In [1]:

```
import numpy as np
import pandas as pd
from pylab import rcParams
import matplotlib.pyplot as plt
import warnings
import itertools
import statsmodels.api as sm
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers import Dropout
from sklearn.metrics import mean_squared_error
from keras.callbacks import ReduceLROnPlateau, EarlyStopping, ModelCheckpoint
from sklearn.metrics import mean_squared_error
from sklearn.metrics import mean_absolute_error
import seaborn as sns
sns.set_context("paper", font_scale=1.3)
sns.set_style('white')
import math
from sklearn.preprocessing import MinMaxScaler
warnings.filterwarnings("ignore")
plt.style.use('fivethirtyeight')
from keras.utils import plot_model
```

```
Using TensorFlow backend.
```

In [2]:

```
pd.read_csv("BrentOilPrices.csv").head()
```

Out[2]:

	Date	Price
0	May 20, 1987	18.63
1	May 21, 1987	18.45
2	May 22, 1987	18.55
3	May 25, 1987	18.60
4	May 26, 1987	18.63

In [3]:

```
dateparse = lambda x: pd.datetime.strptime(x, '%b %d, %Y')
```

In [4]:

```
df = pd.read_csv("BrentOilPrices.csv", parse_dates=['Date'], date_parser=dateparse)
```

In [5]:

```
df = df.sort_values('Date')
```

In [6]:

```
df.set_index('Date', inplace=True)
```

In [7]:

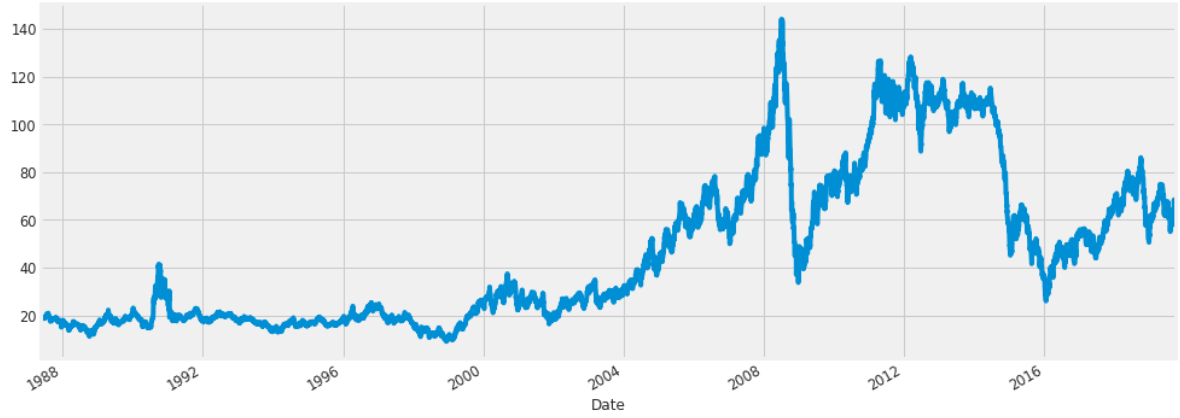
```
df.index
```

Out[7]:

```
DatetimeIndex(['1987-05-20', '1987-05-21', '1987-05-22', '1987-05-25',
               '1987-05-26', '1987-05-27', '1987-05-28', '1987-05-29',
               '1987-06-01', '1987-06-02',
               ...
               '2019-09-17', '2019-09-18', '2019-09-19', '2019-09-20',
               '2019-09-23', '2019-09-24', '2019-09-25', '2019-09-26',
               '2019-09-27', '2019-09-30'],
              dtype='datetime64[ns]', name='Date', length=8216, freq=N
one)
```

