Task 1

In [221]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.preprocessing import LabelEncoder ,OneHotEncoder ,StandardScaler
from sklearn.compose import ColumnTransformer
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score ,confusion_matrix ,classification_report
import seaborn as sns
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
```

In [222]:
```
df = pd.read_csv("../DataSets/heart.csv")
df.head(5)
```

Out[222]:

	Age	Sex	ChestPainType	RestingBP	Cholesterol	FastingBS	RestingECG	MaxHR	ExerciseAngina	Oldpeak	ST_Slope	HeartDisea
0	40	M	ATA	140	289	0	Normal	172	N	0.0	Up	
1	49	F	NAP	160	180	0	Normal	156	N	1.0	Flat	
2	37	M	ATA	130	283	0	ST	98	N	0.0	Up	
3	48	F	ASY	138	214	0	Normal	108	Y	1.5	Flat	
4	54	M	NAP	150	195	0	Normal	122	N	0.0	Up	

In [223]:
```
##split the data  into x and y

x = df.drop("HeartDisease",axis = 1)
y = df["HeartDisease"]
x.head(1)
```

Out[223]:

	Age	Sex	ChestPainType	RestingBP	Cholesterol	FastingBS	RestingECG	MaxHR	ExerciseAngina	Oldpeak	ST_Slope
0	40	M	ATA	140	289	0	Normal	172	N	0.0	Up

In [224]:
```
## standard deviation
std_devs = df.std()
print(std_devs)
```

```
Age               9.432617
RestingBP        18.514154
Cholesterol     109.384145
FastingBS         0.423046
MaxHR            25.460334
Oldpeak           1.066570
HeartDisease      0.497414
dtype: float64
```

```
C:\Users\Barcha\AppData\Local\Temp\ipykernel_13644\1787614816.py:2: FutureWarning: The default value of nume
ric_only in DataFrame.std is deprecated. In a future version, it will default to False. In addition, specify
ing 'numeric_only=None' is deprecated. Select only valid columns or specify the value of numeric_only to sil
ence this warning.
  std_devs = df.std()
```

In [183]:
```
## Will apply all the math function in it
df.describe()
```

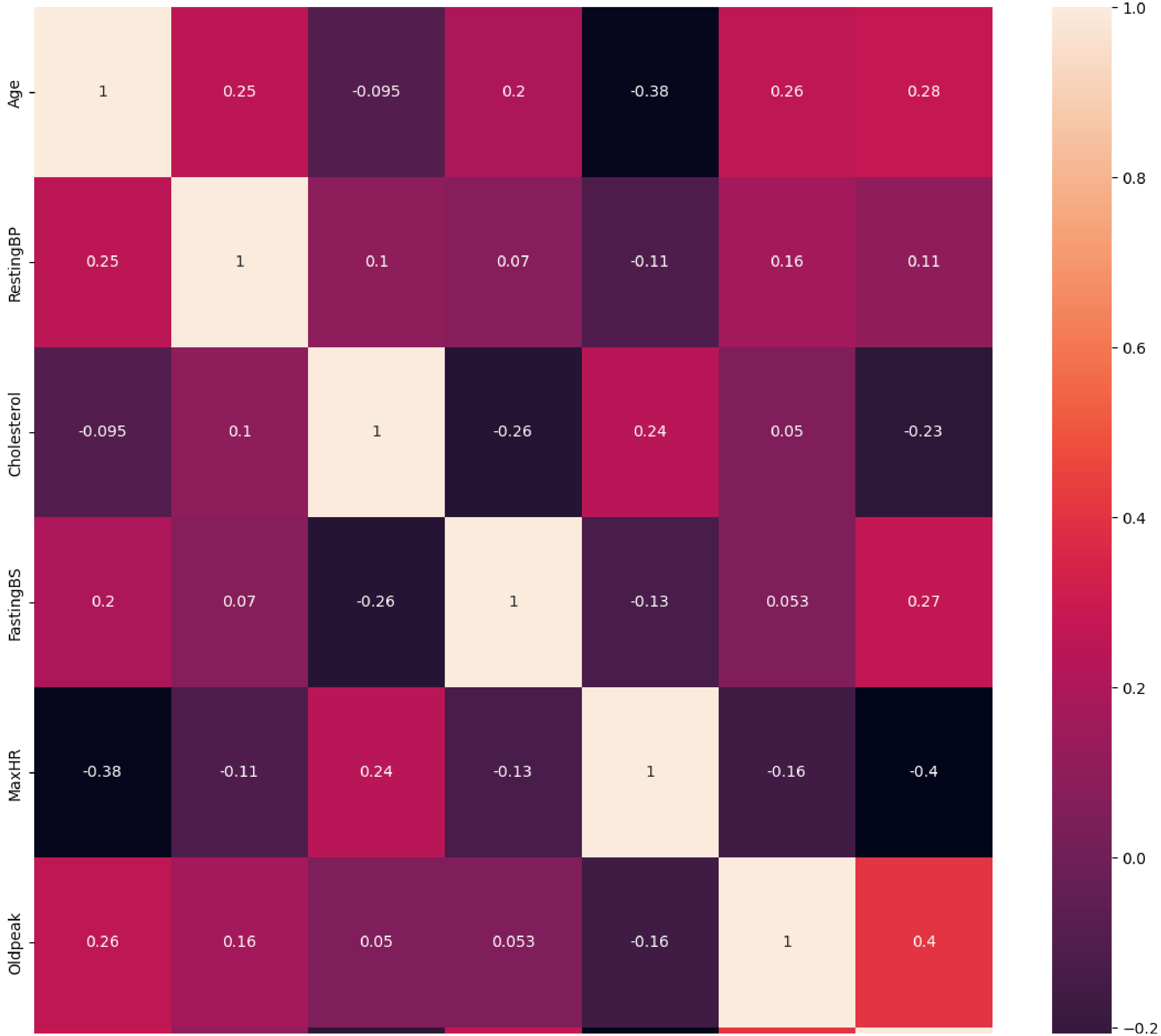
Out[183]:

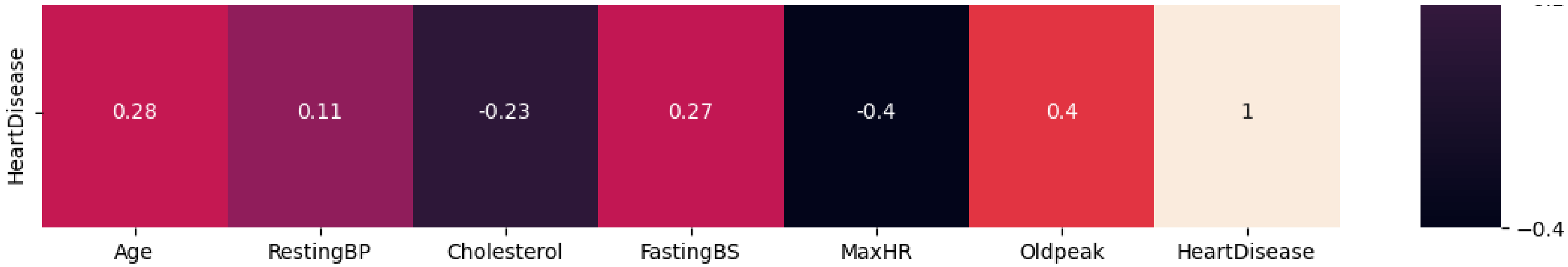
	Age	RestingBP	Cholesterol	FastingBS	MaxHR	Oldpeak	HeartDisease
count	918.000000	918.000000	918.000000	918.000000	918.000000	918.000000	918.000000
mean	53.510893	132.396514	198.799564	0.233115	136.809368	0.887364	0.553377
std	9.432617	18.514154	109.384145	0.423046	25.460334	1.066570	0.497414
min	28.000000	0.000000	0.000000	0.000000	60.000000	-2.600000	0.000000
25%	47.000000	120.000000	173.250000	0.000000	120.000000	0.000000	0.000000
50%	54.000000	130.000000	223.000000	0.000000	138.000000	0.600000	1.000000
75%	60.000000	140.000000	267.000000	0.000000	156.000000	1.500000	1.000000
max	77.000000	200.000000	603.000000	1.000000	202.000000	6.200000	1.000000

In [184]:
```
heCorr = df.corr()
plt.figure(figsize = (14,14))
sns.heatmap(heCorr , annot = True)
```

