In [2]:
```
import pandas as pd
import numpy as np
%matplotlib inline
import matplotlib.pyplot as plt
```

In [3]:
```
df = pd.read_csv('complete_dataset.csv',index_col='date')
```

In [4]:
```
df.head()
```

Out[4]:

| date | demand | RRP | demand_pos_RRP | RRP_positive | demand_neg_RRP | RRP_negative | fra |
|---|---|---|---|---|---|---|---|
| 01-01-2015 | 99635.030 | 25.633696 | 97319.240 | 26.415953 | 2315.790 | -7.240000 | |
| 02-01-2015 | 129606.010 | 33.138988 | 121082.015 | 38.837661 | 8523.995 | -47.809776 | |
| 03-01-2015 | 142300.540 | 34.564855 | 142300.540 | 34.564855 | 0.000 | 0.000000 | |
| 04-01-2015 | 104330.715 | 25.005560 | 104330.715 | 25.005560 | 0.000 | 0.000000 | |
| 05-01-2015 | 118132.200 | 26.724176 | 118132.200 | 26.724176 | 0.000 | 0.000000 | |

In [5]:
```
df.columns
```

Out[5]:
```
Index(['demand', 'RRP', 'demand_pos_RRP', 'RRP_positive', 'demand_neg_RRP',
       'RRP_negative', 'frac_at_neg_RRP', 'min_temperature', 'max_temperature',
       'solar_exposure', 'rainfall', 'school_day', 'holiday'],
      dtype='object')
```

In [6]:
```
df=df.drop(['RRP', 'demand_pos_RRP', 'RRP_positive', 'demand_neg_RRP',
       'RRP_negative', 'frac_at_neg_RRP', 'min_temperature', 'max_temperature',
       'solar_exposure', 'rainfall', 'school_day', 'holiday'],axis=1)
```

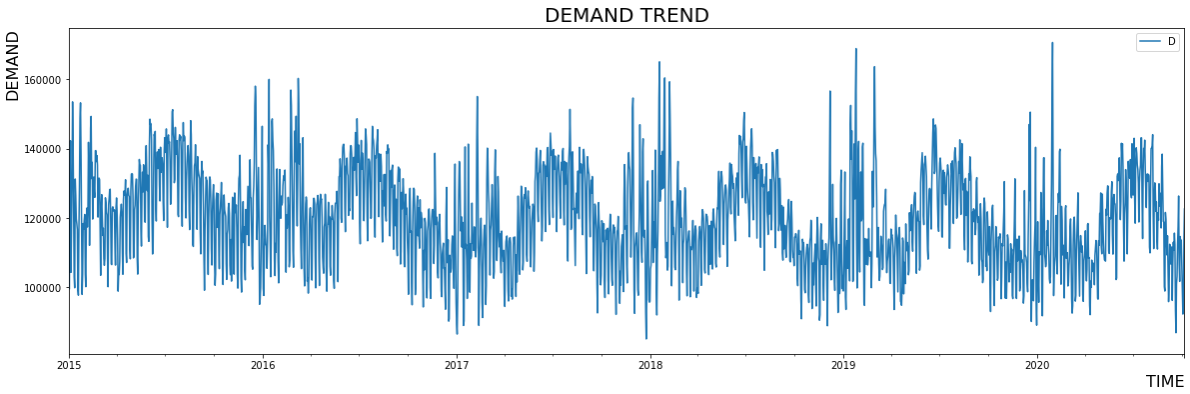
In [7]:
```
df.index=pd.to_datetime(df.index,format='%d-%m-%Y')
```

In [8]:
```
df.index.freq='D'
```

In [9]:
```
df.index
```

Out[9]:
```
DatetimeIndex(['2015-01-01', '2015-01-02', '2015-01-03', '2015-01-04',
               '2015-01-05', '2015-01-06', '2015-01-07', '2015-01-08',
               '2015-01-09', '2015-01-10',
               ...
               '2020-09-27', '2020-09-28', '2020-09-29', '2020-09-30',
               '2020-10-01', '2020-10-02', '2020-10-03', '2020-10-04',
               '2020-10-05', '2020-10-06'],
              dtype='datetime64[ns]', name='date', length=2106, freq='D')
```

In [70]:
```
df['demand'].plot(figsize=(20,6))
plt.title('DEMAND TREND', fontsize=20)
plt.xlabel('TIME', fontsize=16, loc='right')
plt.ylabel('DEMAND', fontsize=16, loc='top')
plt.legend('DEMAND', loc='upper right', fontsize=10)
plt.savefig('DEMAND TREND', dpi = 300)
```



