Ismet Okan Celik CWID:10472265

In [2]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

Question-1

Manually Programing and Plotting ROC Curve via calculating True Positive Rate vs. False Positive Rate

In [31]:
```
Probabilities=np.array([0.967,0.448,0.568,0.879,0.015,0.780,0.978,0.004])
Classifications=np.array([1,0,1,0,1,0,1,0])

data=pd.DataFrame(Classifications.T,columns=['Classes'])
data['Prob']=pd.DataFrame(Probabilities.T)
data
```

Out[31]:

	Classes	Prob
0	1	0.967
1	0	0.448
2	1	0.568
3	0	0.879
4	1	0.015
5	0	0.780
6	1	0.978
7	0	0.004

In [32]:
```
threshold=np.linspace(0,1,50)
threshold=[float('{:.2f}'.format(i)) for i in threshold]
print('Number of Threshold=',len(threshold),'\n')
print('The List of Threshold Values\n',np.array(threshold))
```

```
Number of Threshold= 50

The List of Threshold Values
 [0.   0.02 0.04 0.06 0.08 0.1  0.12 0.14 0.16 0.18 0.2  0.22 0.24 0.27
 0.29 0.31 0.33 0.35 0.37 0.39 0.41 0.43 0.45 0.47 0.49 0.51 0.53 0.55
 0.57 0.59 0.61 0.63 0.65 0.67 0.69 0.71 0.73 0.76 0.78 0.8  0.82 0.84
 0.86 0.88 0.9  0.92 0.94 0.96 0.98 1.  ]
```

In [33]:

```
List_TP_FP=[]

for z in threshold:
    sub_list=[]
    for i in Probabilities:
        if i>=z:
            sub_list.append(1)
        else:
            sub_list.append(0)
    List_TP_FP.append(sub_list)
```

In [34]:

```
List_TP_FP=np.array(List_TP_FP)
threshold_df=pd.DataFrame(List_TP_FP.T,columns=[str(i) for i in threshold])
```

In [35]:

```
data=data.join(threshold_df)
data
```

Out[35]:

	Classes	Prob	0.0	0.02	0.04	0.06	0.08	0.1	0.12	0.14	...	0.82	0.84	0.86	0.88	0.9	0.92	0.9
0	1	0.967	1	1	1	1	1	1	1	1	...	1	1	1	1	1	1	
1	0	0.448	1	1	1	1	1	1	1	1	...	0	0	0	0	0	0	
2	1	0.568	1	1	1	1	1	1	1	1	...	0	0	0	0	0	0	
3	0	0.879	1	1	1	1	1	1	1	1	...	1	1	1	0	0	0	
4	1	0.015	1	0	0	0	0	0	0	0	...	0	0	0	0	0	0	
5	0	0.780	1	1	1	1	1	1	1	1	...	0	0	0	0	0	0	
6	1	0.978	1	1	1	1	1	1	1	1	...	1	1	1	1	1	1	
7	0	0.004	1	0	0	0	0	0	0	0	...	0	0	0	0	0	0	

8 rows × 52 columns

In [36]:

```
TP_List=[]
FP_List=[]
for i in range(len(threshold)):
    tp=0
    fp=0
    for k in range(len(Probabilities)):
        if data['Classes'].values[k]==1 and threshold_df[str(threshold[i])].values[k
            tp+=1
        if threshold_df[str(threshold[i])].values[k]==1 and data['Classes'].values[k
            fp+=1
    TP_List.append(tp)
    FP_List.append(fp)

print('Number of True Positive for Every Given Threshold\n',TP_List,'\n')
print('Number of False Positive for Every Given Threshold\n',FP_List)
```

```
Number of True Positive for Every Given Threshold
 [4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3,
3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 0, 0]

Number of False Positive for Every Given Threshold
 [4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2,
2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0]
```