```
C:\Users\Barcha\AppData\Local\Temp\ipykernel_13644\2068051862.py:1: FutureWarning: The default value of nume
ric_only in DataFrame.corr is deprecated. In a future version, it will default to False. Select only valid c
olumns or specify the value of numeric_only to silence this warning.
  heCorr = df.corr()
```

Out[184]:
```
<Axes: >
```


Age
RestingBP
Cholesterol
FastingBS
MaxHR
Oldpeak
1 0.25 -0.095 0.2 -0.38 0.26 0.28
0.25 1 0.1 0.07 -0.11 0.16 0.11
-0.095 0.1 1 -0.26 0.24 0.05 -0.23
0.2 0.07 -0.26 1 -0.13 0.053 0.27
-0.38 -0.11 0.24 -0.13 1 -0.16 -0.4
0.26 0.16 0.05 0.053 -0.16 1 0.4
1.0
0.8
0.6
0.4
0.2
0.0
−0.2

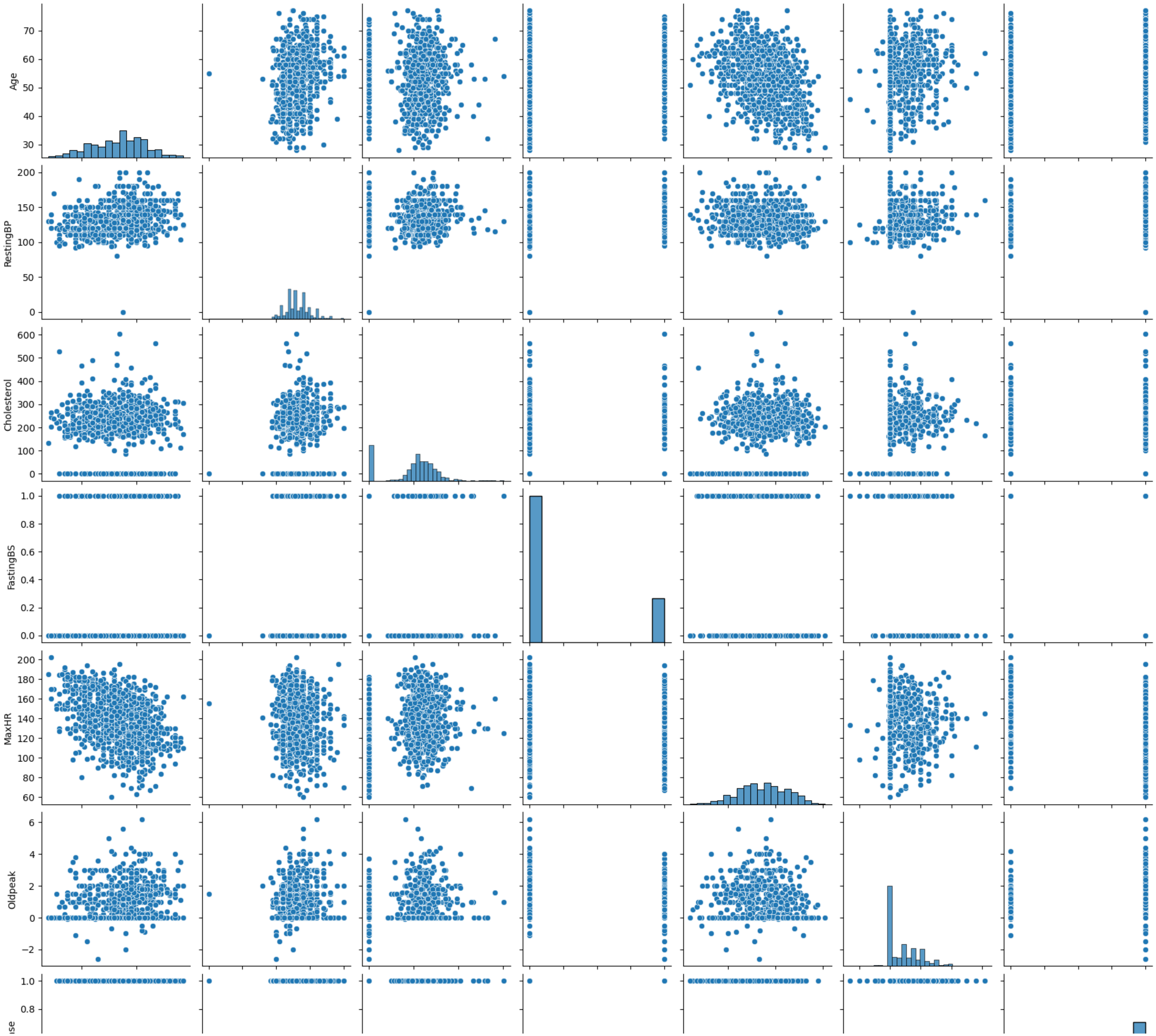


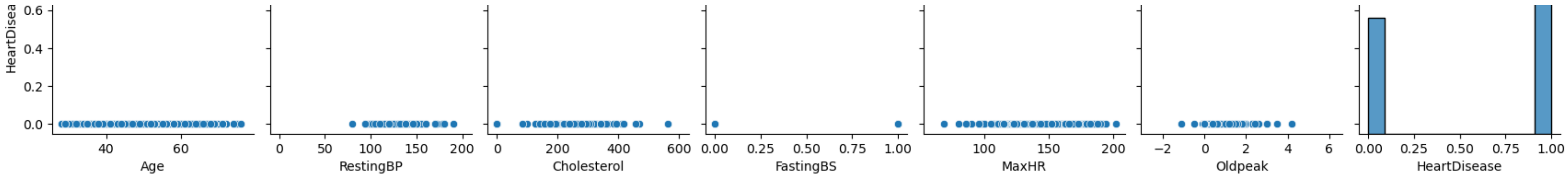
In [185]:
```
df['FastingBS'].value_counts()
```

Out[185]:
```
0    704
1    214
Name: FastingBS, dtype: int64
```

In [225]:
```
sns.pairplot(df)
```

Out[225]:
```
<seaborn.axisgrid.PairGrid at 0x18eba94ff40>
```


Age
RestingBP
Cholesterol
FastingBS
MaxHR
Oldpeak

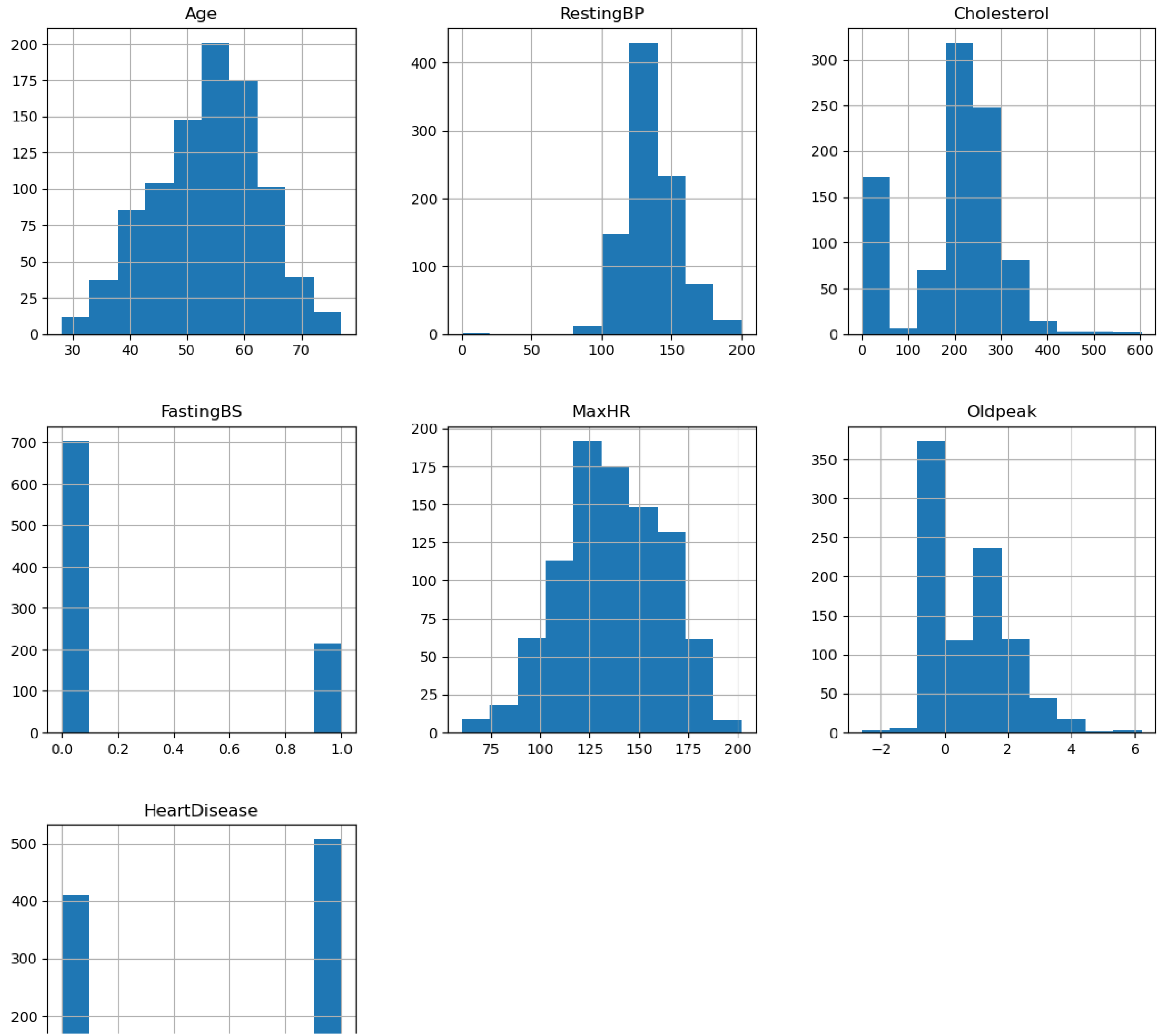

HeartDisea
0.6
0.4
0.2
0.0
40
60
Age
0
50
100
150
200
RestingBP
0
200
400
600
Cholesterol
0.00
0.25
0.50
0.75
1.00
FastingBS
100
150
200
MaxHR
−2
0
2
4
6
Oldpeak
0.00
0.25
0.50
0.75
1.00
HeartDisease

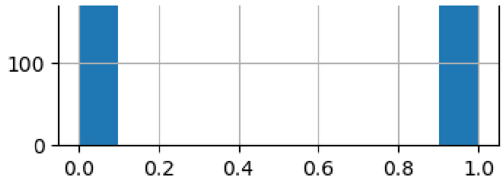
In [229]:

