In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import precision_score,recall_score,accuracy_score,confusion_matrix
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import BaggingClassifier,AdaBoostClassifier,RandomForestClassifier,Gradie
```

In [2]:

```
df=pd.read_csv("D:/Project/Air.csv")
```

In [3]:

```
df
```

Out[3]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Length	Price	Total Stop	Delay
0	1	Jet Airways	269	Delhi	Cochin	3	205	3898	non-stop	1
1	2	IndiGo	1558	Kolkata	Banglore	3	222	7663	1 stop	1
2	3	Jet Airways	2400	Delhi	Cochin	3	165	13883	1 stop	1
3	4	Multiple carriers	2466	Delhi	Cochin	3	195	6219	1 stop	1
4	5	Air Asia	108	Banglore	Delhi	3	202	13303	1 stop	0
...	...	...	...	...	...	...	...	...	...	...
311	312	Air India	5479	Kolkata	Banglore	3	120	14715	1 stop	0
312	313	Air India	5491	Kolkata	Banglore	3	98	9900	1 stop	0
313	314	Jet Airways	5507	Kolkata	Banglore	3	102	14872	1 stop	0
314	315	Air India	5564	Mumbai	Hyderabad	3	88	7296	non-stop	1
315	316	Air India	5605	Delhi	Cochin	3	86	13466	1 stop	0

316 rows × 10 columns

In [4]:

```
df.head()
```

Out[4]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Length	Price	Total Stop	Delay
0	1	Jet Airways	269	Delhi	Cochin	3	205	3898	non-stop	1
1	2	IndiGo	1558	Kolkata	Banglore	3	222	7663	1 stop	1
2	3	Jet Airways	2400	Delhi	Cochin	3	165	13883	1 stop	1
3	4	Multiple carriers	2466	Delhi	Cochin	3	195	6219	1 stop	1
4	5	Air Asia	108	Banglore	Delhi	3	202	13303	1 stop	0

In [5]:

```
df.columns
```

Out[5]:

```
Index(['id', 'Airline', 'Flight', 'AirportFrom', 'AirportTo', 'DayOfWeek',
       'Length', 'Price', 'Total Stop', 'Delay'],
      dtype='object')
```

In [6]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 316 entries, 0 to 315
Data columns (total 10 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   id           316 non-null    int64 
 1   Airline      316 non-null    object
 2   Flight       316 non-null    int64 
 3   AirportFrom  316 non-null    object
 4   AirportTo    316 non-null    object
 5   DayOfWeek    316 non-null    int64 
 6   Length       316 non-null    int64 
 7   Price        316 non-null    int64 
 8   Total Stop   316 non-null    object
 9   Delay        316 non-null    int64 
dtypes: int64(6), object(4)
memory usage: 24.8+ KB
```

In [7]:
```
df.size  # Size of DataSet Total Number Present in Dataset
```

Out[7]:
```
3160
```

In [8]:
```
df.shape # Shape of Dataset Total Row And Columns Present In Dataset
```

Out[8]:
```
(316, 10)
```

In [9]:
```
df.isnull().sum() #Checking Null Values Of Dataset
```

Out[9]:
```
id             0
Airline        0
Flight         0
AirportFrom    0
AirportTo      0
DayOfWeek      0
Length         0
Price          0
Total Stop     0
Delay          0
dtype: int64
```

In [10]:
```
df.isnull().sum().sum() #Total Null Value
```

Out[10]:
```
0
```

Performing LabelEncoding On DataSet

In [11]:
```
le=LabelEncoder()     # To convert categorical data into numerical data for model building
```

In [12]:
```
df
```

Out[12]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Length	Price	Total Stop	Delay
0	1	Jet Airways	269	Delhi	Cochin	3	205	3898	non-stop	1
1	2	IndiGo	1558	Kolkata	Banglore	3	222	7663	1 stop	1
2	3	Jet Airways	2400	Delhi	Cochin	3	165	13883	1 stop	1
3	4	Multiple carriers	2466	Delhi	Cochin	3	195	6219	1 stop	1
4	5	Air Asia	108	Banglore	Delhi	3	202	13303	1 stop	0
...	...	...	...	...	...	...	...	...	...	...
311	312	Air India	5479	Kolkata	Banglore	3	120	14715	1 stop	0
312	313	Air India	5491	Kolkata	Banglore	3	98	9900	1 stop	0
313	314	Jet Airways	5507	Kolkata	Banglore	3	102	14872	1 stop	0
314	315	Air India	5564	Mumbai	Hyderabad	3	88	7296	non-stop	1
315	316	Air India	5605	Delhi	Cochin	3	86	13466	1 stop	0