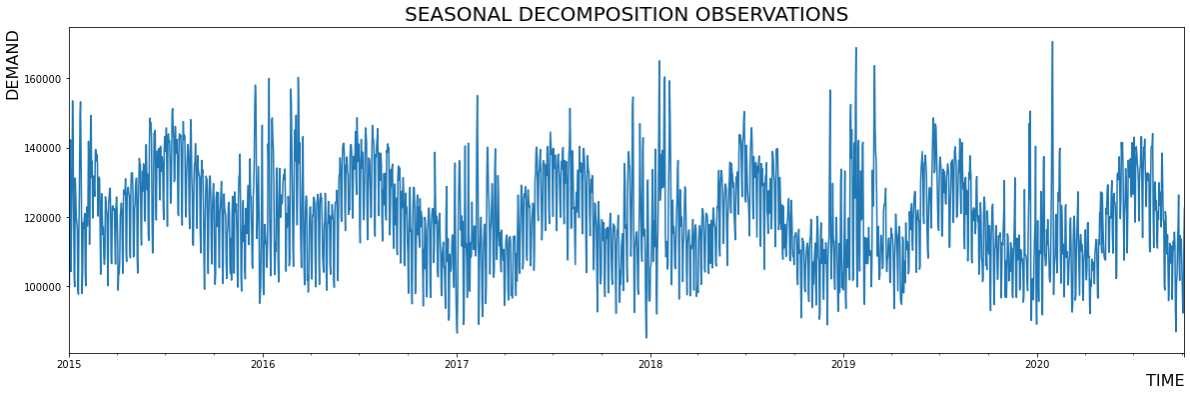

# ETS DECOMPOSITION

In [38]:
```
from statsmodels.tsa.seasonal import seasonal_decompose
```

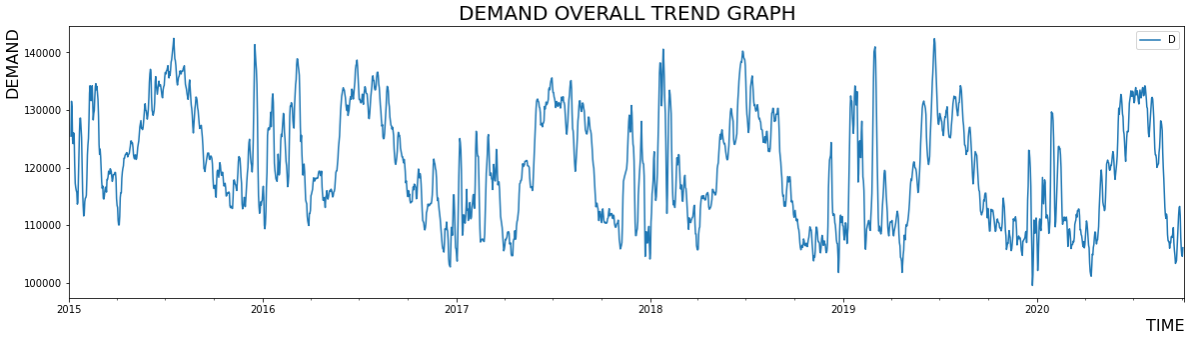
```
C:\Users\Revanth\Anaconda3\lib\site-packages\scipy\__init__.py:146: UserWarning: A
NumPy version >=1.16.5 and <1.23.0 is required for this version of SciPy (detected
version 1.26.0
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

In [69]:
```
results = seasonal_decompose(df['demand'])
results.observed.plot(figsize=(20,6))

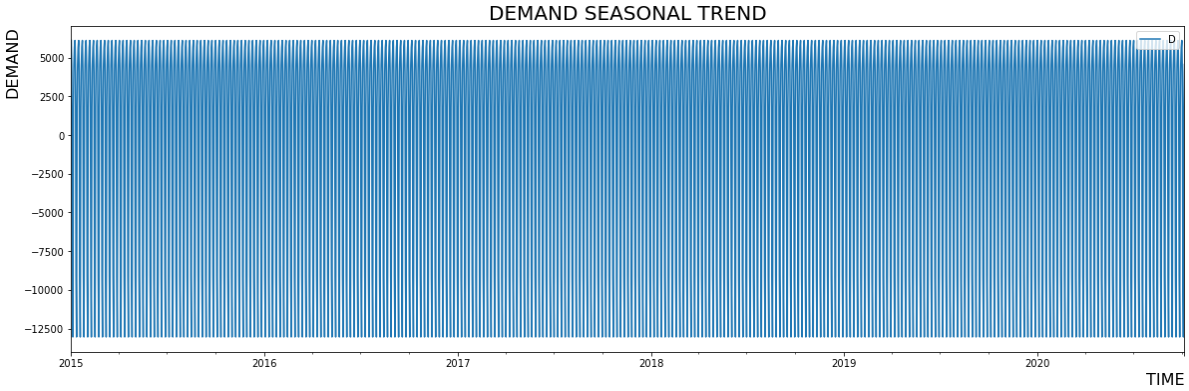
plt.title('SEASONAL DECOMPOSITION OBSERVATIONS', fontsize=20)
plt.xlabel('TIME', fontsize=16, loc='right')
plt.ylabel('DEMAND', fontsize=16, loc='top')
plt.savefig('#2 SEASONAL DECOMPOSITION OBSERVATIONS GRAPH', dpi = 300)
```




In [71]:
```
results.trend.plot(figsize=(20,5))
plt.title('DEMAND OVERALL TREND GRAPH', fontsize=20)
plt.xlabel('TIME', fontsize=16, loc='right')
plt.ylabel('DEMAND', fontsize=16, loc='top')
plt.legend('DEMAND', loc='upper right', fontsize=10)
plt.savefig('#3 DEMAND OVERALL TREND GRAPH', dpi = 300)
```

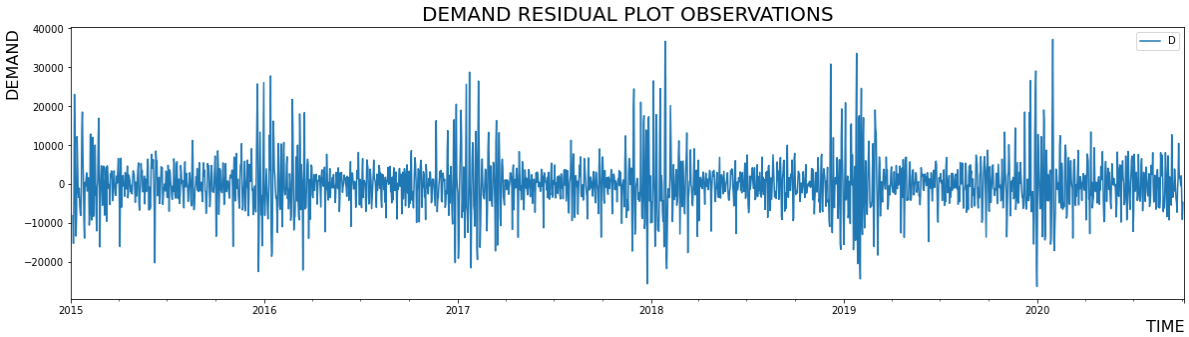



In [72]:
```
results.seasonal.plot(figsize=(20,6))
plt.title('DEMAND SEASONAL TREND', fontsize=20)
plt.xlabel('TIME', fontsize=16, loc='right')
plt.ylabel('DEMAND', fontsize=16, loc='top')
plt.legend('DEMAND', loc='upper right', fontsize=10)
plt.savefig('#4 DEMAND SEASONAL TREND', dpi = 300)
```




In [73]:
```
results.resid.plot(figsize=(20,5))

plt.title('DEMAND RESIDUAL PLOT OBSERVATIONS', fontsize=20)
plt.xlabel('TIME', fontsize=16, loc='right')
plt.ylabel('DEMAND', fontsize=16, loc='top')
plt.legend('DEMAND', loc='upper right', fontsize=10)
plt.savefig('DEMAND RESIDUAL TREND', dpi = 300)
```




# Train Test Split

In [74]:
```
len(df)
```

Out[74]:
```
2106
```

In [75]:
```
2106-90
```

Out[75]:
```
2016
```

In [76]:
```
train = df.iloc[:2016]
test = df.iloc[2016:]
```

In [77]:
```
len(test)
```

Out[77]:
```
90
```

# Scale Data

In [78]:
```
from sklearn.preprocessing import MinMaxScaler
```

In [79]:
```
scaler = MinMaxScaler()
```

In [80]:
```
# IGNORE WARNING ITS JUST CONVERTING TO FLOATS
# WE ONLY FIT TO TRAININ DATA, OTHERWISE WE ARE CHEATING ASSUMING INFO ABOUT TEST S
scaler.fit(train)
```

Out[80]:
```
MinMaxScaler()
```

In [81]:
```
scaled_train = scaler.transform(train)
scaled_test = scaler.transform(test)
```

In [82]:
```
pip install tensorflow keras
```