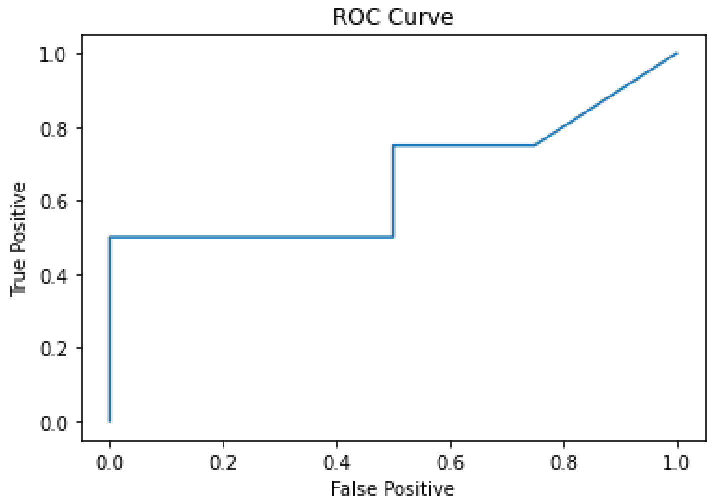
In [37]:

```
class_1_count=(data['Classes'] == 1).sum()
class_0_count=(data['Classes'] == 0).sum()

TP_rate=np.array([i/class_1_count for i in TP_List])
FP_rate=np.array([i/class_0_count for i in FP_List])
print(TP_rate)
print(FP_rate)
```

```
[1.   0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75
 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75
 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
 0.5  0.5  0.5  0.5  0.5  0.5  0.   0.   ]
[1.   0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75
 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.75 0.5  0.5  0.5  0.5  0.5  0.5
 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.25 0.25 0.25
 0.25 0.   0.   0.   0.   0.   0.   0.   ]
```

In [38]:
```
plt.plot(FP_rate,TP_rate)
plt.xlabel('False Positive')
plt.ylabel('True Positive')
plt.title('ROC Curve')
plt.show()
```



Question-2

Task-1

In [39]:
```
data2=pd.read_csv('EE627A_HW3_DataSet1.csv',header=None)
data2.tail()
```

Out[39]:

	0	1	2	3	4	5	6	7	8	9	...	467	468
3995	4.3152	4.3203	4.3152	4.3177	290.45	290.55	290.25	290.45	290.45	290.55	...	22.289	43.479
3996	4.3126	4.3152	4.3074	4.3100	290.36	290.51	290.18	290.31	290.36	290.51	...	22.319	43.479
3997	4.3100	4.3152	4.3022	4.3048	290.41	290.41	290.12	290.15	290.41	290.41	...	22.350	43.479
3998	4.3048	4.3048	4.2790	4.2842	290.18	290.41	290.18	290.27	290.18	290.41	...	22.340	43.479
3999	4.2764	4.2790	4.2661	4.2764	290.40	290.49	290.29	290.41	290.40	290.49	...	22.350	43.707

5 rows × 477 columns

In [40]:
```
from sklearn import metrics
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
```

In [41]:
```
predict=data2.iloc[:,0:476]
response=data2[476]
```

In [42]:
```
Logistic_Regression=LogisticRegression(solver='liblinear',C=1.0, random_state=0)
fitting_model=Logistic_Regression.fit(predict,response)
```

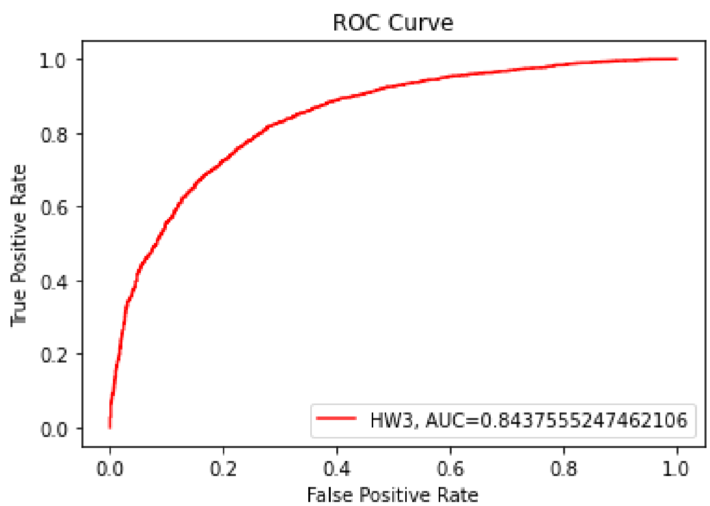
In [43]:
```
prob_y_pred=fitting_model.predict_proba(predict)[:,1]
prob_y_pred
```