316 rows × 10 columns

In [13]:

```
df["Airline"]=le.fit_transform(df["Airline"])
df["AirportFrom"]=le.fit_transform(df["AirportFrom"])
df["AirportTo"]=le.fit_transform(df["AirportTo"])
df["Total Stop"]=le.fit_transform(df["Total Stop"])
```

In [14]:

```
df.head()
```

Out[14]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Length	Price	Total Stop	Delay
0	1	4	269	2	1	3	205	3898	1	1
1	2	3	1558	3	0	3	222	7663	0	1
2	3	4	2400	2	1	3	165	13883	0	1
3	4	5	2466	2	1	3	195	6219	0	1
4	5	0	108	0	2	3	202	13303	0	0

In [15]:

```
df.describe().T        # Statistical Summary Of Dataset
```

Out[15]:

	count	mean	std	min	25%	50%	75%	max
id	316.0	158.500000	91.365566	1.0	79.75	158.5	237.25	316.0
Airline	316.0	3.645570	1.769498	0.0	3.00	4.0	5.00	8.0
Flight	316.0	2712.158228	2022.387751	17.0	1127.75	2214.0	4034.00	7781.0
AirportFrom	316.0	1.981013	1.200378	0.0	2.00	2.0	3.00	4.0
AirportTo	316.0	1.398734	1.492584	0.0	0.00	1.0	2.00	5.0
DayOfWeek	316.0	3.000000	0.000000	3.0	3.00	3.0	3.00	3.0
Length	316.0	125.348101	61.116587	32.0	76.00	115.0	165.00	380.0
Price	316.0	8888.636076	4215.393097	1966.0	5118.00	8243.0	12374.00	27431.0
Total Stop	316.0	0.338608	0.473987	0.0	0.00	0.0	1.00	1.0
Delay	316.0	0.215190	0.411606	0.0	0.00	0.0	0.00	1.0

In [16]:

```
df.dtypes
```

Out[16]:

```
id             int64
Airline        int32
Flight         int64
AirportFrom    int32
AirportTo      int32
DayOfWeek      int64
Length         int64
Price          int64
Total Stop     int32
Delay          int64
dtype: object
```