```
Requirement already satisfied: tensorflow in c:\users\revanth\anaconda3\lib\site-p
ackages (2.14.0)
Requirement already satisfied: keras in c:\users\revanth\anaconda3\lib\site-packag
es (2.14.0)
Requirement already satisfied: tensorflow-intel==2.14.0 in c:\users\revanth\anacon
da3\lib\site-packages (from tensorflow) (2.14.0)
Requirement already satisfied: numpy>=1.23.5 in c:\users\revanth\anaconda3\lib\sit
e-packages (from tensorflow-intel==2.14.0->tensorflow) (1.26.0)
Requirement already satisfied: wrapt<1.15,>=1.11.0 in c:\users\revanth\anaconda3\l
ib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (1.12.1)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in c:\users\re
vanth\anaconda3\lib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (0.3
1.0)
Requirement already satisfied: ml-dtypes==0.2.0 in c:\users\revanth\anaconda3\lib
\site-packages (from tensorflow-intel==2.14.0->tensorflow) (0.2.0)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\revanth\anaconda3\l
ib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (1.59.0)
Requirement already satisfied: tensorboard<2.15,>=2.14 in c:\users\revanth\anacond
a3\lib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (2.14.1)
Requirement already satisfied: google-pasta>=0.1.1 in c:\users\revanth\anaconda3\l
ib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (0.2.0)
Requirement already satisfied: six>=1.12.0 in c:\users\revanth\anaconda3\lib\site-
packages (from tensorflow-intel==2.14.0->tensorflow) (1.16.0)
Requirement already satisfied: termcolor>=1.1.0 in c:\users\revanth\anaconda3\lib
\site-packages (from tensorflow-intel==2.14.0->tensorflow) (2.3.0)
Requirement already satisfied: h5py>=2.9.0 in c:\users\revanth\anaconda3\lib\site-
packages (from tensorflow-intel==2.14.0->tensorflow) (3.6.0)
Requirement already satisfied: astunparse>=1.6.0 in c:\users\revanth\anaconda3\lib
\site-packages (from tensorflow-intel==2.14.0->tensorflow) (1.6.3)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\revanth\anacon
da3\lib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (4.1.1)
Requirement already satisfied: absl-py>=1.0.0 in c:\users\revanth\anaconda3\lib\si
te-packages (from tensorflow-intel==2.14.0->tensorflow) (2.0.0)
Requirement already satisfied: gast!=0.5.0,!=0.5.1,!=0.5.2,>=0.2.1 in c:\users\rev
anth\anaconda3\lib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (0.5.
4)
Requirement already satisfied: protobuf!=4.21.0,!=4.21.1,!=4.21.2,!=4.21.3,!=4.21.
4,!=4.21.5,<5.0.0dev,>=3.20.3 in c:\users\revanth\anaconda3\lib\site-packages (fro
m tensorflow-intel==2.14.0->tensorflow) (4.24.4)
Requirement already satisfied: opt-einsum>=2.3.2 in c:\users\revanth\anaconda3\lib
\site-packages (from tensorflow-intel==2.14.0->tensorflow) (3.3.0)
Requirement already satisfied: packaging in c:\users\revanth\anaconda3\lib\site-pa
ckages (from tensorflow-intel==2.14.0->tensorflow) (21.3)
Requirement already satisfied: setuptools in c:\users\revanth\anaconda3\lib\site-p
ackages (from tensorflow-intel==2.14.0->tensorflow) (61.2.0)
Requirement already satisfied: flatbuffers>=23.5.26 in c:\users\revanth\anaconda3
\lib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (23.5.26)
Requirement already satisfied: libclang>=13.0.0 in c:\users\revanth\anaconda3\lib
\site-packages (from tensorflow-intel==2.14.0->tensorflow) (16.0.6)
Requirement already satisfied: tensorflow-estimator<2.15,>=2.14.0 in c:\users\reva
nth\anaconda3\lib\site-packages (from tensorflow-intel==2.14.0->tensorflow) (2.14.
0)
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\revanth\anaconda3\li
b\site-packages (from astunparse>=1.6.0->tensorflow-intel==2.14.0->tensorflow) (0.
37.1)
Requirement already satisfied: google-auth-oauthlib<1.1,>=0.5 in c:\users\revanth
\anaconda3\lib\site-packages (from tensorboard<2.15,>=2.14->tensorflow-intel==2.1
4.0->tensorflow) (1.0.0)
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\revanth\anaconda3\l
ib\site-packages (from tensorboard<2.15,>=2.14->tensorflow-intel==2.14.0->tensorfl
ow) (2.27.1)
Requirement already satisfied: google-auth<3,>=1.6.3 in c:\users\revanth\anaconda3
\lib\site-packages (from tensorboard<2.15,>=2.14->tensorflow-intel==2.14.0->tensor
flow) (2.23.2)
```

```
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in c:\users\r
evanth\anaconda3\lib\site-packages (from tensorboard<2.15,>=2.14->tensorflow-intel
==2.14.0->tensorflow) (0.7.1)
Requirement already satisfied: markdown>=2.6.8 in c:\users\revanth\anaconda3\lib\s
ite-packages (from tensorboard<2.15,>=2.14->tensorflow-intel==2.14.0->tensorflow)
(3.3.4)
Requirement already satisfied: werkzeug>=1.0.1 in c:\users\revanth\anaconda3\lib\s
ite-packages (from tensorboard<2.15,>=2.14->tensorflow-intel==2.14.0->tensorflow)
(2.0.3)
Requirement already satisfied: pyasn1-modules>=0.2.1 in c:\users\revanth\anaconda3
\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.15,>=2.14->tensorflo
w-intel==2.14.0->tensorflow) (0.2.8)
Requirement already satisfied: rsa<5,>=3.1.4 in c:\users\revanth\anaconda3\lib\sit
e-packages (from google-auth<3,>=1.6.3->tensorboard<2.15,>=2.14->tensorflow-intel=
=2.14.0->tensorflow) (4.7.2)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in c:\users\revanth\anaconda
3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.15,>=2.14->tensorfl
ow-intel==2.14.0->tensorflow) (4.2.2)
Requirement already satisfied: requests-oauthlib>=0.7.0 in c:\users\revanth\anacon
da3\lib\site-packages (from google-auth-oauthlib<1.1,>=0.5->tensorboard<2.15,>=2.1
4->tensorflow-intel==2.14.0->tensorflow) (1.3.1)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in c:\users\revanth\anaconda3
\lib\site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->tensorboard
<2.15,>=2.14->tensorflow-intel==2.14.0->tensorflow) (0.4.8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\revanth\anaconda3
\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.15,>=2.14->tensorflow-
intel==2.14.0->tensorflow) (1.26.9)
Requirement already satisfied: idna<4,>=2.5 in c:\users\revanth\anaconda3\lib\site
-packages (from requests<3,>=2.21.0->tensorboard<2.15,>=2.14->tensorflow-intel==2.
14.0->tensorflow) (3.3)
Requirement already satisfied: charset-normalizer~=2.0.0 in c:\users\revanth\anaco
nda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.15,>=2.14->tensorf
low-intel==2.14.0->tensorflow) (2.0.4)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\revanth\anaconda3\li
b\site-packages (from requests<3,>=2.21.0->tensorboard<2.15,>=2.14->tensorflow-int
el==2.14.0->tensorflow) (2021.10.8)
Requirement already satisfied: oauthlib>=3.0.0 in c:\users\revanth\anaconda3\lib\s
ite-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<1.1,>=0.5->tenso
rboard<2.15,>=2.14->tensorflow-intel==2.14.0->tensorflow) (3.2.2)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in c:\users\revanth\anacon
da3\lib\site-packages (from packaging->tensorflow-intel==2.14.0->tensorflow) (3.0.
4)
Note: you may need to restart the kernel to use updated packages.
```

In [83]:
```
from keras.preprocessing.sequence import TimeseriesGenerator
```

In [84]:
```
scaled_train
```

Out[84]:
```
array([[0.16994794],
       [0.52024209],
       [0.66861293],
       ...,
       [0.59795792],
       [0.64481639],
       [0.6256787 ]])
```

In [85]:
```
# define generator
n_input = 10
n_features = 1
generator = TimeseriesGenerator(scaled_train, scaled_train, length=n_input, batch_s
```

In [86]:
```
len(scaled_train)
```

Out[86]:
```
2016
```

In [87]:
```
len(generator) # n_input = 2
```

Out[87]:
```
2006
```

In [88]:
```
scaled_train
```

Out[88]:
```
array([[0.16994794],
       [0.52024209],
       [0.66861293],
       ...,
       [0.59795792],
       [0.64481639],
       [0.6256787 ]])
```

In [89]:
```
# What does the first batch look like?
X,y = generator[0]
```

In [90]:
```
print(f'Given the Array: \n{X.flatten()}')
print(f'Predict this y: \n {y}')
```

```
Given the Array:
[0.16994794 0.52024209 0.66861293 0.22483006 0.38613875 0.53270681
 0.79968295 0.66528326 0.42902068 0.20978725]
Predict this y:
 [[0.1726446]]
```

In [91]:
```
# Let's redefine to get 12 months back and then predict the next month out
n_input = 10
generator = TimeseriesGenerator(scaled_train, scaled_train, length=n_input, batch_s
```

In [92]:
```
# What does the first batch look like?
X,y = generator[0]
```

In [93]:
```
print(f'Given the Array: \n{X.flatten()}')
print(f'Predict this y: \n {y}')
```

```
Given the Array:
[0.16994794 0.52024209 0.66861293 0.22483006 0.38613875 0.53270681
 0.79968295 0.66528326 0.42902068 0.20978725]
Predict this y:
 [[0.1726446]]
```

## Create the Model

In [94]:
```
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
```

In [95]:
```
# define model
model = Sequential()
model.add(LSTM(100, activation='relu', input_shape=(n_input, n_features)))
model.add(Dense(1))
model.compile(optimizer='adam', loss='mse')
```

In [96]:
```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 lstm (LSTM)                 (None, 100)               40800

 dense (Dense)               (None, 1)                 101

=================================================================
Total params: 40901 (159.77 KB)
Trainable params: 40901 (159.77 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [98]:
```
# fit model
model.fit_generator(generator,epochs=300)
```

```
Epoch 1/300
  40/2006 [..............................] - ETA: 5s - loss: 0.0174
C:\Users\Revanth\AppData\Local\Temp\ipykernel_3772\4155622748.py:2: UserWarning: `
Model.fit_generator` is deprecated and will be removed in a future version. Please
use `Model.fit`, which supports generators.
  model.fit_generator(generator,epochs=300)
```

```
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0126
Epoch 2/300
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0114
Epoch 3/300
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0108
Epoch 4/300
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0106
Epoch 5/300
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0100
Epoch 6/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0097
Epoch 7/300
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0095
Epoch 8/300
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0091
Epoch 9/300
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0091
Epoch 10/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0087
Epoch 11/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0088
Epoch 12/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0087
Epoch 13/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0086
Epoch 14/300
2006/2006 [==============================] - 5s 2ms/step - loss: 0.0086
Epoch 15/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0085
Epoch 16/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0083
Epoch 17/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0082
Epoch 18/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0082
Epoch 19/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0082
Epoch 20/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0081
Epoch 21/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0080
Epoch 22/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0079
Epoch 23/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0080
Epoch 24/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0079
Epoch 25/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0079
Epoch 26/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0078
Epoch 27/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0077
Epoch 28/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0079
Epoch 29/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0076
Epoch 30/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0077
Epoch 31/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0076
Epoch 32/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0076
Epoch 33/300
```

```
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0074
Epoch 34/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0075
Epoch 35/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0074
Epoch 36/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0074
Epoch 37/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0072
Epoch 38/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0071
Epoch 39/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0071
Epoch 40/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0072
Epoch 41/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0072
Epoch 42/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0071
Epoch 43/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0071
Epoch 44/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0072
Epoch 45/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0070
Epoch 46/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0070
Epoch 47/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0071
Epoch 48/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0068
Epoch 49/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0068
Epoch 50/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0069
Epoch 51/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0070
Epoch 52/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0069
Epoch 53/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0068
Epoch 54/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0068
Epoch 55/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0068
Epoch 56/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0067
Epoch 57/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0067
Epoch 58/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0066
Epoch 59/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0066
Epoch 60/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0066
Epoch 61/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0065
Epoch 62/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0065
Epoch 63/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0065
Epoch 64/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0064
Epoch 65/300
```

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2006/2006 [==============================] - 8s 4ms/step - loss: 0.0065
Epoch 66/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0066
Epoch 67/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0063
Epoch 68/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0064
Epoch 69/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0065
Epoch 70/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0063
Epoch 71/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0062
Epoch 72/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0062
Epoch 73/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0064
Epoch 74/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0061
Epoch 75/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0063
Epoch 76/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0062
Epoch 77/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0062
Epoch 78/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0061
Epoch 79/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0060
Epoch 80/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0060
Epoch 81/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0060
Epoch 82/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0059
Epoch 83/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0057
Epoch 84/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0059
Epoch 85/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0058
Epoch 86/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0058
Epoch 87/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0059
Epoch 88/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0059
Epoch 89/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0056
Epoch 90/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0057
Epoch 91/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0057
Epoch 92/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0057
Epoch 93/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0058
Epoch 94/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0057
Epoch 95/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0056
Epoch 96/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0059
Epoch 97/300
```

```
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0055
Epoch 98/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0056
Epoch 99/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0056
Epoch 100/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0055
Epoch 101/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0054
Epoch 102/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0054
Epoch 103/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0051
Epoch 104/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0052
Epoch 105/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0053
Epoch 106/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0052
Epoch 107/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0054
Epoch 108/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0052
Epoch 109/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0052
Epoch 110/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0052
Epoch 111/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0051
Epoch 112/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0051
Epoch 113/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0052
Epoch 114/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0050
Epoch 115/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0051
Epoch 116/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0049
Epoch 117/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0050
Epoch 118/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0050
Epoch 119/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0050
Epoch 120/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0050
Epoch 121/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0050
Epoch 122/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0048
Epoch 123/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0049
Epoch 124/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0049
Epoch 125/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0047
Epoch 126/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0049
Epoch 127/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0048
Epoch 128/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0047
Epoch 129/300
```

```
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0051
Epoch 130/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0047
Epoch 131/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0048
Epoch 132/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0046
Epoch 133/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0046
Epoch 134/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0046
Epoch 135/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0047
Epoch 136/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0046
Epoch 137/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0045
Epoch 138/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0046
Epoch 139/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0045
Epoch 140/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0045
Epoch 141/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0043
Epoch 142/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0046
Epoch 143/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0045
Epoch 144/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0043
Epoch 145/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0043
Epoch 146/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0042
Epoch 147/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0043
Epoch 148/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0041
Epoch 149/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0046
Epoch 150/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0040
Epoch 151/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0041
Epoch 152/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0040
Epoch 153/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0042
Epoch 154/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0042
Epoch 155/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0042
Epoch 156/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0042
Epoch 157/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0042
Epoch 158/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0040
Epoch 159/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0044
Epoch 160/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0040
Epoch 161/300
```

```
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0039
Epoch 162/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0040
Epoch 163/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0038
Epoch 164/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0040
Epoch 165/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0039
Epoch 166/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0039
Epoch 167/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0038
Epoch 168/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0038
Epoch 169/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0038
Epoch 170/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0038
Epoch 171/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0037
Epoch 172/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0036
Epoch 173/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0038
Epoch 174/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0038
Epoch 175/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0036
Epoch 176/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0038
Epoch 177/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0036
Epoch 178/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0037
Epoch 179/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0035
Epoch 180/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0035
Epoch 181/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0035
Epoch 182/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0035
Epoch 183/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0036
Epoch 184/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0035
Epoch 185/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0036
Epoch 186/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0035
Epoch 187/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0033
Epoch 188/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0035
Epoch 189/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0033
Epoch 190/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0035
Epoch 191/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0033
Epoch 192/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0035
Epoch 193/300
```

```
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0032
Epoch 194/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0034
Epoch 195/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0033
Epoch 196/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0036
Epoch 197/300
2006/2006 [==============================] - 9s 4ms/step - loss: 0.0031
Epoch 198/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0033
Epoch 199/300
2006/2006 [==============================] - 10s 5ms/step - loss: 0.0032
Epoch 200/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0032
Epoch 201/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0032
Epoch 202/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0034
Epoch 203/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0032
Epoch 204/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0032
Epoch 205/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0032
Epoch 206/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0031
Epoch 207/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0031
Epoch 208/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0032
Epoch 209/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0034
Epoch 210/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0030
Epoch 211/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0030
Epoch 212/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0030
Epoch 213/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0032
Epoch 214/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0029
Epoch 215/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0031
Epoch 216/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0029
Epoch 217/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0029
Epoch 218/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0029
Epoch 219/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0030
Epoch 220/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0029
Epoch 221/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0029
Epoch 222/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0029
Epoch 223/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0032
Epoch 224/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0029
Epoch 225/300
```

```
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0028
Epoch 226/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0032
Epoch 227/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0027
Epoch 228/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0029
Epoch 229/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0028
Epoch 230/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0027
Epoch 231/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0028
Epoch 232/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0028
Epoch 233/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0028
Epoch 234/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0027
Epoch 235/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0027
Epoch 236/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0029
Epoch 237/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0028
Epoch 238/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0029
Epoch 239/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0027
Epoch 240/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0026
Epoch 241/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0027
Epoch 242/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0027
Epoch 243/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0027
Epoch 244/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0026
Epoch 245/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0025
Epoch 246/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0027
Epoch 247/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0026
Epoch 248/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0026
Epoch 249/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0027
Epoch 250/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0026
Epoch 251/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0026
Epoch 252/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0026
Epoch 253/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0025
Epoch 254/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0024
Epoch 255/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0025
Epoch 256/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0026
Epoch 257/300
```

```
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0024
Epoch 258/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0025
Epoch 259/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0024
Epoch 260/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0024
Epoch 261/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0025
Epoch 262/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0025
Epoch 263/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0025
Epoch 264/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0025
Epoch 265/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0024
Epoch 266/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0025
Epoch 267/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0024
Epoch 268/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0024
Epoch 269/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0025
Epoch 270/300
2006/2006 [==============================] - 9s 4ms/step - loss: 0.0023
Epoch 271/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0024
Epoch 272/300
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0022
Epoch 273/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0025
Epoch 274/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0023
Epoch 275/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0023
Epoch 276/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0025
Epoch 277/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0022
Epoch 278/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0023
Epoch 279/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0023
Epoch 280/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0022
Epoch 281/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0023
Epoch 282/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0023
Epoch 283/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0022
Epoch 284/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0023
Epoch 285/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0022
Epoch 286/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0022
Epoch 287/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0022
Epoch 288/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0023
Epoch 289/300
```

```
2006/2006 [==============================] - 7s 4ms/step - loss: 0.0022
Epoch 290/300
2006/2006 [==============================] - 7s 3ms/step - loss: 0.0023
Epoch 291/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0021
Epoch 292/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0024
Epoch 293/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0022
Epoch 294/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0022
Epoch 295/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0022
Epoch 296/300
2006/2006 [==============================] - 8s 4ms/step - loss: 0.0022
Epoch 297/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0020
Epoch 298/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0021
Epoch 299/300
2006/2006 [==============================] - 6s 3ms/step - loss: 0.0022
Epoch 300/300
2006/2006 [==============================] - 5s 3ms/step - loss: 0.0021
```

Out[98]:
```
<keras.src.callbacks.History at 0x202f02f7a90>
```

In [99]:
```
model.history.history.keys()
```

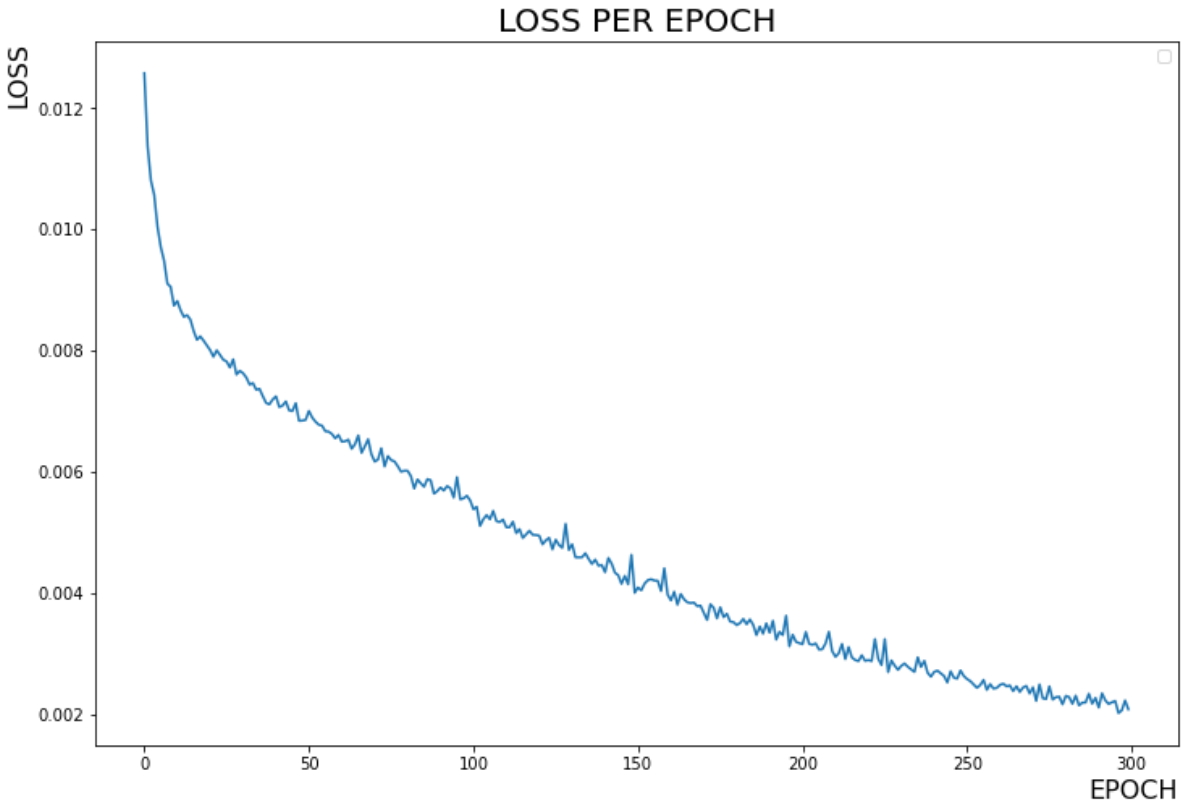
Out[99]:
```
dict_keys(['loss'])
```

In [112…
```
loss_per_epoch = model.history.history['loss']

plt.figure(figsize=(12, 8))
plt.title('LOSS PER EPOCH', fontsize=20)
plt.xlabel('EPOCH', fontsize=16, loc='right')
plt.ylabel('LOSS', fontsize=16, loc='top')
plt.legend('LOSS', loc='upper right', fontsize=10)

plt.plot(range(len(loss_per_epoch)),loss_per_epoch)

plt.savefig('#6 LOSS PER EPOCH', dpi = 300)
```




# Evaluate on Test Data

In [113…
```
first_eval_batch = scaled_train[-10:]
```

In [114…
```
first_eval_batch
```

Out[114]:
```
array([[0.65846152],
       [0.61419844],
       [0.48528056],
       [0.54089089],
       [0.6769081 ],
       [0.47108634],
       [0.39052821],
       [0.59795792],
       [0.64481639],
       [0.6256787 ]])
```

In [115…
```
first_eval_batch = first_eval_batch.reshape((1, n_input, n_features))
```

In [116…
```
model.predict(first_eval_batch)
```

Out[116]:
```
1/1 [==============================] - 0s 137ms/step
array([[0.6372648]], dtype=float32)
```

In [117…
```
scaled_test[0]
```

Out[117]:
```
array([0.58639672])
```

Now let's put this logic in a for loop to predict into the future for the entire test range.

---

In [118…
```
test_predictions = []
```

```
first_eval_batch = scaled_train[-n_input:]
current_batch = first_eval_batch.reshape((1, n_input, n_features))
```

In [119…
```
current_batch.shape
```

Out[119]:
```
(1, 10, 1)
```

In [120…
```
current_batch
```

Out[120]:
```
array([[[0.65846152],
        [0.61419844],
        [0.48528056],
        [0.54089089],
        [0.6769081 ],
        [0.47108634],
        [0.39052821],
        [0.59795792],
        [0.64481639],
        [0.6256787 ]]])
```

In [121…
```
np.append(current_batch[:,1:,:],[[[99]]],axis=1)
```

Out[121]:
```
array([[[ 0.61419844],
        [ 0.48528056],
        [ 0.54089089],
        [ 0.6769081 ],
        [ 0.47108634],
        [ 0.39052821],
        [ 0.59795792],
        [ 0.64481639],
        [ 0.6256787 ],
        [99.        ]]])
```

**NOTE: PAY CLOSE ATTENTION HERE TO WHAT IS BEING OUTPUTED AND IN WHAT DIMENSIONS. ADD YOUR OWN PRINT() STATEMENTS TO SEE WHAT IS TRULY GOING ON!!**

In [122…
```
test_predictions = []

first_eval_batch = scaled_train[-n_input:]
current_batch = first_eval_batch.reshape((1, n_input, n_features))

for i in range(len(test)):

    # get prediction 1 time stamp ahead ([0] is for grabbing just the number instead
    current_pred = model.predict(current_batch)[0]

    # store prediction
    test_predictions.append(current_pred)

    # update batch to now include prediction and drop first value
    current_batch = np.append(current_batch[:,1:,:],[[current_pred]],axis=1)
```

```
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 15ms/step
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1/1 [==============================] - 0s 17ms/step
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1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 14ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 14ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 24ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 21ms/step
1/1 [==============================] - 0s 23ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 21ms/step
1/1 [==============================] - 0s 19ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 19ms/step
1/1 [==============================] - 0s 17ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 16ms/step
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1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 14ms/step
1/1 [==============================] - 0s 14ms/step
1/1 [==============================] - 0s 15ms/step
```

```
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 15ms/step
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1/1 [==============================] - 0s 17ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 15ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 22ms/step
1/1 [==============================] - 0s 25ms/step
1/1 [==============================] - 0s 23ms/step
1/1 [==============================] - 0s 21ms/step
1/1 [==============================] - 0s 22ms/step
```

In [123…

```
test_predictions
```

Out[123]:
```
[array([0.6372648], dtype=float32),
 array([0.58375025], dtype=float32),
 array([0.39677316], dtype=float32),
 array([0.33142948], dtype=float32),
 array([0.51028204], dtype=float32),
 array([0.5772549], dtype=float32),
 array([0.5715054], dtype=float32),
 array([0.5470879], dtype=float32),
 array([0.52291393], dtype=float32),
 array([0.36866075], dtype=float32),
 array([0.33677155], dtype=float32),
 array([0.45831764], dtype=float32),
 array([0.5734291], dtype=float32),
 array([0.57482105], dtype=float32),
 array([0.566343], dtype=float32),
 array([0.52767277], dtype=float32),
 array([0.3620854], dtype=float32),
 array([0.28570038], dtype=float32),
 array([0.45145655], dtype=float32),
 array([0.5123478], dtype=float32),
 array([0.5457964], dtype=float32),
 array([0.5398136], dtype=float32),
 array([0.48315692], dtype=float32),
 array([0.30825418], dtype=float32),
 array([0.26692155], dtype=float32),
 array([0.4717722], dtype=float32),
 array([0.4724201], dtype=float32),
 array([0.45736057], dtype=float32),
 array([0.46505624], dtype=float32),
 array([0.43107504], dtype=float32),
 array([0.26427445], dtype=float32),
 array([0.22100583], dtype=float32),
 array([0.40598333], dtype=float32),
 array([0.43747747], dtype=float32),
 array([0.4430985], dtype=float32),
 array([0.43771136], dtype=float32),
 array([0.41219896], dtype=float32),
 array([0.24480769], dtype=float32),
 array([0.20565514], dtype=float32),
 array([0.43076432], dtype=float32),
 array([0.43560052], dtype=float32),
 array([0.43326825], dtype=float32),
 array([0.4236595], dtype=float32),
 array([0.39021993], dtype=float32),
 array([0.22960117], dtype=float32),
 array([0.1898234], dtype=float32),
 array([0.41199893], dtype=float32),
 array([0.41935372], dtype=float32),
 array([0.43640792], dtype=float32),
 array([0.42761528], dtype=float32),
 array([0.4032082], dtype=float32),
 array([0.23982406], dtype=float32),
 array([0.19277465], dtype=float32),
 array([0.39605463], dtype=float32),
 array([0.4134494], dtype=float32),
 array([0.44336504], dtype=float32),
 array([0.43855238], dtype=float32),
 array([0.4142965], dtype=float32),
 array([0.24662119], dtype=float32),
 array([0.20621675], dtype=float32),
 array([0.39570403], dtype=float32),
 array([0.4212842], dtype=float32),
 array([0.4358883], dtype=float32),
 array([0.4298545], dtype=float32),
```

```
array([0.40582722], dtype=float32),
array([0.24395373], dtype=float32),
array([0.20785764], dtype=float32),
array([0.41788965], dtype=float32),
array([0.42609352], dtype=float32),
array([0.42793763], dtype=float32),
array([0.41852963], dtype=float32),
array([0.39148626], dtype=float32),
array([0.23213366], dtype=float32),
array([0.1935265], dtype=float32),
array([0.42524946], dtype=float32),
array([0.42104596], dtype=float32),
array([0.42875433], dtype=float32),
array([0.41794032], dtype=float32),
array([0.38551033], dtype=float32),
array([0.22452213], dtype=float32),
array([0.18248716], dtype=float32),
array([0.40831125], dtype=float32),
array([0.42289603], dtype=float32),
array([0.44872326], dtype=float32),
array([0.4384647], dtype=float32),
array([0.41798443], dtype=float32),
array([0.24801543], dtype=float32),
array([0.1940732], dtype=float32),
array([0.37322354], dtype=float32),
array([0.38624316], dtype=float32)]
```

In [124…

```
scaled_test
```

Out[124]:
```
array([[0.58639672],
       [0.57207996],
       [0.52588659],
       [0.39437688],
       [0.5262426 ],
       [0.56772866],
       [0.58675478],
       [0.67864514],
       [0.67806618],
       [0.46995981],
       [0.33860596],
       [0.55867618],
       [0.64273111],
       [0.62613447],
       [0.67066794],
       [0.56952583],
       [0.50634778],
       [0.44320263],
       [0.55490009],
       [0.55664233],
       [0.53124876],
       [0.55504397],
       [0.5494585 ],
       [0.30968257],
       [0.29033562],
       [0.50065741],
       [0.64221732],
       [0.64412418],
       [0.65148607],
       [0.68920762],
       [0.4210509 ],
       [0.30471883],
       [0.47762542],
       [0.52649757],
       [0.5008322 ],
       [0.43034473],
       [0.46220152],
       [0.33498112],
       [0.30318528],
       [0.42574127],
       [0.40004317],
       [0.52349994],
       [0.44876952],
       [0.4746718 ],
       [0.49131905],
       [0.37436758],
       [0.58310808],
       [0.62346673],
       [0.51692627],
       [0.39680063],
       [0.39404997],
       [0.17616415],
       [0.16155781],
       [0.42673268],
       [0.40382213],
       [0.33255578],
       [0.28323091],
       [0.34795998],
       [0.23889391],
       [0.12588631],
       [0.17162128],
       [0.31938857],
       [0.31610874],
       [0.28324114],
```