```
df.hist(figsize = [14,14])
```

Out[229]:

```
array([[<Axes: title={'center': 'Age'}>,
        <Axes: title={'center': 'RestingBP'}>,
        <Axes: title={'center': 'Cholesterol'}>],
       [<Axes: title={'center': 'FastingBS'}>,
        <Axes: title={'center': 'MaxHR'}>,
        <Axes: title={'center': 'Oldpeak'}>],
       [<Axes: title={'center': 'HeartDisease'}>, <Axes: >, <Axes: >]],
      dtype=object)
```


Age
200
175
150
125
100
75
50
25
0
30 40 50 60 70
RestingBP
400
300
200
100
0
0 50 100 150 200
Cholesterol
300
250
200
150
100
50
0
0 100 200 300 400 500 600
FastingBS
700
600
500
400
300
200
100
0
0.0 0.2 0.4 0.6 0.8 1.0
MaxHR
200
175
150
125
100
75
50
25
0
75 100 125 150 175 200
Oldpeak
350
300
250
200
150
100
50
0
−2 0 2 4 6
HeartDisease
500
400
300
200



In [186]:
```
## Data preprocessing

encoder = OneHotEncoder()
scaling = StandardScaler()

categorical  = ["Sex","ChestPainType","RestingECG","ExerciseAngina","ST_Slope"]
numerical = ["Age","RestingBP","Cholesterol","MaxHR","FastingBS" ,"Oldpeak"]

transform = ColumnTransformer([("categ",encoder ,categorical),
                               ("scaling",scaling ,numerical)],remainder = "passthrough")

x_trans = transform.fit_transform(x)
x_trans
```

Out[186]:
```
array([[ 0.        ,  1.        ,  0.        , ...,  1.38292822,
        -0.55134134, -0.83243239],
       [ 1.        ,  0.        ,  0.        , ...,  0.75415714,
        -0.55134134,  0.10566353],
       [ 0.        ,  1.        ,  0.        , ..., -1.52513802,
        -0.55134134, -0.83243239],
       ...,
       [ 0.        ,  1.        ,  1.        , ..., -0.85706875,
        -0.55134134,  0.29328271],
       [ 1.        ,  0.        ,  0.        , ...,  1.4615246 ,
        -0.55134134, -0.83243239],
       [ 0.        ,  1.        ,  0.        , ...,  1.42222641,
        -0.55134134, -0.83243239]])
```

In [187]:
```
## Split the data into train test
np.random.seed(42)
x_train ,x_test ,y_train ,y_test = train_test_split(x_trans ,y ,test_size = 0.3 ,random_state = 43)
```

SVC Model

In [188]:
```
## model selection

svc = SVC(C=0.5 ,kernel = "rbf")
svc.fit(x_train ,y_train)
svc.score(x_test ,y_test)
```

Out[188]: 0.855072463768116

In [189]:
```
## Hyperparameter tunning

from sklearn.model_selection import GridSearchCV

# defining parameter range
param_grid = {'C': [0.1, 1, 10, 500],
              'gamma': [1, 0.1, 0.001, 0.0001],
              'kernel': ['rbf' ,"poly" , "linear"] }

grid = GridSearchCV(svc, param_grid, verbose = 2 ,cv = 3)