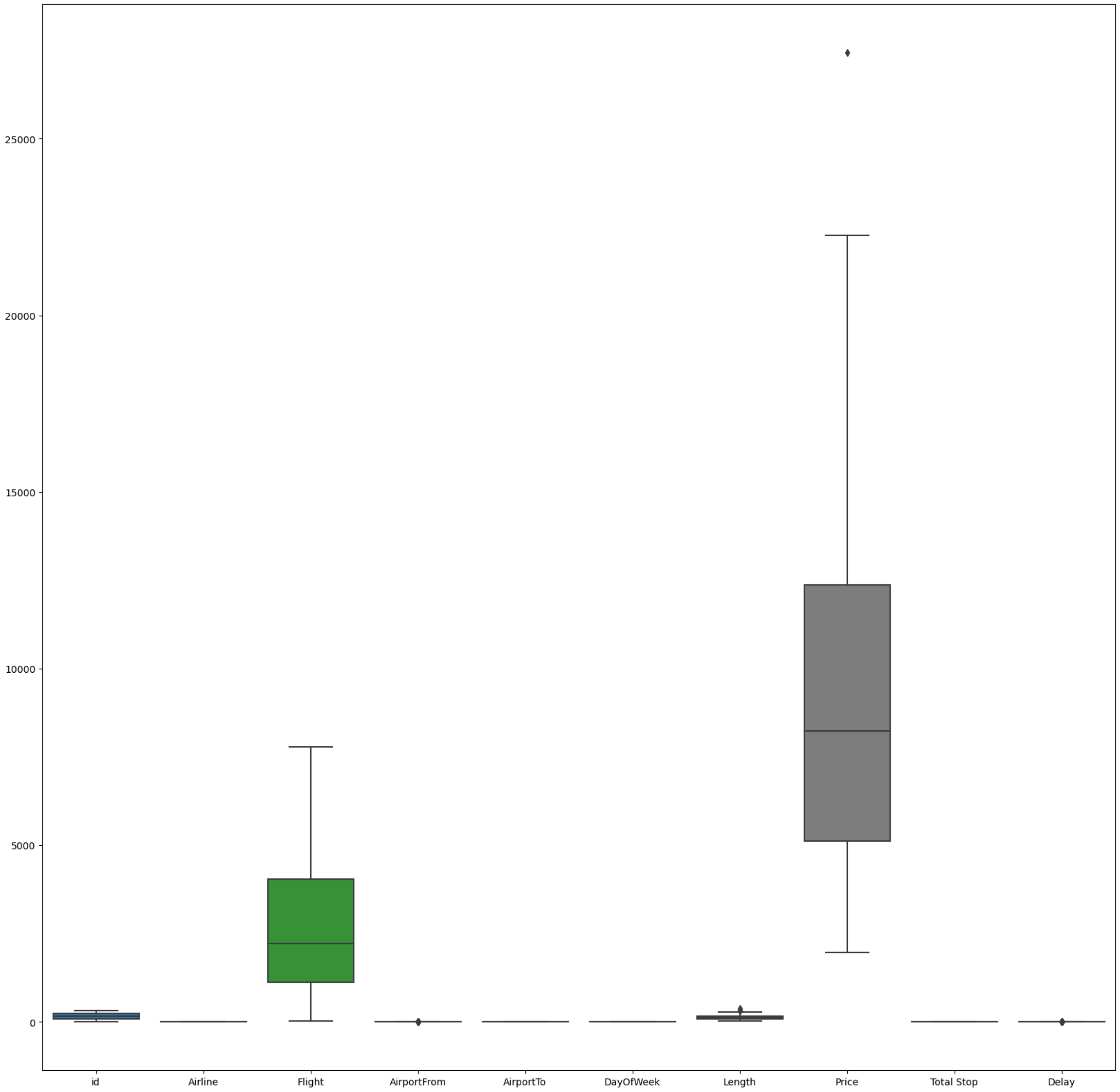
Removing Outliers present in Dataset

In [17]:

```
plt.figure(figsize=(20,20))         # Ploting Boxplot to detect outliers
sns.boxplot(data=df)
```

Out[17]:

```
<Axes: >
```



In [18]:

```
#Steps to Remove Outliers
```

In [19]:

