STAT 6289 HW3

Xue Ming Wang (G20580112)

```
In [147…  import numpy as np
          import pandas as pd
          import matplotlib.pyplot as plt
          from sklearn.model_selection import train_test_split
          from sklearn.preprocessing import MinMaxScaler
          from keras.models import Sequential
          from keras.layers import LSTM, Dense, Dropout
          from keras.optimizers import Adam
```

```
In [3]:   # Load the data and inspect them
          import pandas as pd

          file_path = "/Users/vivianwang/Desktop/Homework3/TSLA.csv"
          df = pd.read_csv(file_path)

          df
```

Out[3]:

	Date	Open	High	Low	Close	Adj Close	Volume
0	2015-07-10	52.444000	52.599998	51.563999	51.830002	51.830002	13054500
1	2015-07-13	52.450001	52.509998	51.209999	52.431999	52.431999	14801500
2	2015-07-14	52.419998	53.198002	52.102001	53.130001	53.130001	9538000
3	2015-07-15	53.348000	53.498001	52.416000	52.627998	52.627998	10108000
4	2015-07-16	52.844002	53.439999	52.632000	53.335999	53.335999	8080000
...	...	...	...	...	...	...	...
1254	2020-07-02	244.296005	245.600006	237.119995	241.731995	241.731995	86250500
1255	2020-07-06	255.337997	275.558014	253.207993	274.316010	274.316010	102849500
1256	2020-07-07	281.002014	285.899994	267.342010	277.971985	277.971985	107448500
1257	2020-07-08	281.000000	283.451996	262.268005	273.175995	273.175995	81556500
1258	2020-07-09	279.398010	281.712006	270.256012	278.855988	278.855988	58588000

1259 rows × 7 columns

Split the data into training and test sets

```
In [4]:   total_rows = df.shape[0]
          split_point = int(total_rows * 0.8)

          training = df.iloc[:split_point, 1:2].values
          testing = df.iloc[split_point:, 1:2].values

          print(f"Training data size: {len(training)}")
          print(f"Test data size: {len(testing)}")

          Training data size: 1007
          Test data size: 252
```

Time Lag = 1

```
In [5]:   scaler = MinMaxScaler(feature_range = (0, 1))
          training_scaled = scaler.fit_transform(training)
          x = []
          y = []
          for i in range(60, 1007):
              x.append(training_scaled[i - 60:i, 0])
              y.append(training_scaled[i, 0])
```

```
x, y = np.array(x), np.array(y)
x = np.reshape(x, (x.shape[0], x.shape[1], 1))

print("Shape of x:", x.shape)
```

```
Shape of x: (947, 60, 1)
```

In [6]: `# Build LSTM mode`

Model 1: Time Lag = 1, 4 layers, 50 units, dropout rate = 0.2, batch size = 32.

In [7]:
```python
# Build LSTM mode
model = Sequential()
model.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1)))
model.add(Dropout(0.2))
model.add(LSTM(units = 50, return_sequences = True))
model.add(Dropout(0.2))
model.add(LSTM(units = 50, return_sequences = True))
model.add(Dropout(0.2))
model.add(LSTM(units = 50))
model.add(Dropout(0.2))
model.add(Dense(units = 1))

# Compiling the RNN
model.compile(optimizer = 'adam', loss = 'mean_squared_error')

# Fitting the RNN to the Training set
history = model.fit(x, y, epochs = 100, batch_size = 32)
```

```
Epoch 1/100
30/30 [==============================] – 15s 101ms/step – loss: 0.0527
Epoch 2/100
30/30 [==============================] – 3s 101ms/step – loss: 0.0150
Epoch 3/100
30/30 [==============================] – 3s 115ms/step – loss: 0.0127
Epoch 4/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0127
Epoch 5/100
30/30 [==============================] – 3s 103ms/step – loss: 0.0119
Epoch 6/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0117
Epoch 7/100
30/30 [==============================] – 3s 111ms/step – loss: 0.0122
Epoch 8/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0110
Epoch 9/100
30/30 [==============================] – 3s 102ms/step – loss: 0.0111
Epoch 10/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0109
Epoch 11/100
30/30 [==============================] – 3s 95ms/step – loss: 0.0095
Epoch 12/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0099
Epoch 13/100
30/30 [==============================] – 3s 105ms/step – loss: 0.0084
Epoch 14/100
30/30 [==============================] – 4s 116ms/step – loss: 0.0082
Epoch 15/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0082
Epoch 16/100
30/30 [==============================] – 3s 100ms/step – loss: 0.0079
Epoch 17/100
30/30 [==============================] – 4s 119ms/step – loss: 0.0075
Epoch 18/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0080
Epoch 19/100
30/30 [==============================] – 3s 104ms/step – loss: 0.0076
Epoch 20/100
30/30 [==============================] – 3s 102ms/step – loss: 0.0073
Epoch 21/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0066
Epoch 22/100
30/30 [==============================] – 3s 100ms/step – loss: 0.0064
Epoch 23/100
30/30 [==============================] – 3s 105ms/step – loss: 0.0066
Epoch 24/100
30/30 [==============================] – 4s 119ms/step – loss: 0.0060
Epoch 25/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0057
Epoch 26/100
30/30 [==============================] – 3s 101ms/step – loss: 0.0057
Epoch 27/100
30/30 [==============================] – 3s 112ms/step – loss: 0.0056
Epoch 28/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0051
Epoch 29/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0054
Epoch 30/100
30/30 [==============================] – 3s 102ms/step – loss: 0.0051
Epoch 31/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0055
Epoch 32/100
30/30 [==============================] – 3s 104ms/step – loss: 0.0048
Epoch 33/100
30/30 [==============================] – 3s 108ms/step – loss: 0.0053
Epoch 34/100
30/30 [==============================] – 4s 124ms/step – loss: 0.0053
Epoch 35/100
30/30 [==============================] – 3s 111ms/step – loss: 0.0046
Epoch 36/100
30/30 [==============================] – 3s 101ms/step – loss: 0.0050
Epoch 37/100
30/30 [==============================] – 4s 118ms/step – loss: 0.0045
Epoch 38/100
```

```
30/30 [==============================] - 3s 105ms/step - loss: 0.0045
Epoch 39/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0049
Epoch 40/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0049
Epoch 41/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0043
Epoch 42/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0044
Epoch 43/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0043
Epoch 44/100
30/30 [==============================] - 4s 116ms/step - loss: 0.0046
Epoch 45/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0040
Epoch 46/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0040
Epoch 47/100
30/30 [==============================] - 3s 115ms/step - loss: 0.0038
Epoch 48/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0041
Epoch 49/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0046
Epoch 50/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0042
Epoch 51/100
30/30 [==============================] - 3s 114ms/step - loss: 0.0044
Epoch 52/100
30/30 [==============================] - 4s 117ms/step - loss: 0.0039
Epoch 53/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0042
Epoch 54/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0039
Epoch 55/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0041
Epoch 56/100
30/30 [==============================] - 3s 100ms/step - loss: 0.0036
Epoch 57/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0033
Epoch 58/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0042
Epoch 59/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0038
Epoch 60/100
30/30 [==============================] - 3s 113ms/step - loss: 0.0042
Epoch 61/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0041
Epoch 62/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0033
Epoch 63/100
30/30 [==============================] - 4s 125ms/step - loss: 0.0037
Epoch 64/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0034
Epoch 65/100
30/30 [==============================] - 3s 110ms/step - loss: 0.0030
Epoch 66/100
30/30 [==============================] - 5s 161ms/step - loss: 0.0031
Epoch 67/100
30/30 [==============================] - 5s 168ms/step - loss: 0.0032
Epoch 68/100
30/30 [==============================] - 4s 140ms/step - loss: 0.0034
Epoch 69/100
30/30 [==============================] - 6s 187ms/step - loss: 0.0034
Epoch 70/100
30/30 [==============================] - 5s 163ms/step - loss: 0.0034
Epoch 71/100
30/30 [==============================] - 6s 195ms/step - loss: 0.0032
Epoch 72/100
30/30 [==============================] - 5s 182ms/step - loss: 0.0031
Epoch 73/100
30/30 [==============================] - 6s 189ms/step - loss: 0.0032
Epoch 74/100
30/30 [==============================] - 6s 191ms/step - loss: 0.0029
Epoch 75/100
30/30 [==============================] - 6s 185ms/step - loss: 0.0030
```

```
Epoch 76/100
30/30 [==============================] – 4s 143ms/step – loss: 0.0031
Epoch 77/100
30/30 [==============================] – 4s 134ms/step – loss: 0.0031
Epoch 78/100
30/30 [==============================] – 4s 117ms/step – loss: 0.0030
Epoch 79/100
30/30 [==============================] – 4s 127ms/step – loss: 0.0028
Epoch 80/100
30/30 [==============================] – 4s 135ms/step – loss: 0.0027
Epoch 81/100
30/30 [==============================] – 4s 127ms/step – loss: 0.0029
Epoch 82/100
30/30 [==============================] – 4s 117ms/step – loss: 0.0028
Epoch 83/100
30/30 [==============================] – 4s 119ms/step – loss: 0.0025
Epoch 84/100
30/30 [==============================] – 4s 122ms/step – loss: 0.0026
Epoch 85/100
30/30 [==============================] – 4s 121ms/step – loss: 0.0028
Epoch 86/100
30/30 [==============================] – 4s 140ms/step – loss: 0.0026
Epoch 87/100
30/30 [==============================] – 4s 123ms/step – loss: 0.0027
Epoch 88/100
30/30 [==============================] – 4s 131ms/step – loss: 0.0027
Epoch 89/100
30/30 [==============================] – 4s 124ms/step – loss: 0.0028
Epoch 90/100
30/30 [==============================] – 3s 115ms/step – loss: 0.0028
Epoch 91/100
30/30 [==============================] – 4s 121ms/step – loss: 0.0028
Epoch 92/100
30/30 [==============================] – 4s 124ms/step – loss: 0.0026
Epoch 93/100
30/30 [==============================] – 4s 118ms/step – loss: 0.0028
Epoch 94/100
30/30 [==============================] – 4s 142ms/step – loss: 0.0027
Epoch 95/100
30/30 [==============================] – 4s 119ms/step – loss: 0.0027
Epoch 96/100
30/30 [==============================] – 4s 131ms/step – loss: 0.0027
Epoch 97/100
30/30 [==============================] – 4s 132ms/step – loss: 0.0025
Epoch 98/100
30/30 [==============================] – 4s 128ms/step – loss: 0.0027
Epoch 99/100
30/30 [==============================] – 4s 118ms/step – loss: 0.0027
Epoch 100/100
30/30 [==============================] – 4s 124ms/step – loss: 0.0027
```

Model 2: Time Lag = 1, 6 layers, 50 units, dropout rate = 0.2, batch size = 32.

```python
In [8]:  model2 = Sequential()
         model2.add(LSTM(units=50, return_sequences=True, input_shape=(x.shape[1], 1)))
         model2.add(Dropout(0.2))
         model2.add(LSTM(units=50, return_sequences=True))
         model2.add(Dropout(0.2))
         model2.add(LSTM(units=50, return_sequences=True))
         model2.add(Dropout(0.2))
         model2.add(LSTM(units=50, return_sequences=True))
         model2.add(Dropout(0.2))
         model2.add(LSTM(units=50, return_sequences=True))
         model2.add(Dropout(0.2))
         model2.add(LSTM(units=50))
         model2.add(Dropout(0.2))
         model2.add(Dense(units=1))

         # Compile the RNN
         model2.compile(optimizer='adam', loss='mean_squared_error')

         # Fit the RNN to the Training set
         history2 = model2.fit(x, y, epochs=100, batch_size=32)
```

```
Epoch 1/100
30/30 [==============================] – 35s 193ms/step – loss: 0.0677
Epoch 2/100
30/30 [==============================] – 6s 198ms/step – loss: 0.0216
Epoch 3/100
30/30 [==============================] – 6s 193ms/step – loss: 0.0186
Epoch 4/100
30/30 [==============================] – 7s 224ms/step – loss: 0.0170
Epoch 5/100
30/30 [==============================] – 6s 206ms/step – loss: 0.0161
Epoch 6/100
30/30 [==============================] – 6s 198ms/step – loss: 0.0160
Epoch 7/100
30/30 [==============================] – 7s 216ms/step – loss: 0.0146
Epoch 8/100
30/30 [==============================] – 7s 233ms/step – loss: 0.0144
Epoch 9/100
30/30 [==============================] – 6s 211ms/step – loss: 0.0130
Epoch 10/100
30/30 [==============================] – 6s 195ms/step – loss: 0.0136
Epoch 11/100
30/30 [==============================] – 7s 229ms/step – loss: 0.0121
Epoch 12/100
30/30 [==============================] – 7s 238ms/step – loss: 0.0118
Epoch 13/100
30/30 [==============================] – 7s 225ms/step – loss: 0.0126
Epoch 14/100
30/30 [==============================] – 7s 220ms/step – loss: 0.0109
Epoch 15/100
30/30 [==============================] – 7s 248ms/step – loss: 0.0108
Epoch 16/100
30/30 [==============================] – 6s 185ms/step – loss: 0.0101
Epoch 17/100
30/30 [==============================] – 5s 175ms/step – loss: 0.0092
Epoch 18/100
30/30 [==============================] – 6s 206ms/step – loss: 0.0092
Epoch 19/100
30/30 [==============================] – 6s 186ms/step – loss: 0.0092
Epoch 20/100
30/30 [==============================] – 6s 195ms/step – loss: 0.0086
Epoch 21/100
30/30 [==============================] – 5s 176ms/step – loss: 0.0081
Epoch 22/100
30/30 [==============================] – 6s 207ms/step – loss: 0.0074
Epoch 23/100
30/30 [==============================] – 5s 181ms/step – loss: 0.0086
Epoch 24/100
30/30 [==============================] – 7s 248ms/step – loss: 0.0083
Epoch 25/100
30/30 [==============================] – 7s 225ms/step – loss: 0.0075
Epoch 26/100
30/30 [==============================] – 6s 214ms/step – loss: 0.0075
Epoch 27/100
30/30 [==============================] – 6s 212ms/step – loss: 0.0069
Epoch 28/100
30/30 [==============================] – 7s 219ms/step – loss: 0.0069
Epoch 29/100
30/30 [==============================] – 7s 229ms/step – loss: 0.0065
Epoch 30/100
30/30 [==============================] – 6s 186ms/step – loss: 0.0068
Epoch 31/100
30/30 [==============================] – 6s 205ms/step – loss: 0.0065
Epoch 32/100
30/30 [==============================] – 7s 247ms/step – loss: 0.0059
Epoch 33/100
30/30 [==============================] – 7s 249ms/step – loss: 0.0059
Epoch 34/100
30/30 [==============================] – 7s 221ms/step – loss: 0.0056
Epoch 35/100
30/30 [==============================] – 7s 232ms/step – loss: 0.0066
Epoch 36/100
30/30 [==============================] – 7s 236ms/step – loss: 0.0053
Epoch 37/100
30/30 [==============================] – 9s 293ms/step – loss: 0.0055
Epoch 38/100
```

```
30/30 [==============================] - 8s 285ms/step - loss: 0.0055
Epoch 39/100
30/30 [==============================] - 7s 249ms/step - loss: 0.0055
Epoch 40/100
30/30 [==============================] - 7s 249ms/step - loss: 0.0060
Epoch 41/100
30/30 [==============================] - 6s 191ms/step - loss: 0.0052
Epoch 42/100
30/30 [==============================] - 7s 221ms/step - loss: 0.0054
Epoch 43/100
30/30 [==============================] - 6s 193ms/step - loss: 0.0049
Epoch 44/100
30/30 [==============================] - 6s 214ms/step - loss: 0.0050
Epoch 45/100
30/30 [==============================] - 5s 169ms/step - loss: 0.0047
Epoch 46/100
30/30 [==============================] - 5s 173ms/step - loss: 0.0048
Epoch 47/100
30/30 [==============================] - 6s 196ms/step - loss: 0.0048
Epoch 48/100
30/30 [==============================] - 5s 182ms/step - loss: 0.0047
Epoch 49/100
30/30 [==============================] - 5s 177ms/step - loss: 0.0050
Epoch 50/100
30/30 [==============================] - 5s 169ms/step - loss: 0.0045
Epoch 51/100
30/30 [==============================] - 6s 192ms/step - loss: 0.0044
Epoch 52/100
30/30 [==============================] - 6s 201ms/step - loss: 0.0051
Epoch 53/100
30/30 [==============================] - 6s 202ms/step - loss: 0.0049
Epoch 54/100
30/30 [==============================] - 6s 205ms/step - loss: 0.0045
Epoch 55/100
30/30 [==============================] - 6s 212ms/step - loss: 0.0048
Epoch 56/100
30/30 [==============================] - 5s 165ms/step - loss: 0.0044
Epoch 57/100
30/30 [==============================] - 5s 159ms/step - loss: 0.0046
Epoch 58/100
30/30 [==============================] - 5s 164ms/step - loss: 0.0045
Epoch 59/100
30/30 [==============================] - 7s 223ms/step - loss: 0.0043
Epoch 60/100
30/30 [==============================] - 6s 212ms/step - loss: 0.0045
Epoch 61/100
30/30 [==============================] - 6s 207ms/step - loss: 0.0040
Epoch 62/100
30/30 [==============================] - 6s 190ms/step - loss: 0.0043
Epoch 63/100
30/30 [==============================] - 6s 199ms/step - loss: 0.0044
Epoch 64/100
30/30 [==============================] - 7s 232ms/step - loss: 0.0040
Epoch 65/100
30/30 [==============================] - 6s 209ms/step - loss: 0.0035
Epoch 66/100
30/30 [==============================] - 7s 218ms/step - loss: 0.0036
Epoch 67/100
30/30 [==============================] - 6s 207ms/step - loss: 0.0040
Epoch 68/100
30/30 [==============================] - 5s 179ms/step - loss: 0.0044
Epoch 69/100
30/30 [==============================] - 6s 184ms/step - loss: 0.0038
Epoch 70/100
30/30 [==============================] - 6s 183ms/step - loss: 0.0037
Epoch 71/100
30/30 [==============================] - 6s 196ms/step - loss: 0.0039
Epoch 72/100
30/30 [==============================] - 6s 215ms/step - loss: 0.0037
Epoch 73/100
30/30 [==============================] - 6s 209ms/step - loss: 0.0037
Epoch 74/100
30/30 [==============================] - 6s 202ms/step - loss: 0.0037
Epoch 75/100
30/30 [==============================] - 7s 234ms/step - loss: 0.0034
```

```
Epoch 76/100
30/30 [==============================] – 6s 212ms/step – loss: 0.0037
Epoch 77/100
30/30 [==============================] – 6s 207ms/step – loss: 0.0037
Epoch 78/100
30/30 [==============================] – 7s 224ms/step – loss: 0.0036
Epoch 79/100
30/30 [==============================] – 6s 184ms/step – loss: 0.0040
Epoch 80/100
30/30 [==============================] – 6s 206ms/step – loss: 0.0037
Epoch 81/100
30/30 [==============================] – 6s 203ms/step – loss: 0.0037
Epoch 82/100
30/30 [==============================] – 6s 212ms/step – loss: 0.0035
Epoch 83/100
30/30 [==============================] – 6s 206ms/step – loss: 0.0033
Epoch 84/100
30/30 [==============================] – 6s 202ms/step – loss: 0.0033
Epoch 85/100
30/30 [==============================] – 6s 201ms/step – loss: 0.0037
Epoch 86/100
30/30 [==============================] – 6s 203ms/step – loss: 0.0036
Epoch 87/100
30/30 [==============================] – 6s 197ms/step – loss: 0.0033
Epoch 88/100
30/30 [==============================] – 6s 215ms/step – loss: 0.0031
Epoch 89/100
30/30 [==============================] – 5s 163ms/step – loss: 0.0029
Epoch 90/100
30/30 [==============================] – 6s 197ms/step – loss: 0.0032
Epoch 91/100
30/30 [==============================] – 7s 219ms/step – loss: 0.0030
Epoch 92/100
30/30 [==============================] – 7s 231ms/step – loss: 0.0033
Epoch 93/100
30/30 [==============================] – 5s 177ms/step – loss: 0.0031
Epoch 94/100
30/30 [==============================] – 5s 183ms/step – loss: 0.0029
Epoch 95/100
30/30 [==============================] – 5s 175ms/step – loss: 0.0036
Epoch 96/100
30/30 [==============================] – 6s 191ms/step – loss: 0.0032
Epoch 97/100
30/30 [==============================] – 6s 183ms/step – loss: 0.0030
Epoch 98/100
30/30 [==============================] – 6s 209ms/step – loss: 0.0031
Epoch 99/100
30/30 [==============================] – 6s 210ms/step – loss: 0.0030
Epoch 100/100
30/30 [==============================] – 6s 194ms/step – loss: 0.0031
```