# fitting the model for grid search
svcHyper = grid.fit(x_train, y_train)
```

```
Fitting 3 folds for each of 48 candidates, totalling 144 fits
[CV] END .........................C=0.1, gamma=1, kernel=rbf; total time=   0.0s
[CV] END .........................C=0.1, gamma=1, kernel=rbf; total time=   0.0s
[CV] END .........................C=0.1, gamma=1, kernel=rbf; total time=   0.0s
[CV] END ........................C=0.1, gamma=1, kernel=poly; total time=   0.0s
[CV] END ........................C=0.1, gamma=1, kernel=poly; total time=   0.0s
[CV] END ........................C=0.1, gamma=1, kernel=poly; total time=   0.0s
[CV] END ......................C=0.1, gamma=1, kernel=linear; total time=   0.0s
[CV] END ......................C=0.1, gamma=1, kernel=linear; total time=   0.0s
[CV] END ......................C=0.1, gamma=1, kernel=linear; total time=   0.0s
[CV] END .......................C=0.1, gamma=0.1, kernel=rbf; total time=   0.0s
[CV] END .......................C=0.1, gamma=0.1, kernel=rbf; total time=   0.0s
[CV] END .......................C=0.1, gamma=0.1, kernel=rbf; total time=   0.0s
[CV] END ......................C=0.1, gamma=0.1, kernel=poly; total time=   0.0s
[CV] END ......................C=0.1, gamma=0.1, kernel=poly; total time=   0.0s
[CV] END ......................C=0.1, gamma=0.1, kernel=poly; total time=   0.0s
[CV] END ....................C=0.1, gamma=0.1, kernel=linear; total time=   0.0s
[CV] END ....................C=0.1, gamma=0.1, kernel=linear; total time=   0.0s
[CV] END ....................C=0.1, gamma=0.1, kernel=linear; total time=   0.0s
```

In [190]:
```
svcHyper.best_score_
```

Out[190]:
```
0.8878504672897196
```

In [191]:
```
svcHyper.best_params_
```

Out[191]:
