoch 8: ReduceLROnPlateau reducing learning rate to 6.25000029685907e-05.
63/63 - 10s - 161ms/step - accuracy: 0.9836 - loss: 0.0536 - val_accuracy:
0.7305 - val_loss: 1.2965 - learning_rate: 1.2500e-04
Epoch 9/50
63/63 - 10s - 163ms/step - accuracy: 0.9868 - loss: 0.0455 - val_accuracy:
0.9435 - val_loss: 0.1722 - learning_rate: 6.2500e-05
Epoch 10/50
63/63 - 10s - 162ms/step - accuracy: 0.9889 - loss: 0.0371 - val_accuracy:
0.9795 - val_loss: 0.0461 - learning_rate: 6.2500e-05
Epoch 11/50
63/63 - 10s - 162ms/step - accuracy: 0.9912 - loss: 0.0318 - val_accuracy:
0.9780 - val_loss: 0.0548 - learning_rate: 6.2500e-05
Epoch 12/50
63/63 - 10s - 163ms/step - accuracy: 0.9905 - loss: 0.0279 - val_accuracy:
0.9920 - val_loss: 0.0198 - learning_rate: 6.2500e-05
Epoch 13/50
63/63 - 10s - 156ms/step - accuracy: 0.9934 - loss: 0.0278 - val_accuracy:
0.9930 - val_loss: 0.0164 - learning_rate: 6.2500e-05
Epoch 14/50
63/63 - 11s - 169ms/step - accuracy: 0.9880 - loss: 0.0457 - val_accuracy:
0.9710 - val_loss: 0.0834 - learning_rate: 6.2500e-05
Epoch 15/50
63/63 - 10s - 155ms/step - accuracy: 0.9911 - loss: 0.0335 - val_accuracy:
0.9945 - val_loss: 0.0116 - learning_rate: 6.2500e-05
Epoch 16/50
63/63 - 11s - 170ms/step - accuracy: 0.9956 - loss: 0.0227 - val_accuracy:
0.9915 - val_loss: 0.0289 - learning_rate: 6.2500e-05
Epoch 17/50
```

```
Epoch 17: ReduceLROnPlateau reducing learning rate to 3.125000148429535e-0
5.
63/63 - 10s - 161ms/step - accuracy: 0.9973 - loss: 0.0190 - val_accuracy:
0.9960 - val_loss: 0.0155 - learning_rate: 6.2500e-05
Epoch 18/50
63/63 - 10s - 162ms/step - accuracy: 0.9970 - loss: 0.0154 - val_accuracy:
0.9975 - val_loss: 0.0106 - learning_rate: 3.1250e-05
Epoch 19/50
63/63 - 9s - 141ms/step - accuracy: 0.9973 - loss: 0.0151 - val_accuracy:
0.9965 - val_loss: 0.0094 - learning_rate: 3.1250e-05
Epoch 20/50
63/63 - 11s - 169ms/step - accuracy: 0.9973 - loss: 0.0147 - val_accuracy:
0.9830 - val_loss: 0.0694 - learning_rate: 3.1250e-05
Epoch 21/50
63/63 - 9s - 148ms/step - accuracy: 0.9958 - loss: 0.0231 - val_accuracy:
0.9970 - val_loss: 0.0091 - learning_rate: 3.1250e-05
Epoch 22/50
63/63 - 10s - 155ms/step - accuracy: 0.9980 - loss: 0.0113 - val_accuracy:
0.9970 - val_loss: 0.0102 - learning_rate: 3.1250e-05
Epoch 23/50

Epoch 23: ReduceLROnPlateau reducing learning rate to 1.5625000742147677e-
05.
63/63 - 10s - 161ms/step - accuracy: 0.9979 - loss: 0.0102 - val_accuracy:
0.9975 - val_loss: 0.0093 - learning_rate: 3.1250e-05
Epoch 24/50
63/63 - 11s - 169ms/step - accuracy: 0.9980 - loss: 0.0099 - val_accuracy:
0.9990 - val_loss: 0.0039 - learning_rate: 1.5625e-05
Epoch 25/50
63/63 - 10s - 163ms/step - accuracy: 0.9984 - loss: 0.0081 - val_accuracy:
0.9980 - val_loss: 0.0083 - learning_rate: 1.5625e-05
Epoch 26/50

Epoch 26: ReduceLROnPlateau reducing learning rate to 7.812500371073838e-0
6.
63/63 - 10s - 156ms/step - accuracy: 0.9985 - loss: 0.0092 - val_accuracy:
0.9970 - val_loss: 0.0102 - learning_rate: 1.5625e-05
Epoch 27/50
63/63 - 11s - 169ms/step - accuracy: 0.9977 - loss: 0.0099 - val_accuracy:
0.9965 - val_loss: 0.0104 - learning_rate: 7.8125e-06
Epoch 28/50

Epoch 28: ReduceLROnPlateau reducing learning rate to 3.906250185536919e-0
6.
63/63 - 10s - 162ms/step - accuracy: 0.9986 - loss: 0.0080 - val_accuracy:
0.9965 - val_loss: 0.0108 - learning_rate: 7.8125e-06
Epoch 29/50
63/63 - 10s - 155ms/step - accuracy: 0.9986 - loss: 0.0081 - val_accuracy:
0.9965 - val_loss: 0.0113 - learning_rate: 3.9063e-06
Epoch 30/50

Epoch 30: ReduceLROnPlateau reducing learning rate to 1.9531250927684596e-
06.
63/63 - 10s - 162ms/step - accuracy: 0.9989 - loss: 0.0096 - val_accuracy:
0.9965 - val_loss: 0.0113 - learning_rate: 3.9063e-06
Epoch 30: early stopping
Restoring model weights from the end of the best epoch: 24.
```


Accuracy per Epoch
Train Acc
Val Acc
Accuracy
Epoch


Loss per Epoch
Train Loss
Val Loss
Loss
Epoch


Confusion Matrix
No QPO
QPO
993
0
2
1005
True label
No QPO
QPO
Predicted label




```
Amplitude 1.0: Best Val Accuracy = 0.9990
```