Model 3: Time Lag = 1, 4 layers, 50 units, dropout rate = 0.2, batch size = 64.

In [9]:
```python
model3 = Sequential()
model3.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1)))
model3.add(Dropout(0.2))
model3.add(LSTM(units = 50, return_sequences = True))
model3.add(Dropout(0.2))
model3.add(LSTM(units = 50, return_sequences = True))
model3.add(Dropout(0.2))
model3.add(LSTM(units = 50))
model3.add(Dropout(0.2))
model3.add(Dense(units = 1))

# Output layer
model3.add(Dense(units=1))

# Compile the RNN
model3.compile(optimizer='adam', loss='mean_squared_error')

# Fit the RNN to the Training set
history3 = model3.fit(x, y, epochs=100, batch_size=64)
```

```
Epoch 1/100
15/15 [==============================] - 15s 134ms/step - loss: 0.0680
Epoch 2/100
15/15 [==============================] - 2s 145ms/step - loss: 0.0204
Epoch 3/100
15/15 [==============================] - 2s 163ms/step - loss: 0.0151
Epoch 4/100
15/15 [==============================] - 2s 129ms/step - loss: 0.0133
Epoch 5/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0135
Epoch 6/100
15/15 [==============================] - 2s 132ms/step - loss: 0.0137
Epoch 7/100
15/15 [==============================] - 2s 152ms/step - loss: 0.0120
Epoch 8/100
15/15 [==============================] - 2s 154ms/step - loss: 0.0120
Epoch 9/100
15/15 [==============================] - 2s 133ms/step - loss: 0.0108
Epoch 10/100
15/15 [==============================] - 2s 133ms/step - loss: 0.0112
Epoch 11/100
15/15 [==============================] - 2s 135ms/step - loss: 0.0109
Epoch 12/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0102
Epoch 13/100
15/15 [==============================] - 2s 139ms/step - loss: 0.0103
Epoch 14/100
15/15 [==============================] - 2s 140ms/step - loss: 0.0101
Epoch 15/100
15/15 [==============================] - 2s 129ms/step - loss: 0.0094
Epoch 16/100
15/15 [==============================] - 2s 135ms/step - loss: 0.0104
Epoch 17/100
15/15 [==============================] - 2s 154ms/step - loss: 0.0093
Epoch 18/100
15/15 [==============================] - 2s 147ms/step - loss: 0.0095
Epoch 19/100
15/15 [==============================] - 2s 147ms/step - loss: 0.0091
Epoch 20/100
15/15 [==============================] - 2s 143ms/step - loss: 0.0089
Epoch 21/100
15/15 [==============================] - 2s 141ms/step - loss: 0.0088
Epoch 22/100
15/15 [==============================] - 3s 173ms/step - loss: 0.0085
Epoch 23/100
15/15 [==============================] - 2s 137ms/step - loss: 0.0083
Epoch 24/100
15/15 [==============================] - 2s 133ms/step - loss: 0.0076
Epoch 25/100
15/15 [==============================] - 2s 132ms/step - loss: 0.0077
Epoch 26/100
15/15 [==============================] - 2s 146ms/step - loss: 0.0075
Epoch 27/100
15/15 [==============================] - 2s 136ms/step - loss: 0.0078
Epoch 28/100
15/15 [==============================] - 2s 138ms/step - loss: 0.0073
Epoch 29/100
15/15 [==============================] - 2s 137ms/step - loss: 0.0063
Epoch 30/100
15/15 [==============================] - 3s 170ms/step - loss: 0.0070
Epoch 31/100
15/15 [==============================] - 2s 143ms/step - loss: 0.0067
Epoch 32/100
15/15 [==============================] - 2s 142ms/step - loss: 0.0070
Epoch 33/100
15/15 [==============================] - 2s 130ms/step - loss: 0.0067
Epoch 34/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0067
Epoch 35/100
15/15 [==============================] - 2s 135ms/step - loss: 0.0061
Epoch 36/100
15/15 [==============================] - 2s 145ms/step - loss: 0.0059
Epoch 37/100
15/15 [==============================] - 2s 140ms/step - loss: 0.0057
Epoch 38/100
```

```
15/15 [==============================] - 2s 134ms/step - loss: 0.0057
Epoch 39/100
15/15 [==============================] - 2s 154ms/step - loss: 0.0055
Epoch 40/100
15/15 [==============================] - 2s 157ms/step - loss: 0.0054
Epoch 41/100
15/15 [==============================] - 2s 141ms/step - loss: 0.0052
Epoch 42/100
15/15 [==============================] - 2s 136ms/step - loss: 0.0050
Epoch 43/100
15/15 [==============================] - 2s 156ms/step - loss: 0.0055
Epoch 44/100
15/15 [==============================] - 2s 142ms/step - loss: 0.0053
Epoch 45/100
15/15 [==============================] - 2s 137ms/step - loss: 0.0049
Epoch 46/100
15/15 [==============================] - 2s 142ms/step - loss: 0.0049
Epoch 47/100
15/15 [==============================] - 2s 135ms/step - loss: 0.0048
Epoch 48/100
15/15 [==============================] - 2s 140ms/step - loss: 0.0051
Epoch 49/100
15/15 [==============================] - 2s 139ms/step - loss: 0.0047
Epoch 50/100
15/15 [==============================] - 2s 136ms/step - loss: 0.0052
Epoch 51/100
15/15 [==============================] - 2s 138ms/step - loss: 0.0046
Epoch 52/100
15/15 [==============================] - 2s 138ms/step - loss: 0.0047
Epoch 53/100
15/15 [==============================] - 2s 160ms/step - loss: 0.0048
Epoch 54/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0046
Epoch 55/100
15/15 [==============================] - 2s 137ms/step - loss: 0.0044
Epoch 56/100
15/15 [==============================] - 2s 138ms/step - loss: 0.0046
Epoch 57/100
15/15 [==============================] - 2s 144ms/step - loss: 0.0041
Epoch 58/100
15/15 [==============================] - 2s 141ms/step - loss: 0.0043
Epoch 59/100
15/15 [==============================] - 2s 136ms/step - loss: 0.0044
Epoch 60/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0045
Epoch 61/100
15/15 [==============================] - 2s 149ms/step - loss: 0.0041
Epoch 62/100
15/15 [==============================] - 2s 143ms/step - loss: 0.0042
Epoch 63/100
15/15 [==============================] - 2s 159ms/step - loss: 0.0042
Epoch 64/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0041
Epoch 65/100
15/15 [==============================] - 2s 142ms/step - loss: 0.0041
Epoch 66/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0038
Epoch 67/100
15/15 [==============================] - 2s 159ms/step - loss: 0.0037
Epoch 68/100
15/15 [==============================] - 2s 148ms/step - loss: 0.0038
Epoch 69/100
15/15 [==============================] - 2s 146ms/step - loss: 0.0035
Epoch 70/100
15/15 [==============================] - 2s 133ms/step - loss: 0.0039
Epoch 71/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0034
Epoch 72/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0037
Epoch 73/100
15/15 [==============================] - 2s 136ms/step - loss: 0.0036
Epoch 74/100
15/15 [==============================] - 2s 145ms/step - loss: 0.0039
Epoch 75/100
15/15 [==============================] - 2s 139ms/step - loss: 0.0036
```

```
Epoch 76/100
15/15 [==============================] - 2s 146ms/step - loss: 0.0032
Epoch 77/100
15/15 [==============================] - 3s 169ms/step - loss: 0.0035
Epoch 78/100
15/15 [==============================] - 2s 144ms/step - loss: 0.0037
Epoch 79/100
15/15 [==============================] - 2s 136ms/step - loss: 0.0040
Epoch 80/100
15/15 [==============================] - 2s 135ms/step - loss: 0.0037
Epoch 81/100
15/15 [==============================] - 2s 158ms/step - loss: 0.0034
Epoch 82/100
15/15 [==============================] - 2s 149ms/step - loss: 0.0040
Epoch 83/100
15/15 [==============================] - 2s 133ms/step - loss: 0.0035
Epoch 84/100
15/15 [==============================] - 2s 143ms/step - loss: 0.0033
Epoch 85/100
15/15 [==============================] - 2s 135ms/step - loss: 0.0035
Epoch 86/100
15/15 [==============================] - 2s 126ms/step - loss: 0.0031
Epoch 87/100
15/15 [==============================] - 2s 130ms/step - loss: 0.0034
Epoch 88/100
15/15 [==============================] - 2s 131ms/step - loss: 0.0031
Epoch 89/100
15/15 [==============================] - 2s 124ms/step - loss: 0.0033
Epoch 90/100
15/15 [==============================] - 2s 126ms/step - loss: 0.0031
Epoch 91/100
15/15 [==============================] - 2s 152ms/step - loss: 0.0032
Epoch 92/100
15/15 [==============================] - 2s 146ms/step - loss: 0.0036
Epoch 93/100
15/15 [==============================] - 2s 127ms/step - loss: 0.0037
Epoch 94/100
15/15 [==============================] - 2s 131ms/step - loss: 0.0031
Epoch 95/100
15/15 [==============================] - 2s 127ms/step - loss: 0.0031
Epoch 96/100
15/15 [==============================] - 2s 143ms/step - loss: 0.0031
Epoch 97/100
15/15 [==============================] - 2s 149ms/step - loss: 0.0034
Epoch 98/100
15/15 [==============================] - 2s 137ms/step - loss: 0.0034
Epoch 99/100
15/15 [==============================] - 2s 136ms/step - loss: 0.0030
Epoch 100/100
15/15 [==============================] - 2s 133ms/step - loss: 0.0030
```

Model 4: Time Lag = 1, 4 layers, 50 units, dropout rate = 0.5, batch size = 32.

model4 = Sequential() model4.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1))) model4.add(Dropout(0.5)) model4.add(LSTM(units = 50, return_sequences = True)) model4.add(Dropout(0.5)) model4.add(LSTM(units = 50, return_sequences = True)) model4.add(Dropout(0.5)) model4.add(LSTM(units = 50)) model4.add(Dropout(0.5)) model4.add(Dense(units = 1))

Compile the RNN

model4.compile(optimizer='adam', loss='mean_squared_error')

Fit the RNN to the Training set

history4 = model4.fit(x, y, epochs=100, batch_size=32)

In [15]:
```python
train = df.iloc[:1007, 1:2]
test = df.iloc[1007:, 1:2]
total = pd.concat((train, test), axis = 0)
predictor = total[len(total) - len(test) - 60:].values
predictor = predictor.reshape(-1,1)
predictor = scaler.transform(predictor)
xtest = []
for i in range(60, 312):
    xtest.append(predictor[i-60:i, 0])
xtest = np.array(xtest)
xtest = np.reshape(xtest, (xtest.shape[0], xtest.shape[1], 1))
print(xtest.shape)
```

(252, 60, 1)

In [16]:
```python
pred = model.predict(xtest)
pred = scaler.inverse_transform(pred)
pred2 = model2.predict(xtest)
pred2 = scaler.inverse_transform(pred2)
pred3 = model3.predict(xtest)
pred3 = scaler.inverse_transform(pred3)
pred4 = model4.predict(xtest)
pred4 = scaler.inverse_transform(pred4)

# Visualising the results
plt.figure(figsize=(12, 6))
plt.plot(df.loc[1007:, 'Date'],test.values, color = 'red', label = 'Real TESLA Stock Price' )
plt.plot(df.loc[1007:, 'Date'],pred, color = 'blue', label = 'Model 1 - 4 layers, dropout = 0.2, batch
plt.plot(df.loc[1007:, 'Date'],pred2, color = 'yellow', label = 'Model 2 - 6 layers, dropout = 0.2, ba
plt.plot(df.loc[1007:, 'Date'],pred3, color = 'green', label = 'Model 3 - 4 layers, dropout = 0.2, bat
plt.plot(df.loc[1007:, 'Date'],pred4, color = 'pink', label = 'Model 4 - 4 layers, dropout = 0.5, batc
plt.xticks(np.arange(0,252,60))
plt.title('TESLA Stock Price Prediction- time lag = 1 ')
plt.xlabel('Time')
plt.ylabel('TESLA Stock Price')
plt.legend()
plt.show()
```

```
8/8 [==============================] - 0s 41ms/step
8/8 [==============================] - 0s 47ms/step
8/8 [==============================] - 0s 35ms/step
8/8 [==============================] - 3s 42ms/step
```
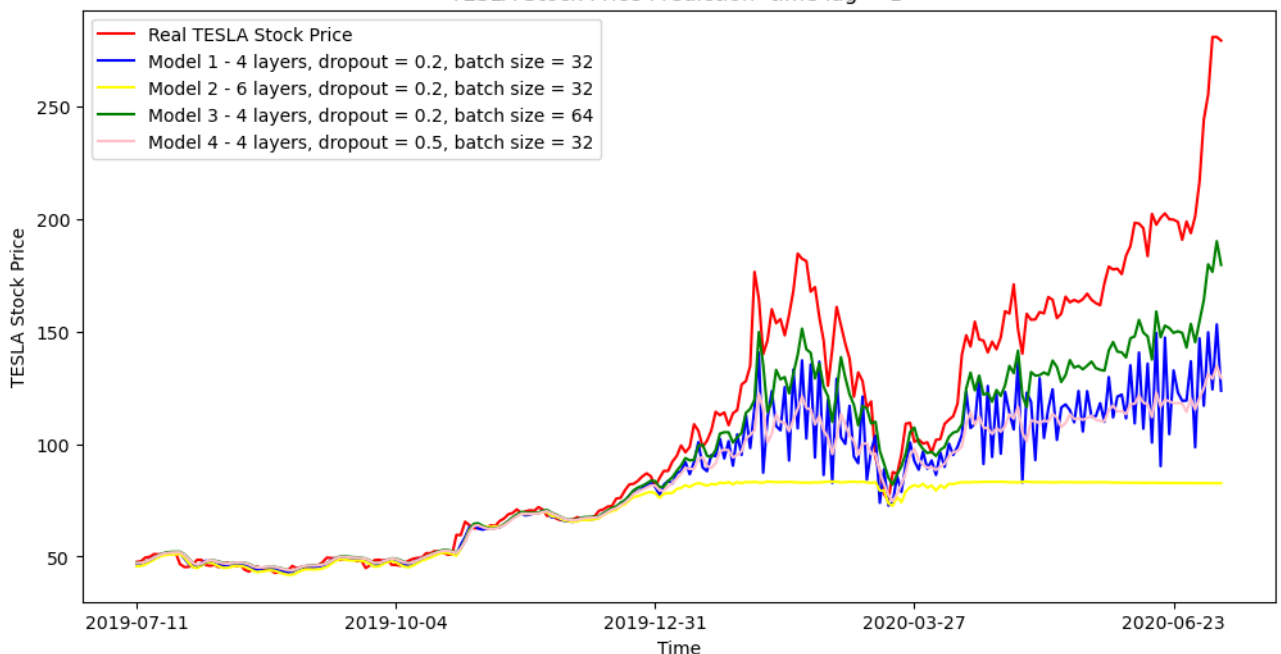