```
{'C': 1, 'gamma': 0.1, 'kernel': 'rbf'}
```

In [192]:
```
## y_pred
y_pred = svc.predict(x_test)
print(accuracy_score(y_test ,y_pred))
```

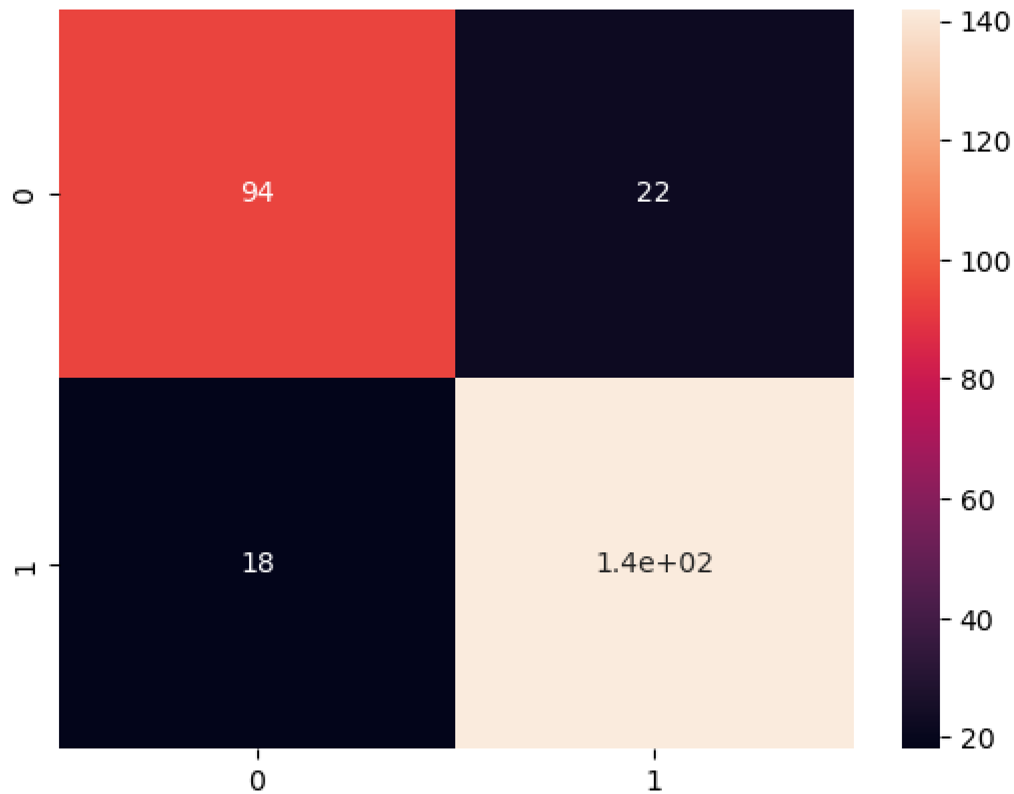
```
0.855072463768116
```

In [193]:
```
sm = confusion_matrix(y_test ,y_pred)
sm
```

Out[193]:
```
array([[ 94,  22],
       [ 18, 142]], dtype=int64)
```

In [194]:
```
sns.heatmap(sm ,annot = True)
```

Out[194]: <Axes: >



DecisionTreeClassifier

In [195]:
```
## Use decion tree model
dec = DecisionTreeClassifier()
dec.fit(x_train ,y_train)
dec.score(x_test ,y_test)
```

Out[195]: 0.7463768115942029

In [196]:
```
## y_pred
y_pred = dec.predict(x_test)
print(accuracy_score(y_test ,y_pred))
```

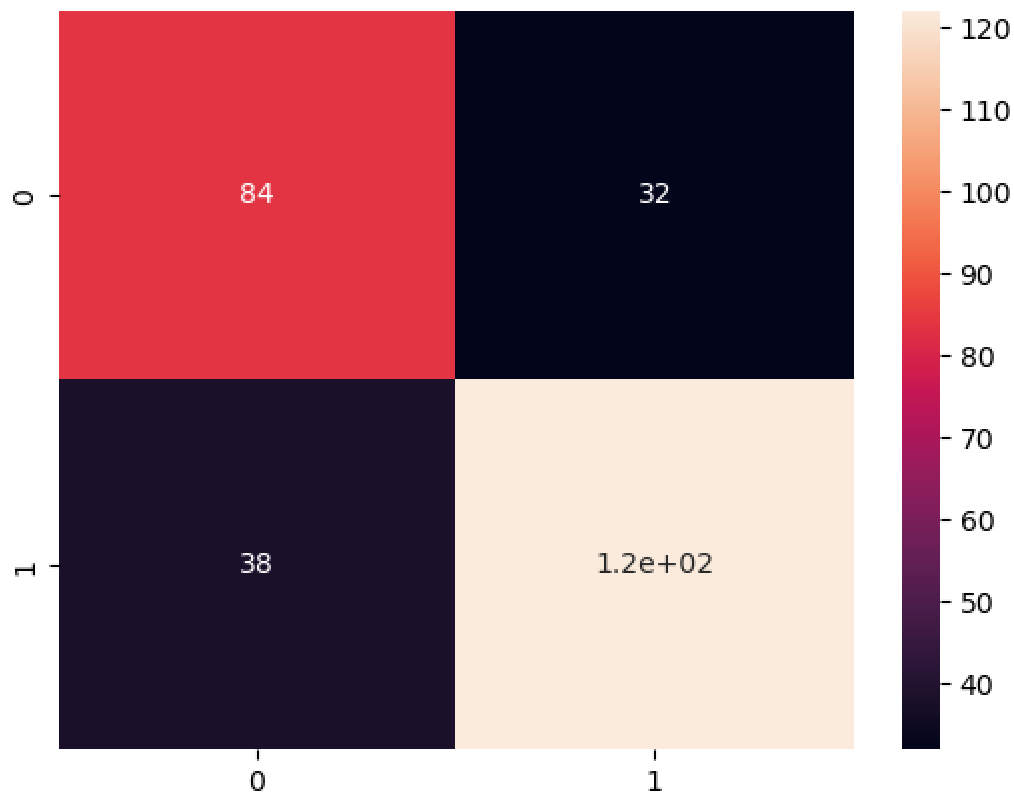
```
0.7463768115942029
```

In [197]:
```
s = confusion_matrix(y_test ,y_pred)
s
```

Out[197]:
```
array([[ 84,  32],
       [ 38, 122]], dtype=int64)
```

In [198]:
```
sns.heatmap(s ,annot = True)
```

Out[198]:
```
<Axes: >
```



RandomForestclassifier

In [199]:
```
np.random.seed(42)
clf = RandomForestClassifier()
clf.fit(x_train ,y_train)
clf.score(x_test ,y_test)
```

Out[199]:
```
0.8695652173913043
```

In [200]:
```
## y_pred
y_pred = clf.predict(x_test)
print(accuracy_score(y_test ,y_pred))
```

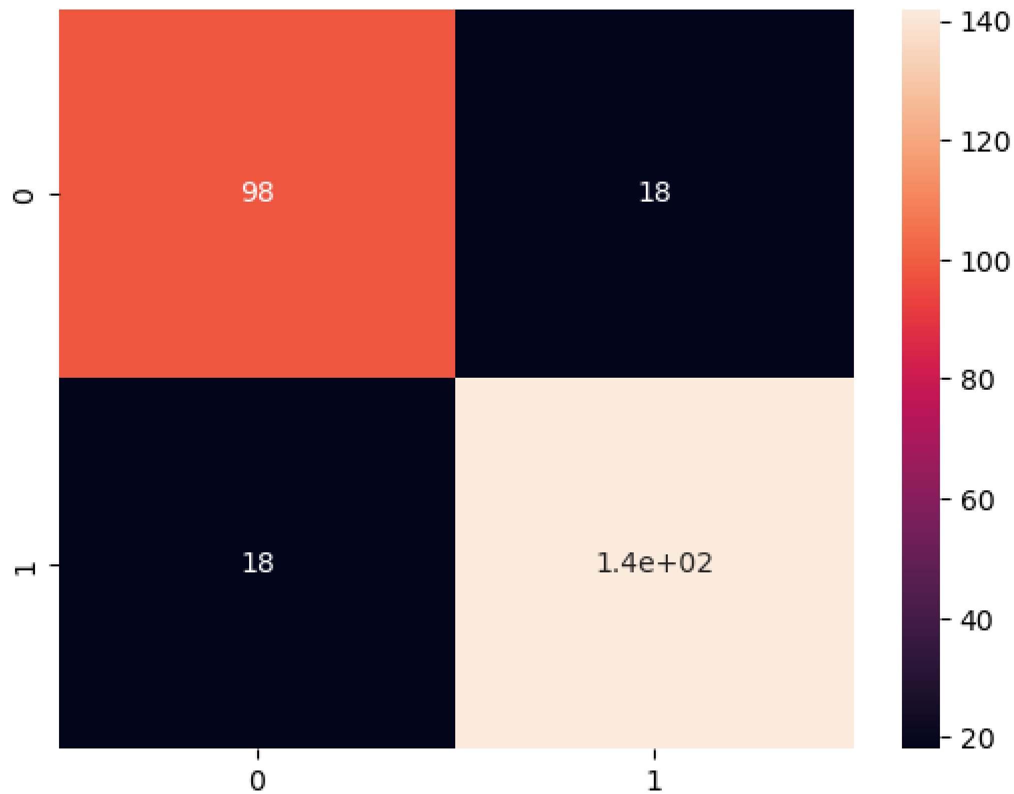
```
0.8695652173913043
```

In [201]:
```
f = confusion_matrix(y_test ,y_pred)
f
```

Out[201]:
```
array([[ 98,  18],
       [ 18, 142]], dtype=int64)
```

In [202]:
```
sns.heatmap(f ,annot = True)
```

Out[202]: <Axes: >



Comparing the scores

In [203]:
```
print("svc accuracy score",svc.score(x_test ,y_test))
print("decision accuracy score",dec.score(x_test ,y_test))
print("RandomForest accuracy score",clf.score(x_test ,y_test))
```

