RESULTS

1. PREPROCESSING OF DATASET

```
Data loaded successfully with shape: (257673, 44)

 Class standardization complete:
attack_cat
normal           93000
generic          58871
exploits         44525
fuzzers          24246
dos              16353
reconnaissance   13987
analysis          2677
backdoor          2329
shellcode         1511
worms              174
Name: count, dtype: int64

 Final Class Distribution (Training Set):
attack_cat
normal           65100
generic          41210
exploits         31167
fuzzers          16972
dos              11447
reconnaissance    9791
analysis          1874
backdoor          1630
shellcode         1058
worms              122
Name: count, dtype: int64

 Processing Completed!
Training shape: (180371, 194)
Test shape: (77302, 194)
Feature dimension: 194
```

2. HANDLE CLASS IMBALANCE

```
Final Training Shape: (181191, 194)

ORIGINAL CLASS DISTRIBUTION:
Normal          : 1874
Analysis        : 1630
Backdoor        : 11447
DoS             : 31167
Exploits        : 16972
Fuzzers         : 41210
Generic         : 65100
Reconnaissance  : 9791
Shellcode       : 1058
Worms           : 122

RESAMPLED CLASS DISTRIBUTION:
Normal          : 1874
Analysis        : 1630
Backdoor        : 11447
DoS             : 31167
Exploits        : 16972
Fuzzers         : 41210
Generic         : 65100
Reconnaissance  : 9791
Shellcode       : 1500
Worms           : 500

CLASS WEIGHTS:
Normal          : 2.3804
Analysis        : 2.5524
Backdoor        : 0.9632
DoS             : 0.5837
Exploits        : 0.7910
Fuzzers         : 0.5076
Generic         : 0.5000
Reconnaissance  : 1.0414
Shellcode       : 2.6607
Worms           : 4.6085
```