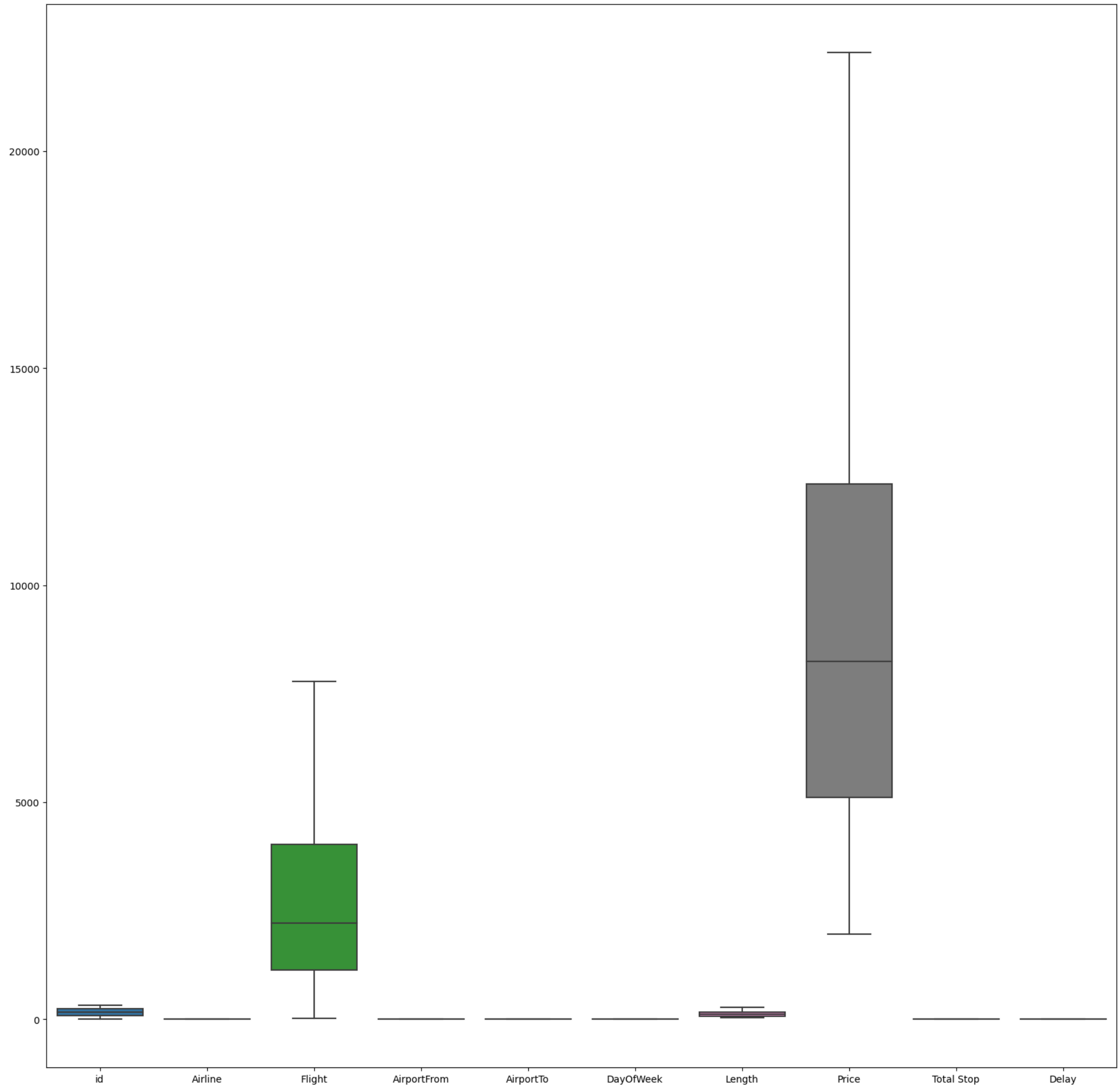
```
Q1=df.quantile(q=0.25)          # finding Q1 value
Q3=df.quantile(q=0.75)          # Finding Q3 value
```

```
IQR=Q3-Q1                       # Finding IQR Value i.e(InterQuantileRange)
upper=Q3+(1.5*IQR)              # to detect upper outliers
lower=Q1-(1.5*IQR)              # to detect lower outliers
```

In [20]:
```
df1=df[~((df>upper)|(df<lower))]
```

In [21]:
```
plt.figure(figsize=(20,20))          # Boxplot after removing Outliers
sns.boxplot(data=df1)
```

Out[21]:
```
<Axes: >
```



In [22]:
```
df1.isnull().sum()
```

Out[22]:
```
id              0
Airline         0
Flight          0
AirportFrom    67
AirportTo       0
DayOfWeek       0
Length          4
Price           1
Total Stop      0
Delay          68
dtype: int64
```

In [23]:
```
df1
```

Out[23]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Length	Price	Total Stop	Delay
0	1	4	269	2.0	1	3	205.0	3898.0	1	NaN
1	2	3	1558	3.0	0	3	222.0	7663.0	0	NaN
2	3	4	2400	2.0	1	3	165.0	13883.0	0	NaN
3	4	5	2466	2.0	1	3	195.0	6219.0	0	NaN
4	5	0	108	NaN	2	3	202.0	13303.0	0	0.0
...	...	...	...	...	...	...	...	...	...	...
311	312	1	5479	3.0	0	3	120.0	14715.0	0	0.0
312	313	1	5491	3.0	0	3	98.0	9900.0	0	0.0
313	314	4	5507	3.0	0	3	102.0	14872.0	0	0.0
314	315	1	5564	4.0	3	3	88.0	7296.0	1	NaN
315	316	1	5605	2.0	1	3	86.0	13466.0	0	0.0