```
svc accuracy score 0.855072463768116
decision accuracy score 0.7463768115942029
RandomForest accuracy score 0.8695652173913043
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

TAsk 2

In [204]:
```
## Read the dataset

data = pd.read_csv("../DataSets/Churn_Modelling.csv")
data.head(5)
```

Out[204]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActive
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	
4	5	15737888	Mitchell	850	Spain	Female	43	2	125510.82	1	1	

In [205]:
```
##split the data  into x and y
df = data.drop(["RowNumber","CustomerId"] ,axis =1)
x = df.drop("Exited",axis = 1)
y = df["Exited"]
x.head(2)
```

Out[205]:

	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary
0	Hargrave	619	France	Female	42	2	0.00	1	1	1	101348.88
1	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.58

In [206]:
```
y
```

Out[206]:
```
0       1
1       0
2       1
3       0
4       0
       ..
9995    0
9996    0
9997    1
9998    1
9999    0
Name: Exited, Length: 10000, dtype: int64
```

In [207]:
```
## Now do the preprocessing ( Label Encoding & StandardScaling)


scaling = StandardScaler()
encoder = OneHotEncoder()

category =["Surname","Geography","Gender","NumOfProducts","HasCrCard","IsActiveMember"]
numerical = ["CreditScore","Age","Tenure","Balance","EstimatedSalary"]

transform = ColumnTransformer([("numerical",scaling,numerical),
                              ("category",encoder,category)],remainder="passthrough")
trans_x = transform.fit_transform(x)
trans_x.shape
```

Out[207]:
```
(10000, 2950)
```

In [208]:
```
## Split the data into train test
np.random.seed(42)
x_train ,x_test ,y_train ,y_test = train_test_split(trans_x ,y ,test_size = 0.3 ,random_state = 43)
```

In [209]:
```
## Import necessary libraries

import tensorflow as tf
from keras.models import Sequential
from keras.layers import Dense
```

For relu

In [210]:
```
## Create a ANN

model = Sequential()


model.add(Dense(32, activation='relu', input_shape=(2950,)))

model.add(Dense(12, activation='relu'))


model.add(Dense(2, activation='softmax'))

model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])

model.summary()
```

```
Model: "sequential_15"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 dense_43 (Dense)            (None, 32)                94432     
                                                                 
 dense_44 (Dense)            (None, 12)                396       
                                                                 
 dense_45 (Dense)            (None, 2)                 26        
                                                                 
=================================================================
Total params: 94854 (370.52 KB)
Trainable params: 94854 (370.52 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [211]:
```
## Encode y_labels using onehotencoder

from keras.utils import to_categorical

y_train_encoded = to_categorical(y_train)
y_test_encoded = to_categorical(y_test)

