Q. Build a simple linear regression model by performing EDA and do necessary transformations and select the best model using R or Python.

1) Delivery_time -> Predict delivery time using sorting time

1. Import Necessary Libraries

In [1]:

```
import pandas as pd

import matplotlib.pyplot as plt
import seaborn as sns

import warnings
warnings.filterwarnings("ignore")

import statsmodels.formula.api as smf
```

2. Import Data

In [6]:
```
delivery_data = pd.read_csv("E:\Data Science by John\Assignments\Assignment 4- Simple Linear Regression\delivery_time.csv
delivery_data
```

Out[6]:

	Delivery Time	Sorting Time
0	21.00	10
1	13.50	4
2	19.75	6
3	24.00	9
4	29.00	10
5	15.35	6
6	19.00	7
7	9.50	3
8	17.90	10
9	18.75	9
10	19.83	8
11	10.75	4
12	16.68	7
13	11.50	3
14	12.03	3
15	14.88	4
16	13.75	6
17	18.11	7
18	8.00	2
19	17.83	7
20	21.50	5

3. Data Understanding

3.1 Perform Initial Analysis

In [7]:
```
delivery_data.shape
```

Out[7]:
```
(21, 2)
```

In [8]:
```
delivery_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 21 entries, 0 to 20
Data columns (total 2 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   Delivery Time  21 non-null     float64
 1   Sorting Time   21 non-null     int64  
dtypes: float64(1), int64(1)
memory usage: 464.0 bytes
```

In [9]:
```
delivery_data.dtypes
```

Out[9]:
```
Delivery Time    float64
Sorting Time       int64
dtype: object
```

In [10]:
```
delivery_data.head()
```

Out[10]:

	Delivery Time	Sorting Time
0	21.00	10
1	13.50	4
2	19.75	6
3	24.00	9
4	29.00	10

In [11]:

```
delivery_data.isna().sum()
```

Out[11]:

```
Delivery Time    0
Sorting Time     0
dtype: int64
```

In [12]:

```
delivery_data.describe()
```

Out[12]:

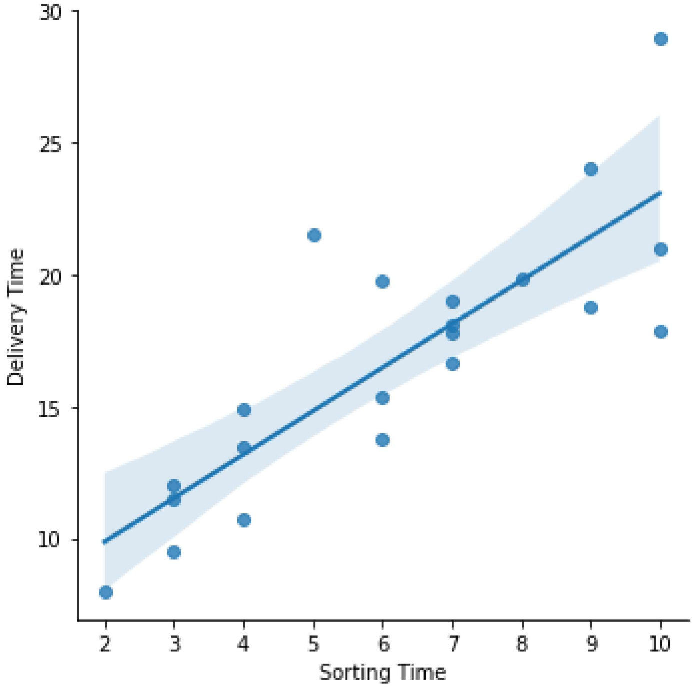
	Delivery Time	Sorting Time
count	21.000000	21.000000
mean	16.790952	6.190476
std	5.074901	2.542028
min	8.000000	2.000000
25%	13.500000	4.000000
50%	17.830000	6.000000
75%	19.750000	8.000000
max	29.000000	10.000000

3.2 Assumptions Check

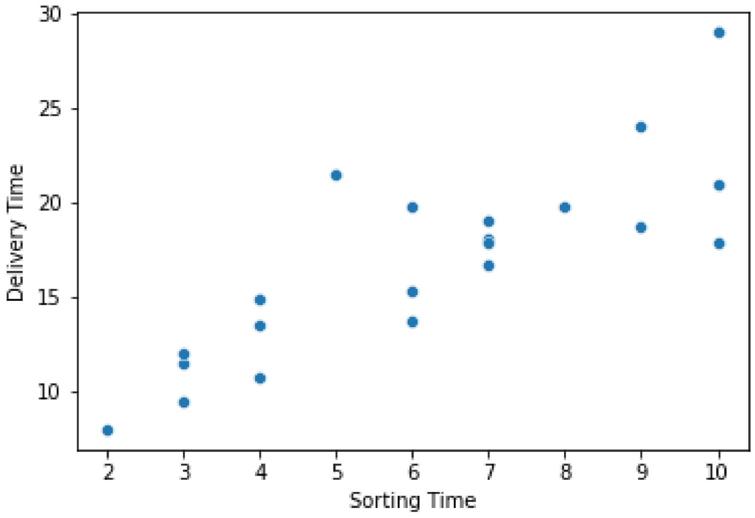
1. Linearity

In [13]:

```
sns.lmplot(x='Sorting Time', y='Delivery Time', data=delivery_data)
plt.xlabel('Sorting Time')
plt.ylabel('Delivery Time')
plt.show()
```



In [14]:
```
sns.scatterplot(x='Sorting Time', y='Delivery Time', data=delivery_data)
plt.xlabel('Sorting Time')
plt.ylabel('Delivery Time')
plt.show()
```



In [15]:
```
delivery_data.skew()
```

Out[15]:
```
Delivery Time    0.352390
Sorting Time     0.047115
dtype: float64
```

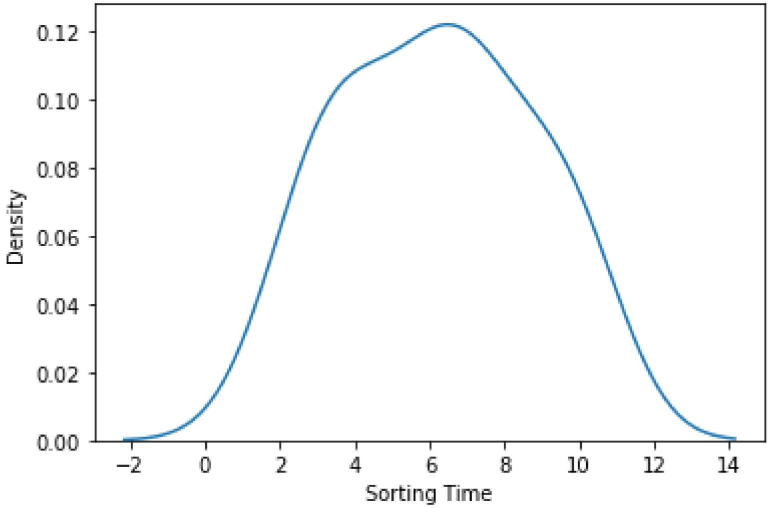
In [16]:
```
delivery_data.kurt()
```

Out[16]:
```
Delivery Time    0.317960
Sorting Time    -1.148455
dtype: float64
```

Linearity test is Failed

2. Normality

In [17]:
```
sns.distplot(a= delivery_data['Sorting Time'],hist = False)
plt.show()
```



Normality test is Failed

3. No Multicolinearity II 4. No Autoregression

These test are passed because we have only one input so No Multicollinearity & We don't have datetime datatype of our data

4. Data Preparation

In [18]:

```
delivery_data.columns = [column.replace(" ","_") for column in delivery_data.columns]
delivery_data.head()
```

Out[18]:

	Delivery_Time	Sorting_Time
0	21.00	10
1	13.50	4
2	19.75	6
3	24.00	9
4	29.00	10

5. Model Building II 6. Model Training

Linear Regression model can be built by using any of the 2 libraries:

1. Statmodels
2. sklearn

Using Statsmodels:

In [19]:

```
linear_model_sm = smf.ols(formula = 'Delivery_Time ~ Sorting_Time', data = delivery_data).fit()
linear_model_sm
```

Out[19]:

```
<statsmodels.regression.linear_model.RegressionResultsWrapper at 0x259a0d6ba60>
```

In [20]:

```
linear_model_sm.params
```

Out[20]:

```
Intercept       6.582734
Sorting_Time    1.649020
dtype: float64
```

7. Model Testing

In [21]:

```
delivery_data.head()
```

Out[21]:

	Delivery_Time	Sorting_Time
0	21.00	10
1	13.50	4
2	19.75	6
3	24.00	9
4	29.00	10

In [22]:

```
Delivery_Time_Pred = linear_model_sm.predict(delivery_data['Sorting_Time'])
Delivery_Time_Pred.head()
```

Out[22]:

```
0    23.072933
1    13.178814
2    16.476853
3    21.423913
4    23.072933
dtype: float64
```

8. Model Evaluation

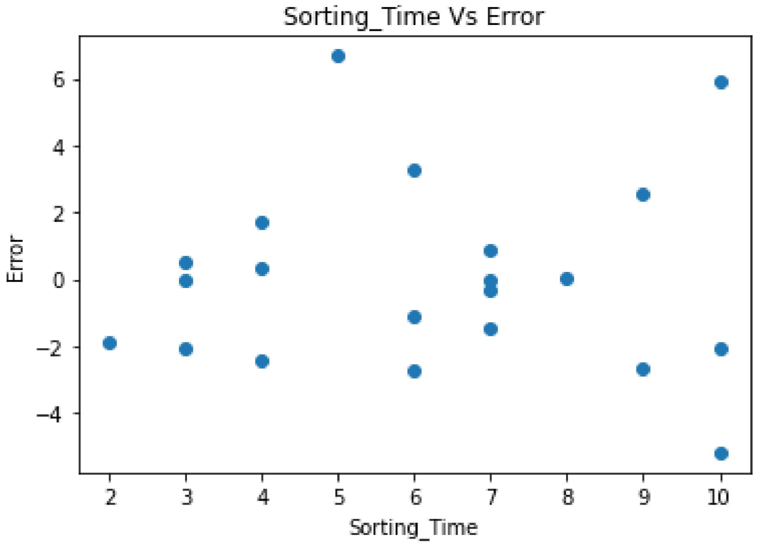
In [23]:
```
error = delivery_data['Delivery_Time'] - Delivery_Time_Pred
error
```

Out[23]:
```
0    -2.072933
1     0.321186
2     3.273147
3     2.576087
4     5.927067
5    -1.126853
6     0.874127
7    -2.029794
8    -5.172933
9    -2.673913
10    0.055107
11   -2.428814
12   -1.445873
13   -0.029794
14    0.500206
15    1.701186
16   -2.726853
17   -0.015873
18   -1.880774
19   -0.295873
20    6.672167
dtype: float64
```

.....back to Assumption Check

5. Homoscedasticity Check

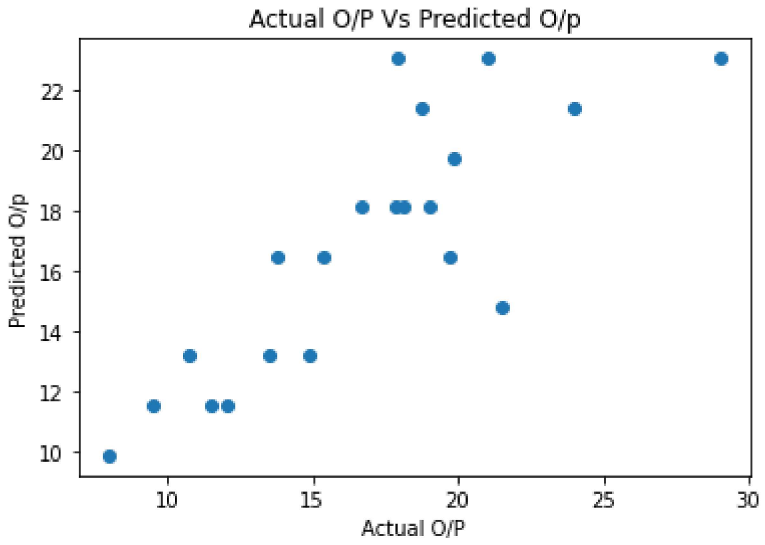
In [24]:
```
plt.scatter(x= delivery_data['Sorting_Time'], y=error)
plt.title('Sorting_Time Vs Error')
plt.xlabel('Sorting_Time')
plt.ylabel('Error')
plt.show()
```



Homoscedasticity Check is Passed

6. Zero Residual Mean across the Fitted Line.

In [25]:
```
plt.scatter(x=delivery_data['Delivery_Time'],y=Delivery_Time_Pred)
plt.title('Actual O/P Vs Predicted O/p')
plt.xlabel('Actual O/P')
plt.ylabel('Predicted O/p')
plt.show()
```



Zero Residual Mean Test is Failed

8.1 Evaluation Metrics of Linear Regression

In [26]:

```
print('R2Score     :',linear_model_sm.rsquared.round(4)) #Overall Contribution of Predictors
print('Adj.R2Score :',linear_model_sm.rsquared_adj.round(4)) #Overall Contribution of Predictors
print('AIC Value   :',linear_model_sm.aic.round(4)) #Error Impurity
print('BIC Value   :',linear_model_sm.bic.round(4)) #Error Impurity
```

```
R2Score     : 0.6823
Adj.R2Score : 0.6655
AIC Value   : 106.714
BIC Value   : 108.803
```

9. Model Prediction

9.1 Manual Prediction

In [28]:

```
linear_model_sm.params
```

Out[28]:

```
Intercept       6.582734
Sorting_Time    1.649020
dtype: float64
```

In [27]:

```
# Manual prediction for sorting time 10
delivery_time = (6.582734) + (1.649020)*(10)
delivery_time
```

Out[27]:

```
23.072933999999997
```

In [29]:

```
# Manual prediction for sorting time 20
delivery_time = (6.582734) + (1.649020)*(20)
delivery_time
```

Out[29]:

```
39.563134
```

9.2 Automatic Prediction using model

In [36]:
```
delivery_data.head()
```

Out[36]:

	Delivery_Time	Sorting_Time
0	21.00	10
1	13.50	4
2	19.75	6
3	24.00	9
4	29.00	10

In [37]:
```
test_data = pd.DataFrame(data = {"Sorting_Time":[10,20]})
test_data
```

Out[37]:

	Sorting_Time
0	10
1	20

In [38]:
```
linear_model_sm.predict(test_data)
```

Out[38]:
```
0    23.072933
1    39.563132
dtype: float64
```