```
[0.25185612],
[0.31031313],
[0.13010291],
[0.25832601],
[0.32625724],
[0.30053186],
[0.35705068],
[0.31839055],
[0.09688729],
[0.02100124],
[0.18564369],
[0.211622  ],
[0.31928753],
[0.37916717],
[0.48224127],
[0.25246289],
[0.19412364],
[0.3454529 ],
[0.31536061],
[0.33340362],
[0.25184139],
[0.16937296],
[0.08394922],
[0.10504028],
[0.33328463],
[0.43844576]])
```

# Inverse Transformations and Compare

In [125…
```
true_predictions = scaler.inverse_transform(test_predictions)
```

In [126…
```
true_predictions
```

Out[126]:
```
array([[139618.40933752],
       [135039.73390867],
       [119042.07425352],
       [113451.30412291],
       [128753.83331091],
       [134483.99467644],
       [133992.07360956],
       [131902.92369858],
       [129834.61133144],
       [116636.7913658 ],
       [113908.36845651],
       [124307.78685973],
       [134156.66266733],
       [134275.75693101],
       [133550.37989691],
       [130241.77469428],
       [116074.20828045],
       [109538.74673173],
       [123720.75561354],
       [128930.58015245],
       [131792.42249936],
       [131280.53594444],
       [126433.0225417 ],
       [111468.43792491],
       [107932.04001801],
       [125458.9515127 ],
       [125514.38570301],
       [124225.90031017],
       [124884.33813711],
       [121976.9245    ],
       [107705.55539743],
       [104003.51533613],
       [119830.0914127 ],
       [122524.71323521],
       [123005.64435911],
       [122544.72462092],
       [120361.89755799],
       [106039.99001697],
       [102690.11898091],
       [121950.33954746],
       [122364.12237479],
       [122164.57458891],
       [121342.4554582 ],
       [118481.38317227],
       [104738.92866155],
       [101335.56388683],
       [120344.78282545],
       [120974.05523064],
       [122433.2034734 ],
       [121680.91000356],
       [119592.65254734],
       [105613.592979  ],
       [101588.07121344],
       [118980.59686951],
       [120468.8850353 ],
       [123028.45040318],
       [122616.68197375],
       [120541.36256176],
       [106195.15220254],
       [102738.17002043],
       [118950.6001899 ],
       [121139.22565894],
       [122388.74392684],
       [121872.49709292],
```

```
       [119816.73518966],
       [105966.92602023],
       [102878.56335456],
       [120848.79027972],
       [121550.70850285],
       [121708.48940569],
       [120903.54620441],
       [118589.7297307 ],
       [104955.60647918],
       [101652.39935295],
       [121478.4910632 ],
       [121118.84199209],
       [121778.36606397],
       [120853.12506001],
       [118078.43219592],
       [104304.36821234],
       [100707.87877618],
       [120029.26691744],
       [121277.13286909],
       [123486.89676673],
       [122609.18025398],
       [120856.89886874],
       [106314.44280627],
       [101699.17418216],
       [117027.18167878],
       [118141.13351789]])
```

In [127…
```
test
```

Out[127]:

| date | demand |
|---|---|
| **2020-07-09** | 135266.165 |
| **2020-07-10** | 134041.230 |
| **2020-07-11** | 130088.950 |
| **2020-07-12** | 118837.050 |
| **2020-07-13** | 130119.410 |
| **…** | … |
| **2020-10-02** | 99585.835 |
| **2020-10-03** | 92277.025 |
| **2020-10-04** | 94081.565 |
| **2020-10-05** | 113610.030 |
| **2020-10-06** | 122607.560 |

90 rows × 1 columns

In [128…
```
# IGNORE WARNINGS
test['Predictions'] = true_predictions
```

```
C:\Users\Revanth\AppData\Local\Temp\ipykernel_3772\1339453577.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  test['Predictions'] = true_predictions
```

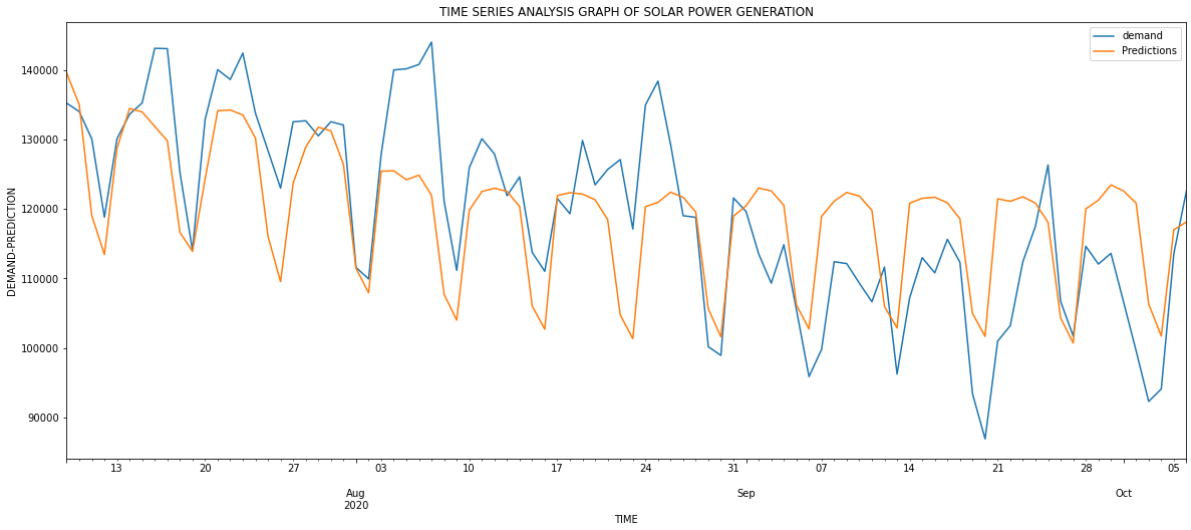
In [129…
```
test
```

Out[129]:

| date | demand | Predictions |
|---|---|---|
| **2020-07-09** | 135266.165 | 139618.409338 |
| **2020-07-10** | 134041.230 | 135039.733909 |
| **2020-07-11** | 130088.950 | 119042.074254 |
| **2020-07-12** | 118837.050 | 113451.304123 |
| **2020-07-13** | 130119.410 | 128753.833311 |
| **...** | ... | ... |
| **2020-10-02** | 99585.835 | 120856.898869 |
| **2020-10-03** | 92277.025 | 106314.442806 |
| **2020-10-04** | 94081.565 | 101699.174182 |
| **2020-10-05** | 113610.030 | 117027.181679 |
| **2020-10-06** | 122607.560 | 118141.133518 |

90 rows × 2 columns

In [150…
```
test.plot(figsize=(20,8), title = 'TIME SERIES ANALYSIS GRAPH OF SOLAR POWER GENERA
plt.savefig('#7 TSA GRAPH', dpi = 300)
```




# Saving and Loading Models

In [ ]:
```
model.save('my_rnn_model.h5')
```

# load a model

In [ ]:
```
from keras.models import load_model
new_model = load_model('my_rnn_model.h5')
```

In [ ]:
```
new_model.summary()
```

In [ ]:
```

```