```
import pandas as pd
from matplotlib import pyplot as plt
```

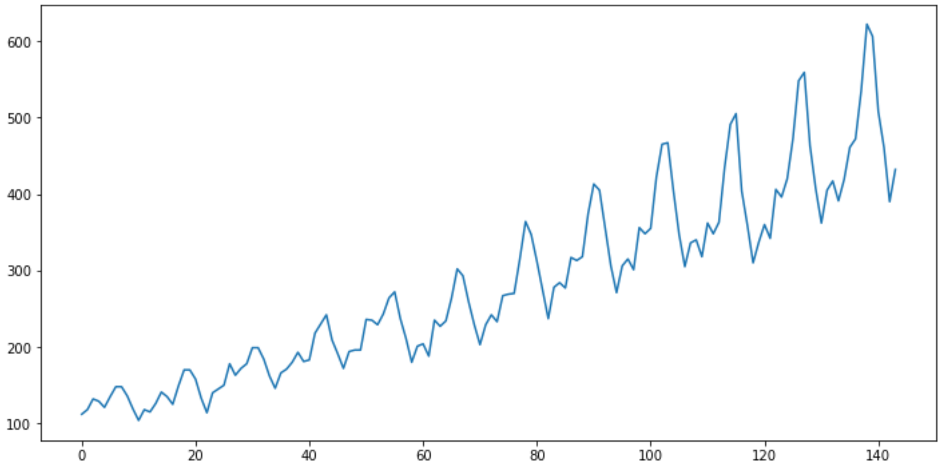
```
df = pd.read_csv('AirPassengers.csv')
df
```

	Month	#Passengers
0	1949-01	112
1	1949-02	118
2	1949-03	132
3	1949-04	129
4	1949-05	121
...	...	...
139	1960-08	606
140	1960-09	508
141	1960-10	461
142	1960-11	390
143	1960-12	432

144 rows × 2 columns

```
df['#Passengers'].plot()
```

```
<AxesSubplot:>
```



```
df['#Passengers_diff'] = df['#Passengers'] - df['#Passengers'].shift(1)
```

```
df
```

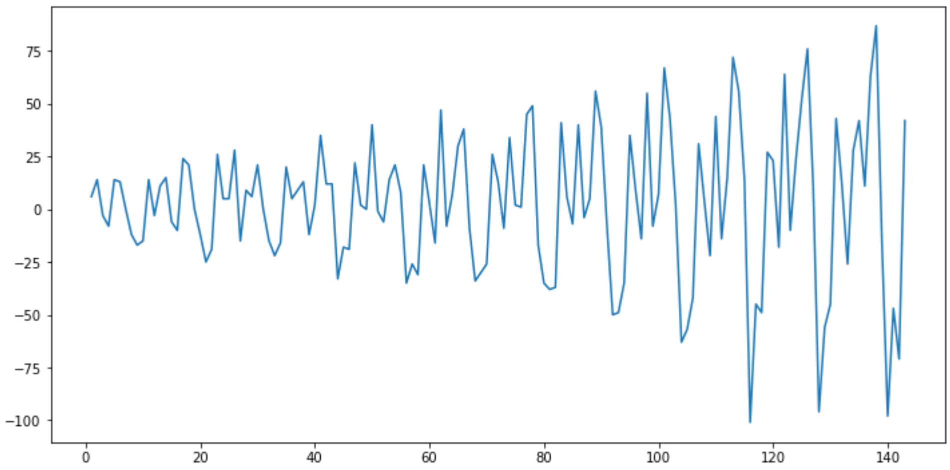
	Month	#Passengers	#Passengers_diff
0	1949-01	112	NaN
1	1949-02	118	6.0
2	1949-03	132	14.0
3	1949-04	129	-3.0
4	1949-05	121	-8.0
...	...	...	...
139	1960-08	606	-16.0
140	1960-09	508	-98.0
141	1960-10	461	-47.0
142	1960-11	390	-71.0
143	1960-12	432	42.0