history = model.fit(x_train ,y_train_encoded ,batch_size = 32 ,epochs = 10 )
```

```
Epoch 1/10
219/219 [==============================] - 2s 4ms/step - loss: 0.4698 - accuracy: 0.7993
Epoch 2/10
219/219 [==============================] - 1s 4ms/step - loss: 0.3599 - accuracy: 0.8499
Epoch 3/10
219/219 [==============================] - 1s 4ms/step - loss: 0.3232 - accuracy: 0.8719
Epoch 4/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2902 - accuracy: 0.8876
Epoch 5/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2599 - accuracy: 0.8979
Epoch 6/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2312 - accuracy: 0.9100
Epoch 7/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2100 - accuracy: 0.9186
Epoch 8/10
219/219 [==============================] - 1s 4ms/step - loss: 0.1921 - accuracy: 0.9270
Epoch 9/10
219/219 [==============================] - 1s 4ms/step - loss: 0.1760 - accuracy: 0.9321
Epoch 10/10
219/219 [==============================] - 1s 5ms/step - loss: 0.1624 - accuracy: 0.9367
```

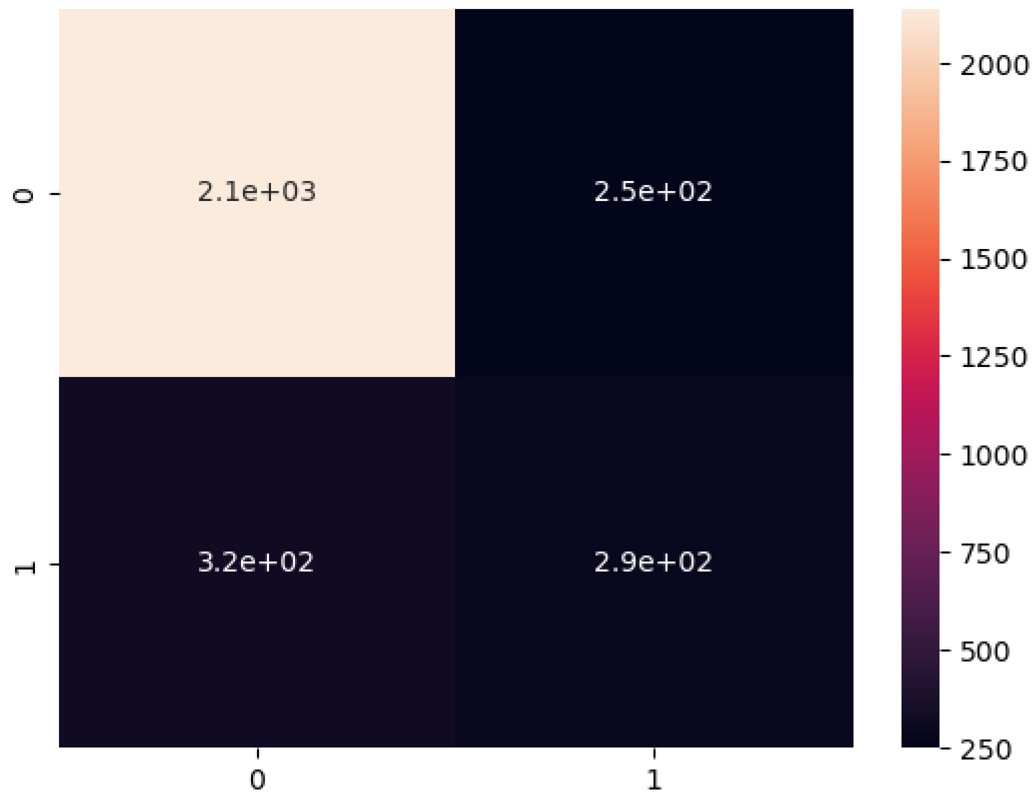
In [212]:
```
y_predict_encoded = model.predict(x_test)
y_preds = np.argmax(y_predict_encoded,axis = 1)
model.evaluate(x_test , y_test_encoded)
```

```
94/94 [==============================] - 0s 3ms/step
94/94 [==============================] - 1s 4ms/step - loss: 0.4874 - accuracy: 0.8093
```

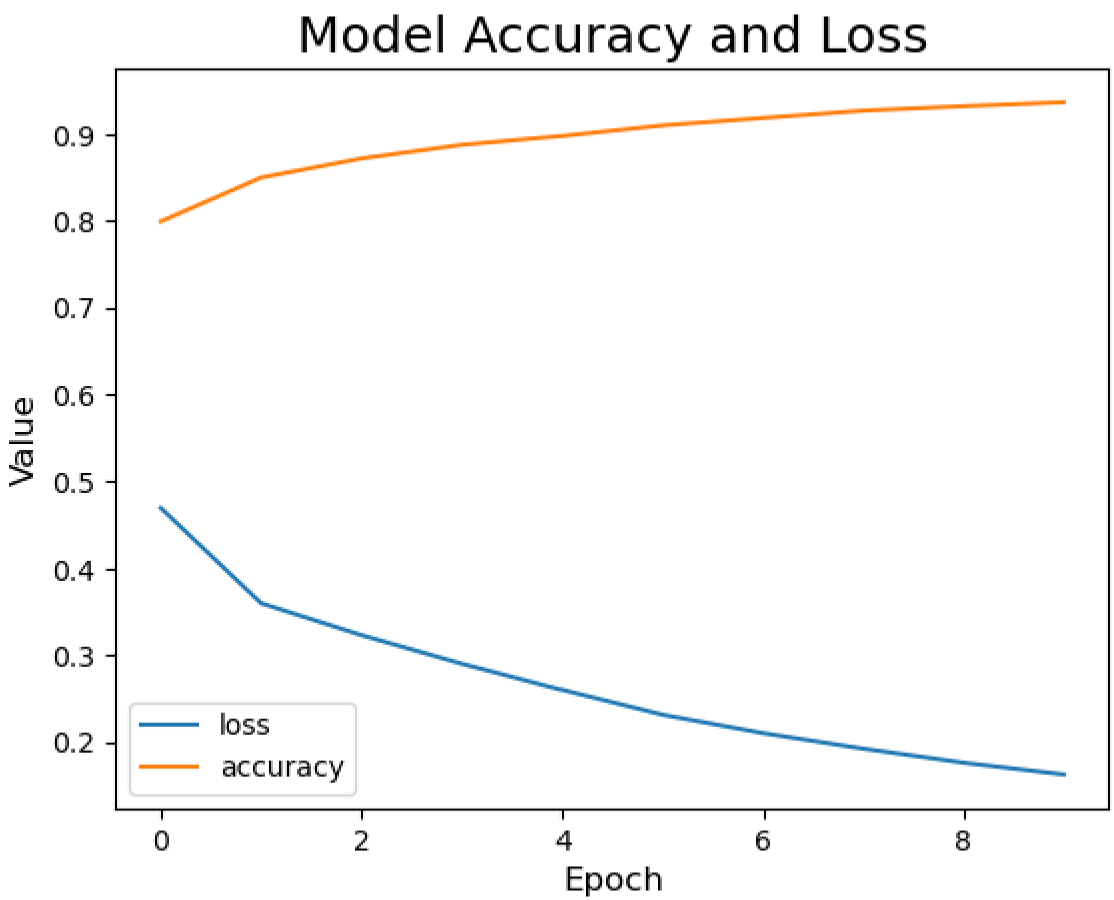
Out[212]:
```
[0.48743578791618347, 0.809333324432373]
```

In [213]:
```
accuracy_score(y_test ,y_preds)
```
Out[213]:
```
0.8093333333333333
```

In [214]:
```
an = confusion_matrix(y_test ,y_preds)
print(an)
sns.heatmap(an ,annot = True)
```
```
[[2138  249]
 [ 323  290]]
```
Out[214]:
```
<Axes: >
```



In [215]:
```
plt.plot(history.epoch , history.history["loss"])
plt.plot(history.epoch , history.history["accuracy"])
plt.title("Model Accuracy and Loss", fontsize=18)
plt.xlabel("Epoch", fontsize=12)
plt.ylabel("Value", fontsize=12)
plt.legend(["loss" ,"accuracy"])
plt.show()
```



For Tanh

In [216]:
```
## Create a ANN  for relu activation

