In [48]:

```
from datetime import datetime
import tensorflow as tf
from tensorflow import keras
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
import numpy as np
import seaborn as sns
from keras.models import Sequential
from keras.layers import LSTM, Dense, Dropout
from keras.metrics import RootMeanSquaredError
```

In [49]:

```
microsoft_dataframe = pd.read_csv("MSFT.csv")
microsoft_dataframe.head()
```

Out[49]:

	Date	Open	High	Low	Close	Adj Close	Volume
0	2010-01-04	30.620001	31.100000	30.590000	30.950001	23.431593	38409100
1	2010-01-05	30.850000	31.100000	30.639999	30.959999	23.439156	49749600
2	2010-01-06	30.879999	31.080000	30.520000	30.770000	23.295313	58182400
3	2010-01-07	30.629999	30.700001	30.190001	30.450001	23.053047	50559700
4	2010-01-08	30.280001	30.879999	30.240000	30.660000	23.212036	51197400

In [50]:

```
microsoft_dataframe.shape
```

Out[50]:

```
(2515, 7)
```

In [51]:

```
microsoft_dataframe.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2515 entries, 0 to 2514
Data columns (total 7 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   Date       2515 non-null   object 
 1   Open       2515 non-null   float64
 2   High       2515 non-null   float64
 3   Low        2515 non-null   float64
 4   Close      2515 non-null   float64
 5   Adj Close  2515 non-null   float64
 6   Volume     2515 non-null   int64  
dtypes: float64(5), int64(1), object(1)
memory usage: 137.7+ KB
```

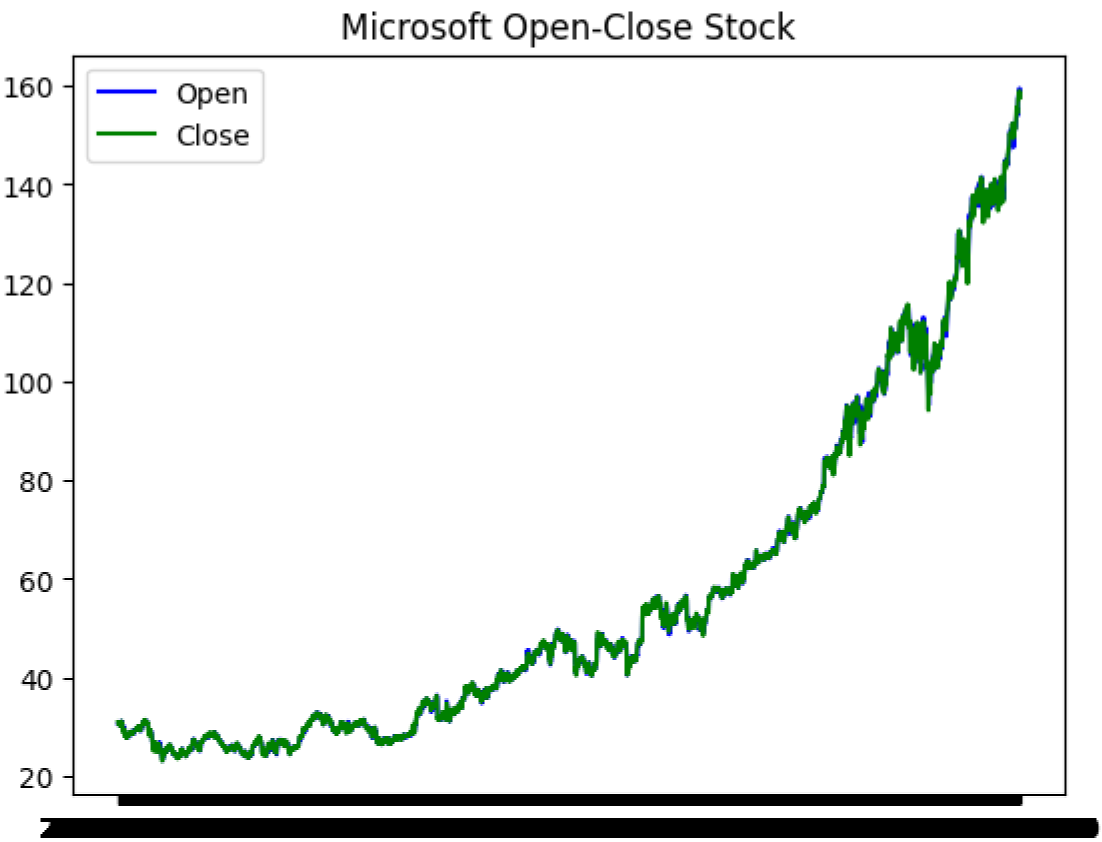
In [52]:

```
microsoft_dataframe.describe()
```