144 rows × 3 columns

```
df['#Passengers_diff'].dropna().plot()
```

```
df['#Passengers_diff'].dropna().plot()
```

```
<AxesSubplot:>
```



```
from statsmodels.tsa.stattools import adfuller
```

```
adfuller(df['#Passengers_diff'].dropna())
```

```
(-2.8292668241700007,
 0.05421329028382537,
 12,
 130,
 {'1%': -3.4816817173418295,
  '5%': -2.8840418343195267,
  '10%': -2.578770059171598},
 988.5069317854085)
```

```
def adf_test(series):
    result=adfuller(series)
    print('ADF Statistics: {}'.format(result[0]))
    print('p- value: {}'.format(result[1]))
    if result[1] <= 0.05:
        print("strong evidence against the null hypothesis, reject the null hypothesis.indicating it is stationary")
    else:
        print("weak evidence against null hypothesis,indicating it is non-stationary ")
```

```
adf_test(df['#Passengers_diff'].dropna())
```

```
ADF Statistics: -2.8292668241700007
p- value: 0.05421329028382537
weak evidence against null hypothesis, time series has a unit root, indicating it is non-stationary
```

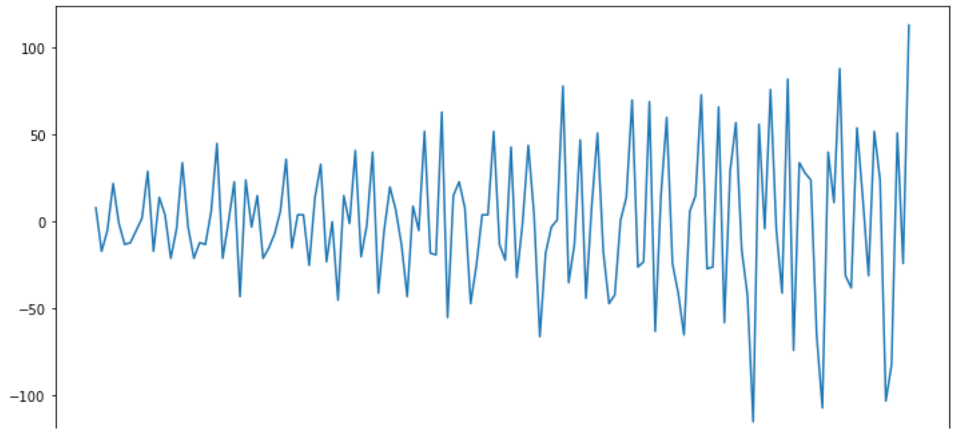
```
df['#Passengers_sec_diff'] = df['#Passengers_diff'] - df['#Passengers_diff'].shift(1)
df
```

	Month	#Passengers	#Passengers_diff	#Passengers_sec_diff
0	1949-01	112	NaN	NaN
1	1949-02	118	6.0	NaN
2	1949-03	132	14.0	8.0
3	1949-04	129	-3.0	-17.0
4	1949-05	121	-8.0	-5.0
...	...	...	...	...
139	1960-08	606	-16.0	-103.0
140	1960-09	508	-98.0	-82.0
141	1960-10	461	-47.0	51.0
142	1960-11	390	-71.0	-24.0
143	1960-12	432	42.0	113.0

144 rows × 4 columns

```
df['#Passengers_sec_diff'].dropna().plot()
```

```
<AxesSubplot:>
```



```
adf_test(df['#Passengers_sec_diff'].dropna())
```

```
ADF Statistics: -16.384231542468516
p- value: 2.7328918500141235e-29
strong evidence against the null hypothesis, reject the null hypothesis. Data has no unit root and is stationary
```

```
from statsmodels.tsa.ar_model import AutoReg
```

```
model = AutoReg(df['#Passengers_sec_diff'].dropna(),lags=1).fit()
```

```
pred = model.predict(start=len(train),end=len(df)-1)
```

```
df.tail()
```

	Month	#Passengers	#Passengers_diff	#Passengers_sec_diff
139	1960-08	606	-16.0	-103.0
140	1960-09	508	-98.0	-82.0
141	1960-10	461	-47.0	51.0
142	1960-11	390	-71.0	-24.0
143	1960-12	432	42.0	113.0

```
dff = df['#Passengers_sec_diff'].dropna()
dff
```

```
2        8.0
3      -17.0
4       -5.0
5       22.0
6       -1.0
       ...
139   -103.0
140    -82.0
141     51.0
142    -24.0
143    113.0
Name: #Passengers_sec_diff, Length: 142, dtype: float64
```

```
train = dff[:len(df)-7]
```

```
train.shape
```

```
(137,)
```

```
df.shape
```

```
(144, 4)
```

```
test = dff[len(dff)-7:]
```

```
test.shape
```