Out[43]:
```
array([0.89530769, 0.91323699, 0.65207578, ..., 0.33087727, 0.47175371,
       0.65063082])
```

In [44]:
```
FalsePositiveRate,TruePositiveRate,_= metrics.roc_curve(response,prob_y_pred)
AUC=metrics.roc_auc_score(response,prob_y_pred)
```

In [45]:
```
plt.plot(FalsePositiveRate,TruePositiveRate,label='HW3, AUC='+str(AUC),color='r')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve')
plt.legend(loc=4)
plt.show
```

Out[45]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```



Task-2

In [47]:
```
# Splitting Data: First 3000 data will be used as Training Purpose and rest of 1000

x_train, x_test, y_train, y_test=train_test_split(data2.iloc[:,0:-1], data2.iloc[:,-
print(np.shape(x_train))
print(np.shape(x_test))
print(np.shape(y_train))
print(np.shape(y_test))
```

```
(3000, 476)
(1000, 476)
(3000,)
(1000,)
```

In [48]:
```
Logistic_Regression2=LogisticRegression(solver='liblinear',C=10.0, random_state=0)
Model2=Logistic_Regression2.fit(x_train,y_train)
```

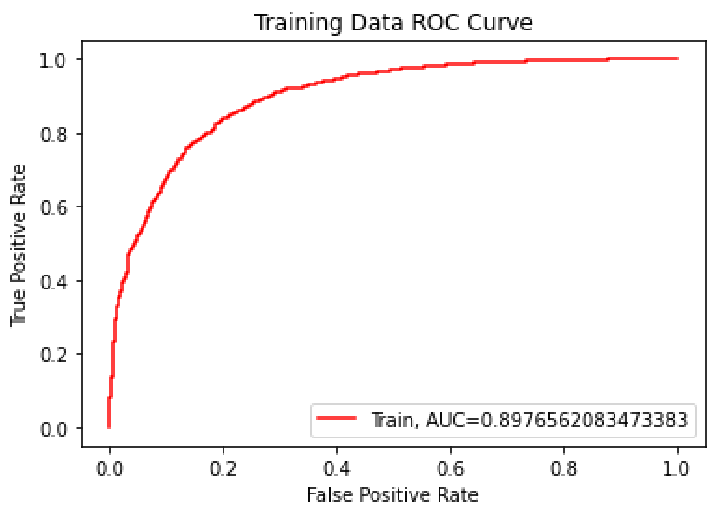
In [49]:
```
prob_y_pred2=Model2.predict_proba(x_train.iloc[:,0:])[:,1]
prob_y_pred2
```

Out[49]:
```
array([0.99995833, 0.9989204 , 0.90182109, ..., 0.92841773, 0.88061359,
       0.76238846])
```

In [50]:
```
FP_Rate_Train,TP_Rate_Train,_ = metrics.roc_curve(y_train,prob_y_pred2)
AUC_Train=metrics.roc_auc_score(y_train,prob_y_pred2)
```

In [51]:
```
plt.plot(FP_Rate_Train,TP_Rate_Train,label='Train, AUC='+str(AUC_Train),color='r')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Training Data ROC Curve')
plt.legend(loc=4)
plt.show
```