316 rows × 10 columns

In [24]:
```
df2=df1.dropna()      # removing that nan values
```

In [25]:
```
df2
```

Out[25]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Length	Price	Total Stop	Delay
7	8	3	2722	3.0	0	3	228.0	22271.0	0	0.0
12	13	5	2055	2.0	1	3	210.0	4668.0	1	0.0
14	15	4	132	2.0	1	3	215.0	4805.0	1	0.0
16	17	5	98	2.0	1	3	213.0	5831.0	0	0.0
17	18	7	1496	3.0	0	3	162.0	10263.0	0	0.0
...	...	...	...	...	...	...	...	...	...	...
306	307	4	5366	3.0	0	3	119.0	9135.0	0	0.0
311	312	1	5479	3.0	0	3	120.0	14715.0	0	0.0
312	313	1	5491	3.0	0	3	98.0	9900.0	0	0.0
313	314	4	5507	3.0	0	3	102.0	14872.0	0	0.0
315	316	1	5605	2.0	1	3	86.0	13466.0	0	0.0

193 rows × 10 columns

In [26]:
```
df2.drop(["Delay"],axis=1,inplace=True)
```

```
C:\Users\PC\AppData\Local\Temp\ipykernel_12224\591671106.py:1: SettingWithCopyWarning: 
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/i
ndexing.html#returning-a-view-versus-a-copy
  df2.drop(["Delay"],axis=1,inplace=True)
```

In [27]:
```
df2.head()
```

Out[27]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Length	Price	Total Stop
7	8	3	2722	3.0	0	3	228.0	22271.0	0
12	13	5	2055	2.0	1	3	210.0	4668.0	1
14	15	4	132	2.0	1	3	215.0	4805.0	1
16	17	5	98	2.0	1	3	213.0	5831.0	0
17	18	7	1496	3.0	0	3	162.0	10263.0	0