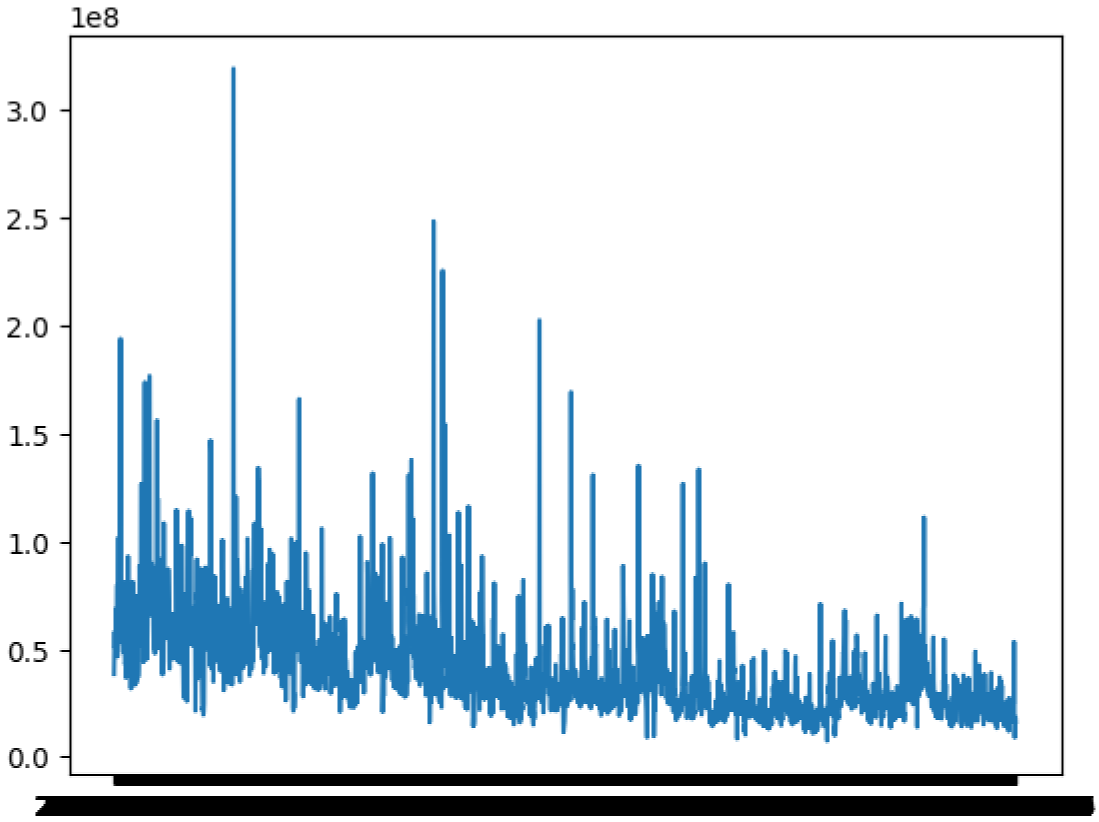
Out[52]:

	Open	High	Low	Close	Adj Close	Volume
count	2515.000000	2515.000000	2515.000000	2515.000000	2515.000000	2.515000e+03
mean	56.270426	56.728847	55.775523	56.281857	50.442187	3.993488e+07
std	33.821095	34.053276	33.521595	33.809735	33.806716	2.299236e+07
min	23.090000	23.320000	22.730000	23.010000	17.580826	7.425600e+06
25%	29.590000	29.800000	29.205000	29.559999	23.476507	2.431615e+07
50%	44.529999	44.980000	44.080002	44.400002	38.653267	3.424840e+07
75%	70.755001	71.265000	70.099998	70.760002	65.251064	4.978645e+07
max	159.449997	159.550003	158.220001	158.960007	152.897141	3.193179e+08