Out[51]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```

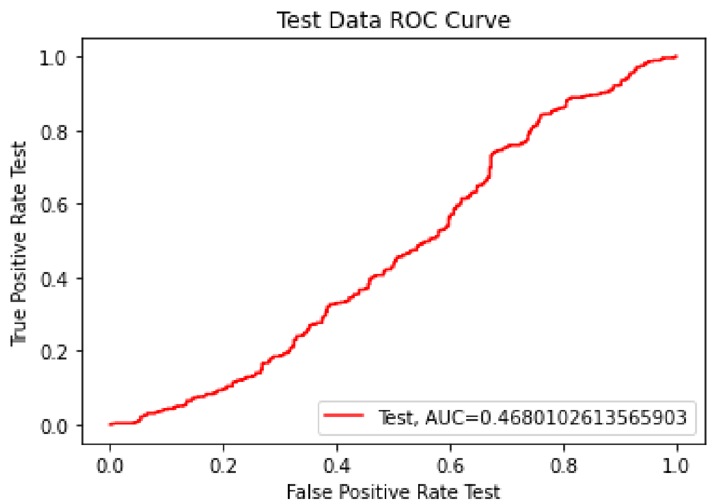


In [52]:
```
prob_y_pred3=Model2.predict_proba(x_test.iloc[:,0:])[:,1]
```

In [53]:
```
FP_Rate_Test,TP_Rate_Test,_ = metrics.roc_curve(y_test,prob_y_pred3)
AUC_Test=metrics.roc_auc_score(y_test,prob_y_pred3)
```

In [54]:
```
plt.plot(FP_Rate_Test,TP_Rate_Test,label='Test, AUC='+str(AUC_Test),color='r')
plt.xlabel('False Positive Rate Test')
plt.ylabel('True Positive Rate Test')
plt.title('Test Data ROC Curve')
plt.legend(loc=4)
plt.show
```

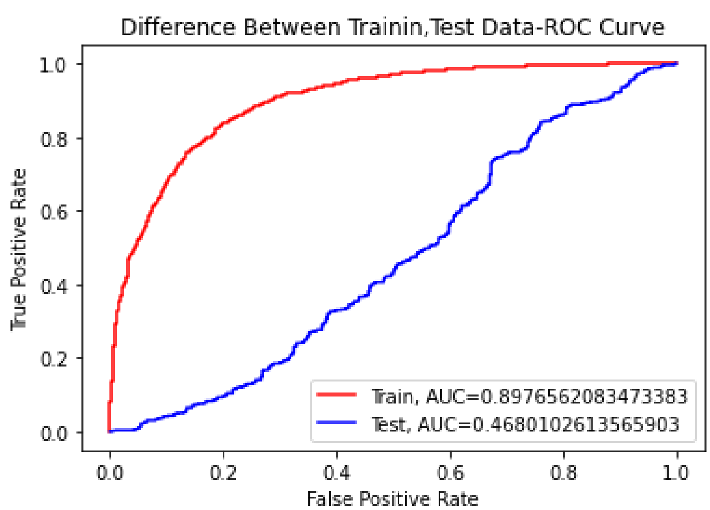
Out[54]: <function matplotlib.pyplot.show(close=None, block=None)>



In [55]:
```
AUC_Difference=AUC_Train-AUC_Test
print('Difference Between AUC_Training and AUC_Test=',AUC_Difference)
plt.plot(FP_Rate_Train,TP_Rate_Train,label='Train, AUC='+str(AUC_Train),color='r')
plt.plot(FP_Rate_Test,TP_Rate_Test,label='Test, AUC='+str(AUC_Test),color='b')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Difference Between Trainin,Test Data-ROC Curve')
plt.legend(loc=4)
plt.show
```

```
Difference Between AUC_Training and AUC_Test= 0.429645946990748
```

Out[55]: <function matplotlib.pyplot.show(close=None, block=None)>




```
As we can see above, the difference between AUC_Training-AUC_Test=0.4299 is a high
value. Also, AUC_Test is under 0.5, and it means that model is not able to distinguish
between Class-1 and Class-2. For these reasons, we can say that model is not good.
```