In [28]:

```
df2.isnull().sum().sum()
```

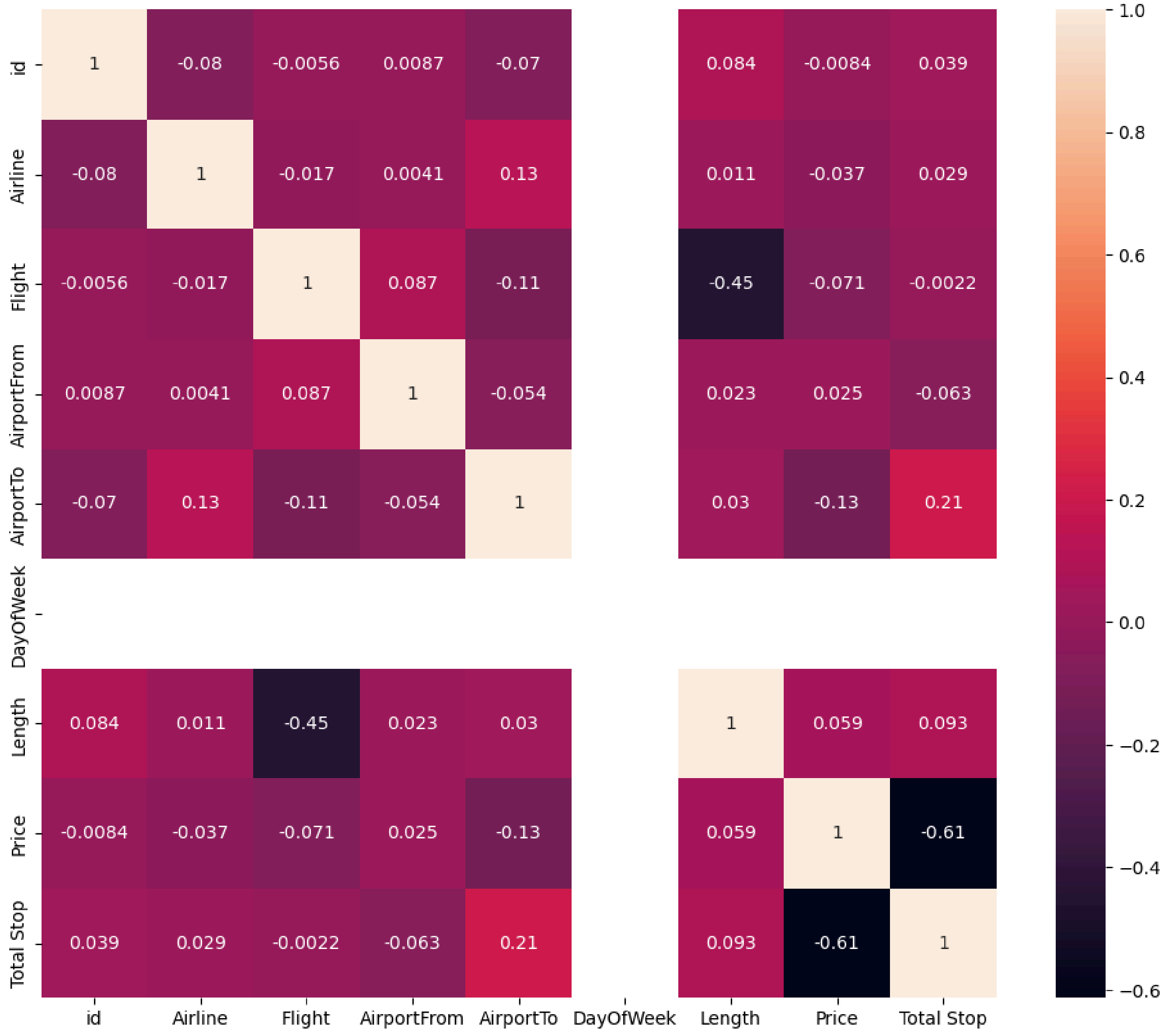
Out[28]:

```
0
```

HeatMap To Show Corelation between Data

In [29]:

```
plt.figure(figsize=(12,10))
sns.heatmap(df2.corr(),annot=True)
plt.show()
```



In [30]:

```
df2
```

Out[30]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Length	Price	Total Stop
7	8	3	2722	3.0	0	3	228.0	22271.0	0
12	13	5	2055	2.0	1	3	210.0	4668.0	1
14	15	4	132	2.0	1	3	215.0	4805.0	1
16	17	5	98	2.0	1	3	213.0	5831.0	0
17	18	7	1496	3.0	0	3	162.0	10263.0	0
...	...	...	...	...	...	...	...	...	...
306	307	4	5366	3.0	0	3	119.0	9135.0	0
311	312	1	5479	3.0	0	3	120.0	14715.0	0
312	313	1	5491	3.0	0	3	98.0	9900.0	0
313	314	4	5507	3.0	0	3	102.0	14872.0	0
315	316	1	5605	2.0	1	3	86.0	13466.0	0

193 rows × 9 columns

In [31]:

```
print(df2["Total Stop"].unique())
```

```
[0 1]
```

In [32]:

```
print(df2["Total Stop"].value_counts(normalize=True)*100)
```

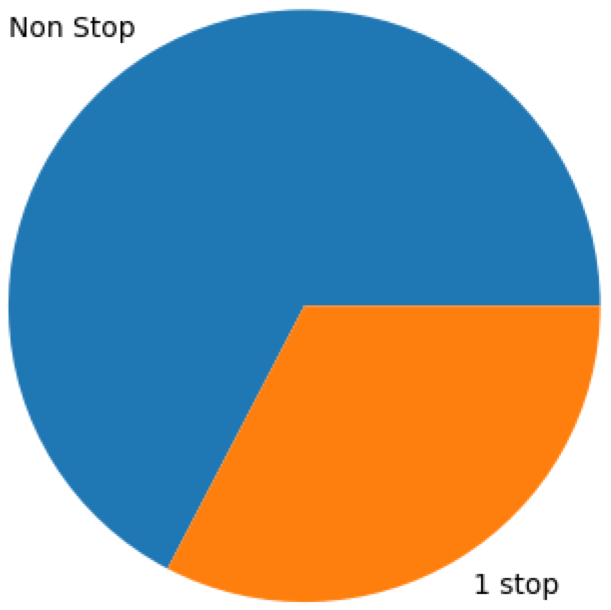
```
Total Stop
0    67.357513
1    32.642487
Name: proportion, dtype: float64
```