model = Sequential()


model.add(Dense(32, activation='tanh', input_shape=(2950,)))

model.add(Dense(12, activation='tanh'))


model.add(Dense(2, activation='softmax'))

model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])

model.summary()
```

```
Model: "sequential_16"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_46 (Dense)            (None, 32)                94432

 dense_47 (Dense)            (None, 12)                396

 dense_48 (Dense)            (None, 2)                 26

=================================================================
Total params: 94854 (370.52 KB)
Trainable params: 94854 (370.52 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [217]:
```
## Encode y_labels using onehotencoder

from keras.utils import to_categorical

y_train_encoded = to_categorical(y_train)
y_test_encoded = to_categorical(y_test)

history = model.fit(x_train ,y_train_encoded ,batch_size = 32 ,epochs = 10 )
```

```
Epoch 1/10
219/219 [==============================] - 2s 3ms/step - loss: 0.4502 - accuracy: 0.8053
Epoch 2/10
219/219 [==============================] - 1s 4ms/step - loss: 0.3615 - accuracy: 0.8493
Epoch 3/10
219/219 [==============================] - 1s 3ms/step - loss: 0.3346 - accuracy: 0.8631
Epoch 4/10
219/219 [==============================] - 1s 4ms/step - loss: 0.3035 - accuracy: 0.8769
Epoch 5/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2838 - accuracy: 0.8861
Epoch 6/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2714 - accuracy: 0.8894
Epoch 7/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2628 - accuracy: 0.8873
Epoch 8/10
219/219 [==============================] - 1s 5ms/step - loss: 0.2551 - accuracy: 0.8940
Epoch 9/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2490 - accuracy: 0.8951
Epoch 10/10
219/219 [==============================] - 1s 4ms/step - loss: 0.2476 - accuracy: 0.8973
```

In [218]:
```
y_predict_encoded = model.predict(x_test)
y_preds = np.argmax(y_predict_encoded,axis = 1)
model.evaluate(x_test , y_test_encoded)
```

```
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step - loss: 0.4829 - accuracy: 0.8183
```

Out[218]:
```
[0.48287254571914673, 0.8183333277702332]
```

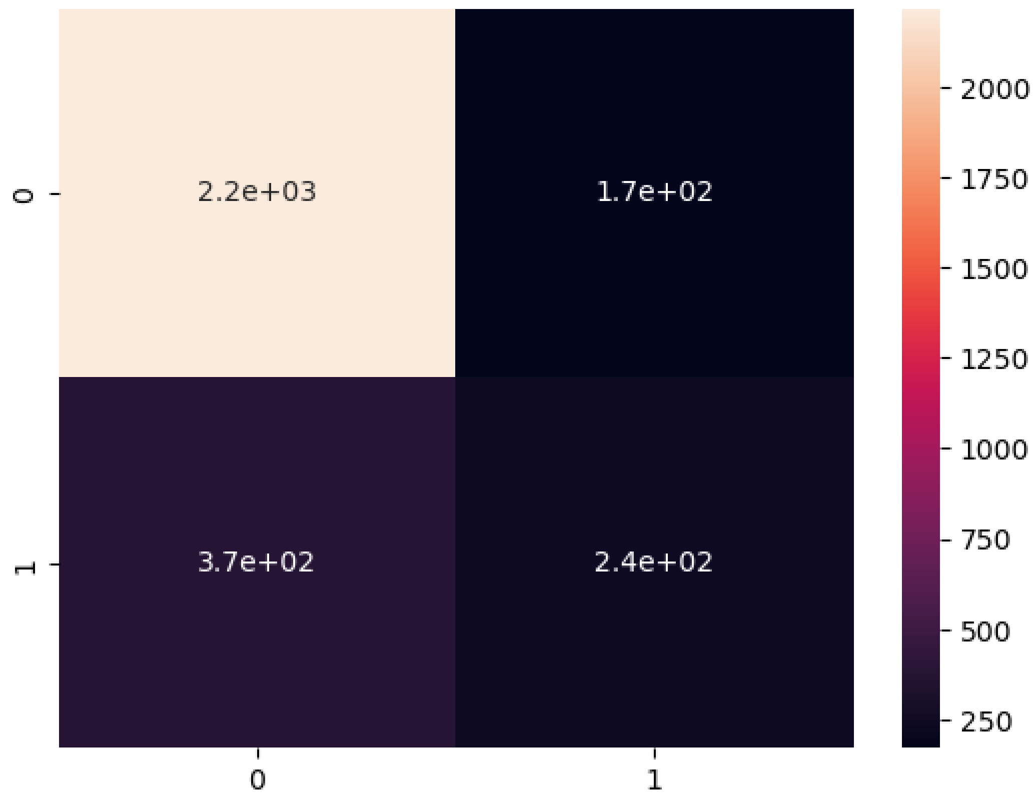
In [219]:
```
accuracy_score(y_test ,y_preds)
```

Out[219]: 0.8183333333333334

In [220]:
```
an = confusion_matrix(y_test ,y_preds)
print(an)
sns.heatmap(an ,annot = True)
```

```
[[2216  171]
 [ 374  239]]
```

Out[220]: <Axes: >



In [ ]:

```

```

In [ ]:

```

```