In [1]:

```
#Importing Libraries
```

In [5]:

```
import seaborn as sns   # To use Seaborn functions
```

In [6]:

```
import matplotlib.pyplot as plt    # This imports the pyplot module from the matplotl
```

In [8]:

```
%matplotlib inline
```

In [9]:

```
import pandas as pd    # In order to import and use the pandas library
```

In [10]:

```
sns.set() #
```

In [11]:

```
import numpy as np   #the code tells Python to bring the NumPy library into your curr
```

In [12]:

```
from sklearn.preprocessing import StandardScaler    # to transform input dataset valu
```

In [13]:

```
from sklearn.model_selection import train_test_split   # To splitting data arrays int
```

In [14]:

```
from sklearn.metrics import classification_report, confusion_matrix     #Compute conf
```

In [15]:

```
df = pd.read_csv('heart.csv') #T import dataset
```

In [16]:

```
1 df.head()  #To show header of dataset
```

Out[16]:

	age	sex	cp	trtbps	chol	fbs	restecg	thalachh	exng	oldpeak	slp	caa	thall	output
0	63	1	3	145	233	1	0	150	0	2.3	0	0	1	1
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2	1
2	41	0	1	130	204	0	0	172	0	1.4	2	0	2	1
3	56	1	1	120	236	0	1	178	0	0.8	2	0	2	1
4	57	0	0	120	354	0	1	163	1	0.6	2	0	2	1

In [17]:

```
1 df.info()  #To show information of dataset
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 303 entries, 0 to 302
Data columns (total 14 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   age       303 non-null    int64  
 1   sex       303 non-null    int64  
 2   cp        303 non-null    int64  
 3   trtbps    303 non-null    int64  
 4   chol      303 non-null    int64  
 5   fbs       303 non-null    int64  
 6   restecg   303 non-null    int64  
 7   thalachh  303 non-null    int64  
 8   exng      303 non-null    int64  
 9   oldpeak   303 non-null    float64
 10  slp       303 non-null    int64  
 11  caa       303 non-null    int64  
 12  thall     303 non-null    int64  
 13  output    303 non-null    int64  
dtypes: float64(1), int64(13)
memory usage: 33.3 KB
```

In [18]:

```
df.isnull()    #To check whether if any value is null
```

Out[18]:

	age	sex	cp	trtbps	chol	fbs	restecg	thalachh	exng	oldpeak	slp	caa
0	False	False	False	False	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False	False	False	False	False
4	False	False	False	False	False	False	False	False	False	False	False	False
...	...	...	...	...	...	...	...	...	...	...	...	...
298	False	False	False	False	False	False	False	False	False	False	False	False
299	False	False	False	False	False	False	False	False	False	False	False	False
300	False	False	False	False	False	False	False	False	False	False	False	False
301	False	False	False	False	False	False	False	False	False	False	False	False
302	False	False	False	False	False	False	False	False	False	False	False	False

303 rows × 14 columns

In [19]:

```
df.isnull().sum()    #It gives you pandas series of column names along with the sum c
```

Out[19]:

```
age         0
sex         0
cp          0
trtbps      0
chol        0
fbs         0
restecg     0
thalachh    0
exng        0
oldpeak     0
slp         0
caa         0
thall       0
output      0
dtype: int64
```

In [20]:

```
df_copy = df.copy(deep=True)    # To create a shallow copy of Pandas DataFrame
```

In [21]:

```
df_copy[['trtbps','chol','thalachh','oldpeak']] = df_copy[['trtbps','chol','thalachh'
```

In [22]:

```
print(df_copy.isnull().sum())   #To find the total number of missing value
```

```
age          0
sex          0
cp           0
trtbps       0
chol         0
fbs          0
restecg      0
thalachh     0
exng         0
oldpeak     99
slp          0
caa          0
thall        0
output       0
dtype: int64
```

In [23]:

```
df_copy['oldpeak'].fillna(df_copy['oldpeak'].mean(), inplace = True) # To create a sh
```

In [24]:

```
color_wheel = {1: "#0392cf",2:"#7bc043"}  #The short answer is determine the color of
```