In [33]:

```
plt.pie(df2["Total Stop"].value_counts(normalize=True)*100,labels=["Non Stop","1 stop"])
```

Out[33]:

```
([<matplotlib.patches.Wedge at 0x1e9d08f0ed0>,
  <matplotlib.patches.Wedge at 0x1e9d0915650>],
 [Text(-0.5705443762240192, 0.9404674979812674, 'Non Stop'),
  Text(0.5705444642769384, -0.9404674445630435, '1 stop')])
```



Model Building for DataSet

In [34]:

```
x=df2.drop(["Total Stop"],axis=1)
y=df2["Total Stop"]
```

In [35]:

```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.3,random_state=1)     # splliting
```

In [36]:

```
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(135, 8)
(58, 8)
(135,)
(58,)
```

LOGISTIC REGRESSION ALGORITHM

In [37]:

```
lr=LogisticRegression()
lr.fit(x_train,y_train)
```

```
C:\Users\PC\anaconda3\Lib\site-packages\sklearn\linear_model\_logistic.py:460: ConvergenceWarni
ng: 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 in:
    https://scikit-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-regression
  n_iter_i = _check_optimize_result(
```

Out[37]:

```
▾ LogisticRegression
LogisticRegression()
```

In [38]:

```
y_true,y_pred=y_test,lr.predict(x_test)
```

In [39]:

```
lr.score(x_train,y_train)*100
```

Out[39]:

```
90.37037037037037
```

In [40]:

```
lr.score(x_test,y_test)*100
```

Out[40]:

```
81.03448275862068
```

In [41]:

```
print(precision_score(y_true,y_pred)*100)
print(recall_score(y_true,y_pred)*100)
print(accuracy_score(y_true,y_pred)*100)
```

```
63.63636363636363
82.35294117647058
81.03448275862068
```

RandomForestClassifier

```
In [42]: rf=RandomForestClassifier(n_estimators=6,random_state=1)
         rf.fit(x_train,y_train)

Out[42]: ▾ RandomForestClassifier
         RandomForestClassifier(n_estimators=6, random_state=1)
```

```
In [43]: y_true,y_pred=y_test,rf.predict(x_test)
```

```
In [44]: rf.score(x_train,y_train)*100

Out[44]: 97.77777777777777
```

```
In [45]: rf.score(x_test,y_test)*100

Out[45]: 87.93103448275862
```

```
In [46]: print(precision_score(y_true,y_pred)*100)
         print(recall_score(y_true,y_pred)*100)
         print(accuracy_score(y_true,y_pred)*100)

         85.71428571428571
         70.58823529411765
         87.93103448275862
```

DecisionTreeClassifier

```
In [47]: dt=DecisionTreeClassifier(criterion="gini",max_depth=4,random_state=1)
         dt.fit(x_train,y_train)

Out[47]: ▾ DecisionTreeClassifier
         DecisionTreeClassifier(max_depth=4, random_state=1)
```

```
In [48]: y_true,y_pred=y_test,dt.predict(x_test)
```

```
In [49]: dt.score(x_train,y_train)*100

Out[49]: 91.85185185185185
```

```
In [50]: dt.score(x_test,y_test)*100

Out[50]: 87.93103448275862
```

```
In [51]: print(precision_score(y_true,y_pred)*100)
         print(recall_score(y_true,y_pred)*100)
         print(accuracy_score(y_true,y_pred)*100)

         77.77777777777779
         82.35294117647058
         87.93103448275862
```

GRADIENT BOOSTING CLASSIFIER ALGORITHM

```
In [52]: gb=GradientBoostingClassifier(n_estimators=20)
         gb.fit(x_train,y_train)
```