In [17]:
```python
# Plot the loss
plt.figure(figsize=(12, 6))
plt.plot(history.history['loss'], label='Model 1 Loss')
plt.plot(history2.history['loss'], label='Model 2 Loss')
plt.plot(history3.history['loss'], label='Model 3 Loss')
```

```python
plt.plot(history4.history['loss'], label='Model 4 Loss')

plt.title('Loss Comparison Across Models')
plt.xlabel('Epoch')
plt.ylabel('Mean Squared Error Loss')
plt.legend()
plt.show()
```
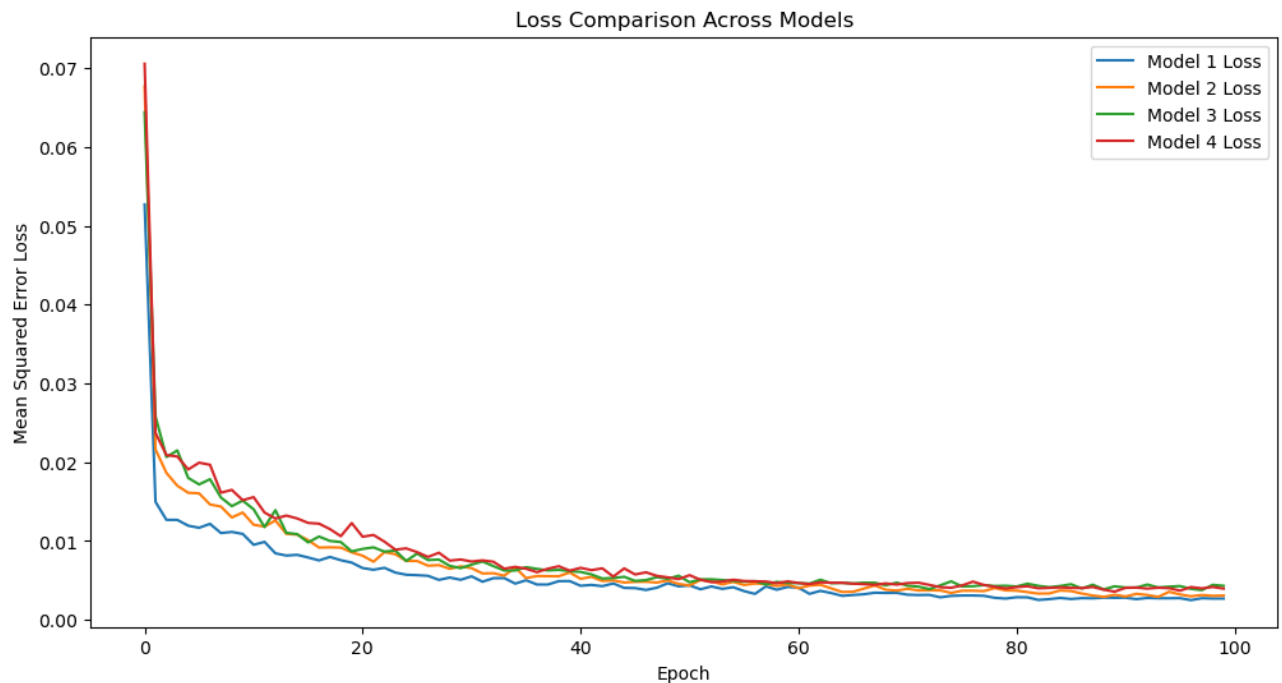


```python
In [19]:  model1_loss = model.evaluate(x, y)
          model2_loss = model2.evaluate(x, y)
          model3_loss = model3.evaluate(x, y)
          model4_loss = model4.evaluate(x, y)
          model1loss_arr = np.array(model1_loss).reshape(1,1)
          model2loss_arr = np.array(model2_loss).reshape(1,1)
          model3loss_arr = np.array(model3_loss).reshape(1,1)
          model4loss_arr = np.array(model4_loss).reshape(1,1)
          c_loss_arr = np.vstack((model1loss_arr, model2loss_arr, model3loss_arr, model4loss_arr))
          c_loss_df = pd.DataFrame(c_loss_arr)
          c_loss_df.columns = ["Overall Loss"]
          c_loss_df.index = ["Model 1", "Model 2", "Model 3", "Model 4"]
          c_loss_df
```

```
30/30 [==============================] - 1s 34ms/step - loss: 0.0013
30/30 [==============================] - 1s 43ms/step - loss: 0.0016
30/30 [==============================] - 1s 30ms/step - loss: 0.0019
30/30 [==============================] - 1s 33ms/step - loss: 0.0019
```

Out[19]:

	Overall Loss
Model 1	0.001298
Model 2	0.001605
Model 3	0.001918
Model 4	0.001927

Model 3 is better than other models.

Time Lag = 7

```python
In [31]:  scaler = MinMaxScaler(feature_range = (0, 1))
          training_scaled = scaler.fit_transform(training)
          x = []
          y = []
          for i in range(54, 1007):
```

```
    x.append(training_scaled[i - 54:i, 0])
    y.append(training_scaled[i, 0])

x, y = np.array(x), np.array(y)
x = np.reshape(x, (x.shape[0], x.shape[1], 1))

print("Shape of x:", x.shape)
```

```
Shape of x: (953, 54, 1)
```

Model 5: Time Lag = 7, 4 layers, 50 units, dropout rate = 0.2, batch size = 32.

In [32]:
```python
# Build LSTM mode
model5 = Sequential()
model5.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1)))
model5.add(Dropout(0.5))
model5.add(LSTM(units = 50, return_sequences = True))
model5.add(Dropout(0.5))
model5.add(LSTM(units = 50, return_sequences = True))
model5.add(Dropout(0.5))
model5.add(LSTM(units = 50))
model5.add(Dropout(0.5))
model5.add(Dense(units = 1))

# Compiling the RNN
model5.compile(optimizer = 'adam', loss = 'mean_squared_error')

# Fitting the RNN to the Training set
history5 = model5.fit(x, y, epochs = 100, batch_size = 32)
```

```
Epoch 1/100
30/30 [==============================] - 17s 95ms/step - loss: 0.0657
Epoch 2/100
30/30 [==============================] - 4s 124ms/step - loss: 0.0251
Epoch 3/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0211
Epoch 4/100
30/30 [==============================] - 3s 87ms/step - loss: 0.0189
Epoch 5/100
30/30 [==============================] - 3s 91ms/step - loss: 0.0185
Epoch 6/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0184
Epoch 7/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0182
Epoch 8/100
30/30 [==============================] - 3s 88ms/step - loss: 0.0164
Epoch 9/100
30/30 [==============================] - 3s 91ms/step - loss: 0.0163
Epoch 10/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0146
Epoch 11/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0154
Epoch 12/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0140
Epoch 13/100
30/30 [==============================] - 3s 88ms/step - loss: 0.0137
Epoch 14/100
30/30 [==============================] - 3s 88ms/step - loss: 0.0143
Epoch 15/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0132
Epoch 16/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0144
Epoch 17/100
30/30 [==============================] - 3s 91ms/step - loss: 0.0165
Epoch 18/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0144
Epoch 19/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0111
Epoch 20/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0122
Epoch 21/100
30/30 [==============================] - 3s 96ms/step - loss: 0.0112
Epoch 22/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0105
Epoch 23/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0111
Epoch 24/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0098
Epoch 25/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0105
Epoch 26/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0102
Epoch 27/100
30/30 [==============================] - 3s 91ms/step - loss: 0.0100
Epoch 28/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0104
Epoch 29/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0094
Epoch 30/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0098
Epoch 31/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0100
Epoch 32/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0089
Epoch 33/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0095
Epoch 34/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0086
Epoch 35/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0080
Epoch 36/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0085
Epoch 37/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0092
Epoch 38/100
```

```
30/30 [==============================] - 3s 97ms/step - loss: 0.0085
Epoch 39/100
30/30 [==============================] - 3s 100ms/step - loss: 0.0080
Epoch 40/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0082
Epoch 41/100
30/30 [==============================] - 3s 97ms/step - loss: 0.0079
Epoch 42/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0079
Epoch 43/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0072
Epoch 44/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0070
Epoch 45/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0064
Epoch 46/100
30/30 [==============================] - 3s 91ms/step - loss: 0.0075
Epoch 47/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0065
Epoch 48/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0068
Epoch 49/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0066
Epoch 50/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0067
Epoch 51/100
30/30 [==============================] - 3s 87ms/step - loss: 0.0064
Epoch 52/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0065
Epoch 53/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0067
Epoch 54/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0060
Epoch 55/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0060
Epoch 56/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0064
Epoch 57/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0060
Epoch 58/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0059
Epoch 59/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0058
Epoch 60/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0054
Epoch 61/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0055
Epoch 62/100
30/30 [==============================] - 3s 92ms/step - loss: 0.0050
Epoch 63/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0056
Epoch 64/100
30/30 [==============================] - 3s 88ms/step - loss: 0.0057
Epoch 65/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0055
Epoch 66/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0058
Epoch 67/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0060
Epoch 68/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0054
Epoch 69/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0049
Epoch 70/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0052
Epoch 71/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0051
Epoch 72/100
30/30 [==============================] - 3s 114ms/step - loss: 0.0051
Epoch 73/100
30/30 [==============================] - 3s 89ms/step - loss: 0.0048
Epoch 74/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0050
Epoch 75/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0057
```

```
Epoch 76/100
30/30 [==============================] – 3s 93ms/step – loss: 0.0048
Epoch 77/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0054
Epoch 78/100
30/30 [==============================] – 3s 91ms/step – loss: 0.0049
Epoch 79/100
30/30 [==============================] – 3s 108ms/step – loss: 0.0043
Epoch 80/100
30/30 [==============================] – 3s 91ms/step – loss: 0.0045
Epoch 81/100
30/30 [==============================] – 3s 92ms/step – loss: 0.0051
Epoch 82/100
30/30 [==============================] – 3s 105ms/step – loss: 0.0044
Epoch 83/100
30/30 [==============================] – 3s 108ms/step – loss: 0.0053
Epoch 84/100
30/30 [==============================] – 3s 87ms/step – loss: 0.0048
Epoch 85/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0046
Epoch 86/100
30/30 [==============================] – 3s 94ms/step – loss: 0.0044
Epoch 87/100
30/30 [==============================] – 3s 93ms/step – loss: 0.0049
Epoch 88/100
30/30 [==============================] – 3s 90ms/step – loss: 0.0047
Epoch 89/100
30/30 [==============================] – 3s 89ms/step – loss: 0.0047
Epoch 90/100
30/30 [==============================] – 3s 111ms/step – loss: 0.0048
Epoch 91/100
30/30 [==============================] – 3s 89ms/step – loss: 0.0041
Epoch 92/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0044
Epoch 93/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0045
Epoch 94/100
30/30 [==============================] – 3s 103ms/step – loss: 0.0043
Epoch 95/100
30/30 [==============================] – 3s 93ms/step – loss: 0.0043
Epoch 96/100
30/30 [==============================] – 3s 94ms/step – loss: 0.0043
Epoch 97/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0043
Epoch 98/100
30/30 [==============================] – 3s 94ms/step – loss: 0.0047
Epoch 99/100
30/30 [==============================] – 3s 91ms/step – loss: 0.0047
Epoch 100/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0043
```