In [25]:

```
colors = df["output"].map(lambda x:color_wheel.get(x + 1))
```

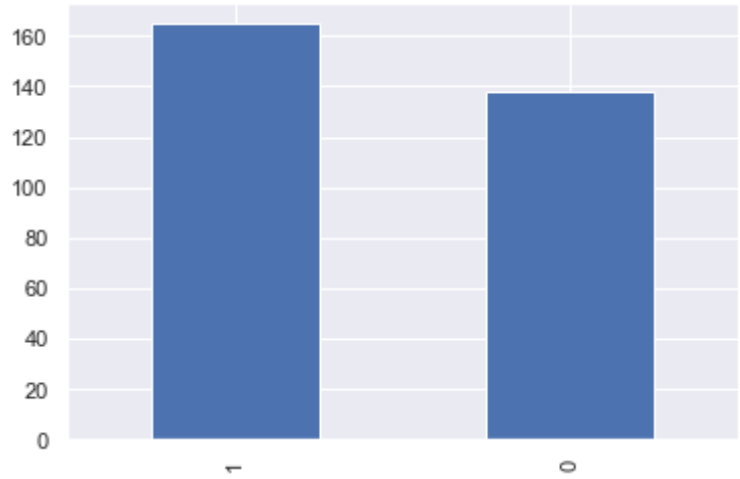
In [26]:

```
print(df.output.value_counts())   # to get the counts of unique values of the datafra
```

```
1    165
0    138
Name: output, dtype: int64
```

In [27]:

```
p=df.output.value_counts().plot(kind="bar")     # plot value_counts of Series
```

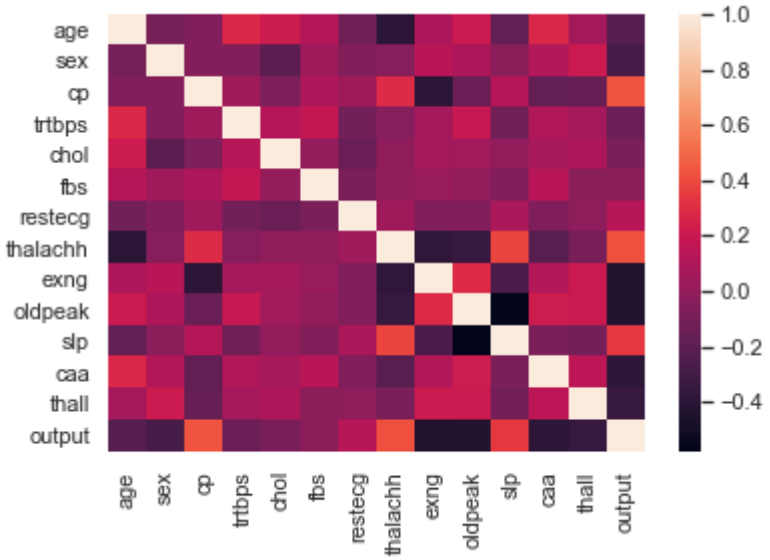


In [28]:

```
1 sns.heatmap(df.corr()) #To see the coreiation using heatmap
```

Out[28]:

<AxesSubplot:>



In [29]:

```
X = df.drop('output',axis=1)   # Remove the  column from the DataFrame
print(X)
```

```
     age  sex  cp  trtbps  chol  fbs  restecg  thalachh  exng  oldpeak  sl
p  \
0     63    1   3     145   233    1        0       150     0      2.3
0
1     37    1   2     130   250    0        1       187     0      3.5
0
2     41    0   1     130   204    0        0       172     0      1.4
2
3     56    1   1     120   236    0        1       178     0      0.8
2
4     57    0   0     120   354    0        1       163     1      0.6
2
..   ...  ...  ..     ...   ...  ...      ...       ...   ...      ...
...
298   57    0   0     140   241    0        1       123     1      0.2
1
299   45    1   3     110   264    0        1       132     0      1.2
1
300   68    1   0     144   193    1        1       141     0      3.4
1
301   57    1   0     130   131    0        1       115     1      1.2
1
302   57    0   1     130   236    0        0       174     0      0.0
1

     caa  thall
0      0      1
1      0      2
2      0      2
3      0      2
4      0      2
..   ...    ...
298    0      3
299    0      3
300    2      3
301    1      3
302    1      2

[303 rows x 13 columns]
```

In [30]:

```
y = df['output']   # show output after dropping
print(y)
```

```
0      1
1      1
2      1
3      1
4      1
      ..
298    0
299    0
300    0
301    0
302    0
Name: output, Length: 303, dtype: int64
```

In [31]:

```
#Splitting the data set into training and test data
from sklearn.model_selection import train_test_split,cross_val_score,cross_val_predic
```

In [32]:

```
X_train,X_test,y_train,y_test = train_test_split(X,y, test_size=0.2,random_state=7)
```

In [33]:

```
#Fitting Decision tree classifier to the training set
from sklearn.tree import DecisionTreeClassifier
```

In [34]:

```
dtree = DecisionTreeClassifier()
```

In [35]:

```
dtree.fit(X_train, y_train)
```

Out[35]:

```
DecisionTreeClassifier()
```

In [36]:

```
#Predicting the test set result
y_pred = dtree.predict(X_test)
```

In [37]:

```
print("Classification report - \n", classification_report(y_test,y_pred))
```

```
Classification report -
              precision    recall  f1-score   support

           0       0.84      0.53      0.65        30
           1       0.67      0.90      0.77        31

    accuracy                           0.72        61
   macro avg       0.75      0.72      0.71        61
weighted avg       0.75      0.72      0.71        61
```

In [38]:

```
#creating the confusion matrix
cm = confusion_matrix(y_test, y_pred)
```

In [39]:

```
plt.figure(figsize=(5,5))
```

Out[39]:

```
<Figure size 360x360 with 0 Axes>
```

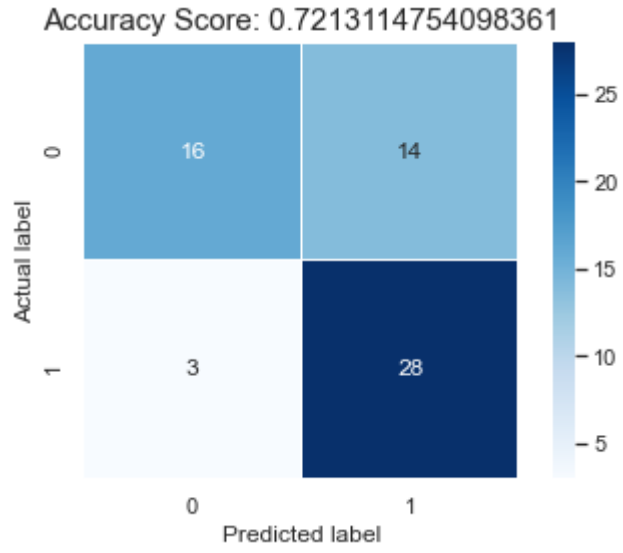

```
<Figure size 360x360 with 0 Axes>
```


In [40]:

```
sns.heatmap(data=cm,linewidths= .5, annot=True, square=True, cmap = 'Blues')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
all_sample_title = 'Accuracy Score: {0}'.format(dtree.score(X_test, y_test))
plt.title(all_sample_title, size = 15)

```

Out[40]:

```
Text(0.5, 1.0, 'Accuracy Score: 0.7213114754098361')
```



In [41]:

```
from sklearn.metrics import roc_curve, roc_auc_score
```

In [42]:

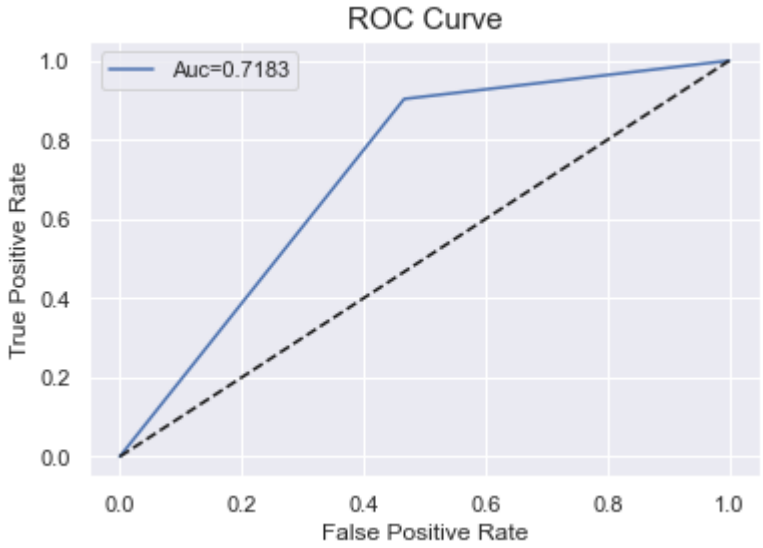
```
y_pred_proba = dtree.predict_proba(X_test)[:][:,1]
```