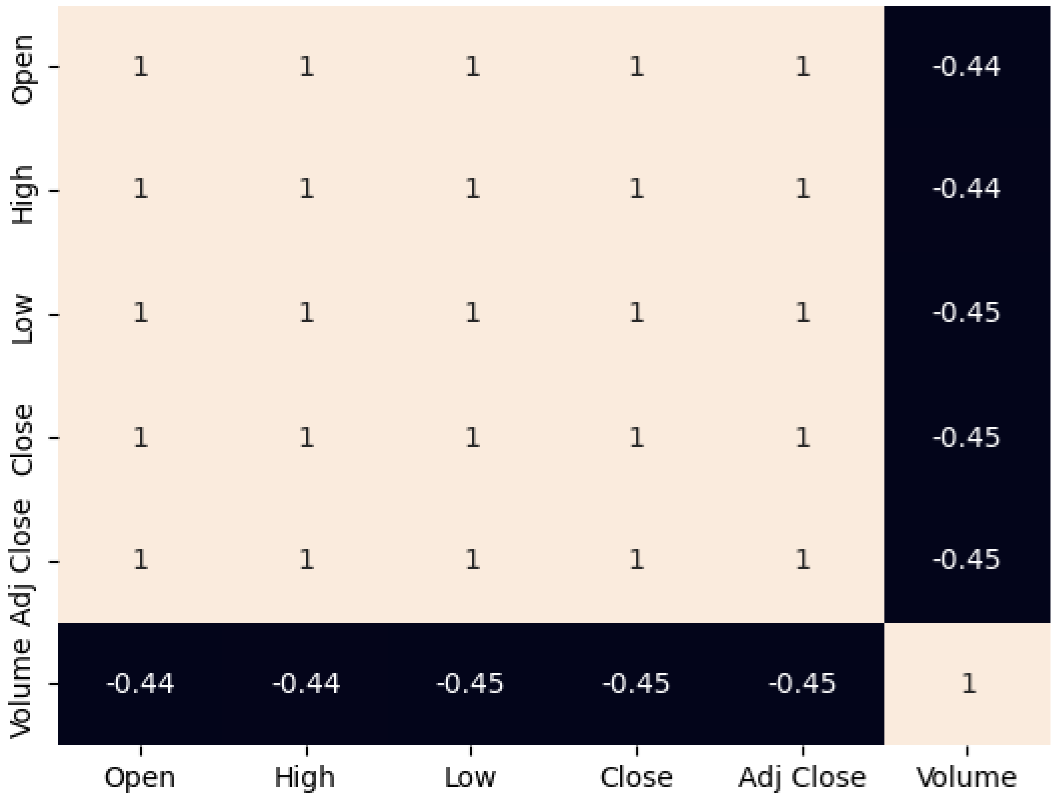
In [53]:
```python
plt.plot(microsoft_dataframe['Date'],
         microsoft_dataframe['Open'],
         color = "blue",
         label = "Open")
plt.plot(microsoft_dataframe['Date'],
         microsoft_dataframe['Close'],
         color = "green",
         label = "Close")
plt.title("Microsoft Open-Close Stock")
plt.legend()
plt.show()
# range: 1/4/2010 --> 12/30/2019, x-axis not showing for some reason
```



In [54]:
```python
plt.plot(microsoft_dataframe['Date'], microsoft_dataframe['Volume'])
plt.show()
```



