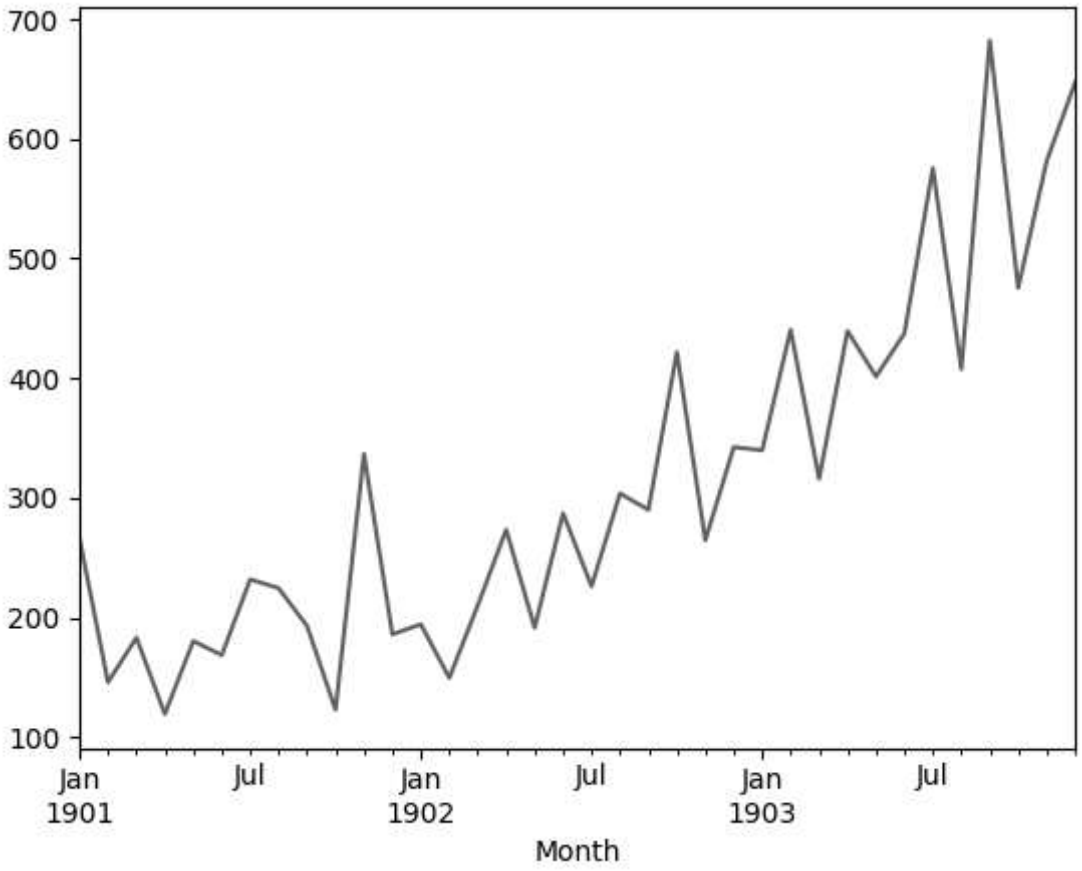
In [ ]:
```
from pandas import read_csv
from pandas import datetime
from matplotlib import pyplot

def parser(x):
        return datetime.strptime('190'+x, '%Y-%m')

series = read_csv('shampoo_sales.csv', header=0, parse_dates=[0], index_col=0, sque
print(series.head())
series.plot()
pyplot.show()
```

```
<ipython-input-8-8dde3198265a>:2: FutureWarning: The pandas.datetime class is deprec
ated and will be removed from pandas in a future version. Import from datetime modul
e instead.
  from pandas import datetime
<ipython-input-8-8dde3198265a>:8: FutureWarning: The squeeze argument has been depre
cated and will be removed in a future version. Append .squeeze("columns") to the cal
l to squeeze.


  series = read_csv('shampoo_sales.csv', header=0, parse_dates=[0], index_col=0, squ
eeze=True, date_parser=parser)
Month
1901-01-01    266.0
1901-02-01    145.9
1901-03-01    183.1
1901-04-01    119.3
1901-05-01    180.3
Name: Sales, dtype: float64
```