Out[52]:

```
▾ GradientBoostingClassifier
GradientBoostingClassifier(n_estimators=20)
```

In [53]:

```
y_true,y_pred=y_test,gb.predict(x_test)
```

In [54]:

```
gb.score(x_train,y_train)*100
```

Out[54]:

```
94.81481481481482
```

In [55]:

```
gb.score(x_test,y_test)*100
```

Out[55]:

```
84.48275862068965
```

In [56]:

```
print(precision_score(y_true,y_pred)*100)
print(recall_score(y_true,y_pred)*100)
print(accuracy_score(y_true,y_pred)*100)
```

```
70.0
82.35294117647058
84.48275862068965
```

BAGGING CLASSIFIER ALGORITHM

In [57]:

```
bg=BaggingClassifier(n_estimators=20)
bg.fit(x_train,y_train)
```

Out[57]:

```
▾ BaggingClassifier
BaggingClassifier(n_estimators=20)
```

In [58]:

```
y_true,y_pred=y_test,bg.predict(x_test)
```

In [59]:

```
bg.score(x_train,y_train)*100
```

Out[59]:

```
100.0
```

In [60]:

```
bg.score(x_test,y_test)*100
```

Out[60]:

```
87.93103448275862
```

In [61]:

```
print(precision_score(y_true,y_pred)*100)
print(recall_score(y_true,y_pred)*100)
print(accuracy_score(y_true,y_pred)*100)
```

```
75.0
88.23529411764706
87.93103448275862
```

ADABOOST CLASSIFIER ALGORITHM

In [62]:

```
ad=AdaBoostClassifier(n_estimators=20,estimator=dt,random_state=1)
ad.fit(x_train,y_train)
```

Out[62]:
```
▸          AdaBoostClassifier
▸ estimator: DecisionTreeClassifier
      ▸ DecisionTreeClassifier
```

In [63]:
```
y_true,y_pred=y_test,ad.predict(x_test)
```

In [64]:
```
ad.score(x_train,y_train)*100
```

Out[64]:
```
100.0
```

In [65]:
```
ad.score(x_test,y_test)*100
```

Out[65]:
```
81.03448275862068
```

In [66]:
```
print(precision_score(y_true,y_pred)*100)
print(recall_score(y_true,y_pred)*100)
print(accuracy_score(y_true,y_pred)*100)
```

```
65.0
76.47058823529412
81.03448275862068
```

KNeighbors CLASSIFIER ALGORITHM

In [67]:
```
kn=KNeighborsClassifier(weights="distance")
kn.fit(x_train,y_train)
```

Out[67]:
```
▾          KNeighborsClassifier
KNeighborsClassifier(weights='distance')
```

In [68]:
```
y_true,y_pred=y_test,kn.predict(x_test)
```

In [69]:
```
kn.score(x_train,y_train)*100
```

Out[69]:
```
100.0
```

In [70]:
```
kn.score(x_test,y_test)*100
```

Out[70]:
```
79.3103448275862
```

In [71]:
```
print(precision_score(y_true,y_pred)*100)
print(recall_score(y_true,y_pred)*100)
print(accuracy_score(y_true,y_pred)*100)
```

```
61.904761904761905
76.47058823529412
79.3103448275862
```

SVC (SUPPORT VECTOR CLASSIFIER) ALGORITHM

In [72]:
```
svc=SVC(C=1.0,kernel="linear")
svc.fit(x_train,y_train)
```

```
Out[72]: ▾ SVC
         SVC(kernel='linear')
```

```
In [73]: y_true,y_pred=y_test,svc.predict(x_test)
```

```
In [74]: svc.score(x_train,y_train)*100
```

```
Out[74]: 88.88888888888889
```

```
In [75]: svc.score(x_test,y_test)*100
```

```
Out[75]: 81.03448275862068
```

```
In [76]: print(precision_score(y_true,y_pred)*100)
         print(recall_score(y_true,y_pred)*100)
         print(accuracy_score(y_true,y_pred)*100)
```

```
65.0
76.47058823529412
81.03448275862068
```

```
In [ ]:
```

```
In [ ]:
```

```
In [ ]:
```

```
In [ ]:
```