In [43]:

```
df_actual_predicted=pd.concat([pd.DataFrame(np.array(y_test),columns=['y_actual']),pd
df_actual_predicted.index=y_test.index
fpr, tpr, tr = roc_curve(df_actual_predicted['y_actual'], df_actual_predicted['y_pred
auc = roc_auc_score(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_prob
plt.plot(fpr,tpr,label='Auc=%0.4f'%auc)
plt.plot(fpr,fpr,linestyle='--',color='k')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve',size=15)
plt.legend()
```

Out[43]:

```
<matplotlib.legend.Legend at 0x271d318d700>
```



In [44]:

```
#fitting the svm classifier to the training set
from sklearn import svm
from sklearn.svm import SVC
svm = svm.SVC(kernel='linear',gamma='auto',probability=True)
svm.fit(X_train,y_train)
y_pred = svm.predict(X_test)
print("Classification report - \n", classification_report(y_test,y_pred))
```

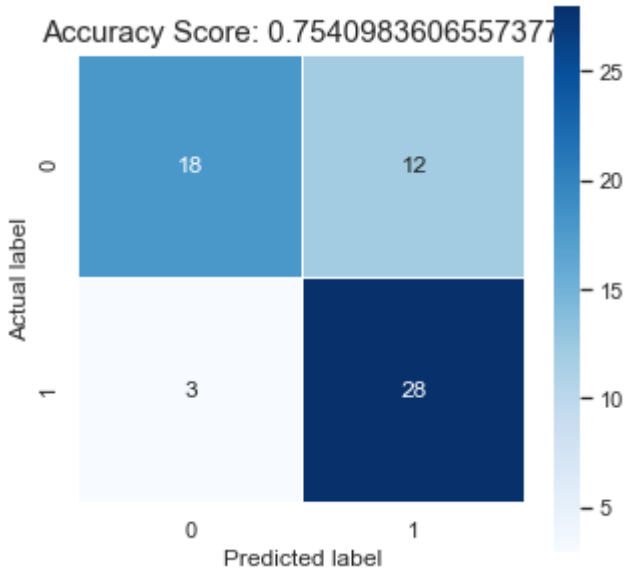
```
Classification report -
               precision    recall  f1-score   support

           0       0.86      0.60      0.71        30
           1       0.70      0.90      0.79        31

    accuracy                           0.75        61
   macro avg       0.78      0.75      0.75        61
weighted avg       0.78      0.75      0.75        61
```

In [45]:

```
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(5,5))
sns.heatmap(data=cm,linewidths= .5, annot=True, square=True, cmap = 'Blues')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
all_sample_title = 'Accuracy Score: {0}'.format(svm.score(X_test, y_test))
plt.title(all_sample_title, size = 15)
```

Out[45]:

```
Text(0.5, 1.0, 'Accuracy Score: 0.7540983606557377')
```

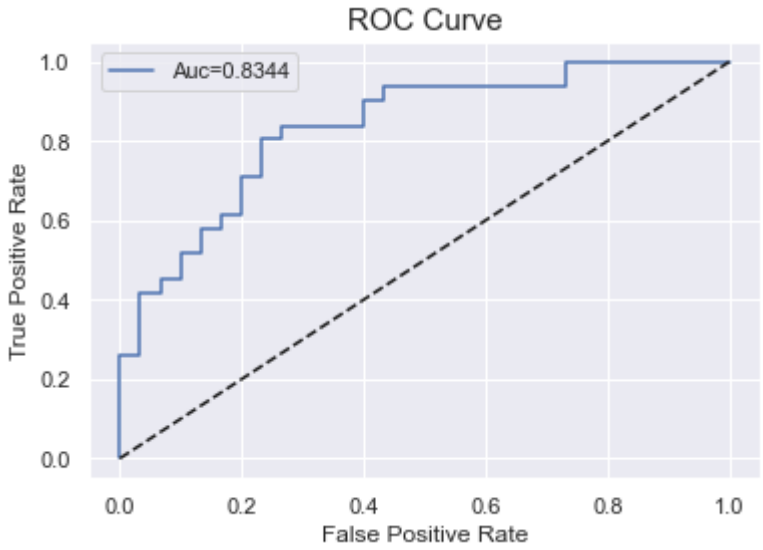


In [46]:

```
from sklearn.metrics import roc_curve, roc_auc_score
y_pred_proba = svm.predict_proba(X_test)[:][:,1]
df_actual_predicted=pd.concat([pd.DataFrame(np.array(y_test),columns=['y_actual']),pd
df_actual_predicted.index=y_test.index
fpr, tpr, tr = roc_curve(df_actual_predicted['y_actual'], df_actual_predicted['y_pred
auc = roc_auc_score(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_prob
plt.plot(fpr,tpr,label='Auc=%0.4f'%auc)
plt.plot(fpr,fpr,linestyle='--',color='k')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve',size=15)
plt.legend()


```

Out[46]:

<matplotlib.legend.Legend at 0x271d1524e50>



In [47]:

```
#fitting logistic regression to the training set
from sklearn.linear_model import LogisticRegression
logreg=LogisticRegression()
logreg.fit(X_train ,y_train)
```

```
C:\Users\HP\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:
763: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown i
n:
    https://scikit-learn.org/stable/modules/preprocessing.html (https://sc
ikit-learn.org/stable/modules/preprocessing.html)
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-reg
ression (https://scikit-learn.org/stable/modules/linear_model.html#logisti
c-regression)
  n_iter_i = _check_optimize_result(
```

Out[47]:

```
LogisticRegression()
```

In [48]:

```
y_pred = logreg.predict(X_test)
print("Classification report - \n", classification_report(y_test,y_pred))
```

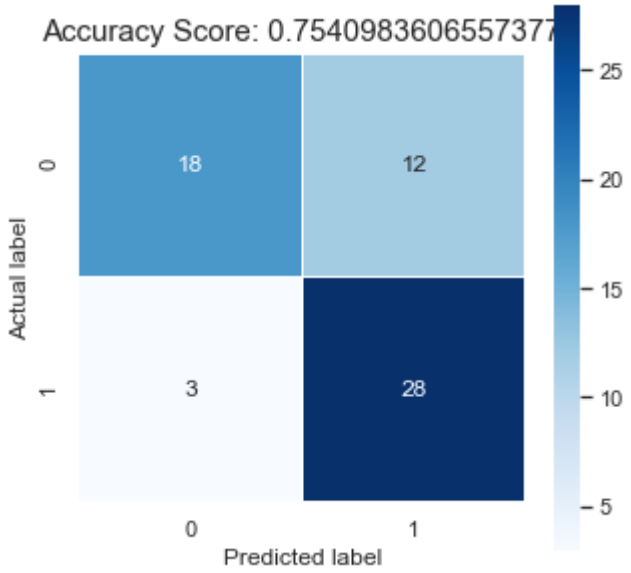
```
Classification report -
              precision    recall  f1-score   support

           0       0.86      0.60      0.71        30
           1       0.70      0.90      0.79        31

    accuracy                           0.75        61
   macro avg       0.78      0.75      0.75        61
weighted avg       0.78      0.75      0.75        61
```

In [49]:

```
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(5,5))
sns.heatmap(data=cm,linewidths= .5, annot=True, square=True, cmap = 'Blues')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
all_sample_title = 'Accuracy Score: {0}'.format(logreg.score(X_test, y_test))
plt.title(all_sample_title, size = 15)
```