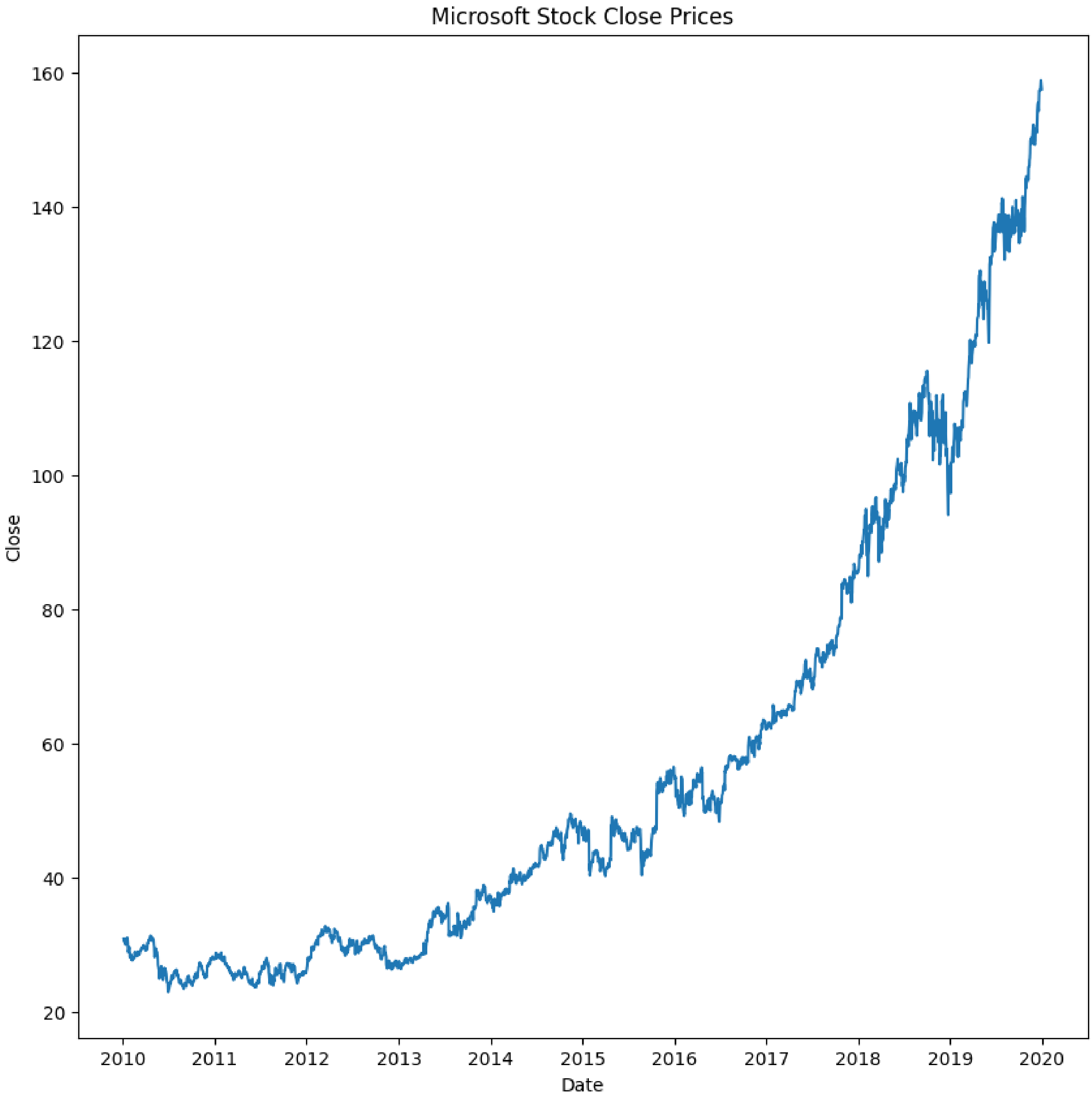
In [55]:
```
range_except_date = microsoft_dataframe.loc[:, microsoft_dataframe.columns != 'Date']
sns.heatmap(range_except_date.corr(), annot = True, cbar = False)
plt.show()
```



In [56]:
```
microsoft_dataframe['Date'] = pd.to_datetime(microsoft_dataframe['Date'])
prediction = microsoft_dataframe.loc[(microsoft_dataframe['Date'] > datetime(2010, 1, 1)
plt.figure(figsize=(10, 10))
plt.plot(microsoft_dataframe['Date'], microsoft_dataframe['Close'])
plt.xlabel('Date')
plt.ylabel('Close')
plt.title('Microsoft Stock Close Prices')
```

Out[56]:

```
Text(0.5, 1.0, 'Microsoft Stock Close Prices')
```



In [57]:

```
msft_close_prices = microsoft_dataframe.filter(['Close'])
dataset = msft_close_prices.values
training = int(np.ceil(len(dataset) * 0.95))

ss = StandardScaler()
ss = ss.fit_transform(dataset)

train_data = ss[0:int(training), :1]

x_train = []
y_train = []

for i in range(60, len(train_data)):
    x_train.append(train_data[i - 60: i, 0])
    y_train.append(train_data[i, 0])

x_train, y_train = np.array(x_train), np.array(y_train)
X_train = np.reshape(x_train, (x_train.shape[0], x_train.shape[1], 1))
```