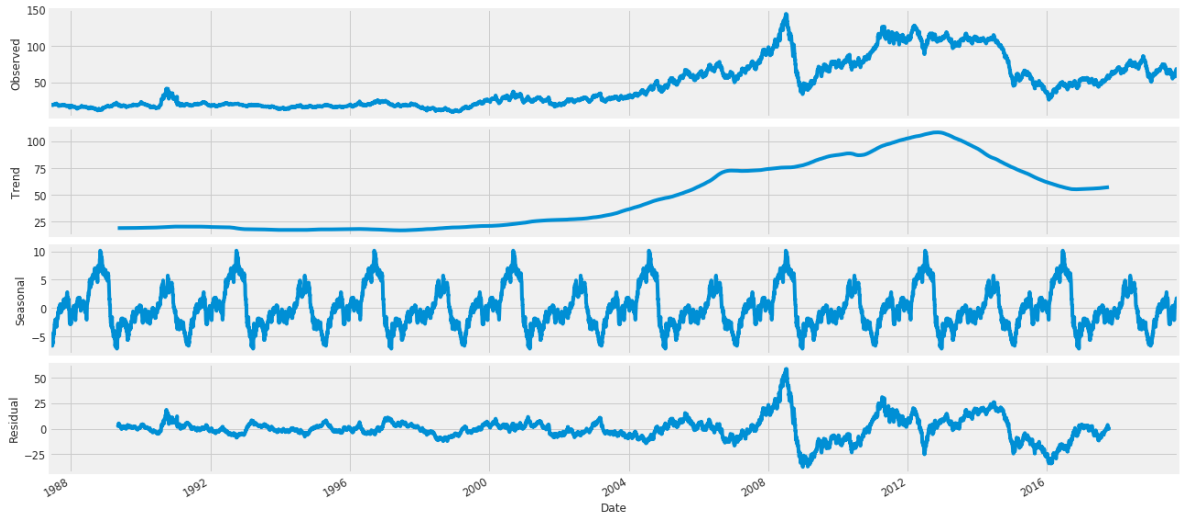
In [8]:

```
df['Price'].plot(figsize=(15, 6))
plt.show()
```



In [9]:

```
rcParams['figure.figsize'] = 18, 8
decomposition = sm.tsa.seasonal_decompose(df["Price"], model='additive', freq=1000)
fig = decomposition.plot()
plt.show()
```



In [10]:

```
sc = MinMaxScaler(feature_range = (0, 1))
scaled_Array = sc.fit_transform(df)
```

In [11]:

```
df["Scaled Price"] = scaled_Array
```

In [12]:

```
df.head()
```

Out[12]:

Date	Price	Scaled Price
1987-05-20	18.63	0.070671
1987-05-21	18.45	0.069336
1987-05-22	18.55	0.070078
1987-05-25	18.60	0.070449
1987-05-26	18.63	0.070671

In [13]:

```
train_size = int(len(df) * 0.70)
test_size = len(df) - train_size
train, test = df.iloc[0:train_size, 1:2], df.iloc[train_size:len(df), 1:2]
```

In [14]:

```
def create_data_set(_data_set, _look_back=1):
    data_x, data_y = [], []
    for i in range(len(_data_set) - _look_back - 1):
        a = _data_set.iloc[i:(i + _look_back), 0]
        data_x.append(a)
        data_y.append(_data_set.iloc[i + _look_back, 0])
    return np.array(data_x), np.array(data_y)
```

In [15]:

```
look_back = 60
X_train,Y_train,X_test,Ytest = [],[],[],[]
X_train,Y_train=create_data_set(train,look_back)
X_train = np.reshape(X_train, (X_train.shape[0], X_train.shape[1], 1))
X_test,Y_test=create_data_set(test,look_back)
X_test = np.reshape(X_test, (X_test.shape[0], X_test.shape[1], 1))
```

In [16]:

```
Y_train
```

Out[16]:

```
array([0.07638116, 0.07526882, 0.07230256, ..., 0.50048202, 0.5009269
6,
       0.50812013])
```