Out[49]:

```
Text(0.5, 1.0, 'Accuracy Score: 0.7540983606557377')
```

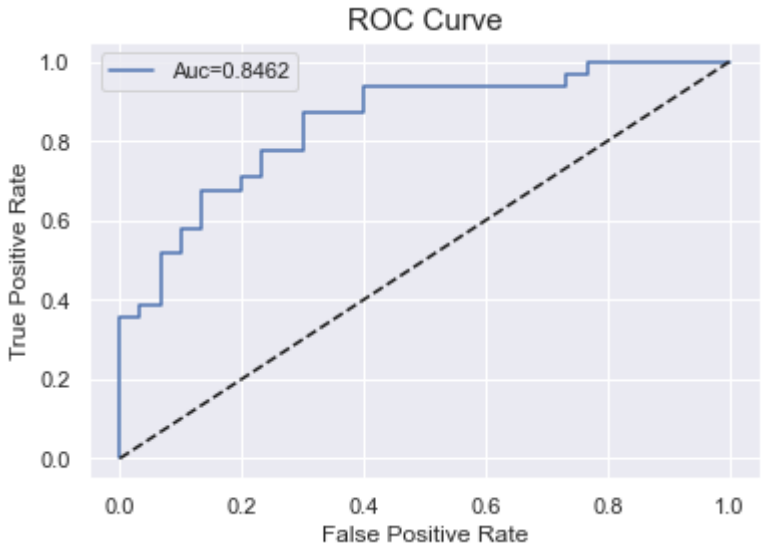


In [50]:

```
from sklearn.metrics import roc_curve, roc_auc_score
y_pred_proba = logreg.predict_proba(X_test)[:][:,1]
df_actual_predicted=pd.concat([pd.DataFrame(np.array(y_test),columns=['y_actual']),pd
df_actual_predicted.index=y_test.index
fpr, tpr, tr = roc_curve(df_actual_predicted['y_actual'], df_actual_predicted['y_pred
auc = roc_auc_score(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_prob
plt.plot(fpr,tpr,label='Auc=%0.4f'%auc)
plt.plot(fpr,fpr,linestyle='--',color='k')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve',size=15)
plt.legend()

```

Out[50]:

```
<matplotlib.legend.Legend at 0x271d328f550>
```



In [51]:

```
#fitting K-NN classifier to the training data
from sklearn.neighbors import KNeighborsClassifier
knn=KNeighborsClassifier()
knn.fit(X_train,y_train)
y_pred = knn.predict(X_test)
print("Classification report - \n", classification_report(y_test,y_pred))


```

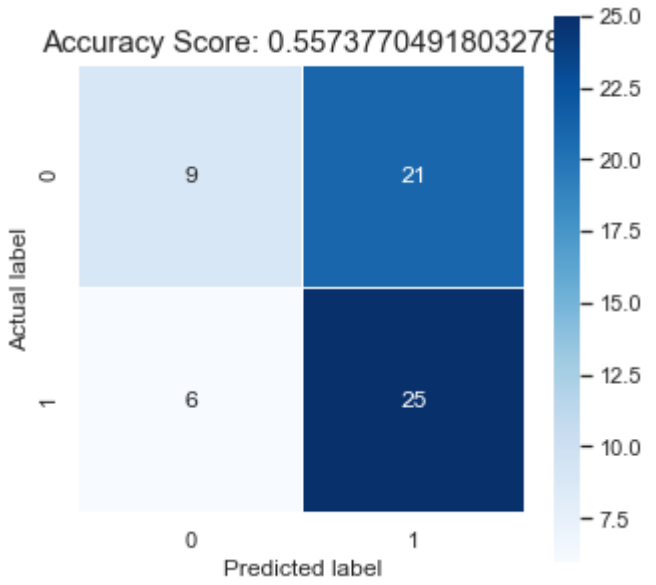
```
Classification report -
              precision    recall  f1-score   support

           0       0.60      0.30      0.40        30
           1       0.54      0.81      0.65        31

    accuracy                           0.56        61
   macro avg       0.57      0.55      0.52        61
weighted avg       0.57      0.56      0.53        61
```

In [52]:

```
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(5,5))
sns.heatmap(data=cm,linewidths= .5, annot=True, square=True, cmap = 'Blues')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
all_sample_title = 'Accuracy Score: {0}'.format(knn.score(X_test, y_test))
plt.title(all_sample_title, size = 15)
```

Out[52]:

```
Text(0.5, 1.0, 'Accuracy Score: 0.5573770491803278')
```



In [53]:

```
from sklearn.metrics import roc_curve, roc_auc_score
y_pred_proba = knn.predict_proba(X_test)[:][:,1]
df_actual_predicted=pd.concat([pd.DataFrame(np.array(y_test),columns=['y_actual']),pd
df_actual_predicted.index=y_test.index
fpr, tpr, tr = roc_curve(df_actual_predicted['y_actual'], df_actual_predicted['y_pred
auc = roc_auc_score(df_actual_predicted['y_actual'], df_actual_predicted['y_pred_prob
plt.plot(fpr,tpr,label='Auc=%0.4f'%auc)
plt.plot(fpr,fpr,linestyle='--',color='k')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve',size=15)
plt.legend()
```

Out[53]:

```
<matplotlib.legend.Legend at 0x271d33c5dc0>
```