In [59]:

```
model = keras.models.Sequential()
model.add(keras.layers.LSTM(units = 64, return_sequences = True, input_shape = (X_train.
model.add(keras.layers.LSTM(units = 64))
model.add(keras.layers.Dense(128))
model.add(keras.layers.Dropout(0.5))
model.add(keras.layers.Dense(1))
model.summary()
```

```
Model: "sequential_4"

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
□ Layer (type)                      □ Output Shape              □        Param # □
□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
│ lstm_8 (LSTM)                     │ (None, 60, 64)            │         16,896 │
├───────────────────────────────────┼───────────────────────────┼────────────────┤
│ lstm_9 (LSTM)                     │ (None, 64)                │         33,024 │
├───────────────────────────────────┼───────────────────────────┼────────────────┤
│ dense_8 (Dense)                   │ (None, 128)               │          8,320 │
├───────────────────────────────────┼───────────────────────────┼────────────────┤
│ dropout_4 (Dropout)               │ (None, 128)               │              0 │
├───────────────────────────────────┼───────────────────────────┼────────────────┤
│ dense_9 (Dense)                   │ (None, 1)                 │            129 │
└───────────────────────────────────┴───────────────────────────┴────────────────┘

 Total params: 58,369 (228.00 KB)

 Trainable params: 58,369 (228.00 KB)

 Non-trainable params: 0 (0.00 B)
```

In [61]:

```
model.compile(optimizer = "adam", loss = "mae", metrics = [RootMeanSquaredError()])
history = model.fit(X_train, y_train, epochs = 20)
```

```
Epoch 1/20
73/73 □□□□□□□□□□□□□□□□□□□□ 3s 24ms/step - loss: 0.2393 - root_mean_squared_error: 0.3610
Epoch 2/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0809 - root_mean_squared_error: 0.1178
Epoch 3/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 23ms/step - loss: 0.0702 - root_mean_squared_error: 0.1024
Epoch 4/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0678 - root_mean_squared_error: 0.0949
Epoch 5/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0740 - root_mean_squared_error: 0.1050
Epoch 6/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 25ms/step - loss: 0.0720 - root_mean_squared_error: 0.1018
Epoch 7/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0668 - root_mean_squared_error: 0.0981
Epoch 8/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 25ms/step - loss: 0.0656 - root_mean_squared_error: 0.0939
Epoch 9/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 25ms/step - loss: 0.0614 - root_mean_squared_error: 0.0893
Epoch 10/20
73/73 □□□□□□□□□□□□□□□□□□□□ 3s 42ms/step - loss: 0.0638 - root_mean_squared_error: 0.0937
Epoch 11/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 25ms/step - loss: 0.0625 - root_mean_squared_error: 0.0894
Epoch 12/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 25ms/step - loss: 0.0643 - root_mean_squared_error: 0.0925
Epoch 13/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0604 - root_mean_squared_error: 0.0865
Epoch 14/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0586 - root_mean_squared_error: 0.0868
Epoch 15/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0638 - root_mean_squared_error: 0.0910
Epoch 16/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 23ms/step - loss: 0.0601 - root_mean_squared_error: 0.0892
Epoch 17/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0606 - root_mean_squared_error: 0.0876
```

```
Epoch 18/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 25ms/step - loss: 0.0545 - root_mean_squared_error: 0.0780
Epoch 19/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 26ms/step - loss: 0.0574 - root_mean_squared_error: 0.0845
Epoch 20/20
73/73 □□□□□□□□□□□□□□□□□□□□ 2s 24ms/step - loss: 0.0613 - root_mean_squared_error: 0.0912
```

In [62]:

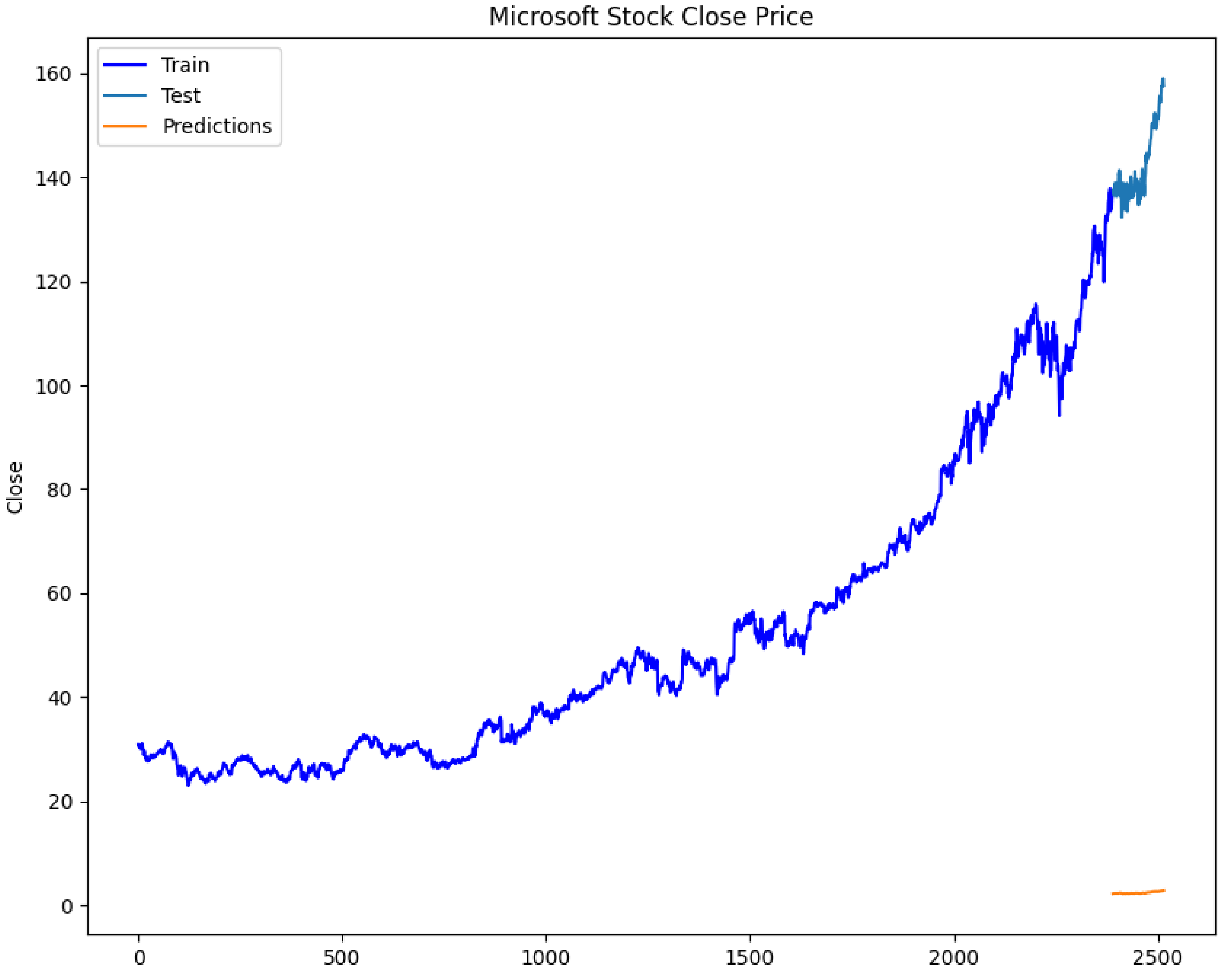
```
testing = ss[training - 60:, :]
x_test = []
y_test = dataset[training:, :]
for i in range(60, len(testing)):
    x_test.append(testing[i-60:i, 0])

x_test = np.array(x_test)
X_test = np.reshape(x_test, (x_test.shape[0], x_test.shape[1], 1))
pred = model.predict(X_test)
```

```
4/4 □□□□□□□□□□□□□□□□□□□□ 0s 39ms/step
```

In [66]:

```
train = microsoft_dataframe[:training].copy()
test = microsoft_dataframe[training:].copy()
test['Predictions'] = pred
plt.figure(figsize=(10, 8))
plt.plot(train['Close'], c = "b")
plt.plot(test[['Close', 'Predictions']])
plt.title('Microsoft Stock Close Price')
plt.ylabel("Close")
plt.legend(['Train', 'Test', 'Predictions'])
plt.show()
```


Microsoft Stock Close Price
Train
Test
Predictions
Close