In [17]:

```
regressor = Sequential()

regressor.add(LSTM(units = 60, return_sequences = True, input_shape = (X_train.shap
regressor.add(Dropout(0.2))

regressor.add(LSTM(units = 60, return_sequences = True))
regressor.add(Dropout(0.2))

regressor.add(LSTM(units = 60, return_sequences = True))
regressor.add(Dropout(0.2))

regressor.add(LSTM(units = 60))
regressor.add(Dropout(0.2))

regressor.add(Dense(units = 1))

regressor.compile(optimizer = 'adam', loss = 'mean_squared_error')
reduce_lr = ReduceLROnPlateau(monitor='val_loss',patience=5)
```

```
WARNING:tensorflow:From /home/bat/anaconda3/lib/python3.7/site-package
s/keras/backend/tensorflow_backend.py:74: The name tf.get_default_grap
h is deprecated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /home/bat/anaconda3/lib/python3.7/site-package
s/keras/backend/tensorflow_backend.py:517: The name tf.placeholder is
deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /home/bat/anaconda3/lib/python3.7/site-package
s/keras/backend/tensorflow_backend.py:4138: The name tf.random_uniform
is deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /home/bat/anaconda3/lib/python3.7/site-package
s/keras/backend/tensorflow_backend.py:133: The name tf.placeholder_wit
h_default is deprecated. Please use tf.compat.v1.placeholder_with_defa
ult instead.

WARNING:tensorflow:From /home/bat/anaconda3/lib/python3.7/site-package
s/keras/backend/tensorflow_backend.py:3445: calling dropout (from tens
orflow.python.ops.nn_ops) with keep_prob is deprecated and will be rem
oved in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate
= 1 - keep_prob`.
WARNING:tensorflow:From /home/bat/anaconda3/lib/python3.7/site-package
s/keras/optimizers.py:790: The name tf.train.Optimizer is deprecated.
Please use tf.compat.v1.train.Optimizer instead.
```

In [18]:

```
plot_model(regressor, to_file='model.png')
```

In [19]:

```
history =regressor.fit(X_train, Y_train, epochs = 25, batch_size = 64,validation_da
```

```
WARNING:tensorflow:From /home/bat/anaconda3/lib/python3.7/site-package
s/tensorflow/python/ops/math_grad.py:1250: add_dispatch_support.<local
s>.wrapper (from tensorflow.python.ops.array_ops) is deprecated and wi
ll be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /home/bat/anaconda3/lib/python3.7/site-package
s/keras/backend/tensorflow_backend.py:986: The name tf.assign_add is d
eprecated. Please use tf.compat.v1.assign_add instead.

Train on 5690 samples, validate on 2404 samples
Epoch 1/25
5690/5690 [==============================] - 69s 12ms/step - loss: 0.0
052 - val_loss: 0.0032
Epoch 2/25
5690/5690 [==============================] - 29s 5ms/step - loss: 0.00
11 - val_loss: 0.0035
Epoch 3/25
5690/5690 [==============================] - 25s 4ms/step - loss: 0.00
12 - val_loss: 0.0011
Epoch 4/25
5690/5690 [==============================] - 25s 4ms/step - loss: 8.62
40e-04 - val_loss: 7.8663e-04
Epoch 5/25
5690/5690 [==============================] - 25s 4ms/step - loss: 7.60
44e-04 - val_loss: 0.0010
Epoch 6/25
5690/5690 [==============================] - 24s 4ms/step - loss: 7.28
65e-04 - val_loss: 0.0017
Epoch 7/25
5690/5690 [==============================] - 24s 4ms/step - loss: 7.66
51e-04 - val_loss: 0.0019
Epoch 8/25
5690/5690 [==============================] - 25s 4ms/step - loss: 7.64
68e-04 - val_loss: 6.6758e-04
Epoch 9/25
5690/5690 [==============================] - 26s 5ms/step - loss: 6.75
41e-04 - val_loss: 5.7536e-04
Epoch 10/25
5690/5690 [==============================] - 24s 4ms/step - loss: 7.53
02e-04 - val_loss: 5.7107e-04
Epoch 11/25
5690/5690 [==============================] - 24s 4ms/step - loss: 7.43
41e-04 - val_loss: 7.2808e-04
Epoch 12/25
5690/5690 [==============================] - 24s 4ms/step - loss: 6.75
71e-04 - val_loss: 5.1733e-04
Epoch 13/25
5690/5690 [==============================] - 24s 4ms/step - loss: 6.85
47e-04 - val_loss: 5.1071e-04
Epoch 14/25
5690/5690 [==============================] - 24s 4ms/step - loss: 5.40
88e-04 - val_loss: 7.4278e-04
Epoch 15/25
5690/5690 [==============================] - 24s 4ms/step - loss: 5.13
39e-04 - val_loss: 8.6022e-04
```

```
Epoch 16/25
5690/5690 [==============================] - 23s 4ms/step - loss: 5.11
77e-04 - val_loss: 4.7575e-04
Epoch 17/25
5690/5690 [==============================] - 24s 4ms/step - loss: 5.71
44e-04 - val_loss: 7.1576e-04
Epoch 18/25
5690/5690 [==============================] - 24s 4ms/step - loss: 5.06
89e-04 - val_loss: 4.9964e-04
Epoch 19/25
5690/5690 [==============================] - 24s 4ms/step - loss: 4.59
80e-04 - val_loss: 4.3477e-04
Epoch 20/25
5690/5690 [==============================] - 23s 4ms/step - loss: 4.66
02e-04 - val_loss: 4.6543e-04
Epoch 21/25
5690/5690 [==============================] - 23s 4ms/step - loss: 4.68
55e-04 - val_loss: 6.5988e-04
Epoch 22/25
5690/5690 [==============================] - 23s 4ms/step - loss: 4.66
68e-04 - val_loss: 4.2192e-04
Epoch 23/25
5690/5690 [==============================] - 24s 4ms/step - loss: 4.82
14e-04 - val_loss: 4.4778e-04
Epoch 24/25
5690/5690 [==============================] - 24s 4ms/step - loss: 4.58
91e-04 - val_loss: 4.2560e-04
Epoch 25/25
5690/5690 [==============================] - 25s 4ms/step - loss: 4.43
23e-04 - val_loss: 4.3840e-04
```