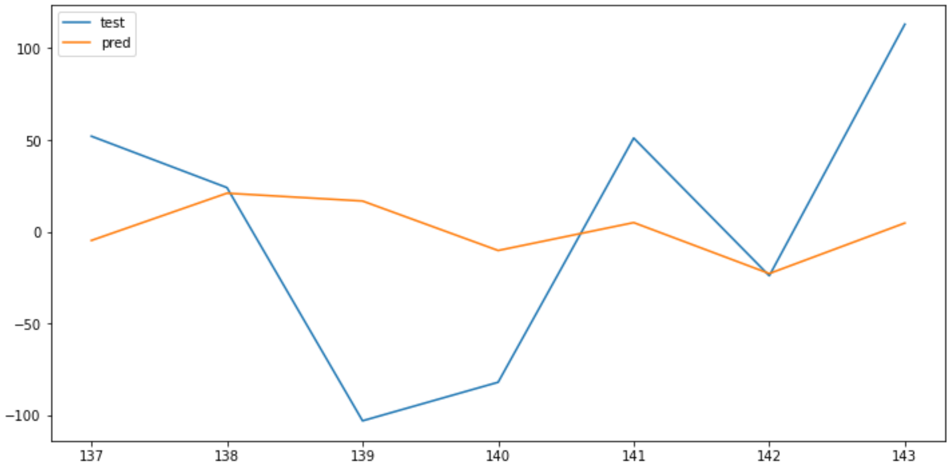
```
(7,)
```

```
test
```

```
137     52.0
138     24.0
139   -103.0
140    -82.0
141     51.0
142    -24.0
143    113.0
Name: #Passengers_sec_diff, dtype: float64
```

```
plt.plot(test,label='test')
plt.plot(pred,label= 'pred')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7fc77d5e96d0>
```



```
from sklearn.metrics import mean_absolute_error
```

```
import numpy as np
rmse = np.sqrt(mean_absolute_error(test,pred))
print("RMSE Of Prediction is : ",rmse)
```

```
RMSE Of Prediction is :  7.623340515371777
```

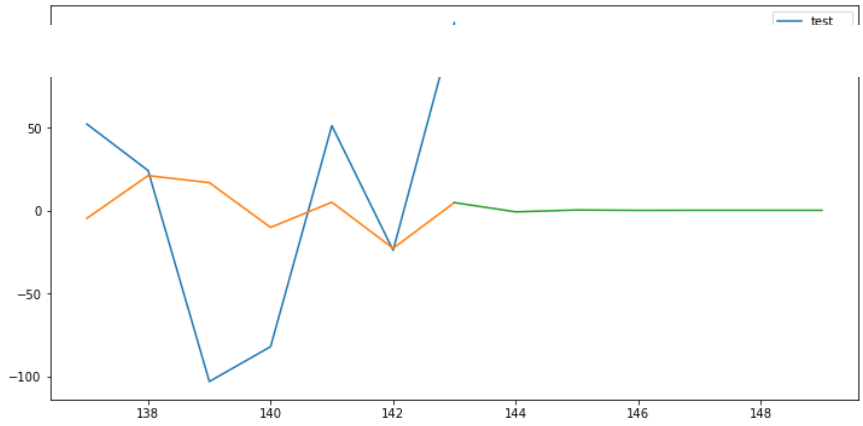
```
predict_future = model.predict(start=len(dff)+1,end=len(dff)+7)
```

```
predict_future
```

```
143    4.709067
144   -0.866191
145    0.263437
146    0.034558
147    0.080932
148    0.071536
149    0.073440
dtype: float64
```

```
plt.plot(test,label='test')
plt.plot(pred,label= 'pred')
plt.plot(predict_future,label='future')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7fc748d340d0>
```


test
50
0
−50
−100
138
140
142
144
146
148