Model 6: Time Lag = 7, 6 layers, 50 units, dropout rate = 0.2, batch size = 32.

```python
In [33]:  # Build LSTM mode
          model6 = Sequential()
          model6.add(LSTM(units=50, return_sequences=True, input_shape=(x.shape[1], 1)))
          model6.add(Dropout(0.2))
          model6.add(LSTM(units=50, return_sequences=True))
          model6.add(Dropout(0.2))
          model6.add(LSTM(units=50, return_sequences=True))
          model6.add(Dropout(0.2))
          model6.add(LSTM(units=50, return_sequences=True))
          model6.add(Dropout(0.2))
          model6.add(LSTM(units=50, return_sequences=True))
          model6.add(Dropout(0.2))
          model6.add(LSTM(units=50))
          model6.add(Dropout(0.2))
          model6.add(Dense(units=1))

          # Compiling the RNN
          model6.compile(optimizer = 'adam', loss = 'mean_squared_error')

          # Fitting the RNN to the Training set
          history6 = model6.fit(x, y, epochs = 100, batch_size = 32)
```

```
Epoch 1/100
30/30 [==============================] - 27s 167ms/step - loss: 0.0647
Epoch 2/100
30/30 [==============================] - 4s 145ms/step - loss: 0.0195
Epoch 3/100
30/30 [==============================] - 4s 134ms/step - loss: 0.0174
Epoch 4/100
30/30 [==============================] - 5s 157ms/step - loss: 0.0163
Epoch 5/100
30/30 [==============================] - 4s 127ms/step - loss: 0.0157
Epoch 6/100
30/30 [==============================] - 4s 136ms/step - loss: 0.0156
Epoch 7/100
30/30 [==============================] - 4s 143ms/step - loss: 0.0141
Epoch 8/100
30/30 [==============================] - 4s 142ms/step - loss: 0.0141
Epoch 9/100
30/30 [==============================] - 4s 151ms/step - loss: 0.0125
Epoch 10/100
30/30 [==============================] - 5s 153ms/step - loss: 0.0129
Epoch 11/100
30/30 [==============================] - 5s 153ms/step - loss: 0.0136
Epoch 12/100
30/30 [==============================] - 4s 137ms/step - loss: 0.0128
Epoch 13/100
30/30 [==============================] - 4s 129ms/step - loss: 0.0112
Epoch 14/100
30/30 [==============================] - 4s 134ms/step - loss: 0.0107
Epoch 15/100
30/30 [==============================] - 4s 135ms/step - loss: 0.0095
Epoch 16/100
30/30 [==============================] - 4s 134ms/step - loss: 0.0097
Epoch 17/100
30/30 [==============================] - 4s 146ms/step - loss: 0.0089
Epoch 18/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0083
Epoch 19/100
30/30 [==============================] - 4s 140ms/step - loss: 0.0087
Epoch 20/100
30/30 [==============================] - 4s 142ms/step - loss: 0.0087
Epoch 21/100
30/30 [==============================] - 4s 138ms/step - loss: 0.0089
Epoch 22/100
30/30 [==============================] - 4s 132ms/step - loss: 0.0072
Epoch 23/100
30/30 [==============================] - 4s 131ms/step - loss: 0.0075
Epoch 24/100
30/30 [==============================] - 4s 139ms/step - loss: 0.0072
Epoch 25/100
30/30 [==============================] - 4s 145ms/step - loss: 0.0069
Epoch 26/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0067
Epoch 27/100
30/30 [==============================] - 4s 147ms/step - loss: 0.0071
Epoch 28/100
30/30 [==============================] - 4s 136ms/step - loss: 0.0057
Epoch 29/100
30/30 [==============================] - 4s 135ms/step - loss: 0.0060
Epoch 30/100
30/30 [==============================] - 4s 134ms/step - loss: 0.0058
Epoch 31/100
30/30 [==============================] - 4s 134ms/step - loss: 0.0057
Epoch 32/100
30/30 [==============================] - 4s 136ms/step - loss: 0.0060
Epoch 33/100
30/30 [==============================] - 4s 146ms/step - loss: 0.0053
Epoch 34/100
30/30 [==============================] - 4s 142ms/step - loss: 0.0070
Epoch 35/100
30/30 [==============================] - 5s 171ms/step - loss: 0.0058
Epoch 36/100
30/30 [==============================] - 4s 144ms/step - loss: 0.0057
Epoch 37/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0058
Epoch 38/100
```

```
30/30 [==============================] - 4s 134ms/step - loss: 0.0052
Epoch 39/100
30/30 [==============================] - 4s 136ms/step - loss: 0.0053
Epoch 40/100
30/30 [==============================] - 5s 156ms/step - loss: 0.0054
Epoch 41/100
30/30 [==============================] - 4s 139ms/step - loss: 0.0049
Epoch 42/100
30/30 [==============================] - 4s 147ms/step - loss: 0.0051
Epoch 43/100
30/30 [==============================] - 4s 141ms/step - loss: 0.0054
Epoch 44/100
30/30 [==============================] - 4s 137ms/step - loss: 0.0049
Epoch 45/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0048
Epoch 46/100
30/30 [==============================] - 4s 138ms/step - loss: 0.0044
Epoch 47/100
30/30 [==============================] - 4s 138ms/step - loss: 0.0050
Epoch 48/100
30/30 [==============================] - 5s 152ms/step - loss: 0.0042
Epoch 49/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0046
Epoch 50/100
30/30 [==============================] - 5s 157ms/step - loss: 0.0046
Epoch 51/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0043
Epoch 52/100
30/30 [==============================] - 4s 139ms/step - loss: 0.0044
Epoch 53/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0044
Epoch 54/100
30/30 [==============================] - 4s 138ms/step - loss: 0.0043
Epoch 55/100
30/30 [==============================] - 5s 153ms/step - loss: 0.0041
Epoch 56/100
30/30 [==============================] - 4s 136ms/step - loss: 0.0040
Epoch 57/100
30/30 [==============================] - 5s 151ms/step - loss: 0.0042
Epoch 58/100
30/30 [==============================] - 4s 140ms/step - loss: 0.0044
Epoch 59/100
30/30 [==============================] - 4s 136ms/step - loss: 0.0040
Epoch 60/100
30/30 [==============================] - 4s 135ms/step - loss: 0.0045
Epoch 61/100
30/30 [==============================] - 4s 142ms/step - loss: 0.0040
Epoch 62/100
30/30 [==============================] - 4s 149ms/step - loss: 0.0040
Epoch 63/100
30/30 [==============================] - 5s 152ms/step - loss: 0.0038
Epoch 64/100
30/30 [==============================] - 4s 141ms/step - loss: 0.0038
Epoch 65/100
30/30 [==============================] - 5s 154ms/step - loss: 0.0034
Epoch 66/100
30/30 [==============================] - 4s 135ms/step - loss: 0.0040
Epoch 67/100
30/30 [==============================] - 4s 137ms/step - loss: 0.0040
Epoch 68/100
30/30 [==============================] - 4s 150ms/step - loss: 0.0038
Epoch 69/100
30/30 [==============================] - 4s 138ms/step - loss: 0.0037
Epoch 70/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0037
Epoch 71/100
30/30 [==============================] - 4s 139ms/step - loss: 0.0041
Epoch 72/100
30/30 [==============================] - 4s 133ms/step - loss: 0.0041
Epoch 73/100
30/30 [==============================] - 5s 156ms/step - loss: 0.0036
Epoch 74/100
30/30 [==============================] - 4s 146ms/step - loss: 0.0041
Epoch 75/100
30/30 [==============================] - 5s 149ms/step - loss: 0.0036
```

```
Epoch 76/100
30/30 [==============================] – 4s 143ms/step – loss: 0.0036
Epoch 77/100
30/30 [==============================] – 4s 140ms/step – loss: 0.0035
Epoch 78/100
30/30 [==============================] – 4s 139ms/step – loss: 0.0035
Epoch 79/100
30/30 [==============================] – 4s 140ms/step – loss: 0.0034
Epoch 80/100
30/30 [==============================] – 5s 154ms/step – loss: 0.0036
Epoch 81/100
30/30 [==============================] – 4s 139ms/step – loss: 0.0035
Epoch 82/100
30/30 [==============================] – 4s 136ms/step – loss: 0.0034
Epoch 83/100
30/30 [==============================] – 5s 153ms/step – loss: 0.0036
Epoch 84/100
30/30 [==============================] – 4s 144ms/step – loss: 0.0038
Epoch 85/100
30/30 [==============================] – 5s 158ms/step – loss: 0.0034
Epoch 86/100
30/30 [==============================] – 5s 153ms/step – loss: 0.0029
Epoch 87/100
30/30 [==============================] – 5s 180ms/step – loss: 0.0032
Epoch 88/100
30/30 [==============================] – 5s 154ms/step – loss: 0.0033
Epoch 89/100
30/30 [==============================] – 5s 150ms/step – loss: 0.0032
Epoch 90/100
30/30 [==============================] – 5s 160ms/step – loss: 0.0030
Epoch 91/100
30/30 [==============================] – 4s 144ms/step – loss: 0.0032
Epoch 92/100
30/30 [==============================] – 4s 143ms/step – loss: 0.0035
Epoch 93/100
30/30 [==============================] – 4s 143ms/step – loss: 0.0031
Epoch 94/100
30/30 [==============================] – 4s 147ms/step – loss: 0.0030
Epoch 95/100
30/30 [==============================] – 5s 155ms/step – loss: 0.0030
Epoch 96/100
30/30 [==============================] – 4s 145ms/step – loss: 0.0030
Epoch 97/100
30/30 [==============================] – 4s 144ms/step – loss: 0.0031
Epoch 98/100
30/30 [==============================] – 5s 157ms/step – loss: 0.0029
Epoch 99/100
30/30 [==============================] – 4s 149ms/step – loss: 0.0031
Epoch 100/100
30/30 [==============================] – 4s 147ms/step – loss: 0.0029
```

Model 7: Time Lag = 7, 4 layers, 50 units, dropout rate = 0.2, batch size = 64.

```python
In [34]:  model7 = Sequential()
          model7.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1)))
          model7.add(Dropout(0.2))
          model7.add(LSTM(units = 50, return_sequences = True))
          model7.add(Dropout(0.2))
          model7.add(LSTM(units = 50, return_sequences = True))
          model7.add(Dropout(0.2))
          model7.add(LSTM(units = 50))
          model7.add(Dropout(0.2))
          model7.add(Dense(units = 1))

          # Output layer
          model7.add(Dense(units=1))

          # Compile the RNN
          model7.compile(optimizer='adam', loss='mean_squared_error')

          # Fit the RNN to the Training set
          history7 = model7.fit(x, y, epochs=100, batch_size=64)
```

```
Epoch 1/100
15/15 [==============================] - 14s 117ms/step - loss: 0.1563
Epoch 2/100
15/15 [==============================] - 2s 123ms/step - loss: 0.0383
Epoch 3/100
15/15 [==============================] - 2s 121ms/step - loss: 0.0190
Epoch 4/100
15/15 [==============================] - 2s 126ms/step - loss: 0.0127
Epoch 5/100
15/15 [==============================] - 2s 146ms/step - loss: 0.0118
Epoch 6/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0127
Epoch 7/100
15/15 [==============================] - 2s 128ms/step - loss: 0.0122
Epoch 8/100
15/15 [==============================] - 2s 122ms/step - loss: 0.0115
Epoch 9/100
15/15 [==============================] - 2s 126ms/step - loss: 0.0129
Epoch 10/100
15/15 [==============================] - 2s 129ms/step - loss: 0.0118
Epoch 11/100
15/15 [==============================] - 2s 144ms/step - loss: 0.0110
Epoch 12/100
15/15 [==============================] - 2s 123ms/step - loss: 0.0103
Epoch 13/100
15/15 [==============================] - 2s 121ms/step - loss: 0.0099
Epoch 14/100
15/15 [==============================] - 2s 118ms/step - loss: 0.0100
Epoch 15/100
15/15 [==============================] - 2s 120ms/step - loss: 0.0098
Epoch 16/100
15/15 [==============================] - 2s 122ms/step - loss: 0.0096
Epoch 17/100
15/15 [==============================] - 2s 115ms/step - loss: 0.0095
Epoch 18/100
15/15 [==============================] - 2s 119ms/step - loss: 0.0091
Epoch 19/100
15/15 [==============================] - 2s 124ms/step - loss: 0.0095
Epoch 20/100
15/15 [==============================] - 2s 123ms/step - loss: 0.0086
Epoch 21/100
15/15 [==============================] - 2s 129ms/step - loss: 0.0084
Epoch 22/100
15/15 [==============================] - 2s 126ms/step - loss: 0.0091
Epoch 23/100
15/15 [==============================] - 2s 139ms/step - loss: 0.0076
Epoch 24/100
15/15 [==============================] - 2s 133ms/step - loss: 0.0077
Epoch 25/100
15/15 [==============================] - 2s 126ms/step - loss: 0.0080
Epoch 26/100
15/15 [==============================] - 2s 123ms/step - loss: 0.0076
Epoch 27/100
15/15 [==============================] - 2s 131ms/step - loss: 0.0080
Epoch 28/100
15/15 [==============================] - 2s 124ms/step - loss: 0.0077
Epoch 29/100
15/15 [==============================] - 2s 147ms/step - loss: 0.0067
Epoch 30/100
15/15 [==============================] - 2s 133ms/step - loss: 0.0067
Epoch 31/100
15/15 [==============================] - 2s 123ms/step - loss: 0.0066
Epoch 32/100
15/15 [==============================] - 2s 125ms/step - loss: 0.0064
Epoch 33/100
15/15 [==============================] - 2s 129ms/step - loss: 0.0061
Epoch 34/100
15/15 [==============================] - 2s 120ms/step - loss: 0.0064
Epoch 35/100
15/15 [==============================] - 2s 122ms/step - loss: 0.0065
Epoch 36/100
15/15 [==============================] - 2s 127ms/step - loss: 0.0063
Epoch 37/100
15/15 [==============================] - 2s 125ms/step - loss: 0.0061
Epoch 38/100
```

```
15/15 [==============================] - 2s 126ms/step - loss: 0.0058
Epoch 39/100
15/15 [==============================] - 2s 138ms/step - loss: 0.0057
Epoch 40/100
15/15 [==============================] - 2s 149ms/step - loss: 0.0058
Epoch 41/100
15/15 [==============================] - 2s 147ms/step - loss: 0.0056
Epoch 42/100
15/15 [==============================] - 2s 135ms/step - loss: 0.0052
Epoch 43/100
15/15 [==============================] - 2s 125ms/step - loss: 0.0059
Epoch 44/100
15/15 [==============================] - 2s 140ms/step - loss: 0.0054
Epoch 45/100
15/15 [==============================] - 3s 205ms/step - loss: 0.0052
Epoch 46/100
15/15 [==============================] - 2s 151ms/step - loss: 0.0055
Epoch 47/100
15/15 [==============================] - 2s 151ms/step - loss: 0.0053
Epoch 48/100
15/15 [==============================] - 2s 159ms/step - loss: 0.0055
Epoch 49/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0049
Epoch 50/100
15/15 [==============================] - 2s 134ms/step - loss: 0.0052
Epoch 51/100
15/15 [==============================] - 2s 144ms/step - loss: 0.0054
Epoch 52/100
15/15 [==============================] - 2s 122ms/step - loss: 0.0053
Epoch 53/100
15/15 [==============================] - 2s 118ms/step - loss: 0.0058
Epoch 54/100
15/15 [==============================] - 2s 136ms/step - loss: 0.0053
Epoch 55/100
15/15 [==============================] - 2s 151ms/step - loss: 0.0054
Epoch 56/100
15/15 [==============================] - 2s 139ms/step - loss: 0.0049
Epoch 57/100
15/15 [==============================] - 2s 119ms/step - loss: 0.0054
Epoch 58/100
15/15 [==============================] - 2s 137ms/step - loss: 0.0047
Epoch 59/100
15/15 [==============================] - 2s 137ms/step - loss: 0.0048
Epoch 60/100
15/15 [==============================] - 2s 145ms/step - loss: 0.0055
Epoch 61/100
15/15 [==============================] - 2s 153ms/step - loss: 0.0045
Epoch 62/100
15/15 [==============================] - 3s 165ms/step - loss: 0.0046
Epoch 63/100
15/15 [==============================] - 3s 167ms/step - loss: 0.0044
Epoch 64/100
15/15 [==============================] - 2s 146ms/step - loss: 0.0047
Epoch 65/100
15/15 [==============================] - 2s 119ms/step - loss: 0.0044
Epoch 66/100
15/15 [==============================] - 2s 121ms/step - loss: 0.0044
Epoch 67/100
15/15 [==============================] - 2s 119ms/step - loss: 0.0053
Epoch 68/100
15/15 [==============================] - 2s 119ms/step - loss: 0.0048
Epoch 69/100
15/15 [==============================] - 2s 122ms/step - loss: 0.0044
Epoch 70/100
15/15 [==============================] - 2s 144ms/step - loss: 0.0041
Epoch 71/100
15/15 [==============================] - 2s 124ms/step - loss: 0.0046
Epoch 72/100
15/15 [==============================] - 3s 214ms/step - loss: 0.0043
Epoch 73/100
15/15 [==============================] - 3s 184ms/step - loss: 0.0041
Epoch 74/100
15/15 [==============================] - 3s 184ms/step - loss: 0.0042
Epoch 75/100
15/15 [==============================] - 3s 163ms/step - loss: 0.0045
```

```
Epoch 76/100
15/15 [==============================] – 3s 183ms/step – loss: 0.0042
Epoch 77/100
15/15 [==============================] – 3s 185ms/step – loss: 0.0043
Epoch 78/100
15/15 [==============================] – 3s 178ms/step – loss: 0.0041
Epoch 79/100
15/15 [==============================] – 3s 174ms/step – loss: 0.0046
Epoch 80/100
15/15 [==============================] – 2s 160ms/step – loss: 0.0039
Epoch 81/100
15/15 [==============================] – 2s 159ms/step – loss: 0.0039
Epoch 82/100
15/15 [==============================] – 2s 159ms/step – loss: 0.0039
Epoch 83/100
15/15 [==============================] – 2s 149ms/step – loss: 0.0041
Epoch 84/100
15/15 [==============================] – 2s 144ms/step – loss: 0.0042
Epoch 85/100
15/15 [==============================] – 2s 141ms/step – loss: 0.0042
Epoch 86/100
15/15 [==============================] – 2s 148ms/step – loss: 0.0040
Epoch 87/100
15/15 [==============================] – 2s 167ms/step – loss: 0.0044
Epoch 88/100
15/15 [==============================] – 3s 179ms/step – loss: 0.0045
Epoch 89/100
15/15 [==============================] – 3s 201ms/step – loss: 0.0042
Epoch 90/100
15/15 [==============================] – 3s 184ms/step – loss: 0.0039
Epoch 91/100
15/15 [==============================] – 3s 212ms/step – loss: 0.0037
Epoch 92/100
15/15 [==============================] – 3s 186ms/step – loss: 0.0036
Epoch 93/100
15/15 [==============================] – 3s 178ms/step – loss: 0.0037
Epoch 94/100
15/15 [==============================] – 2s 143ms/step – loss: 0.0037
Epoch 95/100
15/15 [==============================] – 2s 146ms/step – loss: 0.0034
Epoch 96/100
15/15 [==============================] – 2s 117ms/step – loss: 0.0034
Epoch 97/100
15/15 [==============================] – 2s 126ms/step – loss: 0.0034
Epoch 98/100
15/15 [==============================] – 2s 113ms/step – loss: 0.0036
Epoch 99/100
15/15 [==============================] – 2s 127ms/step – loss: 0.0036
Epoch 100/100
15/15 [==============================] – 2s 129ms/step – loss: 0.0035
```

Model 8: Time Lag = 7, 4 layers, 50 units, dropout rate = 0.5, batch size = 32.

```python
In [35]: model8 = Sequential()
         model8.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1)))
         model8.add(Dropout(0.5))
         model8.add(LSTM(units = 50, return_sequences = True))
         model8.add(Dropout(0.5))
         model8.add(LSTM(units = 50, return_sequences = True))
         model8.add(Dropout(0.5))
         model8.add(LSTM(units = 50))
         model8.add(Dropout(0.5))
         model8.add(Dense(units = 1))

         # Output layer
         model8.add(Dense(units=1))

         # Compile the RNN
         model8.compile(optimizer='adam', loss='mean_squared_error')

         # Fit the RNN to the Training set
         history8 = model8.fit(x, y, epochs=100, batch_size=32)
```

```
Epoch 1/100
30/30 [==============================] - 23s 123ms/step - loss: 0.0791
Epoch 2/100
30/30 [==============================] - 4s 116ms/step - loss: 0.0245
Epoch 3/100
30/30 [==============================] - 5s 173ms/step - loss: 0.0206
Epoch 4/100
30/30 [==============================] - 4s 138ms/step - loss: 0.0195
Epoch 5/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0188
Epoch 6/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0172
Epoch 7/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0177
Epoch 8/100
30/30 [==============================] - 3s 116ms/step - loss: 0.0164
Epoch 9/100
30/30 [==============================] - 4s 119ms/step - loss: 0.0153
Epoch 10/100
30/30 [==============================] - 4s 129ms/step - loss: 0.0151
Epoch 11/100
30/30 [==============================] - 5s 152ms/step - loss: 0.0145
Epoch 12/100
30/30 [==============================] - 4s 142ms/step - loss: 0.0131
Epoch 13/100
30/30 [==============================] - 4s 131ms/step - loss: 0.0130
Epoch 14/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0129
Epoch 15/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0129
Epoch 16/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0119
Epoch 17/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0125
Epoch 18/100
30/30 [==============================] - 3s 100ms/step - loss: 0.0115
Epoch 19/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0110
Epoch 20/100
30/30 [==============================] - 3s 114ms/step - loss: 0.0101
Epoch 21/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0111
Epoch 22/100
30/30 [==============================] - 3s 111ms/step - loss: 0.0094
Epoch 23/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0094
Epoch 24/100
30/30 [==============================] - 3s 106ms/step - loss: 0.0094
Epoch 25/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0092
Epoch 26/100
30/30 [==============================] - 4s 123ms/step - loss: 0.0080
Epoch 27/100
30/30 [==============================] - 3s 111ms/step - loss: 0.0077
Epoch 28/100
30/30 [==============================] - 3s 113ms/step - loss: 0.0081
Epoch 29/100
30/30 [==============================] - 4s 121ms/step - loss: 0.0083
Epoch 30/100
30/30 [==============================] - 4s 122ms/step - loss: 0.0078
Epoch 31/100
30/30 [==============================] - 4s 146ms/step - loss: 0.0073
Epoch 32/100
30/30 [==============================] - 4s 118ms/step - loss: 0.0073
Epoch 33/100
30/30 [==============================] - 3s 91ms/step - loss: 0.0071
Epoch 34/100
30/30 [==============================] - 4s 132ms/step - loss: 0.0074
Epoch 35/100
30/30 [==============================] - 4s 126ms/step - loss: 0.0067
Epoch 36/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0069
Epoch 37/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0069
Epoch 38/100
```

```
30/30 [==============================] - 3s 93ms/step - loss: 0.0067
Epoch 39/100
30/30 [==============================] - 3s 97ms/step - loss: 0.0061
Epoch 40/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0062
Epoch 41/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0055
Epoch 42/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0057
Epoch 43/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0057
Epoch 44/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0053
Epoch 45/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0059
Epoch 46/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0055
Epoch 47/100
30/30 [==============================] - 3s 111ms/step - loss: 0.0055
Epoch 48/100
30/30 [==============================] - 3s 91ms/step - loss: 0.0056
Epoch 49/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0051
Epoch 50/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0053
Epoch 51/100
30/30 [==============================] - 3s 96ms/step - loss: 0.0053
Epoch 52/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0052
Epoch 53/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0049
Epoch 54/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0053
Epoch 55/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0053
Epoch 56/100
30/30 [==============================] - 3s 96ms/step - loss: 0.0051
Epoch 57/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0050
Epoch 58/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0052
Epoch 59/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0048
Epoch 60/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0043
Epoch 61/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0047
Epoch 62/100
30/30 [==============================] - 3s 93ms/step - loss: 0.0048
Epoch 63/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0047
Epoch 64/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0045
Epoch 65/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0044
Epoch 66/100
30/30 [==============================] - 3s 90ms/step - loss: 0.0043
Epoch 67/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0044
Epoch 68/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0043
Epoch 69/100
30/30 [==============================] - 3s 106ms/step - loss: 0.0043
Epoch 70/100
30/30 [==============================] - 3s 95ms/step - loss: 0.0042
Epoch 71/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0042
Epoch 72/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0043
Epoch 73/100
30/30 [==============================] - 3s 96ms/step - loss: 0.0042
Epoch 74/100
30/30 [==============================] - 3s 94ms/step - loss: 0.0042
Epoch 75/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0046
```

```
Epoch 76/100
30/30 [==============================] – 3s 106ms/step – loss: 0.0044
Epoch 77/100
30/30 [==============================] – 3s 114ms/step – loss: 0.0040
Epoch 78/100
30/30 [==============================] – 4s 120ms/step – loss: 0.0040
Epoch 79/100
30/30 [==============================] – 4s 123ms/step – loss: 0.0043
Epoch 80/100
30/30 [==============================] – 3s 107ms/step – loss: 0.0043
Epoch 81/100
30/30 [==============================] – 3s 105ms/step – loss: 0.0040
Epoch 82/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0038
Epoch 83/100
30/30 [==============================] – 3s 104ms/step – loss: 0.0041
Epoch 84/100
30/30 [==============================] – 4s 130ms/step – loss: 0.0039
Epoch 85/100
30/30 [==============================] – 4s 128ms/step – loss: 0.0042
Epoch 86/100
30/30 [==============================] – 3s 95ms/step – loss: 0.0041
Epoch 87/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0041
Epoch 88/100
30/30 [==============================] – 3s 102ms/step – loss: 0.0039
Epoch 89/100
30/30 [==============================] – 4s 123ms/step – loss: 0.0039
Epoch 90/100
30/30 [==============================] – 4s 119ms/step – loss: 0.0040
Epoch 91/100
30/30 [==============================] – 3s 105ms/step – loss: 0.0040
Epoch 92/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0042
Epoch 93/100
30/30 [==============================] – 3s 100ms/step – loss: 0.0039
Epoch 94/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0038
Epoch 95/100
30/30 [==============================] – 3s 104ms/step – loss: 0.0038
Epoch 96/100
30/30 [==============================] – 4s 121ms/step – loss: 0.0036
Epoch 97/100
30/30 [==============================] – 3s 104ms/step – loss: 0.0037
Epoch 98/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0035
Epoch 99/100
30/30 [==============================] – 3s 107ms/step – loss: 0.0037
Epoch 100/100
30/30 [==============================] – 3s 104ms/step – loss: 0.0036
```

In [46]:
```python
train = df.iloc[:1007, 1:2]
test = df.iloc[1007:, 1:2]
total = pd.concat((train, test), axis = 0)
predictor = total[len(total) – len(test) – 60:].values
predictor = predictor.reshape(–1,1)
predictor = scaler.transform(predictor)
xtest = []
for i in range(60, 312):
    xtest.append(predictor[i–60:i, 0])
xtest = np.array(xtest)
xtest = np.reshape(xtest, (xtest.shape[0], xtest.shape[1], 1))
print(xtest.shape)
```

```
(252, 60, 1)
```

In [47]:
```python
pred5 = model5.predict(xtest)
pred5 = scaler.inverse_transform(pred5)
pred6 = model6.predict(xtest)
pred6 = scaler.inverse_transform(pred6)
pred7 = model7.predict(xtest)
pred7 = scaler.inverse_transform(pred7)
pred8 = model8.predict(xtest)
pred8 = scaler.inverse_transform(pred8)
```

```python
# Visualising the results
plt.figure(figsize=(12, 6))
plt.plot(df.loc[1007:, 'Date'],test.values, color = 'red', label = 'Real TESLA Stock Price' )
plt.plot(df.loc[1007:, 'Date'],pred5, color = 'blue', label = 'Model 5 – 4 layers, dropout = 0.2, batc
plt.plot(df.loc[1007:, 'Date'],pred6, color = 'yellow', label = 'Model 6 – 6 layers, dropout = 0.2, ba
plt.plot(df.loc[1007:, 'Date'],pred7, color = 'green', label = 'Model 7 – 4 layers, dropout = 0.2, bat
plt.plot(df.loc[1007:, 'Date'],pred8, color = 'pink', label = 'Model 8 – 4 layers, dropout = 0.5, batc
plt.xticks(np.arange(0,252,60))
plt.title('TESLA Stock Price Prediction– time lag = 7')
plt.xlabel('Time')
plt.ylabel('TESLA Stock Price')
plt.legend()
plt.show()
```

```
8/8 [==============================] – 3s 30ms/step
8/8 [==============================] – 4s 42ms/step
8/8 [==============================] – 3s 31ms/step
8/8 [==============================] – 3s 30ms/step
```
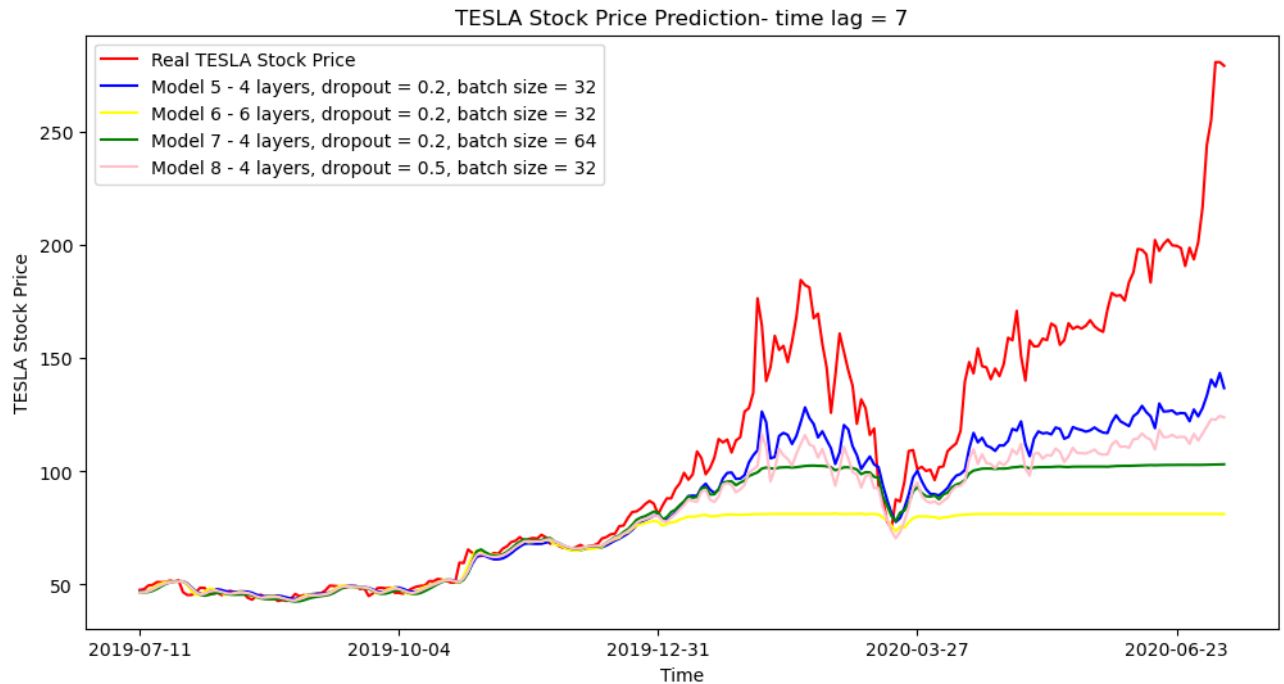

In [43]:
```python
# Plot the loss
plt.figure(figsize=(12, 6))
plt.plot(history5.history['loss'], label='Model 5 Loss')
plt.plot(history6.history['loss'], label='Model 6 Loss')
plt.plot(history7.history['loss'], label='Model 7 Loss')
plt.plot(history8.history['loss'], label='Model 8 Loss')

plt.title('Loss Comparison Across Models')
plt.xlabel('Epoch')
plt.ylabel('Mean Squared Error Loss')
plt.legend()
plt.show()
```

Loss Comparison Across Models
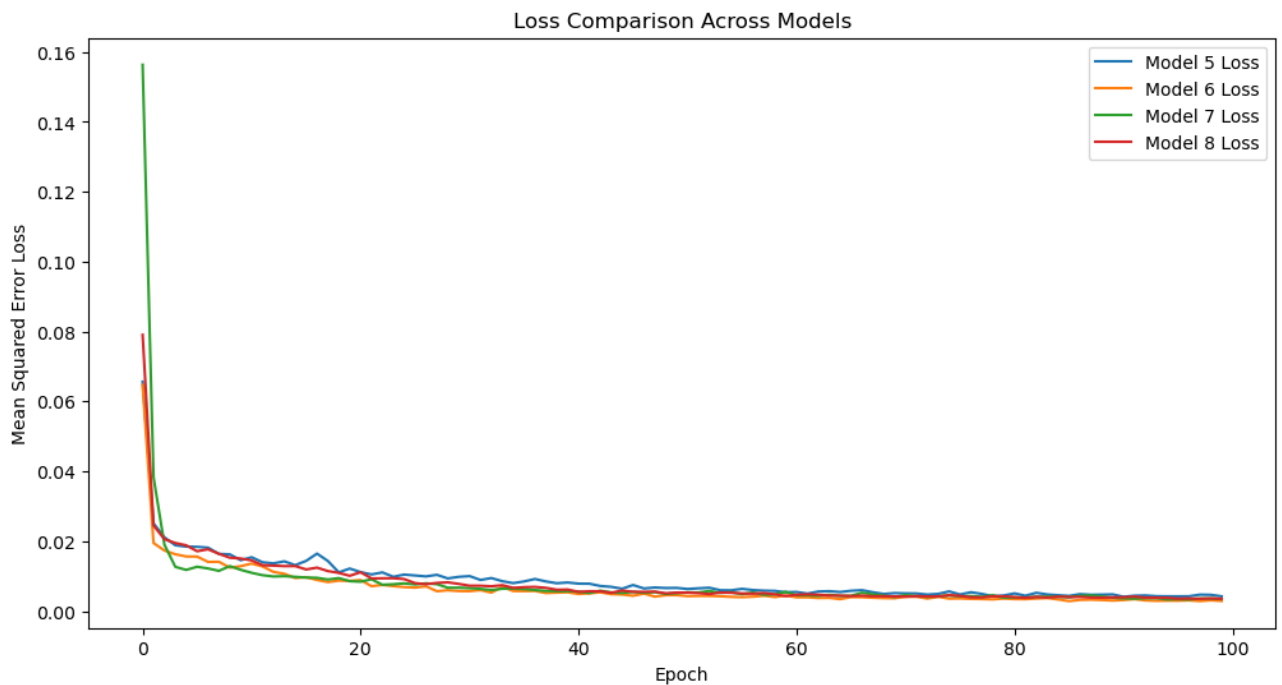

```
In [44]: model5_loss = model5.evaluate(x, y)
         model6_loss = model6.evaluate(x, y)
         model7_loss = model7.evaluate(x, y)
         model8_loss = model8.evaluate(x, y)
         model5loss_arr = np.array(model5_loss).reshape(1,1)
         model6loss_arr = np.array(model6_loss).reshape(1,1)
         model7loss_arr = np.array(model7_loss).reshape(1,1)
         model8loss_arr = np.array(model8_loss).reshape(1,1)
         c_loss_arr = np.vstack((model5loss_arr, model6loss_arr, model7loss_arr, model8loss_arr))
         c_loss_df = pd.DataFrame(c_loss_arr)
         c_loss_df.columns = ["Overall Loss"]
         c_loss_df.index = ["Model 5", "Model 6", "Model 7", "Model 8"]
         c_loss_df
```

```
30/30 [==============================] - 4s 30ms/step - loss: 0.0021
30/30 [==============================] - 5s 49ms/step - loss: 0.0016
30/30 [==============================] - 4s 27ms/step - loss: 0.0018
30/30 [==============================] - 4s 28ms/step - loss: 0.0018
```

Out[44]:

	Overall Loss
Model 5	0.002121
Model 6	0.001592
Model 7	0.001771
Model 8	0.001782

Model 5 is better than other models.

Time Lag = 14

```
In [87]: scaler = MinMaxScaler(feature_range = (0, 1))
         training_scaled = scaler.fit_transform(training)
         x = []
         y = []
         for i in range(47, 1007):
             x.append(training_scaled[i - 47:i, 0])
             y.append(training_scaled[i, 0])

         x, y = np.array(x), np.array(y)
         x = np.reshape(x, (x.shape[0], x.shape[1], 1))

         print("Shape of x:", x.shape)
```

```
Shape of x: (960, 47, 1)
```

Model 9: Time Lag = 14, 4 layers, 50 units, dropout rate = 0.2, batch size = 32.

In [88]:
```python
# Build LSTM mode
model9 = Sequential()
model9.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1)))
model9.add(Dropout(0.2))
model9.add(LSTM(units = 50, return_sequences = True))
model9.add(Dropout(0.2))
model9.add(LSTM(units = 50, return_sequences = True))
model9.add(Dropout(0.2))
model9.add(LSTM(units = 50))
model9.add(Dropout(0.2))
model9.add(Dense(units = 1))

# Compiling the RNN
model9.compile(optimizer = 'adam', loss = 'mean_squared_error')

# Fitting the RNN to the Training set
history9 = model9.fit(x, y, epochs = 100, batch_size = 32)
```

```
Epoch 1/100
30/30 [==============================] – 12s 71ms/step – loss: 0.0640
Epoch 2/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0159
Epoch 3/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0138
Epoch 4/100
30/30 [==============================] – 2s 66ms/step – loss: 0.0129
Epoch 5/100
30/30 [==============================] – 2s 72ms/step – loss: 0.0116
Epoch 6/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0114
Epoch 7/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0117
Epoch 8/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0107
Epoch 9/100
30/30 [==============================] – 2s 80ms/step – loss: 0.0108
Epoch 10/100
30/30 [==============================] – 2s 78ms/step – loss: 0.0100
Epoch 11/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0099
Epoch 12/100
30/30 [==============================] – 2s 70ms/step – loss: 0.0094
Epoch 13/100
30/30 [==============================] – 2s 70ms/step – loss: 0.0092
Epoch 14/100
30/30 [==============================] – 2s 78ms/step – loss: 0.0083
Epoch 15/100
30/30 [==============================] – 2s 70ms/step – loss: 0.0077
Epoch 16/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0077
Epoch 17/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0082
Epoch 18/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0084
Epoch 19/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0072
Epoch 20/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0075
Epoch 21/100
30/30 [==============================] – 2s 70ms/step – loss: 0.0081
Epoch 22/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0062
Epoch 23/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0062
Epoch 24/100
30/30 [==============================] – 2s 82ms/step – loss: 0.0057
Epoch 25/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0059
Epoch 26/100
30/30 [==============================] – 2s 72ms/step – loss: 0.0056
Epoch 27/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0054
Epoch 28/100
30/30 [==============================] – 2s 76ms/step – loss: 0.0053
Epoch 29/100
30/30 [==============================] – 2s 76ms/step – loss: 0.0049
Epoch 30/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0050
Epoch 31/100
30/30 [==============================] – 2s 72ms/step – loss: 0.0052
Epoch 32/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0049
Epoch 33/100
30/30 [==============================] – 2s 82ms/step – loss: 0.0047
Epoch 34/100
30/30 [==============================] – 2s 74ms/step – loss: 0.0050
Epoch 35/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0045
Epoch 36/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0048
Epoch 37/100
30/30 [==============================] – 3s 87ms/step – loss: 0.0043
Epoch 38/100
```

```
30/30 [==============================] – 2s 79ms/step – loss: 0.0042
Epoch 39/100
30/30 [==============================] – 2s 79ms/step – loss: 0.0046
Epoch 40/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0045
Epoch 41/100
30/30 [==============================] – 2s 81ms/step – loss: 0.0046
Epoch 42/100
30/30 [==============================] – 2s 77ms/step – loss: 0.0044
Epoch 43/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0041
Epoch 44/100
30/30 [==============================] – 2s 70ms/step – loss: 0.0041
Epoch 45/100
30/30 [==============================] – 2s 75ms/step – loss: 0.0045
Epoch 46/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0044
Epoch 47/100
30/30 [==============================] – 2s 81ms/step – loss: 0.0043
Epoch 48/100
30/30 [==============================] – 2s 72ms/step – loss: 0.0041
Epoch 49/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0040
Epoch 50/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0041
Epoch 51/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0038
Epoch 52/100
30/30 [==============================] – 2s 78ms/step – loss: 0.0036
Epoch 53/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0037
Epoch 54/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0040
Epoch 55/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0035
Epoch 56/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0042
Epoch 57/100
30/30 [==============================] – 3s 87ms/step – loss: 0.0036
Epoch 58/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0035
Epoch 59/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0037
Epoch 60/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0036
Epoch 61/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0037
Epoch 62/100
30/30 [==============================] – 2s 72ms/step – loss: 0.0034
Epoch 63/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0038
Epoch 64/100
30/30 [==============================] – 2s 70ms/step – loss: 0.0036
Epoch 65/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0032
Epoch 66/100
30/30 [==============================] – 2s 76ms/step – loss: 0.0032
Epoch 67/100
30/30 [==============================] – 2s 74ms/step – loss: 0.0033
Epoch 68/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0029
Epoch 69/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0031
Epoch 70/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0029
Epoch 71/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0033
Epoch 72/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0030
Epoch 73/100
30/30 [==============================] – 2s 75ms/step – loss: 0.0028
Epoch 74/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0032
Epoch 75/100
30/30 [==============================] – 2s 73ms/step – loss: 0.0032
```

```
Epoch 76/100
30/30 [==============================] - 2s 82ms/step - loss: 0.0029
Epoch 77/100
30/30 [==============================] - 2s 70ms/step - loss: 0.0028
Epoch 78/100
30/30 [==============================] - 2s 73ms/step - loss: 0.0029
Epoch 79/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0034
Epoch 80/100
30/30 [==============================] - 2s 75ms/step - loss: 0.0029
Epoch 81/100
30/30 [==============================] - 2s 73ms/step - loss: 0.0027
Epoch 82/100
30/30 [==============================] - 2s 77ms/step - loss: 0.0029
Epoch 83/100
30/30 [==============================] - 2s 76ms/step - loss: 0.0029
Epoch 84/100
30/30 [==============================] - 2s 66ms/step - loss: 0.0027
Epoch 85/100
30/30 [==============================] - 2s 65ms/step - loss: 0.0027
Epoch 86/100
30/30 [==============================] - 2s 77ms/step - loss: 0.0029
Epoch 87/100
30/30 [==============================] - 2s 72ms/step - loss: 0.0031
Epoch 88/100
30/30 [==============================] - 2s 70ms/step - loss: 0.0028
Epoch 89/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0029
Epoch 90/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0028
Epoch 91/100
30/30 [==============================] - 2s 72ms/step - loss: 0.0030
Epoch 92/100
30/30 [==============================] - 2s 67ms/step - loss: 0.0025
Epoch 93/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0026
Epoch 94/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0025
Epoch 95/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0026
Epoch 96/100
30/30 [==============================] - 2s 80ms/step - loss: 0.0026
Epoch 97/100
30/30 [==============================] - 2s 81ms/step - loss: 0.0025
Epoch 98/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0027
Epoch 99/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0023
Epoch 100/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0026
```

Model 10: Time Lag = 14, 6 layers, 50 units, dropout rate = 0.2, batch size = 32.

```python
In [89]:  model10 = Sequential()
          model10.add(LSTM(units=50, return_sequences=True, input_shape=(x.shape[1], 1)))
          model10.add(Dropout(0.2))
          model10.add(LSTM(units=50, return_sequences=True))
          model10.add(Dropout(0.2))
          model10.add(LSTM(units=50, return_sequences=True))
          model10.add(Dropout(0.2))
          model10.add(LSTM(units=50, return_sequences=True))
          model10.add(Dropout(0.2))
          model10.add(LSTM(units=50, return_sequences=True))
          model10.add(Dropout(0.2))
          model10.add(LSTM(units=50))
          model10.add(Dropout(0.2))

          # Output layer
          model10.add(Dense(units=1))

          # Compile the RNN
          model10.compile(optimizer='adam', loss='mean_squared_error')
```

```python
# Fit the RNN to the Training set
history10 = model10.fit(x, y, epochs=100, batch_size=32)
```

```
Epoch 1/100
30/30 [==============================] – 27s 108ms/step – loss: 0.0543
Epoch 2/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0191
Epoch 3/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0165
Epoch 4/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0178
Epoch 5/100
30/30 [==============================] – 3s 110ms/step – loss: 0.0159
Epoch 6/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0141
Epoch 7/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0140
Epoch 8/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0128
Epoch 9/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0128
Epoch 10/100
30/30 [==============================] – 3s 100ms/step – loss: 0.0120
Epoch 11/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0122
Epoch 12/100
30/30 [==============================] – 3s 111ms/step – loss: 0.0107
Epoch 13/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0104
Epoch 14/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0107
Epoch 15/100
30/30 [==============================] – 3s 113ms/step – loss: 0.0106
Epoch 16/100
30/30 [==============================] – 3s 102ms/step – loss: 0.0094
Epoch 17/100
30/30 [==============================] – 3s 96ms/step – loss: 0.0091
Epoch 18/100
30/30 [==============================] – 3s 98ms/step – loss: 0.0082
Epoch 19/100
30/30 [==============================] – 3s 104ms/step – loss: 0.0083
Epoch 20/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0078
Epoch 21/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0085
Epoch 22/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0074
Epoch 23/100
30/30 [==============================] – 4s 122ms/step – loss: 0.0062
Epoch 24/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0062
Epoch 25/100
30/30 [==============================] – 3s 106ms/step – loss: 0.0066
Epoch 26/100
30/30 [==============================] – 3s 112ms/step – loss: 0.0065
Epoch 27/100
30/30 [==============================] – 3s 97ms/step – loss: 0.0062
Epoch 28/100
30/30 [==============================] – 3s 104ms/step – loss: 0.0063
Epoch 29/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0065
Epoch 30/100
30/30 [==============================] – 3s 99ms/step – loss: 0.0055
Epoch 31/100
30/30 [==============================] – 3s 103ms/step – loss: 0.0056
Epoch 32/100
30/30 [==============================] – 3s 100ms/step – loss: 0.0056
Epoch 33/100
30/30 [==============================] – 3s 113ms/step – loss: 0.0055
Epoch 34/100
30/30 [==============================] – 3s 100ms/step – loss: 0.0062
Epoch 35/100
30/30 [==============================] – 3s 100ms/step – loss: 0.0050
Epoch 36/100
30/30 [==============================] – 3s 107ms/step – loss: 0.0052
Epoch 37/100
30/30 [==============================] – 3s 105ms/step – loss: 0.0057
Epoch 38/100
```

```
30/30 [==============================] - 3s 104ms/step - loss: 0.0052
Epoch 39/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0045
Epoch 40/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0051
Epoch 41/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0049
Epoch 42/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0046
Epoch 43/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0046
Epoch 44/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0047
Epoch 45/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0044
Epoch 46/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0046
Epoch 47/100
30/30 [==============================] - 3s 113ms/step - loss: 0.0043
Epoch 48/100
30/30 [==============================] - 3s 100ms/step - loss: 0.0042
Epoch 49/100
30/30 [==============================] - 3s 104ms/step - loss: 0.0045
Epoch 50/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0047
Epoch 51/100
30/30 [==============================] - 3s 106ms/step - loss: 0.0043
Epoch 52/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0042
Epoch 53/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0045
Epoch 54/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0049
Epoch 55/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0042
Epoch 56/100
30/30 [==============================] - 3s 100ms/step - loss: 0.0039
Epoch 57/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0039
Epoch 58/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0039
Epoch 59/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0041
Epoch 60/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0041
Epoch 61/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0036
Epoch 62/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0038
Epoch 63/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0041
Epoch 64/100
30/30 [==============================] - 3s 110ms/step - loss: 0.0036
Epoch 65/100
30/30 [==============================] - 3s 106ms/step - loss: 0.0036
Epoch 66/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0035
Epoch 67/100
30/30 [==============================] - 4s 117ms/step - loss: 0.0035
Epoch 68/100
30/30 [==============================] - 3s 97ms/step - loss: 0.0039
Epoch 69/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0039
Epoch 70/100
30/30 [==============================] - 3s 108ms/step - loss: 0.0037
Epoch 71/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0038
Epoch 72/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0038
Epoch 73/100
30/30 [==============================] - 3s 112ms/step - loss: 0.0035
Epoch 74/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0033
Epoch 75/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0039
```

```
Epoch 76/100
30/30 [==============================] - 3s 113ms/step - loss: 0.0036
Epoch 77/100
30/30 [==============================] - 3s 109ms/step - loss: 0.0032
Epoch 78/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0033
Epoch 79/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0033
Epoch 80/100
30/30 [==============================] - 3s 106ms/step - loss: 0.0035
Epoch 81/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0034
Epoch 82/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0029
Epoch 83/100
30/30 [==============================] - 4s 119ms/step - loss: 0.0034
Epoch 84/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0032
Epoch 85/100
30/30 [==============================] - 3s 106ms/step - loss: 0.0030
Epoch 86/100
30/30 [==============================] - 3s 100ms/step - loss: 0.0031
Epoch 87/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0028
Epoch 88/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0032
Epoch 89/100
30/30 [==============================] - 3s 107ms/step - loss: 0.0032
Epoch 90/100
30/30 [==============================] - 3s 109ms/step - loss: 0.0029
Epoch 91/100
30/30 [==============================] - 3s 102ms/step - loss: 0.0029
Epoch 92/100
30/30 [==============================] - 3s 98ms/step - loss: 0.0029
Epoch 93/100
30/30 [==============================] - 3s 117ms/step - loss: 0.0038
Epoch 94/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0030
Epoch 95/100
30/30 [==============================] - 3s 105ms/step - loss: 0.0027
Epoch 96/100
30/30 [==============================] - 3s 110ms/step - loss: 0.0030
Epoch 97/100
30/30 [==============================] - 3s 99ms/step - loss: 0.0029
Epoch 98/100
30/30 [==============================] - 3s 101ms/step - loss: 0.0030
Epoch 99/100
30/30 [==============================] - 3s 103ms/step - loss: 0.0026
Epoch 100/100
30/30 [==============================] - 4s 117ms/step - loss: 0.0025
```

Model 11: Time Lag = 14, 4 layers, 50 units, dropout rate = 0.2, batch size = 64.

```python
In [90]:  # Build LSTM mode
          model11 = Sequential()
          model11.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1)))
          model11.add(Dropout(0.2))
          model11.add(LSTM(units = 50, return_sequences = True))
          model11.add(Dropout(0.2))
          model11.add(LSTM(units = 50, return_sequences = True))
          model11.add(Dropout(0.2))
          model11.add(LSTM(units = 50))
          model11.add(Dropout(0.2))
          model11.add(Dense(units = 1))

          # Compiling the RNN
          model11.compile(optimizer = 'adam', loss = 'mean_squared_error')

          # Fitting the RNN to the Training set
          history11 = model11.fit(x, y, epochs = 100, batch_size = 64)
```

```
Epoch 1/100
15/15 [==============================] – 11s 91ms/step – loss: 0.1104
Epoch 2/100
15/15 [==============================] – 1s 99ms/step – loss: 0.0287
Epoch 3/100
15/15 [==============================] – 1s 92ms/step – loss: 0.0196
Epoch 4/100
15/15 [==============================] – 1s 91ms/step – loss: 0.0142
Epoch 5/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0118
Epoch 6/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0138
Epoch 7/100
15/15 [==============================] – 2s 116ms/step – loss: 0.0133
Epoch 8/100
15/15 [==============================] – 2s 106ms/step – loss: 0.0129
Epoch 9/100
15/15 [==============================] – 1s 94ms/step – loss: 0.0126
Epoch 10/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0117
Epoch 11/100
15/15 [==============================] – 1s 92ms/step – loss: 0.0120
Epoch 12/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0109
Epoch 13/100
15/15 [==============================] – 1s 96ms/step – loss: 0.0107
Epoch 14/100
15/15 [==============================] – 1s 92ms/step – loss: 0.0111
Epoch 15/100
15/15 [==============================] – 1s 91ms/step – loss: 0.0107
Epoch 16/100
15/15 [==============================] – 1s 97ms/step – loss: 0.0104
Epoch 17/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0094
Epoch 18/100
15/15 [==============================] – 1s 96ms/step – loss: 0.0100
Epoch 19/100
15/15 [==============================] – 1s 96ms/step – loss: 0.0091
Epoch 20/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0093
Epoch 21/100
15/15 [==============================] – 2s 112ms/step – loss: 0.0098
Epoch 22/100
15/15 [==============================] – 2s 111ms/step – loss: 0.0086
Epoch 23/100
15/15 [==============================] – 1s 98ms/step – loss: 0.0087
Epoch 24/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0089
Epoch 25/100
15/15 [==============================] – 1s 95ms/step – loss: 0.0092
Epoch 26/100
15/15 [==============================] – 1s 99ms/step – loss: 0.0095
Epoch 27/100
15/15 [==============================] – 1s 98ms/step – loss: 0.0087
Epoch 28/100
15/15 [==============================] – 2s 101ms/step – loss: 0.0082
Epoch 29/100
15/15 [==============================] – 2s 109ms/step – loss: 0.0073
Epoch 30/100
15/15 [==============================] – 1s 95ms/step – loss: 0.0070
Epoch 31/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0074
Epoch 32/100
15/15 [==============================] – 1s 91ms/step – loss: 0.0075
Epoch 33/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0078
Epoch 34/100
15/15 [==============================] – 1s 94ms/step – loss: 0.0076
Epoch 35/100
15/15 [==============================] – 1s 91ms/step – loss: 0.0066
Epoch 36/100
15/15 [==============================] – 2s 100ms/step – loss: 0.0074
Epoch 37/100
15/15 [==============================] – 1s 97ms/step – loss: 0.0073
Epoch 38/100
```

```
15/15 [==============================] - 1s 98ms/step - loss: 0.0067
Epoch 39/100
15/15 [==============================] - 1s 94ms/step - loss: 0.0068
Epoch 40/100
15/15 [==============================] - 1s 93ms/step - loss: 0.0068
Epoch 41/100
15/15 [==============================] - 1s 89ms/step - loss: 0.0065
Epoch 42/100
15/15 [==============================] - 2s 108ms/step - loss: 0.0061
Epoch 43/100
15/15 [==============================] - 2s 108ms/step - loss: 0.0062
Epoch 44/100
15/15 [==============================] - 2s 102ms/step - loss: 0.0064
Epoch 45/100
15/15 [==============================] - 1s 89ms/step - loss: 0.0062
Epoch 46/100
15/15 [==============================] - 1s 91ms/step - loss: 0.0056
Epoch 47/100
15/15 [==============================] - 1s 89ms/step - loss: 0.0059
Epoch 48/100
15/15 [==============================] - 2s 107ms/step - loss: 0.0055
Epoch 49/100
15/15 [==============================] - 2s 103ms/step - loss: 0.0053
Epoch 50/100
15/15 [==============================] - 2s 112ms/step - loss: 0.0058
Epoch 51/100
15/15 [==============================] - 2s 107ms/step - loss: 0.0057
Epoch 52/100
15/15 [==============================] - 2s 99ms/step - loss: 0.0054
Epoch 53/100
15/15 [==============================] - 2s 103ms/step - loss: 0.0058
Epoch 54/100
15/15 [==============================] - 1s 97ms/step - loss: 0.0060
Epoch 55/100
15/15 [==============================] - 2s 100ms/step - loss: 0.0072
Epoch 56/100
15/15 [==============================] - 1s 95ms/step - loss: 0.0059
Epoch 57/100
15/15 [==============================] - 2s 100ms/step - loss: 0.0052
Epoch 58/100
15/15 [==============================] - 2s 114ms/step - loss: 0.0050
Epoch 59/100
15/15 [==============================] - 2s 106ms/step - loss: 0.0047
Epoch 60/100
15/15 [==============================] - 2s 103ms/step - loss: 0.0049
Epoch 61/100
15/15 [==============================] - 2s 107ms/step - loss: 0.0048
Epoch 62/100
15/15 [==============================] - 1s 95ms/step - loss: 0.0050
Epoch 63/100
15/15 [==============================] - 2s 103ms/step - loss: 0.0048
Epoch 64/100
15/15 [==============================] - 2s 101ms/step - loss: 0.0050
Epoch 65/100
15/15 [==============================] - 2s 109ms/step - loss: 0.0050
Epoch 66/100
15/15 [==============================] - 1s 92ms/step - loss: 0.0046
Epoch 67/100
15/15 [==============================] - 1s 91ms/step - loss: 0.0051
Epoch 68/100
15/15 [==============================] - 2s 102ms/step - loss: 0.0049
Epoch 69/100
15/15 [==============================] - 1s 91ms/step - loss: 0.0049
Epoch 70/100
15/15 [==============================] - 1s 90ms/step - loss: 0.0047
Epoch 71/100
15/15 [==============================] - 1s 100ms/step - loss: 0.0049
Epoch 72/100
15/15 [==============================] - 2s 116ms/step - loss: 0.0049
Epoch 73/100
15/15 [==============================] - 1s 98ms/step - loss: 0.0046
Epoch 74/100
15/15 [==============================] - 1s 91ms/step - loss: 0.0045
Epoch 75/100
15/15 [==============================] - 1s 99ms/step - loss: 0.0050
```

```
Epoch 76/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0042
Epoch 77/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0046
Epoch 78/100
15/15 [==============================] – 1s 88ms/step – loss: 0.0043
Epoch 79/100
15/15 [==============================] – 2s 105ms/step – loss: 0.0044
Epoch 80/100
15/15 [==============================] – 2s 114ms/step – loss: 0.0042
Epoch 81/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0042
Epoch 82/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0044
Epoch 83/100
15/15 [==============================] – 1s 92ms/step – loss: 0.0043
Epoch 84/100
15/15 [==============================] – 1s 99ms/step – loss: 0.0043
Epoch 85/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0043
Epoch 86/100
15/15 [==============================] – 1s 99ms/step – loss: 0.0040
Epoch 87/100
15/15 [==============================] – 1s 94ms/step – loss: 0.0043
Epoch 88/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0041
Epoch 89/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0041
Epoch 90/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0039
Epoch 91/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0043
Epoch 92/100
15/15 [==============================] – 1s 89ms/step – loss: 0.0041
Epoch 93/100
15/15 [==============================] – 2s 100ms/step – loss: 0.0041
Epoch 94/100
15/15 [==============================] – 2s 110ms/step – loss: 0.0039
Epoch 95/100
15/15 [==============================] – 1s 90ms/step – loss: 0.0037
Epoch 96/100
15/15 [==============================] – 2s 105ms/step – loss: 0.0041
Epoch 97/100
15/15 [==============================] – 1s 97ms/step – loss: 0.0039
Epoch 98/100
15/15 [==============================] – 1s 93ms/step – loss: 0.0040
Epoch 99/100
15/15 [==============================] – 1s 94ms/step – loss: 0.0035
Epoch 100/100
15/15 [==============================] – 1s 95ms/step – loss: 0.0040
```

Model 12: Time Lag = 14, 4 layers, 50 units, dropout rate = 0.5, batch size = 32.

In [91]:
```python
# Build LSTM mode
model12 = Sequential()
model12.add(LSTM(units = 50, return_sequences = True, input_shape = (x.shape[1], 1)))
model12.add(Dropout(0.5))
model12.add(LSTM(units = 50, return_sequences = True))
model12.add(Dropout(0.5))
model12.add(LSTM(units = 50, return_sequences = True))
model12.add(Dropout(0.5))
model12.add(LSTM(units = 50))
model12.add(Dropout(0.5))
model12.add(Dense(units = 1))

# Compiling the RNN
model12.compile(optimizer = 'adam', loss = 'mean_squared_error')

# Fitting the RNN to the Training set
history12 = model12.fit(x, y, epochs = 100, batch_size = 32)
```

```
Epoch 1/100
30/30 [==============================] – 12s 76ms/step – loss: 0.0783
Epoch 2/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0246
Epoch 3/100
30/30 [==============================] – 2s 65ms/step – loss: 0.0213
Epoch 4/100
30/30 [==============================] – 2s 72ms/step – loss: 0.0221
Epoch 5/100
30/30 [==============================] – 2s 66ms/step – loss: 0.0179
Epoch 6/100
30/30 [==============================] – 2s 77ms/step – loss: 0.0190
Epoch 7/100
30/30 [==============================] – 2s 70ms/step – loss: 0.0179
Epoch 8/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0158
Epoch 9/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0161
Epoch 10/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0160
Epoch 11/100
30/30 [==============================] – 2s 66ms/step – loss: 0.0160
Epoch 12/100
30/30 [==============================] – 2s 66ms/step – loss: 0.0141
Epoch 13/100
30/30 [==============================] – 2s 66ms/step – loss: 0.0153
Epoch 14/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0153
Epoch 15/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0143
Epoch 16/100
30/30 [==============================] – 2s 77ms/step – loss: 0.0148
Epoch 17/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0143
Epoch 18/100
30/30 [==============================] – 2s 66ms/step – loss: 0.0135
Epoch 19/100
30/30 [==============================] – 2s 72ms/step – loss: 0.0130
Epoch 20/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0116
Epoch 21/100
30/30 [==============================] – 2s 78ms/step – loss: 0.0113
Epoch 22/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0103
Epoch 23/100
30/30 [==============================] – 2s 74ms/step – loss: 0.0116
Epoch 24/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0115
Epoch 25/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0106
Epoch 26/100
30/30 [==============================] – 2s 74ms/step – loss: 0.0101
Epoch 27/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0106
Epoch 28/100
30/30 [==============================] – 2s 66ms/step – loss: 0.0100
Epoch 29/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0100
Epoch 30/100
30/30 [==============================] – 2s 70ms/step – loss: 0.0092
Epoch 31/100
30/30 [==============================] – 3s 85ms/step – loss: 0.0090
Epoch 32/100
30/30 [==============================] – 2s 71ms/step – loss: 0.0090
Epoch 33/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0085
Epoch 34/100
30/30 [==============================] – 2s 66ms/step – loss: 0.0090
Epoch 35/100
30/30 [==============================] – 2s 67ms/step – loss: 0.0082
Epoch 36/100
30/30 [==============================] – 2s 69ms/step – loss: 0.0083
Epoch 37/100
30/30 [==============================] – 2s 68ms/step – loss: 0.0086
Epoch 38/100
```

```
30/30 [==============================] - 2s 71ms/step - loss: 0.0079
Epoch 39/100
30/30 [==============================] - 2s 83ms/step - loss: 0.0078
Epoch 40/100
30/30 [==============================] - 2s 64ms/step - loss: 0.0080
Epoch 41/100
30/30 [==============================] - 2s 66ms/step - loss: 0.0073
Epoch 42/100
30/30 [==============================] - 2s 66ms/step - loss: 0.0072
Epoch 43/100
30/30 [==============================] - 2s 74ms/step - loss: 0.0071
Epoch 44/100
30/30 [==============================] - 2s 78ms/step - loss: 0.0069
Epoch 45/100
30/30 [==============================] - 2s 67ms/step - loss: 0.0077
Epoch 46/100
30/30 [==============================] - 2s 73ms/step - loss: 0.0071
Epoch 47/100
30/30 [==============================] - 2s 70ms/step - loss: 0.0069
Epoch 48/100
30/30 [==============================] - 2s 70ms/step - loss: 0.0073
Epoch 49/100
30/30 [==============================] - 2s 66ms/step - loss: 0.0071
Epoch 50/100
30/30 [==============================] - 2s 67ms/step - loss: 0.0066
Epoch 51/100
30/30 [==============================] - 2s 72ms/step - loss: 0.0064
Epoch 52/100
30/30 [==============================] - 2s 67ms/step - loss: 0.0064
Epoch 53/100
30/30 [==============================] - 2s 80ms/step - loss: 0.0068
Epoch 54/100
30/30 [==============================] - 2s 81ms/step - loss: 0.0071
Epoch 55/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0067
Epoch 56/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0064
Epoch 57/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0057
Epoch 58/100
30/30 [==============================] - 2s 75ms/step - loss: 0.0061
Epoch 59/100
30/30 [==============================] - 2s 81ms/step - loss: 0.0058
Epoch 60/100
30/30 [==============================] - 2s 67ms/step - loss: 0.0058
Epoch 61/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0056
Epoch 62/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0055
Epoch 63/100
30/30 [==============================] - 2s 70ms/step - loss: 0.0055
Epoch 64/100
30/30 [==============================] - 2s 70ms/step - loss: 0.0055
Epoch 65/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0055
Epoch 66/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0054
Epoch 67/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0051
Epoch 68/100
30/30 [==============================] - 3s 83ms/step - loss: 0.0054
Epoch 69/100
30/30 [==============================] - 2s 72ms/step - loss: 0.0053
Epoch 70/100
30/30 [==============================] - 2s 74ms/step - loss: 0.0048
Epoch 71/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0050
Epoch 72/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0048
Epoch 73/100
30/30 [==============================] - 2s 77ms/step - loss: 0.0049
Epoch 74/100
30/30 [==============================] - 2s 75ms/step - loss: 0.0052
Epoch 75/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0056
```

```
Epoch 76/100
30/30 [==============================] - 2s 70ms/step - loss: 0.0053
Epoch 77/100
30/30 [==============================] - 2s 77ms/step - loss: 0.0044
Epoch 78/100
30/30 [==============================] - 2s 70ms/step - loss: 0.0050
Epoch 79/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0045
Epoch 80/100
30/30 [==============================] - 2s 73ms/step - loss: 0.0047
Epoch 81/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0057
Epoch 82/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0045
Epoch 83/100
30/30 [==============================] - 2s 82ms/step - loss: 0.0048
Epoch 84/100
30/30 [==============================] - 2s 73ms/step - loss: 0.0047
Epoch 85/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0051
Epoch 86/100
30/30 [==============================] - 2s 72ms/step - loss: 0.0047
Epoch 87/100
30/30 [==============================] - 2s 75ms/step - loss: 0.0043
Epoch 88/100
30/30 [==============================] - 2s 76ms/step - loss: 0.0049
Epoch 89/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0045
Epoch 90/100
30/30 [==============================] - 2s 73ms/step - loss: 0.0041
Epoch 91/100
30/30 [==============================] - 2s 71ms/step - loss: 0.0043
Epoch 92/100
30/30 [==============================] - 2s 72ms/step - loss: 0.0044
Epoch 93/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0044
Epoch 94/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0043
Epoch 95/100
30/30 [==============================] - 2s 74ms/step - loss: 0.0042
Epoch 96/100
30/30 [==============================] - 2s 69ms/step - loss: 0.0045
Epoch 97/100
30/30 [==============================] - 2s 67ms/step - loss: 0.0043
Epoch 98/100
30/30 [==============================] - 2s 82ms/step - loss: 0.0041
Epoch 99/100
30/30 [==============================] - 2s 78ms/step - loss: 0.0041
Epoch 100/100
30/30 [==============================] - 2s 68ms/step - loss: 0.0045
```

In [95]:
```python
train = df.iloc[:1007, 1:2]
test = df.iloc[1007:, 1:2]
total = pd.concat((train, test), axis=0)
predictor = total[len(total) - len(test) -60:].values  # Changed the sequence length to 54
predictor = predictor.reshape(-1, 1)
predictor = scaler.transform(predictor)
xtest = []
for i in range(60, 312):  # Changed the sequence length to 54
    xtest.append(predictor[i - 60:i, 0])  # Changed the sequence length to 54
xtest = np.array(xtest)
xtest = np.reshape(xtest, (xtest.shape[0], xtest.shape[1], 1))
print(xtest.shape)
```

```
(252, 60, 1)
```

In [97]:
```python
pred9 = model9.predict(xtest)
pred9 = scaler.inverse_transform(pred9)
pred10 = model10.predict(xtest)
pred10 = scaler.inverse_transform(pred10)
pred11 = model11.predict(xtest)
pred11 = scaler.inverse_transform(pred11)
pred12 = model12.predict(xtest)
pred12 = scaler.inverse_transform(pred12)
```

```python
# Visualising the results
plt.figure(figsize=(12, 6))
plt.plot(df.loc[1007:, 'Date'],test.values, color = 'red', label = 'Real TESLA Stock Price' )
plt.plot(df.loc[1007:, 'Date'],pred9, color = 'blue', label = 'Model 9 – 4 layers, dropout = 0.2, batc
plt.plot(df.loc[1007:, 'Date'],pred10, color = 'yellow', label = 'Model 10 – 6 layers, dropout = 0.2,
plt.plot(df.loc[1007:, 'Date'],pred11, color = 'green', label = 'Model 11 – 4 layers, dropout = 0.2, b
plt.plot(df.loc[1007:, 'Date'],pred12, color = 'pink', label = 'Model 12 – 4 layers, dropout = 0.5, ba
plt.xticks(np.arange(0,252,60))
plt.title('TESLA Stock Price Prediction– time lag = 14')
plt.xlabel('Time')
plt.ylabel('TESLA Stock Price')
plt.legend()
plt.show()
```

```
8/8 [==============================] – 0s 39ms/step
8/8 [==============================] – 0s 50ms/step
8/8 [==============================] – 0s 33ms/step
8/8 [==============================] – 0s 52ms/step
```


TESLA Stock Price Prediction- time lag = 14
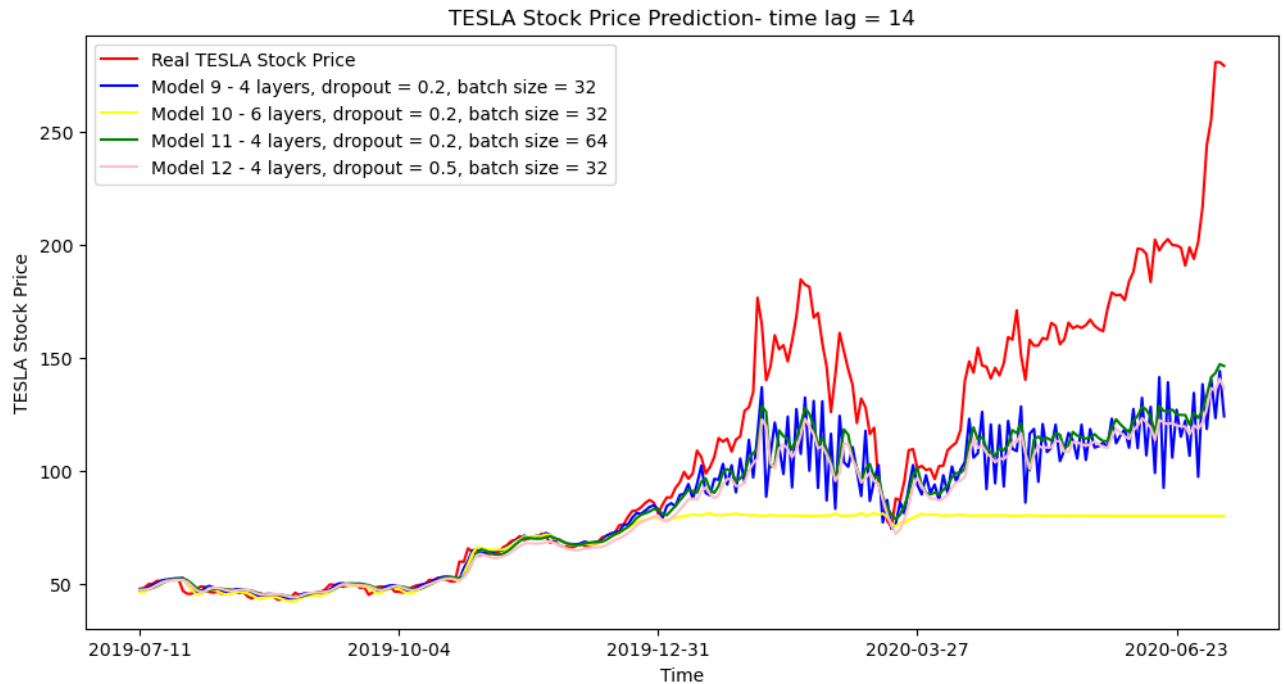
```python
In [146…    # Plot the loss
           plt.figure(figsize=(12, 6))
           plt.plot(history9.history['loss'], label='Model 9 Loss')
           plt.plot(history10.history['loss'], label='Model 10 Loss')
           plt.plot(history11.history['loss'], label='Model 11 Loss')
           plt.plot(history12.history['loss'], label='Model 12 Loss')

           plt.title('Loss Comparison Across Models')
           plt.xlabel('Epoch')
           plt.ylabel('Mean Squared Error Loss')
           plt.legend()
           plt.show()
```

Loss Comparison Across Models
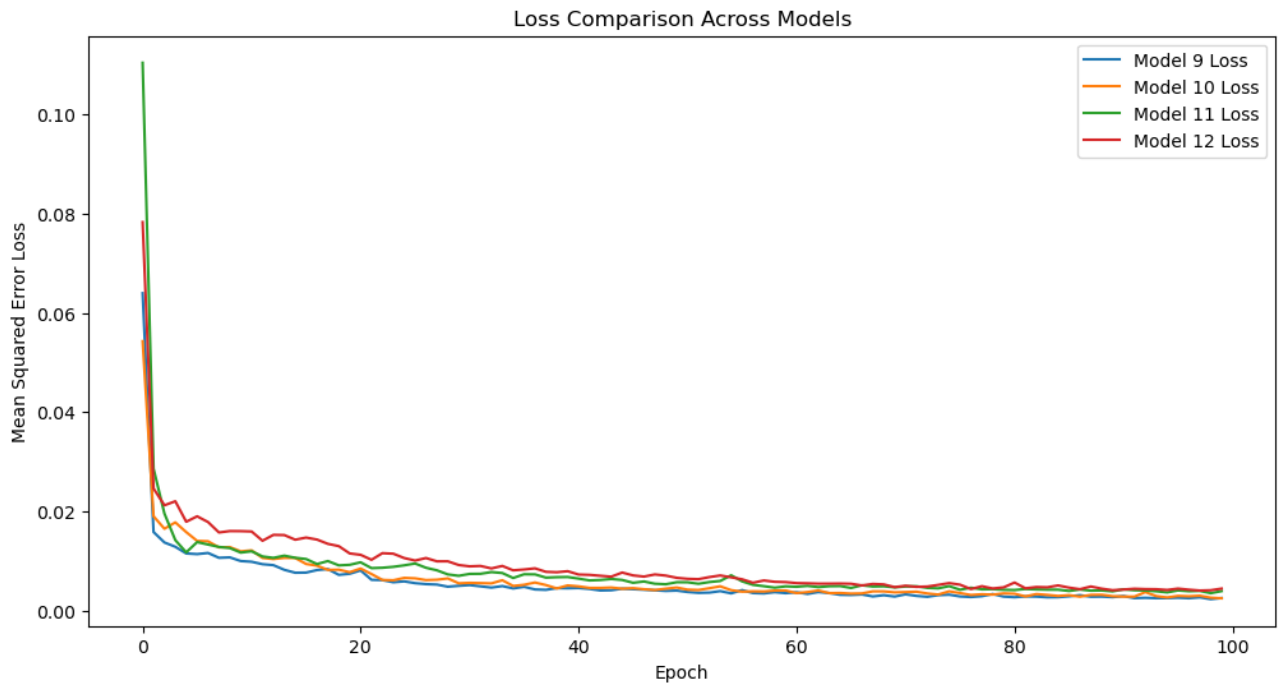

```
In [100…  model9_loss = model9.evaluate(x, y)
          model10_loss = model10.evaluate(x, y)
          model11_loss = model11.evaluate(x, y)
          model12_loss = model12.evaluate(x, y)
          model9loss_arr = np.array(model9_loss).reshape(1,1)
          model10loss_arr = np.array(model10_loss).reshape(1,1)
          model11loss_arr = np.array(model11_loss).reshape(1,1)
          model12loss_arr = np.array(model12_loss).reshape(1,1)
          c_loss_arr = np.vstack((model1loss_arr, model2loss_arr, model3loss_arr, model4loss_arr))
          c_loss_df = pd.DataFrame(c_loss_arr)
          c_loss_df.columns = ["Overall Loss"]
          c_loss_df.index = ["Model 9", "Model 10", "Model 11", "Model 12"]
          c_loss_df
```

```
30/30 [==============================] – 3s 25ms/step – loss: 0.0016
30/30 [==============================] – 5s 40ms/step – loss: 0.0015
30/30 [==============================] – 3s 28ms/step – loss: 0.0024
30/30 [==============================] – 4s 34ms/step – loss: 0.0022
```

Out[100]:

	Overall Loss
Model 9	0.001298
Model 10	0.001605
Model 11	0.001918
Model 12	0.001927

Model 9 is better than other models.

Make predictions for future 1 day, 1 week, two week

```
In [140…  import numpy as np
          from datetime import datetime, timedelta

          start_date = datetime(2020, 7, 9)

          # Predict 1 day ahead with model 3
          future_1_day = model3.predict(xtest)
          future_1_day = scaler.inverse_transform(future_1_day)
          future_1_day_value = future_1_day[-1, 0]

          # Predict 7 days ahead with model 5
          future_7_days = model5.predict(xtest)
          future_7_days = scaler.inverse_transform(future_7_days)
```

```
future_7_days_values = future_7_days[:, 0]
date_values = [start_date + timedelta(days=i) for i in range(7)]

# Predict 14 days ahead with model 9
future_14_days = model9.predict(xtest)
future_14_days = scaler.inverse_transform(future_14_days)
future_14_days_values = future_14_days[:, 0]
date_values = [start_date + timedelta(days=i) for i in range(14)]
```

```
8/8 [==============================] - 0s 41ms/step
8/8 [==============================] - 0s 34ms/step
8/8 [==============================] - 0s 31ms/step
```

1 Day Prediction

In [141…
```
time_indices = np.arange(len(xtest) - 1, len(xtest) + len(future_1_day))
time_indices = time_indices[:500]

plt.figure(figsize=(12, 6))
plt.plot(total[:500], label='Original Data')
plt.plot(time_indices, np.concatenate([total[-1:], future_1_day])[:500], 'r--', label='1 Day Predictio
plt.title('1 Day Prediction')
plt.legend()
plt.show()
```
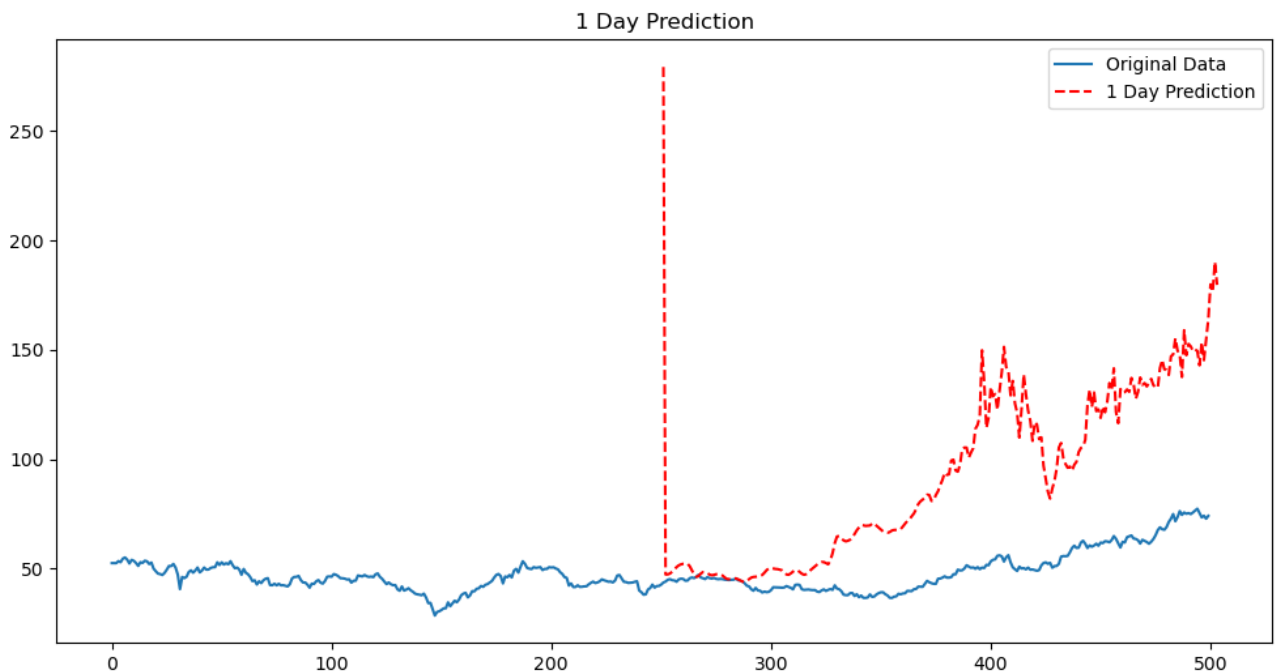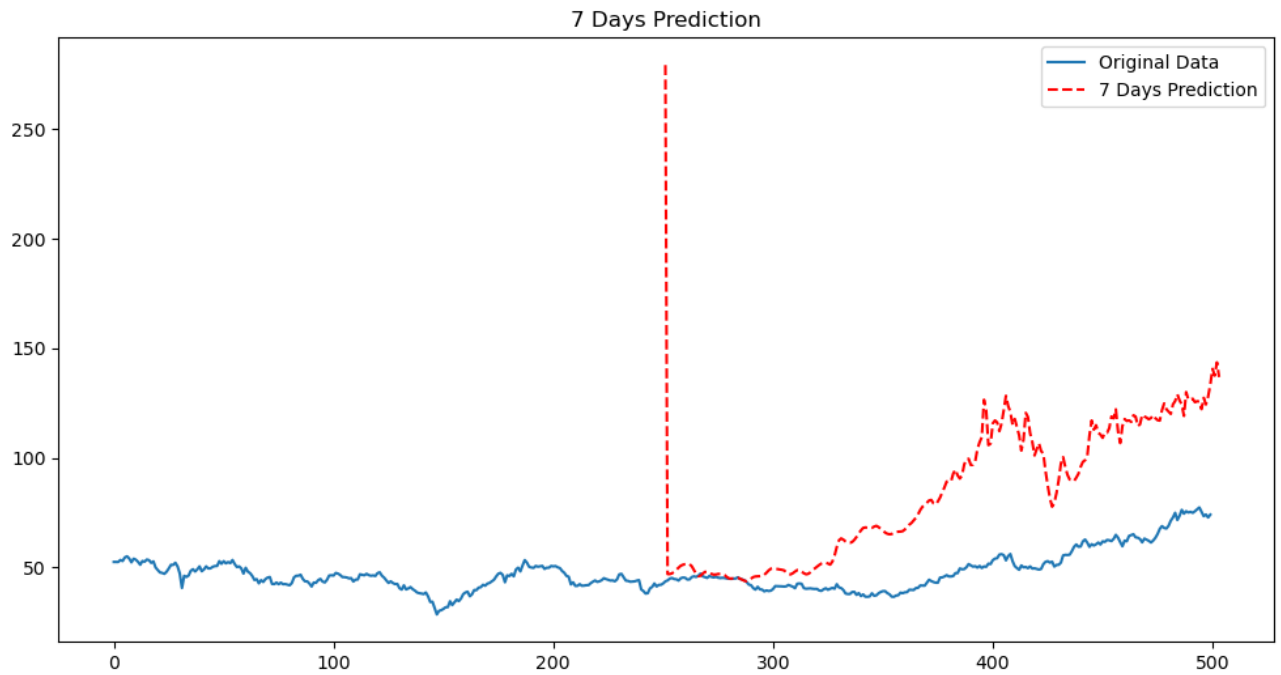

7 Days Prediction

In [144…
```
time_indices = np.arange(len(xtest) - 1, len(xtest) + len(future_7_days))
time_indices = time_indices[:500]

plt.figure(figsize=(12, 6))
plt.plot(total[:500], label='Original Data')
plt.plot(time_indices, np.concatenate([total[-1:], future_7_days])[:500], 'r--', label='7 Days Predict
plt.title('7 Days Prediction')
plt.legend()
plt.show()
```

7 Days Prediction
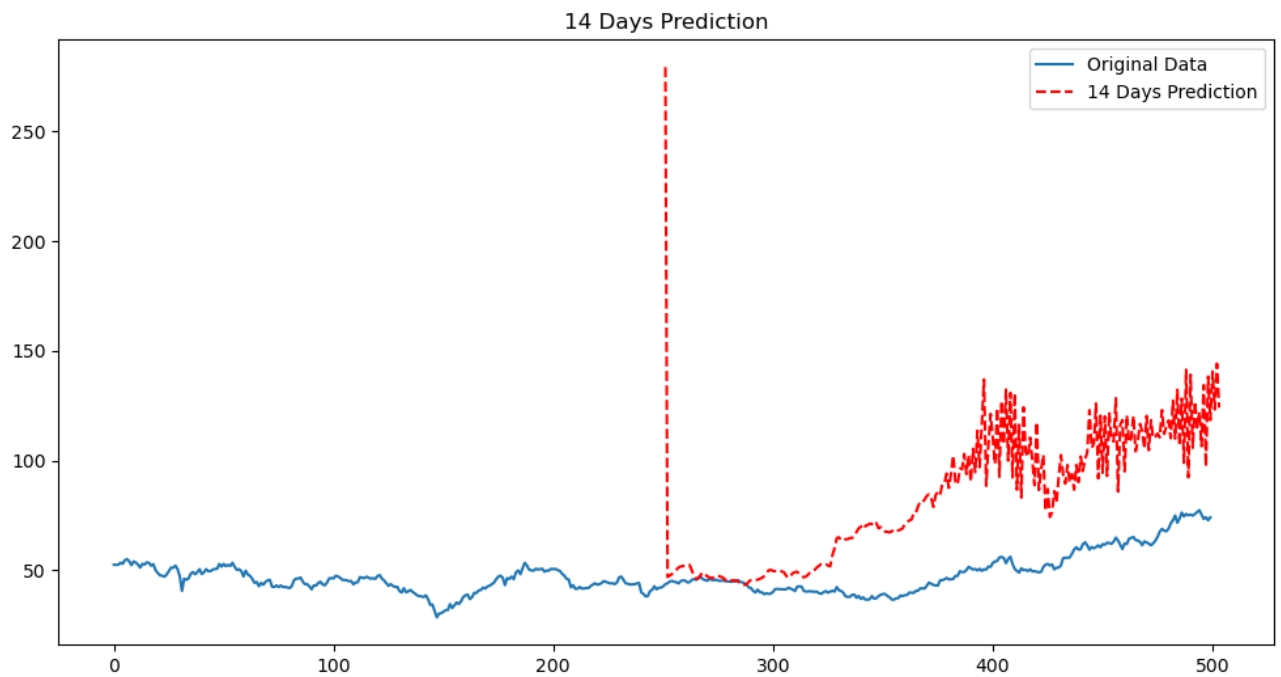

2 Weeks Prediction

```
In [145...  time_indices = np.arange(len(xtest) - 1, len(xtest) + len(future_14_days))
            time_indices = time_indices[:500]

            plt.figure(figsize=(12, 6))
            plt.plot(total[:500], label='Original Data')
            plt.plot(time_indices, np.concatenate([total[-1:], future_14_days])[:500], 'r--', label='14 Days Predi
            plt.title('14 Days Prediction')
            plt.legend()
            plt.show()
```

14 Days Prediction


```
In [ ]:
```