In [20]:

```
train_predict = regressor.predict(X_train)
test_predict = regressor.predict(X_test)
```

In [21]:

```
train_predict = sc.inverse_transform(train_predict)
Y_train = sc.inverse_transform([Y_train])
test_predict = sc.inverse_transform(test_predict)
Y_test = sc.inverse_transform([Y_test])
```

In [22]:

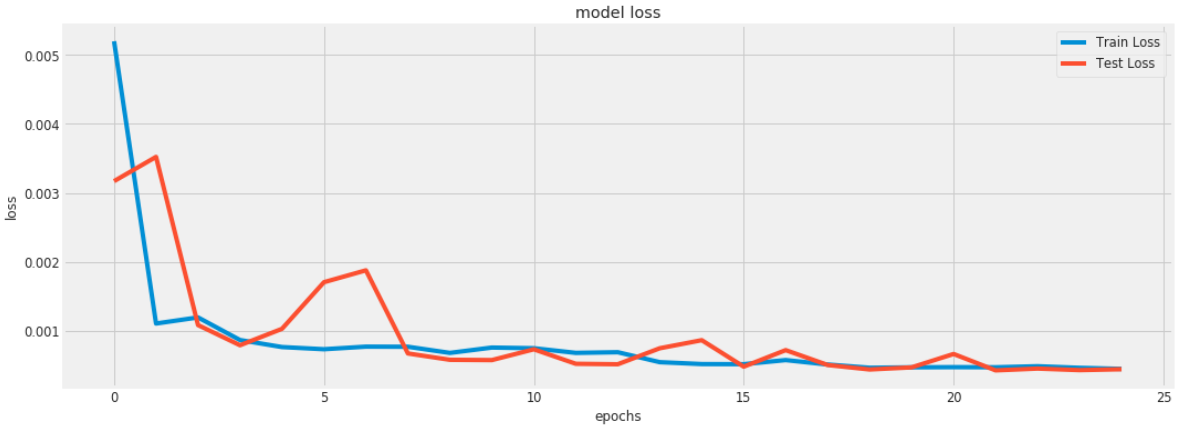
```
Y_test = Y_test.reshape(Y_test.shape[1],Y_test.shape[0])
Y_train = Y_train.reshape(Y_train.shape[1],Y_train.shape[0])
```