3. HYBRID CNN+LSTM(MULTICLASS CLASSIFICATION)

```
Final Classification Report:
                precision    recall  f1-score   support

      Analysis       0.29      0.25      0.27       535
      Backdoor       0.20      0.24      0.21       466
           DoS       0.36      0.64      0.46      3271
      Exploits       0.78      0.59      0.67      8905
       Fuzzers       0.78      0.73      0.75      4849
       Generic       1.00      0.98      0.99     11774
        Normal       0.96      0.95      0.96     18600
Reconnaissance       0.79      0.80      0.79      2798
     Shellcode       0.39      0.78      0.52       302
         Worms       0.18      0.73      0.28        60

      accuracy                           0.83     51560
     macro avg       0.57      0.67      0.59     51560
  weighted avg       0.86      0.83      0.84     51560
```
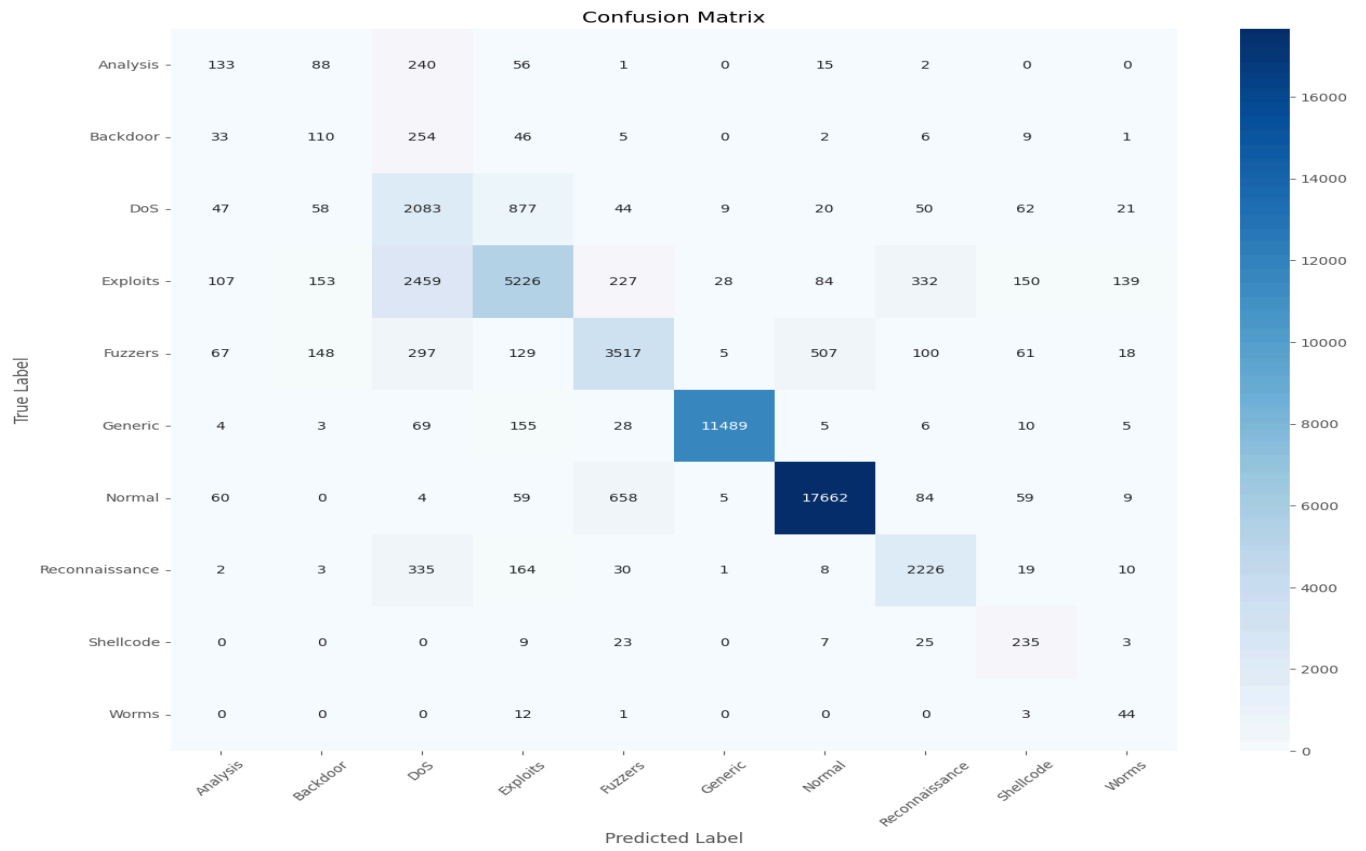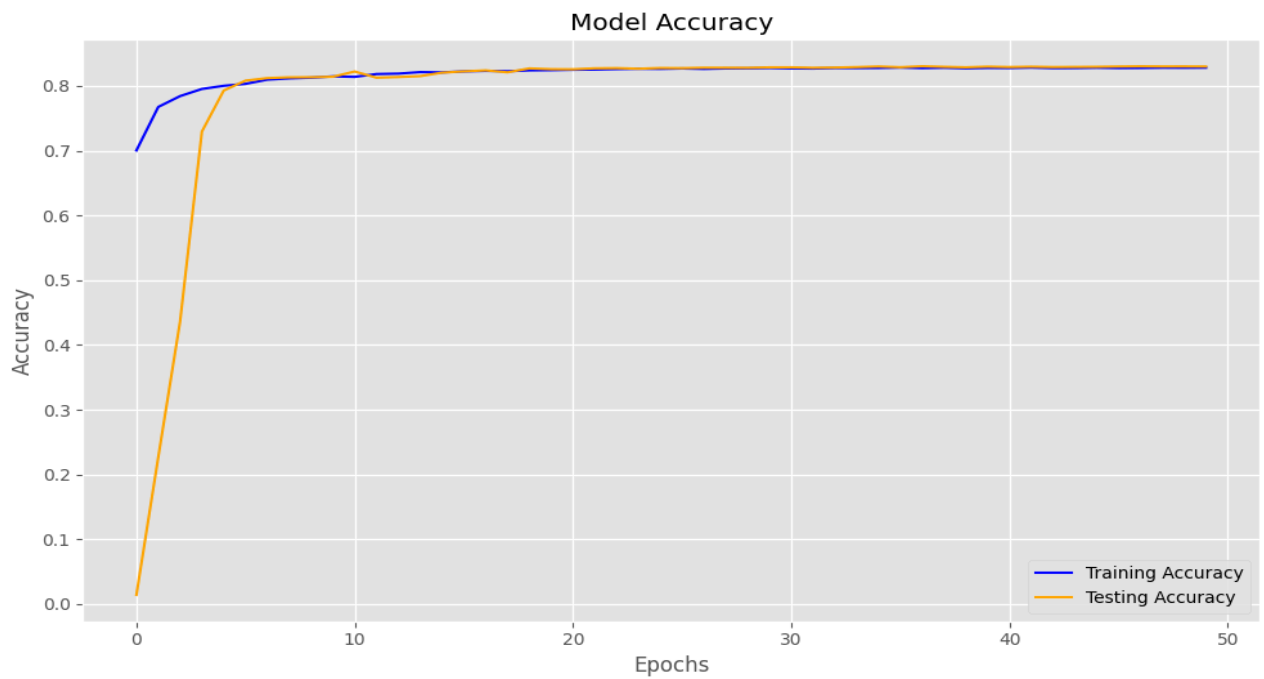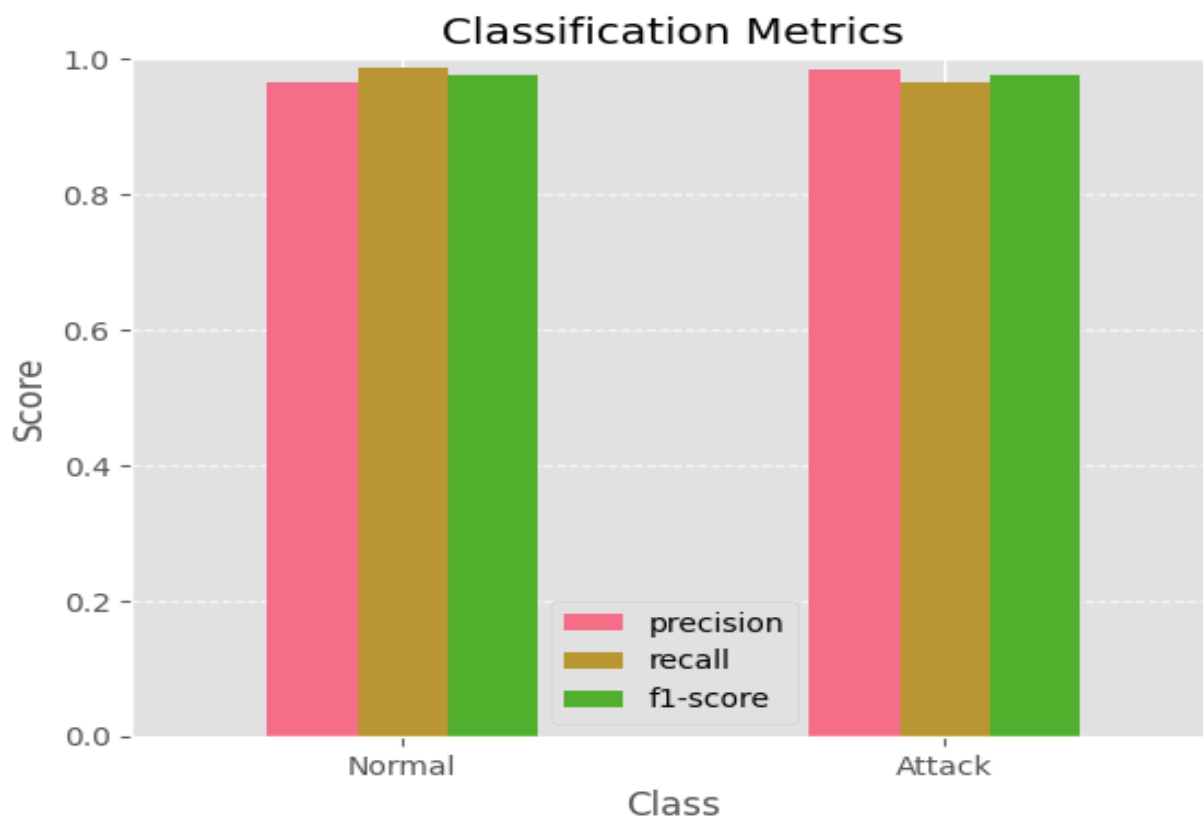
➢ **BAR GRAPH**

➤ HEAT MAP

Confusion Matrix
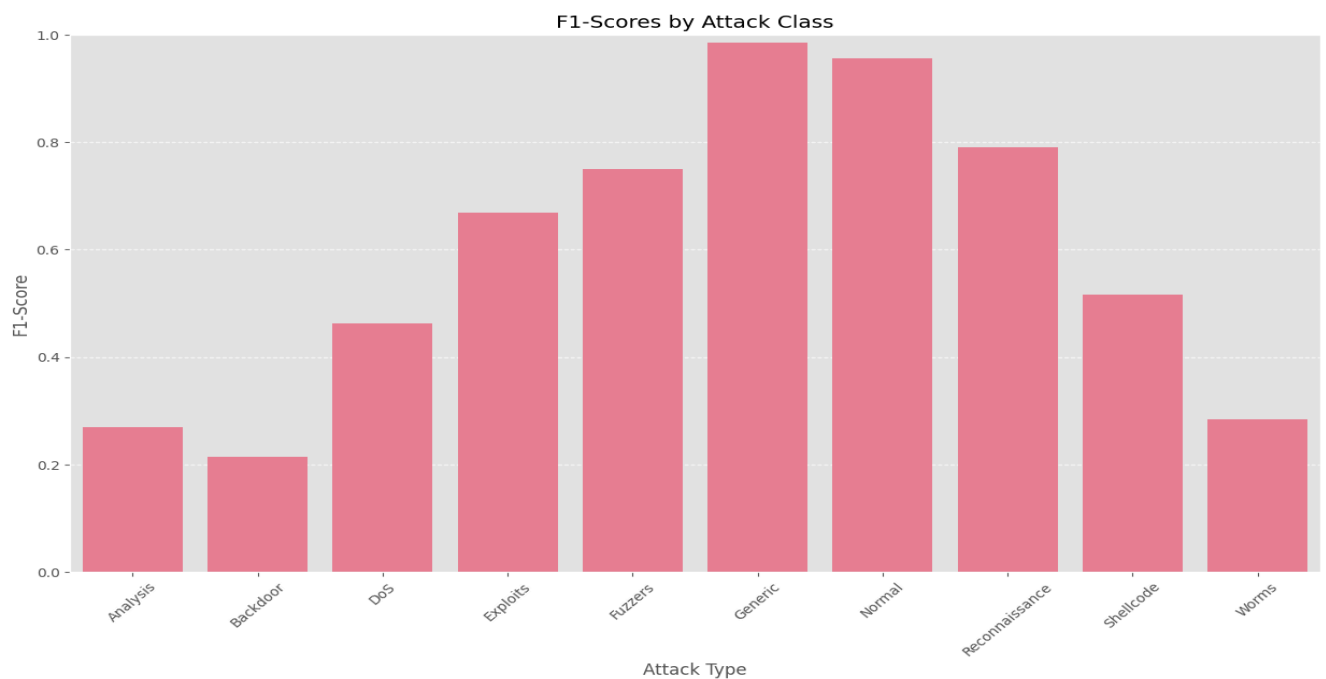
➤ MODEL ACCURACY

Model Accuracy

4.BINARY CLASSIFICATION

☐ CLASSIFICATION REPORT

```
Classification Report:
              precision    recall  f1-score   support

      Normal       0.97      0.99      0.98     32935
      Attack       0.99      0.97      0.98     32935

    accuracy                           0.98     65870
   macro avg       0.98      0.98      0.98     65870
weighted avg       0.98      0.98      0.98     65870
```
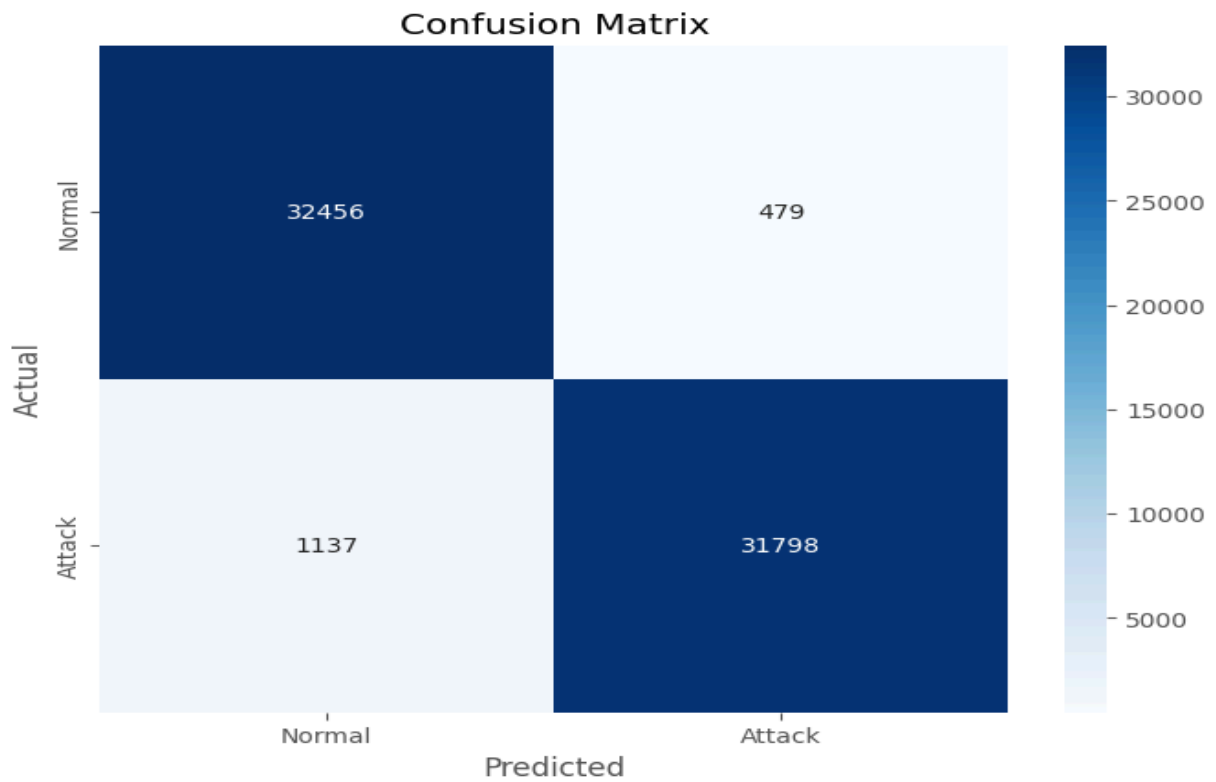
➢ BAR GRAPH

➢ **HEAT MAP**

➢ **MODEL ACCURACY**