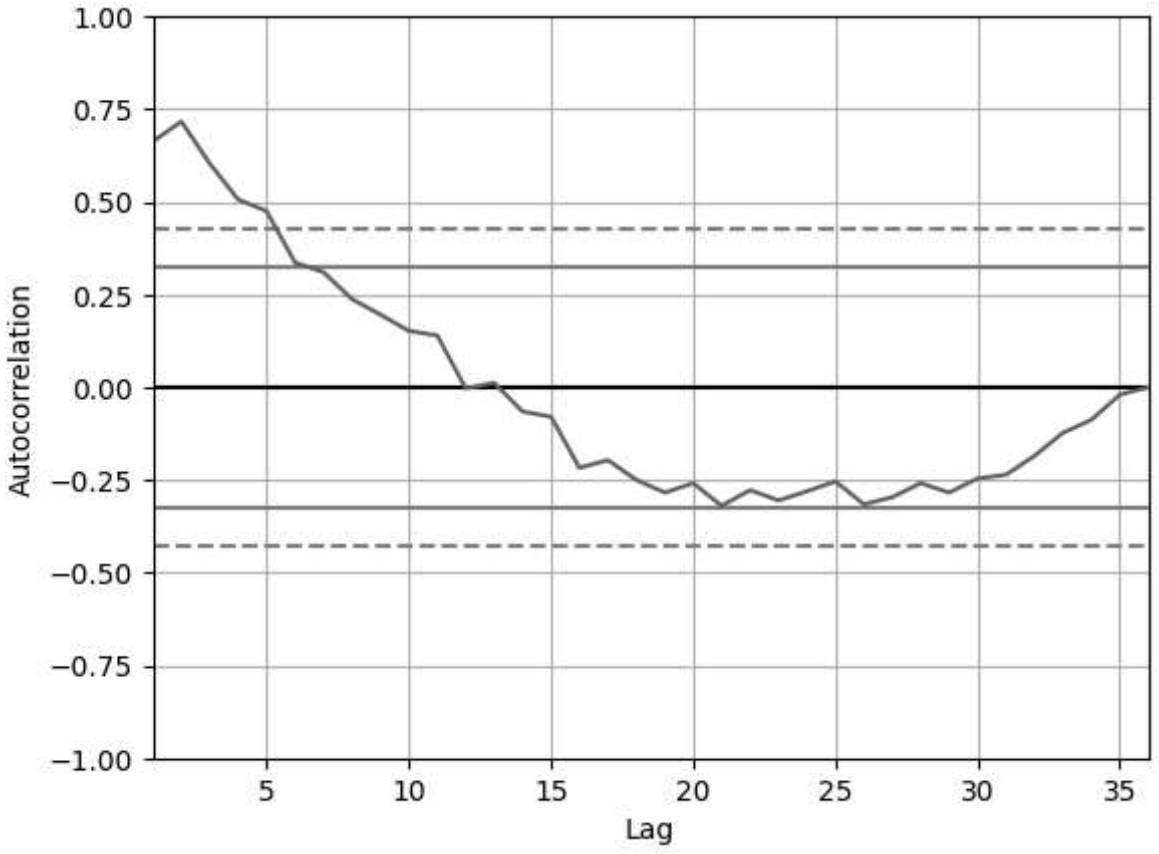
In [ ]:
```
from pandas import read_csv
from pandas import datetime
from matplotlib import pyplot
from pandas.plotting import autocorrelation_plot

def parser(x):
 return datetime.strptime('190'+x, '%Y-%m')

series = read_csv('shampoo_sales.csv', header=0, parse_dates=[0], index_col=0, sque
autocorrelation_plot(series)
pyplot.show()
```

```
<ipython-input-9-ccf566f03399>:2: FutureWarning: The pandas.datetime class is deprec
ated and will be removed from pandas in a future version. Import from datetime modul
e instead.
  from pandas import datetime
<ipython-input-9-ccf566f03399>:9: FutureWarning: The squeeze argument has been depre
cated and will be removed in a future version. Append .squeeze("columns") to the cal
l to squeeze.


  series = read_csv('shampoo_sales.csv', header=0, parse_dates=[0], index_col=0, squ
eeze=True, date_parser=parser)
```



In [ ]:
```
from pandas import datetime
from pandas import read_csv
from pandas import DataFrame
from statsmodels.tsa.arima.model import ARIMA
from matplotlib import pyplot
def parser(x):
        return datetime.strptime('190'+x, '%Y-%m')
series = read_csv('shampoo_sales.csv', header=0, index_col=0, parse_dates=True, squ
series.index = series.index.to_period('M')
model = ARIMA(series, order=(5,1,0))
model_fit = model.fit()
print(model_fit.summary())
residuals = DataFrame(model_fit.resid)
residuals.plot()
pyplot.show()
residuals.plot(kind='kde')
pyplot.show()
print(residuals.describe())
```

```
<ipython-input-10-db7e3cb8fb82>:1: FutureWarning: The pandas.datetime class is depre
cated and will be removed from pandas in a future version. Import from datetime modu
le instead.
  from pandas import datetime
<ipython-input-10-db7e3cb8fb82>:8: FutureWarning: The squeeze argument has been depr
ecated and will be removed in a future version. Append .squeeze("columns") to the ca
ll to squeeze.


  series = read_csv('shampoo_sales.csv', header=0, index_col=0, parse_dates=True, sq
ueeze=True, date_parser=parser)
```

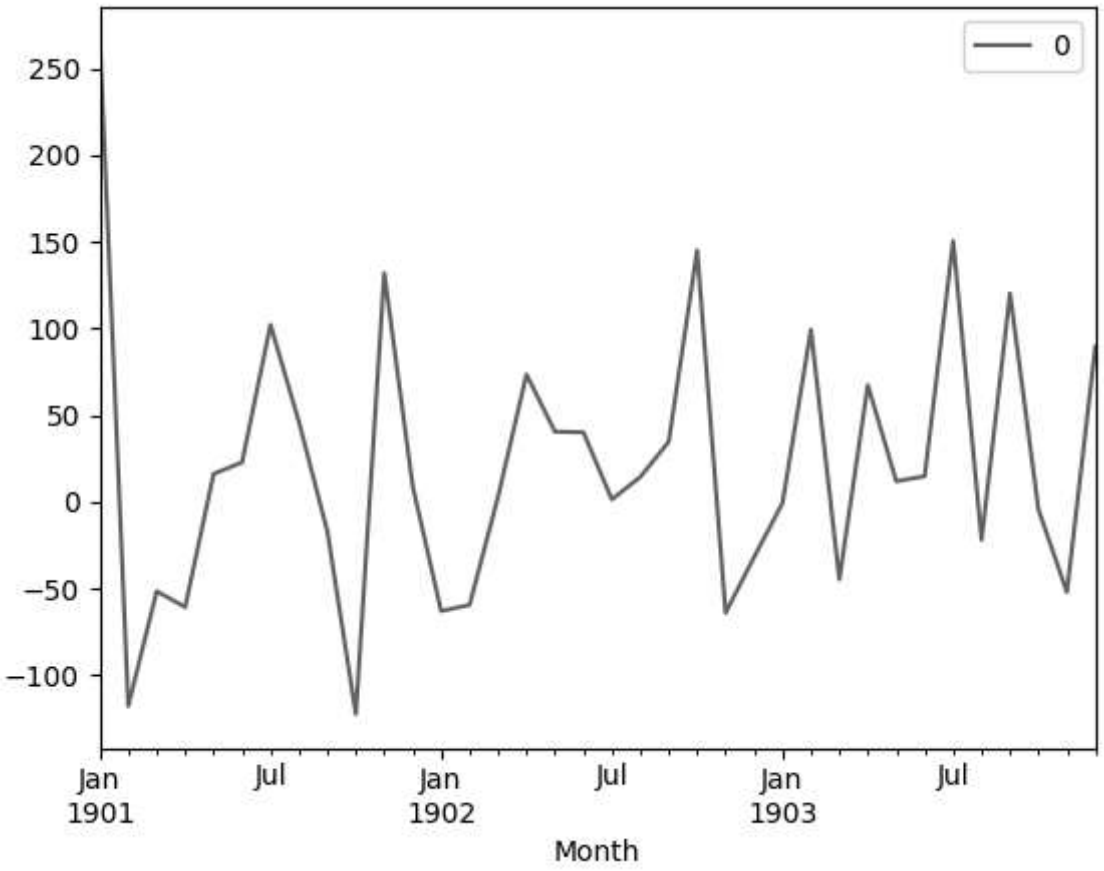
SARIMAX Results

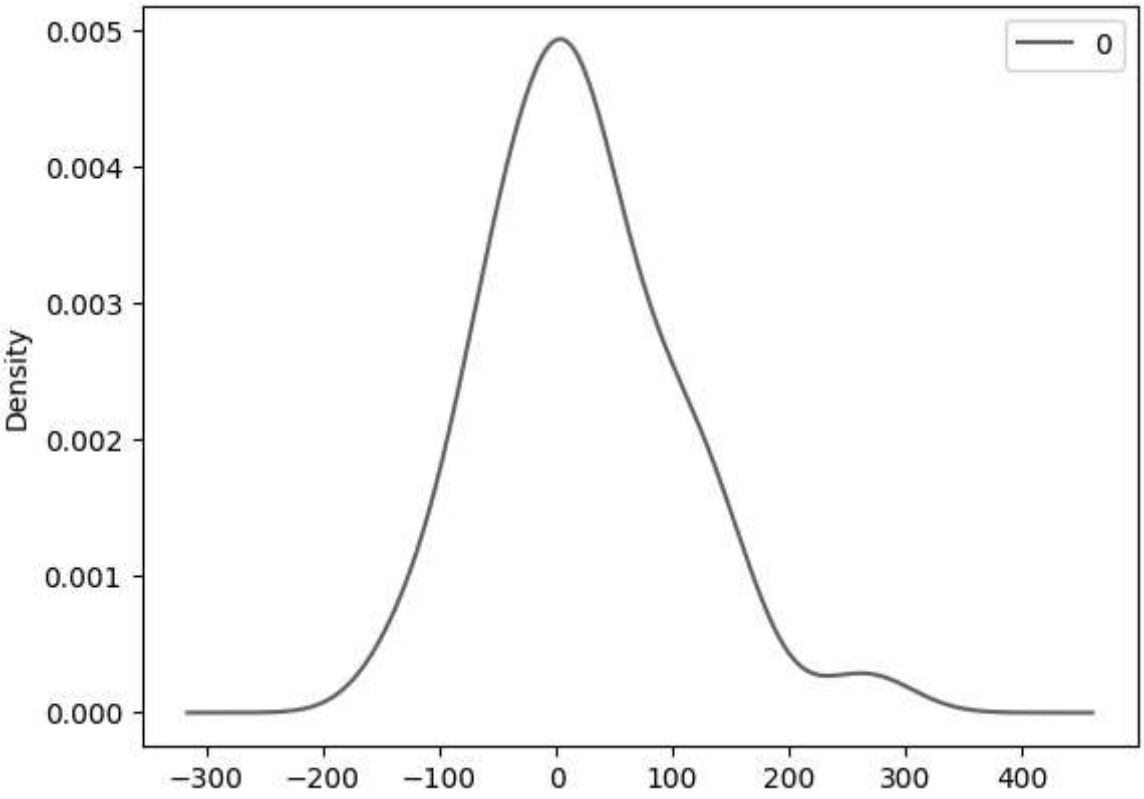
Dep. Variable:	Sales	No. Observations:	36
Model:	ARIMA(5, 1, 0)	Log Likelihood	-198.485
Date:	Tue, 19 Mar 2024	AIC	408.969
Time:	11:42:47	BIC	418.301
Sample:	01-31-1901	HQIC	412.191
	- 12-31-1903		
Covariance Type:	opg		

	coef	std err	z	P>|z|	[0.025	0.975]
ar.L1	-0.9014	0.247	-3.647	0.000	-1.386	-0.417
ar.L2	-0.2284	0.268	-0.851	0.395	-0.754	0.298
ar.L3	0.0747	0.291	0.256	0.798	-0.497	0.646
ar.L4	0.2519	0.340	0.742	0.458	-0.414	0.918
ar.L5	0.3344	0.210	1.593	0.111	-0.077	0.746
sigma2	4728.9608	1316.021	3.593	0.000	2149.607	7308.314

Ljung-Box (L1) (Q):	0.61	Jarque-Bera (JB):	0.96
Prob(Q):	0.44	Prob(JB):	0.62
Heteroskedasticity (H):	1.07	Skew:	0.28
Prob(H) (two-sided):	0.90	Kurtosis:	2.41

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-ste
p).


0
250
200
150
100
50
0
−50
−100
Jan
1901
Jul
Jan
1902
Jul
Jan
1903
Jul
Month


0
0.005
0.004
0.003
0.002
0.001
0.000
Density
−300
−200
−100
0
100
200
300
400

```
                0
count   36.000000
mean    21.936144
std     80.774430
min   -122.292030
25%    -35.040859
50%     13.147219
75%     68.848286
max    266.000000
```

In [ ]:
```
from pandas import read_csv
from pandas import datetime
from matplotlib import pyplot
from statsmodels.tsa.arima.model import ARIMA
from sklearn.metrics import mean_squared_error
from math import sqrt
def parser(x):
        return datetime.strptime('190'+x, '%Y-%m')
series = read_csv('shampoo_sales.csv', header=0, index_col=0, parse_dates=True, squ
series.index = series.index.to_period('M')
X = series.values
size = int(len(X) * 0.66)
train, test = X[0:size], X[size:len(X)]
history = [x for x in train]
predictions = list()
for t in range(len(test)):
        model = ARIMA(history, order=(5,1,0))
        model_fit = model.fit()
        output = model_fit.forecast()
        yhat = output[0]
        predictions.append(yhat)
        obs = test[t]
        history.append(obs)
        print('predicted=%f, expected=%f' % (yhat, obs))
rmse = sqrt(mean_squared_error(test, predictions))
print('Test RMSE: %.3f' % rmse)
pyplot.plot(test)
pyplot.plot(predictions, color='red')
pyplot.show()
```

```
predicted=343.272180, expected=342.300000
<ipython-input-11-c59d2c2e2984>:3: FutureWarning: The pandas.datetime class is depre
cated and will be removed from pandas in a future version. Import from datetime modu
le instead.
  from pandas import datetime
<ipython-input-11-c59d2c2e2984>:10: FutureWarning: The squeeze argument has been dep
recated and will be removed in a future version. Append .squeeze("columns") to the c
all to squeeze.


  series = read_csv('shampoo_sales.csv', header=0, index_col=0, parse_dates=True, sq
ueeze=True, date_parser=parser)
```

```
predicted=293.329674, expected=339.700000
predicted=368.668956, expected=440.400000
predicted=335.044741, expected=315.900000
predicted=363.220221, expected=439.300000
predicted=357.645324, expected=401.300000
predicted=443.047835, expected=437.400000
predicted=378.365674, expected=575.500000
predicted=459.415021, expected=407.600000
predicted=526.890876, expected=682.000000
predicted=457.231275, expected=475.300000
predicted=672.914944, expected=581.300000
predicted=531.541449, expected=646.900000
Test RMSE: 89.021
```