In [23]:

```
print('Train Mean Absolute Error:', mean_absolute_error(Y_train, train_predict))
print('Train Root Mean Squared Error:',np.sqrt(mean_squared_error(Y_train, train_pr
print('Test Mean Absolute Error:', mean_absolute_error(Y_test, test_predict))
print('Test Root Mean Squared Error:',np.sqrt(mean_squared_error(Y_test, test_predi

plt.figure(figsize=(16,6))
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Test Loss')
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epochs')
plt.legend(loc='upper right')
plt.show();
```

```
Train Mean Absolute Error: 1.1962655198913466
Train Root Mean Squared Error: 1.9164871479339118
Test Mean Absolute Error: 2.215981231537119
Test Root Mean Squared Error: 2.823476892225809
```



In [24]:

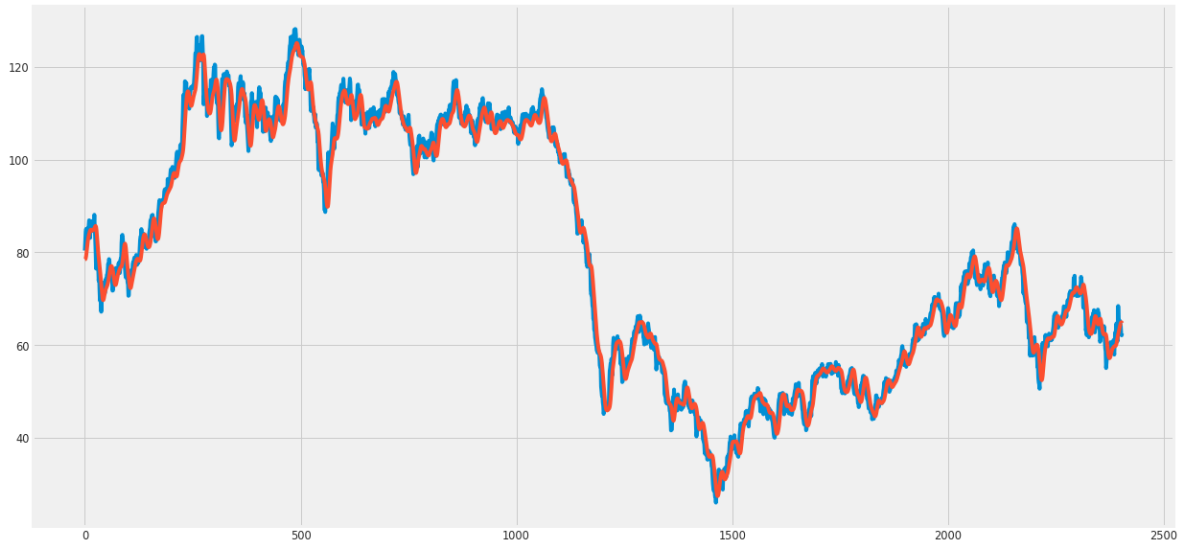
```
(np.diff(Y_train, axis=0) - np.diff(train_predict, axis=0)) / np.diff(Y_train, axis
```

Out[24]:

```
array([[ 0.27705129],
       [ 0.70945835],
       [-0.2547493 ],
       ...,
       [ 0.80106354],
       [-7.63812764],
       [ 0.26037346]])
```

In [28]:

```
plt.figure(figsize=(19,10))
plt.plot(Y_test, label="actual test")
plt.plot(test_predict, label="prediction test")
# plt.plot(Y_train, label="actual train")
# plt.plot(train_predict, label="prediction train")
plt.show();
```



In [ ]:

In [ ]: